# Booysendal South Expansion Project: Phase 2

Consultation Environmental Impact Assessment Report in support of the applications for Environmental Authorisations; the amendment of an Environmental Management Programme and a Waste Management License for the proposed Booysendal South Expansion Project: Phase 2 in terms of the National Environmental Management Act, No 107 of 1998 and the National Environmental Management: Waste Act, No 59 of 2008

Booysendal North Mining Right Reference No: LP 30/5/1/3/2/1 (188) MR)

Booysendal South Mining Right Reference No: MP 30/5/1/2/3/2/1 (127) MR)

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# 0. Executive Summary

## 0.1 Introduction and Background

Booysendal operates a platinum group metal ("**PGM**") mine ("**Booysendal Mine / Booysendal Operation**") approximately 33km west of Mashishing (Lydenburg), 40km south-southwest of Steelpoort, 32km north of Dullstroom and 21km northeast of Roossenekal. The Booysendal Mine operates under two mining rights ("**MR**"), namely Booysendal North MR (Department of Mineral Resources ("**DMR**") reference number: LP 30/5/1/3/2/1 (188) MR) and Booysendal South MR (DMR reference number: MP 30/5/1/2/3/2/1 (127) MR). The Booysendal South MR was acquired from Aquarius Platinum (Pty) Ltd in 2015. Although the two MRs have not been consolidated, the Booysendal Mine is managed as one integrated operation.

The northern section of the Booysendal North MR falls in the Limpopo Province, while the southern section of the Booysendal North MR and the entire Booysendal South MR falls in the Mpumalanga Province. The operational division for day-to-day management is in accordance with the provincial divide, where the northern section of the Booysendal North MR is managed as Booysendal North ("**BN**") and the southern section (which is a combination of the southern section of the Booysendal North MR and the entire Booysendal South MR) as Booysendal South ("**BS**"). BS consists of "**BS1/2**", the Booysendal South Merensky Adits (referred to as the "**the Adits**" or "**BCM1**" **and** "**BCM2**"), and the old Everest Mine ("**BS4**") which includes the Valley Boxcut.

Booysendal has identified an opportunity to increase PGM production to meet short to medium term projected demands for platinum with the expansion of BS in two phases ("**Booysendal South Expansion Project**" or "**the Expansion Project**"). Phase 1 of the Booysendal South Expansion Project ("**Phase 1 Project**") involved the development of a portal complex at BS1/2, BCM1 and BCM2, upgrade of storm water management measures at BS4 and the Valley Boxcut, reprocessing of the tailings and backfilling of the underground workings at BS4 and linear infrastructure components (road, aerial rope conveyor ("**ARC**") and 132kVA powerline) between the operational areas. An environmental authorisation ("**EA**") for this Phase 1 Project was granted in terms of section 24G of the National Environmental Management Act, No 107 of 1998 ("**NEMA**") on 05 January 2018 ("**Section 24G EA**").

As part of Phase 2 of the Booysendal South Expansion Project ("**Booysendal South Expansion Project: Phase 2**" or "**Phase 2 Project**"), Booysendal plans to develop: portals with surface infrastructure at BCM1 and BCM2; an Emergency Escape Portal; an ARC and water pipelines between BS1/2 and BN; access roads to the ARC towers on the Remaining Extent of the Farm Buttonshope 51JT and Farm Booysendal 43JT; a Backfill Plant with an access road, three process water pipelines, a tailings pipeline ("**Tailings Pipeline**") and three emergency backfill ponds along the Tailings Pipeline at BS4.

It is also proposed to change the position of BCM2 Adit approved in the Section 24G EA on the Remaining Extent of the Farm Buttonshope 51JT to a new position on the Farm Booysendal 43JT. Booysendal also seeks to retain the temporary 11kVA power line that traverses the Remaining Extent of the Farm Buttonshope 51JT permanently. This infrastructure is situated on properties held under the Booysendal North MR and was not included in the Section 24G EA. The Environmental Management Programme ("**EMP**") approved as part of the Section 24G EA ("**Section 24G EMP**") needs to be amended to cater for this.

The Phase 2 Project will be undertaken on the properties held under the Booysendal North and South MRs as reflected in Table 1-2 and Table 1-3, which are collectively referred to as the "**Project Area**". The properties held under the Booysendal North MR are, in turn, collectively referred to as the "**Booysendal North MR Phase 2 Project Area**"; while the properties held under the Booysendal South MR are collectively referred to as the "**Booysendal South MR Phase 2 Project Area**".

The Phase 2 Project, requires the following:

- An application for approval of a substantive amendment to the Section 24G EMP ("**EMP Amendment Application**")**,** in terms of NEMA and the 2014 Environmental Impact Assessment Regulations, published under Government Notice ("**GN**") R982 in Government Gazette ("**GG**") 38282 of 4 December 2014 (as amended under GN 326 in GG 40772 of 7 April 2017) ("**2014 EIA Regulations**");
- Two applications for EA in terms of NEMA and the 2014 EIA Regulations ("**EA Applications**");
- Integrated water use licence ("**IWUL**") application ("**IWULA**") in terms of the National Water Act, No 36 of 1998 ("**NWA**") for the entire Booysendal South Expansion Project;
- A waste management licence ("**WML**") application ("**WMLA**") under the National Environmental Management: Waste Act, No 59 of 2008 ("**Waste Act**") and the 2013 List of Waste Management Activities that have, or are likely to have, a Detrimental Effect on the Environment published under GN 921 in GG 37083 of 29 November 2013 ("**2013 WML Regulations**"); and
- Additional permits such as biodiversity permits that may be required,

  collectively, the "**Phase 2 Project Applications**".

This Consultation EIR has been prepared for Booysendal in support of an integrated WMLA; two EA Applications and one EMP Amendment Application (the "**Phase 2 NEMA and Waste Act Applications**"). This Consultation EIR is the next step in the Phase 2 NEMA and Waste Act Application process, following on the submission of the Final Scoping Report to the Limpopo and Mpumalanga Regional Offices of the DMR, who are the respective Competent Authorities ("**CAs**") for the Booysendal North MR and Booysendal South MR, on 13 April 2018.

## 0.2 Motivation for an Integrated Environmental Authorisation Process

The EA, WMLA and EMP Amendment process for the Phase 1 Project was done as one consolidated, integrated application due to the interconnectivity of Booysendal Mine's activities. This approach provided for a holistic view of the baseline conditions and identification of potential cumulative impacts; and one consolidated set of management measures, which is more practicable to implement.

The same approach has been followed for the Phase 2 Project.

As the Phase 2 Project is situated in both the Limpopo and Mpumalanga Provinces, two separate integrated applications have, however, been submitted to the DMR for the Phase 2 NEMA and Waste Act Applications as follows:

- DMR Limpopo Regional Office - one EA Application and an EMP Amendment Application for the activities on properties held under the Booysendal North MR on 26 February 2018; and
- DMR Mpumalanga Regional Office - the WMLA and one EA Application for the activities on properties held under the Booysendal South MR on 27 February 2018.

Although Booysendal has been engaging with the above DMR Regional Offices as to only one Regional Office being appointed as the CA to approve the Phase 2 NEMA and Waste Act Applications, no feedback to this effect has been received from the DMR up to the point of submission of this Consultation EIR.

Given the interconnectivity of the activities and areas pertaining to the Phase 2 Project, a single, consolidated Final Scoping Report for the Phase 2 NEMA and Waste Act Applications has been submitted to both DMR Regional Offices on 13 April 2018 although the regulated last date for submission was 14 April 2018.

In the Final Scoping Report activities, baseline descriptions and footprint areas relevant to each MR were, as far as possible, described separately. The same principle has been followed in the compilation of this Consultation EIR.

## 0.3 Purpose of the Consultation EIR

This Consultation EIR captures and summarise the findings of the environmental impact assessment ("**EIA**") process undertaken for the Phase 2 Project. The purpose of the Consultation EIR is to provide decision makers, stakeholders and potential Interested and Affected Parties ("**I&APs**") with information that will aid the decision-making process based on the outcome of the EIA. The Consultation EIR provides details of the proposed expansion activities and associated environmental legal requirements; documents the existing baseline conditions; identifies potential impacts which may result from the proposed expansions; provides an assessment of the significance of potential Phase 2 Project impacts, including cumulative impacts of the greater Booysendal South Expansion Project activities (Phase 1 and Phase 2); includes an assessment of Phase 2 Project alternatives; identifies residual impacts after mitigation and recommends management requirements; provides a motivation on the need and desirability of the Phase 2 Project; summarises the findings of the specialist investigations; highlights gaps in information; and ultimately, based on the outcome of the EIA, comes to a conclusion on whether the Phase 2 Project should be authorised and the conditions for such authorisation.

## 0.4 Baseline, Impacts and Management Requirements

This section summarises the most pertinent environmental status quo and socio-economic baseline conditions of the Phase 2 Project. The status quo is based on historic specialist studies and specialist studies undertaken as part of the Phase 2 Project EIA. It also provides a summary of the significant impacts that could result from the Phase 2 Project and requisite management, mitigation and monitoring measures.

### 0.4.1 Topography

#### 0.4.1.1 Baseline

The landscape of the larger Project Area is mountainous, traversed by deep river valleys. The Steenkamps Berge lies to the east, south and west of the Project Area at an elevation of 2 024 metres above mean sea level ("**mamsl**") while the steep sided Groot Dwars River valley traverses the Project Area from south to north.

Booysendal North MR:

The Phase 2 Project activities pertaining to the Booysendal North MR (BCM1, BCM2, the Emergency Escape Portal, BS1/2 to BN ARC and three water pipelines and 11 kVA power line) are located in the Groot Dwars River valley at an elevation of approximately 1 052 mamsl.

Booysendal South MR: BS4 is located on a plateau to the east of the Groot Dwars River valley at an elevation of approximately 1 780 mamsl.

#### 0.4.1.2 Topography Impacts

Booysendal North MR:

The natural topography will be changed through excavations and infilling required for the establishment of the terraces and surface infrastructure at BCM1 and BCM2. These changes will result in a change of the natural run-off and flow paths.

The geomorphology of the area may also change if the development leads to an increase in erosion and associated sedimentation.

Booysendal South MR:

The significance of topographical changes at BS4 is expected to be low and will mainly be limited to the Backfill Plant and above ground pipelines.

#### 0.4.1.3 Topography Mitigation and Management

Booysendal North MR and Booysendal South MR:

Footprint areas must be limited and concurrent rehabilitation during construction to mimic the natural topography. Erosion control measures must be put in place, including energy dissipaters and silt control measures.

### 0.4.2 Climate

The Project Area is located in a temperate climate region, with warm summers and cold winters. Average temperatures for the Project Area ranges between 9.5˚C and 22.9˚C. Snow and frost is uncommon.

Rainfall occurs between October and March and is usually in the form of intense thunderstorms, resulting in large volumes of run-off into the Groot Dwars River valley. Evaporation (1 756.3mm/a) exceeds rainfall (730mm/a), making it a water deficit Project Area.

On a macro-level, south-easterly winds are dominant, while winds on a micro-level are mainly topographically induced due to the steep topography, leading to anabatic and katabatic winds. Winds during the day flows out of the valley and during the night into the valley and down in a northerly direction.

#### 0.4.2.1 Climate Change

The Phase 2 Project will have a negligible impact on climate change. The Phase 2 Project is a water positive project, thereby limiting the need for make-up water and optimising the re-use of water. Long term climate change should therefore not have a significant impact on the Phase 2 Project.

#### 0.4.2.2 Climate Mitigation and Monitoring

Different water conservation strategies must be investigated as part of the final Phase 2 Project design and the re-use of water must be optimised.

### 0.4.3 Air Quality

#### 0.4.3.1 Baseline Air Quality

Booysendal has an existing air quality monitoring programme in place for the Booysendal Mine. Results from the monitoring campaigns indicate that ambient air quality for dust outfall mainly falls in the residential air quality limit of 600mg/m²/day. This limit was exceeded twice during 2015 at BN and once in 2016 at BS4.

Emission sources including sources of $CO_2$ , Co, C, $SO_2$, volatile organic compounds ("**VOCs**"), ammonia as $NH_3$ and NO from vehicles, agricultural fertilizers, pesticides, manures, biomass burning and industrial emissions in the wider area of influence ("**AoI**") were determined to be negligible.

Potential receptors which could be impacted by dust outfall and emissions are restricted to the communities to the east and farmers directly to west of the Project Area.

#### 0.4.3.2 Air Quality Impact Assessment

During the air quality impact assessment, the potential increase in particulate emissions from the Booysendal South Expansion Project (Phase 1 and Phase 2) and dust outfall was modelled through AERMOD, using the Phase 2 Project emissions factor and calculated anticipated particulate emissions. The outcome of the dispersion model indicated that unmitigated, the dispersion of particulates should not reach any of the sensitive receptors, although dispersion of emissions from the Phase 2 Project will get close to sensitive receptors. Assuming only 50% of the dust and emissions mitigation measure will be implemented, the dispersion will be reduced to within the Project Area, and mainly within the Groot Dwars River Valley. Dust deposition will follow the direction of the Valley, with deposition mainly occurring along the Valley in a northerly direction. The model indicated that none of the sensitive receptors will be affected by dust deposition.

The separate greenhouse gas emissions ("**GHG**") calculation was also carried out as part of the Phase 1 Project using the emissions factors for $NO_2$, $CO_2$ and $CH_4$ to obtain an indication of the extent the Booysendal South Expansion Project could contribute to climate change. The Booysendal Mine will likely be responsible for emissions of Scope 1 carbon equivalents of not more than approximately 19 500 tons per year. At the current assumed carbon tax rate of R120 per ton, this may result in a tax liability of not more than R2 340 000 per year. However, with offsets and other rebates, this amount per ton should be drastically reduced to between R6 and R40 per ton, or a potential liability of between R43 000 and R286 720.

Carbon tax legislation regulating carbon tax calculations is, however, still being developed and the figures above are indicative only.

#### 0.4.3.3 Air Quality Mitigation and Management

Summary of required mitigating and management measures include:

- Dust suppression on open areas during construction and decommissioning through wet suppression, chemical supernatants, vegetation cover, wind breaks etc.;
- Implementation of the dust suppression plan included in the EMP; and
- Expansion of the current dust monitoring network at BS4 and BN and undertaking trend analysis of dust monitoring results to determine if additional management measures are required.

The following measures are applicable to the Booysendal North MR Activities only:

- Enclose the crusher plant at BCM1 and BCM2;
- Ensure that hoods with filters area installed at the crushers;
- Provide dust suppression at the conveyors; and
- Design and construct the ARC chute to include dust suppression to stop any mobilisation of dust.

The dust outfall monitoring network must be expanded and $PM_{10}$ must be added to the monitoring campaign.

### 0.4.4 Surface Water

#### 0.4.4.1 Surface Water Baseline

The Project Area falls in quaternary catchment B41G of the Olifants Water Management Area ("**WMA**"). The main river systems in the quaternary catchment is the Groot Dwars River which has a mean annual run-off of 66mm/a. The main tributaries of the Groot Dwars River in the Project Area are the Waterfall tributary at Booysendal North MR and the Everest and Kafferspruit draining from BS4 from where it flows into the Groot Dwars River. Various perennial and non-perennial streams and springs originate in the higher laying areas surrounding the Groot Dwars River valley, contributing to drainage and runoff to the Groot Dwars River. Some of these springs and streams are used for domestic and livestock purposes.

The Groot Dwars River is classified as a Freshwater Ecosystem Priority Area ("**FEPA**") due to its near pristine nature, good water quality and aquatic biodiversity. The recommended buffer of the for FEPA systems is 1km (DEA "Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector" 2013) .

Water quality of the Groot Dwars River is near pristine in the upper reaches but deteriorates as it flows past the various mining operations. Elements of concern are nitrate, electric conductivity ("**EC**") and total dissolved solids ("**TDS**") with some concern around the potential leachability of chromium.

Potential sensitive surface water users include the communities and farmers directly to the east of the Project Area. The natural environment is classified highly sensitive in terms of species and habitat integrity and are therefore also considered a sensitive receptor.

#### 0.4.4.2 Surface Water and Hydrology Impact Assessment

General:

The water and salt balance indicated that there is an increase in salt loads further downstream in the Groot Dwars River. The cumulative impacts on water quality are placing increased cumulative pressure on the system and the aquatic biodiversity.

Booysendal North MR:

Both BCM1 and BCM2 are located within 100m of several drainage lines. Any contamination resulting from BCM1 and BCM2 e.g. polluted water, spillages from the pollution control dams ("**PCDs**") or discharge of process water or effluent will lead to cumulative negative impacts on the surface water of the Groot Dwars River system.

BCM1 will lead to the undermining of the Waterfall tributary which serves as habitat to the *Enteromius obivata* subs. *Motebensis*, which is internationally vulnerable and which have an extremely restricted habitat range.

BCM1 and BCM2 surface infrastructure, access roads, ARC towers and associated water management infrastructure could influence the volume of run-off flowing into the natural system. A reduction in run-off or increase in flow velocity could cumulatively impact on the aquatic environment.

Erosion and siltation of exposed areas in turn could lead to increased silt loads in the riparian wetlands and Groot Dwars River system.

Booysendal South MR:

Impeding and temporary diverting the flow of water in the Everest wetland to install the MCC1 PCD to return water dam ("**RWD**") process water pipeline.

Spillages from the process water and slurry pipelines could impact negatively on water quality, the Everest tributary and associated wetland system.

#### 0.4.4.3 Surface Water Mitigating and Management Requirements

Booysendal North MR:

- Clean and dirty water diversion channels upstream of the BCM1 and BCM2 Portals must be put in place prior to construction of other components commences;
- Clean and dirty water infrastructure must be designed to accommodate a 1:100-year flood event due to its location within a FEPA system;
- All dirty water infrastructure must be operated to maintain a 0.8m freeboard as a minimum, especially during flood events and preferably be operated as empty;
- Cut-off trenches must be installed at the workshops and any dirty water areas which poses a risk to the environment. Water from these infrastructures must be contained and either reused in the process or disposed of at a licensed facility;
- Cut-off trenches, oil sumps and oil separators must be cleaned regularly and maintained not to cause spillages into the environment;
- Design of diversion of the potentially affected non-perennial Waterfall tributary must be done though consultation with an aquatic specialist and approved by the Department of Water and Sanitation ("**DWS**");

- All water bearing structures which may result from the non-perennial drainage line and which may cause inflow into the underground workings must be sealed off;
- Watercourses must be avoided; and
- The surface water monitoring network must be expanded up and downstream of the Booysendal North MR Phase 2 Project activities.

Booysendal South MR:

- Encasing of the slurry pipeline where it crosses the Everest tributary;
- Construction of emergency backfill ponds and diversion trench close to where the slurry pipeline crosses the Everest tributary to ensure that any spillage is captured and diverted away from sensitive water resources;
- All pipelines must be provided with flow meters and emergency stops to allow for the timely identification of leaks and to ensure that the flow can be immediate stopped; and
- Storm water management and erosion control measures must be put in place.

## 0.4.5 Geology

The general geology of the Project Area comprises of medium-grained anorthosite, norite and Gabbro of the Dwars River Sub-suite of the Rustenburg Layered Suite of the Bushveld Complex. The Upper Group 2 ("**UG2**") and Merensky Reef are contained within this Layered Suite and outcrops on the surface with a north / south strike direction on the Farms Booysendal 43JT, Buttonshope 53JT and Sterkfontein 51JT. The main economic horizons in this Southern Upper Critical and Main Zones are the PGMs located in the Merensky Reef and the underlying UG2 Chromitite Reef.

There are two major geological faults in the Project Area. The first major fault is the east-west stretching St. Georges fault. This fault has a down-throw of an unknown quantity towards the east, and stretches from east to west underneath the Groot Dwars River. The second is a graben structure, with a down-throw of 100m. There are also approximately 165 geological structures in the Project Area, mainly with north-northeast and north-northwest strike directions.

At BS4 structural geology shows the presence of several significant regional geological structures that could act as preferential flow paths for groundwater. Several dolerites, diabase and syenite intrusions form dykes that intersect the area.

Towards the south of BS1/2, the geological structure is extremely complex with development of several synforms and antiforms.

### 0.4.5.1 Geology Impacts

Booysendal North MR and Booysendal South MR: Non-competent geology can lead to instability, failure and loss of life.

### 0.4.5.2 Geology Mitigation and Management

Competency of the rock must be assessed throughout the Life of Mine ("**LoM**").

## 0.4.6 Groundwater

There is a strong correlation in the topography and the depth of groundwater with shallower groundwater at the higher lying areas and deeper groundwater in the valley areas. There are two main aquifers in the Project Area:

- An upper weathered aquifer, with a depth varying between surface to 20 metres below ground level ("**mbgl**"), and which provides groundwater to surrounding communities. Due to the near-surface contact of the aquifer numerous springs arise, which are used for drinking purposes. The aquifer also contributes to recharge of surface water resources. Any contamination of this aquifer could result in contamination of the surface water resources.
- A deep fractured rock aquifer, which is associated with secondary fracturing forming discrete pathways along the fractures. Groundwater levels vary between 40 to 50mbgl.

An analysis of the chemical character of the groundwater indicates dynamic water which has recently been recharged.

A hydro-census was carried out to determine the location of groundwater resources, groundwater users and the quality of the groundwater in the area surrounding the Phase 2 Project. Recharge of groundwater within the hard host geology is less than 0.03m/day, while recharge in the fractured zones is more than 0.1m/day. The average annual recharge of groundwater in the Phase 2 Project groundwater catchment is approximately 28.754Mm$^3$, while groundwater use by surrounding communities equates to a calculated volume of 8 760m$^3$/annum.

The groundwater quality is generally within the SANS241:2015 drinking water standards. Nitrate levels associated with some of the underground working or mine waste (e.g. tailings storage facility ("**TSF**"), waste rock dumps ("**WRD**")) at times exceed the SANS241:2015 limits. This is especially applicable to seepage from the TSF1 at BS4 and some decanting which occurs at the Valley Boxcut area.

Potential sensitive groundwater users include four farmers within 2km and four communities within 3km from the existing BS4 TSF1.

#### 0.4.6.1 Hydrogeology Impacts

The most significant impacts on groundwater which could result from the Phase 2 Project activities include:

<u>Booysendal North MR:</u>

- Reduction in surface water levels as a result of inflow of water into the underground workings;
- Formation of a contamination plume especially related to nitrates which could impact on the groundwater quality; and
- Decant of groundwater of which the quality is affected by underground mining.

<u>Booysendal South MR:</u>

- Seepage from the backfill material which can lead to a deterioration in groundwater quality and decant of contaminated groundwater at the Valley Boxcut. This could impact on availability of groundwater resources to surrounding communities.

#### 0.4.6.2 Mitigation and Management

<u>Booysendal North MR</u>:

- Sealing of inflow paths from the surface tributaries; and
- Additional up-and down gradient groundwater monitoring points.

<u>Booysendal South MR</u>:

- Monitoring groundwater quality through additional boreholes; and
- Updated the groundwater model every two years.

## 0.4.7 Geochemistry

### 0.4.7.1 Geochemistry Baseline

Geochemical analysis was undertaken on the ore body, waste rock and the tailings to determine the potential for the formation of acid mine drainage ("**AMD**") and leachate of mineral elements.

Geochemical analysis indicates that the tailings and ore bodies at the Phase 2 Project Area are not acid generating. Leachate results showed exceedances in LCT0 values only for chromium, antimony and vanadium. Indicating that these elements could leach out of the tailings.

### 0.4.7.2 Geochemistry Impact Assessment

Should leachate occur from the backfilling operation, potential sensitive receptors (humans and the aquatic) downstream in the Groot Dwars River catchment could be exposed to higher than drinking water quality standards of chromium.

### 0.4.7.3 Mitigation and Monitoring

Any decant resulting from the Backfill Plant area must be monitored on a monthly basis. Trend analysis of water quality especially chromium, antimony and vanadium is essential. The groundwater model must be updated bi-annually.

## 0.4.8 Terrestrial Ecology

### 0.4.8.1 Flora

The Phase 2 Project is located in the Sekhukhune Centre of Plant Endemism ("**SCPE**"), listed as an endangered ("**EN**") ecosystem under GN 1002 of 9 December 2011 and as a Priority Zone for conservation initiatives by the South African National Botanical Institute ("**SANBI**")**.** In terms of the Mpumalanga Biodiversity Sector Plan and the Limpopo Conservation Plan, the Booysendal North MR Phase 2 Project activities fall in a Critical Biodiversity Areas ("**CBA**"). The Project Area is rich in biodiversity, consists of 16 floral communities and 80 conservations important ("**CI**") flora taxa, of which two Vulnerable ("**VU**") and several Near Threatened ("**NT**"), has been recorded in the Project Area. Several CI species were identified in the proposed infrastructure footprint areas.

The Booysendal South MR Phase 2 Project activities will mainly take place in areas previously disturbed by mining.

Alien vegetation is present in disturbed areas around the Phase 1 Project Area and in the BS4 area is of concern.

### 0.4.8.2 Flora Impacts

<u>Booysendal North MR</u>:

Floral impacts associated with the Booysendal North MR Phase 2 Project Area include permanent destruction and extensive fragmentation of undisturbed and unique floral communities, which provide critical habitat for certain locally endemic and threatened plant and animal taxa. Of particular concern is the sensitive location of the proposed Emergency Escape Portal, the large combined extent of the BCM1 and BCM2 areas, and the linear extent of the proposed ARC with its access roads, and the proposed pipelines adjacent to the dirt service road alongside the Groot-Dwars River.

These activities will affect High CI *Lydenburgia-Vitex-Kirkia* Rocky Thicket, *Fauria-Combretum-Halleria* Riparian Vegetation and *Aloe-Myrothamnus-Xerophyta* Sheet Rock, and Moderate-High CI *Acacia-Euclea-Hippobromus-Scolopia* Thicket, *Acacia caffra-Ozoroa-Tristachya* Eastern Slope Grassland and *Loudetia-Themeda* Western Slope Grassland. Affected CI habitats will include e.g. the Groot-Dwars River, its “North

Waterfall" tributary and other smaller drainage lines, riparian vegetation, sheet rock and *Vitex obovata wilmsii* trees (used by the *Pycna sylvia* cicada).

Booysendal South MR:

The only area of concern at BS4 is the two river crossings over the sections of the wetland.

#### 0.4.8.3 Flora Mitigation and Management

Booysendal North MR:

- The Emergency Escape is located in an area of high CI, therefore the location must be moved;
- Avoid areas with high and moderate-high CI vegetation;
- Make use of existing access roads, avoid habitat fragmentation and confine development areas; and
- Residual impacts associated with the Phase 2 Project must be mitigated through like for like offset of the affected reach of the Groot Dwars River valley.

Booysendal South MR:

- Disturbance to wetland vegetation must be minimised and where disturbed wetland rehabilitation must be implemented.

Booysendal North MR and Booysendal South MR:

- Alien vegetation must be removed and an alien and invasive management programme be put in place.

#### 0.4.8.4 Fauna Baseline

The Project Area is very rich in fauna and several threatened and protected species declared in terms of Section 56(1) of the National Environmental Management: Biodiversity Act, No 10 of 2004 ("**NEMBA**") and listed in terms of Regulation GG 587 of 31 March 2015 occur within the Project Area.

A total of 23 CI species over all fauna groups have been recorded in the Project Area. A total of 46 mammal species, 321 bird species, 24 reptile species, 7 frog species, 64 butterflies, 27 dragonflies, 4 scorpions and 4 baboon spider species have been recorded in the Project Area. The Groot Dwars River valley also serves as habitat for the *Pycna sylvia*, previously thought to be extinct.

#### 0.4.8.5 Fauna Impact Assessment

Booysendal North MR:

- There is a CI Golden Mole population in areas next to proposed BS1/2 to BN pipeline route along the Groot Dwars River and the CI Flat Lizard is present in the BCM1 and BCM2 areas. Several other CI species also migrate n the Project Area;
- Destruction and encroachment onto the *Pycna sylvia* habitat; and
- Habitat fragmentation, creation of migration barriers and loss of CI habitat.

#### 0.4.8.6 Fauna Mitigation and Management

- Not enough data is available to understand the breeding habits, life cycle and behaviour of the *Pycna sylvia* therefore additional research is required. A buffer zones is also required around the *Vitex obovate subs, wimsii* in the Phase 2 Project AoI which must not be compromised; and encroachment and fragmentation of this habitat must be avoided;

- Offset of the *Vitex obovate* subs, *wilmsii* must form part of the offset calculations for the Phase 2 Project. The offset calculation must include the compromised *Vitex obovate* subs, *wilmsii* conservation area at BN;
- The purchase or donation and legal protection of offset for the residual impacts associated with the Phase 2 Project activities to ensure that all residual impacts are offset in accordance with the 1:30 ratio to be applied in provincial Irreplaceable CBA, as stipulated in the draft Offset Policy; and
- Demarcate footprint areas to the absolute minimum and avoid any border encroachment.

#### 0.4.8.7 Aquatic Biodiversity Baseline

The Ecological Importance ("**EI**") and Ecological Sensitivity ("**ES**") of the sub-quaternary reach of the Dwars River within the study area (B41G-721), is classified it to be of HIGH EI and VERY HIGH ES (DWS 2013). One vulnerable International Union for Conservation of Nature ("**IUCN**") Red-Listed fish species (IUCN 2016), namely *Enteromius obevata* subs *motebensis*, is known to be present within the Groot Dwars River and the upper reaches of the Everest tributary.

Moving from south to north, the Present Ecological Status ("**PES**") of the Phase 2 Project catchment areas varies from pristine, to moderately modified, to largely modified as the impacts of mining activities influences water regimes. The ES of the Project Area's sub-catchment is very high, which can be attributed to a variety of factors, including the very high levels of sensitivity of the expected fish and aquatic macroinvertebrate communities to flow modifications and impacts on water quality.

The Groot Dwars River upstream of BS1/2 constitutes critical habitat for the *Enteromius obevata* subs *motebensis*. This species is currently listed as VU on the International Union for Conservation of Nature Red List of Threatened Species. The river system is also habitat to six fish species, which are intolerable to change in water quality or flow.

#### 0.4.8.8 Aquatic Biodiversity Impact Assessment

<u>Booysendal North MR and Booysendal South MR</u>:

- Contaminants leading to a decrease in water quality impacting on aquatic species sensitive to change;
- Loss in *Enteromius obevata* subs *motebensis* numbers and habitat; and
- Change in the flow characterises due to unnatural flow or flow reduction impacting on species sensitive to flow change.

#### 0.4.8.9 Aquatic Biodiversity Mitigating and Management

<u>Booysendal North MR and Booysendal South MR</u>:

- Location of infrastructure and activities within 100m or within the 1:100-year floodline must be avoided;
- Storm water management and erosion control must protect the aquatic environments;
- Aquatic impacts from Phase 2 Project must be included in the overall offset strategy and must be agreed with the CAs. The offset must include the identification of pristine to largely pristine like for like catchments which will be formally conserved, preferably the upstream catchment of the Groot Dwars River;
- Rehabilitation of the upper Everest stream must form part of the management and need to include removal of alien and invasive species, removal of predatory fish species and rehabilitation of the wetlands;

- Culverts and stream crossings must be designed not to cause any pooling, flow modifications or migration barriers to aquatic species;
- All dirty water infrastructure and pipelines must be HDPE lined;
- Toxicity testing as part of the water monitoring programme needs to be extended to new PCDs;
- The habitat of the *Enteromius cf. motebensis* must be protected;
- Activities in reaches of rivers and streams classified as having a VERY HIGH sensitivity should be avoided;
- The recommended buffer for FEPA rivers are 1 km. A buffer must be agreed with DWS;
- Biodiversity monitoring should continue in according to the existing monitoring programme, while new monitoring sites must be added to cover the Phase 2 Project; and
- The Booysendal Mine biodiversity management and action plan must amended to include and management measures to protect and conserve the *Enteromius cf. motebensis* throughout the LoM.

### 0.4.9 Wetlands

#### 0.4.9.1 Wetland Baseline

There are five types of wetlands in the Project Area. Most of the wetlands are unmodified and in a natural condition, with a PES of between B and C.

#### 0.4.9.2 Wetland Impact Assessment

<u>Booysendal North MR:</u> The linear infrastructure components (the 11kVa powerline and the ARC) cross several wetlands and the 11kVa powerline impacts directly on the Groot Dwars River riparian wetland. The BCM1, BCM2 terraces and Emergency Escape Portal fall outside of any delineated wetlands.

<u>Booysendal South MR – BS4</u>: The slurry and MCC1 PCD to RWD process water line crosses the riparian wetland of the Everest tributary. The MCC1 to RWD pipeline will lead to direct disturbance of the wetland while the slurry pipeline will only lead to indirect impacts in the event of spillages.

#### 0.4.9.3 Mitigation and Management

<u>Booysendal North MR:</u>

- Disturbance of wetland areas must be avoided. Linear infrastructure components must be developed outside of wetlands.

<u>Booysendal South MR</u>:

- Disturbance of the wetland must be avoided and where it can't be avoided the shortest crossing must be used. No excavations must be made in the wetland and no vehicles of machinery must be allowed in the wetland. Any wetland disturbance must be rehabilitated.

### 0.4.10 Soil, Land Use and Land Capability

The soil, land use and land capability assessment was carried out for the Booysendal South Expansion Project (Phase 1 and Phase 2).

#### 0.4.10.1 Soil, Land Use and Land Capability Baseline

The soil forms in the Project Area are very complex and is made up of 18 soil forms. Due to the topography of the Project Area, the soil forms are highly variable. In the flatter areas soil forms are dominated by clay-loams, with a weak to moderate structure. These soils are suitable for agricultural production. The hill slopes contain young soils characterised by shallow, rocky lithic soils. The soils in the area are generally susceptible to erosion when disturbed. Hydromorphic soils are present next to the Groot Dwars River and Everest tributary.

#### 0.4.10.2 Soil, Land Use and Land Capability Impact Assessment

The most significant impacts which may result from the Phase 2 Project include:

- Loss of soil capability, change in land use, chemical properties and supporting ES due to stripping of soil in footprint areas, topsoil stockpiling and mine infrastructure;
- Soil erosion due to exposure of soils; and
- Chemical soil contamination from hydrocarbon and ore spillages.

#### 0.4.10.3 Soil, Land Use and Capability Mitigation and Management

- Sensitive soils and no-go areas must be avoided;
- All bare soil surfaces must be covered by either vegetation or geotextiles to prevent future soil erosion;
- Disturbance outside planned mining footprint will leads to increased compaction and soil layer inversion and must be avoided; and
- The soil management plan prepared as part of the soil study must be adhered to.

### 0.4.11 Cultural Heritage

#### 0.4.11.1 Cultural Heritage

The Project Area is very rich in cultural heritage sites from the Middle Iron Age, Middle Stone Age to historic sites. Graves can be expected anywhere in the landscape. Several cultural-historic sites have been demarcated as a result of previous cultural heritage studies. The palaeontological Project Area is not expected to contain any palaeontological finds.

<u>Booysendal South MR</u>:

There are no cultural heritage sites at any of the footprint areas.

<u>Booysendal North MR</u>:

This section contains a description of the heritage sites within the Booysendal North MR area and the required mitigation and management.

There are four sites in the footprint area of the Emergency Escape Portal which will be impacted if the position of the Portal is not moved. These sites include feature 5, 6, 7, 31, 66 and 68. The sites fall in an area of approximately 65 x 60m.

- Feature 5: a small historic midden or kraal deposit of low to medium significance. The feature includes some slag, undecorated and decorated ceramics;

  Required mitigation and management: excavations through a Heritage Phase 2 Assessment or move location of Emergency Escape Portal;

- Feature 6: a stone cairn site consisting of stone dressed features. The purpose or the site is unknown and could potentially be a grave site due to the north-south orientation thereof. Should this be a grave, the significance of the anticipated impact is high;

Required mitigation and management: the site must not be disturbed and must be retained in-situ or move location of Emergency Escape Portal;

- Feature 7: is a large communal grinding area of low to medium significance. There is the possibility that the site may be underlain by subsurface Iron Age remains;

Required mitigation and management: Heritage Phase 2 Assessment mapping and excavations or move location of Emergency Escape Portal;

- Feature 31: various stone-packed terrace walls from the Iron Age period. The site is of low significance

Required mitigation and management: none required.

- Feature 66: Iron Age stone packed wall of approximately 10m in diameter of low to medium significance.

Required mitigation and management: Mapping of site after which a destruction permit must be obtained from the South African Heritage and Resources (**"SAHRA"**) or move location of Emergency Escape Portal.

- Feature 68: ruin of a historical homestead. Site of low to medium significance.

#### 0.4.11.2 Cultural Heritage Impact Assessment

All the sites listed in the baseline section will be impacted should the Emergency Escape Portal not be moved.

#### 0.4.11.3 General Cultural Heritage Mitigation and Management

- The location of the Emergency Escape Portal must preferably be moved. A Phase 2 Heritage assessment must be carried out on any sites which will be impacted;
- Heritage sites close to development footprints must be fenced; and
- The existing Booysendal Mine cultural heritage management plan (including the risk assessment specifically applicable to the Phase 2 Project) must be updated and applied to all heritage sites, including those within the Phase 2 Project Area. The chance find procedure must be developed and communicated to all contractors.

### 0.4.12 Traffic

The traffic impact assessment ("**TIA**") was undertaken by Hamatino Consulting Engineers to determine current traffic volumes and safety on the potentially affected roads; to determine the cumulative increase in traffic; to assess if access would be appropriate in terms of safety standards; and to assess if the increased traffic which will result from the Booysendal South Expansion Project can be accommodated safely especially at the various intersections and to provide management recommendations.

#### 0.4.12.1 Traffic Baseline

The Phase 2 Project Area will be accessed via the  main access road. This road feeds onto and off the tarred D874 towards the R577 Lydenburg-Roossenekal road. Both these roads currently have very low traffic flow.

There are three intersections which will be affected by an increase in traffic, namely the:

- D874 and Village road intersection;
- The D874 and R577 Lydenburg-Roossenekal intersection; and
- The R577 Lydenburg-Roossenekal with the D212 Sekhukhune intersection.

The level of service of the first two roads falls in category A (lowest category delays). Surfaced road conditions are generally good. The level of service of the D212 varies between B and D, indicating that the road is reaching its capacity and will require upgrading in future.

#### 0.4.12.2 Traffic Impact Assessment

Traffic impacts could include:

- An increase in traffic incidents and accidents;
- Delays at the D212 – R577 intersection; and
- Deterioration of road conditions leading to a cumulative risk of accidents.

#### 0.4.12.3 Traffic Mitigation and Management

The following traffic management measures are required:

- Carrying capacity: The D212 – R577 intersection will have to be upgraded by year 2023. This intersection will have to monitored;
- An agreement must be reached on the maintenance of the D874;
- Sight distance at the Village Intersection must be improved through the removal of the wattle trees at the D874 / Village Intersection; and
- Speed limits: The TIA assessed that the section of road D874 from distance 1.85km to 3.0km is dangerous and has a high accident probability. Speed limits and calming is recommended. The section of the road at distance 2.45km from the R577 intersection and 400m from the Village Intersection is extremely steep and speed limits must be implemented.

### 0.4.13 Visual

The Visual Impact Assessment ("**VIA**") for the Phase 2 Project was carried out by GISM who also did the Phase 1 Project and the original BN VIA.

#### 0.4.13.1 Visual Baseline

The Project Area has a rural sense of place. The southern section is natural with a high visual value. Due to the valleys and high ridges, the absorption capacity of the Phase 2 Project is high. The most sensitive receptors are located to the east of the Project Area.

#### 0.4.13.2 Visual Impact Assessment

- The rural sense of place will be impacted due to an increase in mining activities to the south; and
- Night glare will result from unnatural night light.

#### 0.4.13.3 Visual Mitigating and Management Measures

- Development footprints must be confined to the smallest possible area;
- Concurrent rehabilitation and rehabilitation monitoring must be carried out as soon as possible. Straight lines must be avoided. An ecological approach to rehabilitation and vegetation screening must be followed that resemble the natural landscape and unnatural landscaping must be avoided as far as possible;
- Lights must only be installed where necessary, directed away from sensitive receptors and directed downwards; and

- Olive greens and tans can be used at the base of buildings, fading to lighter colours, with the top section of the buildings painted a light grey to merge with the skyline. Tall structures' roofs should be painted a 'dirty' grey or light blue. In principle, lighter tones advance toward the viewer while darker tones recede from the viewer. Pure whites, blacks and bright colours must be avoided. The existing colour scheme of Kalahari sands and olive green could be used on the buildings to blend in with the landscape.

### 0.4.14 Noise

The noise and vibration assessment of the Booysendal South Expansion Project: Phase 1 and Phase 2 was done by dBAcoustics.

#### 0.4.14.1 Noise Baseline

In general, it was found that the present noise levels at Booysendal Mine varied between 34.0dBA and 35.4dBA during the day and 28.8dBA and 32.0dBA during the night. This is typical for residential rural areas. Existing noise sources in the study area include: the processing plant at BN (which can be heard near the communities at BS4); heavy duty vehicle noise; distant traffic from the feeder roads; Phase 1 Project construction activities; and sounds associated with farming activities, birds and insects.

Potential sensitive noise receptors are located mainly to the east of BS4.

#### 0.4.14.2 Noise Impact Assessment

Sensitive receptors will hear noise from all the noise emitting areas and equipment cumulatively, and the cumulative increase in noise levels from all mining areas and equipment. The outcome of the noise model indicated that the highest cumulative increase will be 0.7 dBA during the day in summer at receptor B and 3.9 dBA at receptor E during night time in winter. These intrusion levels are well below the regulated 7.0 dBA increase, although the increase will be audible mainly to the receptors to the east of BS4. At some of the receptors it might be possible that intrusion will at times exceed 5.0 dBA but never exceed 7.0 dBA.

#### 0.4.14.3 Noise Mitigation and Management

- Equipment must not exceed noise levels of 85 dBA;
- A noise monitoring plan must be developed. This must include noise monitoring of baseline noise levels and trend analysis of noise levels;
- Where equipment exceeding noise levels of 90 dBA has to be used, it must only be operated during the day
- Noise output of between 85 and 90 dBA must be screened to ensure that noise levels are reduced to below 85 dBA; and
- Vent fans must face away from sensitive receptors.

### 0.4.15 Socio-economic Context

Social surveys were undertaken of the communities surrounding the Project Area to determine the social baseline.

<u>Local Governance Structures</u>

- Ward Committees – elected community members who work closely with the Ward Councillor, and are responsible for service delivery in the communities located in the Project Area;
- Community Development Forums – elected community members responsible for identifying and communicating community development needs to the Ward Committees;

- CPAs – landowners in the Project Area governed by the Communal Property Associations Act, No 28 of 1996 ("**CPA Act**"); and
- Traditional Councils – elected traditional leaders governed by the Traditional Leadership and Governance Framework Act, No 41 of 2003 ("**Framework Act**") who are responsible for preserving cultural heritage resources, managing land and natural resources, supporting local development, and maintaining peace and communal justice systems.

Demographics: The population surrounding the Booysendal Operation comprises both land claimant, labour tenants and commercial farmers. There are approximately 15,927 people in the direct AoI. The average household size is 9.94 people with a complex extended family composition.

Age and Gender: Between 57% and 60% of the population was younger than 18 years. A small number of people was over the age of 60. There is therefore a high dependency ratio and a low life expectancy. Females (62% to 55%) outnumber the number of males (38% to 45%).

Ethnicity and Religion: The majority of the population is Sepedi (90%), followed by 10% Ndebele. The main religion is Christianity while 50% also practice various traditional religions.

Land Use and Access to Land: Community members can acquire one hectare of land through the traditional council and CPAs. At present, the influx into the area is characterised by illegal squatting.

Land Ownership: The main landowners in the project area are CPAs and Booysendal Mine.

Education: There are 3 primary schools and 1 secondary school located within the areas surrounding the Project Area. Challenges experienced in the area include lack of secondary schools, lack of transport, shortage in textbooks, increased number of orphans, no library / computer / laboratory facilities, limited extramural facilities, no flushing toilets and no administrative buildings for teachers.

Healthcare: A mobile clinic is supposed to provide healthcare services to the communities, but this service is unreliable. The closest healthcare services are in Mashishing at the hospital and clinic, and a clinic in Mashishing Township.

The most commonly reported ailments and diseases included high blood pressure, diabetes, tuberculosis, diarrhoea, and colds and flu.

Housing: Most houses are built with cement and brick and corrugated roofing with one or more outbuildings. There are very few traditional houses and some shanty houses are present. Some houses have pit latrines.

Energy: There is electricity in the areas surrounding the Project Area, however, financial conditions restrict the use thereof, therefore many households use wood for cooking and candles for light.

Water Supply, Sanitation and Waste Removal: Most of the communities collect water from springs and streams, mainly tributaries of the Groot Dwars River. Water security in winter months can be a problem and the water quality was reported to be poor.

Some members have pit latrines while a large number make use of the bush. There are no waste services, and refuse is disposed of in public places, in the open or burnt.

Roads and Transport: There are no taxis of public transport in the area. People walk to the R577 where taxis are found. The cost varies between R120 and R160 return to Mashishing or Roossenekal.

Livelihood: Although mines employ people, lack of transport make it difficult for employees to effectively remain employed. Seasonal labour on farms have declined due to land claims. All the households are dependent on subsistence farming including livestock rearing (chickens, cattle, sheep and goats) and planting of maize, sorghum, beans, potatoes and some fruit trees. There are no informal businesses in the area from which income can be generated.

Medicinal plants (i.e. African potato, lengana and aloe) are harvested and used for household consumption. It was reported that some people sell traditional herbs, and that lawang was commonly sold to Somalis.

A number of community members are artisans with varying skills. These skills include welding, driving, operating heavy machinery, construction, bricklaying, baking, catering, and sewing but don't hold formal qualifications required by the mines. Skills training and development was identified, as a priority community need.

Income and Expenditure: Social grants is the main income source and dependence on social grants is very high due to unemployment. The main household expenditure is on transport, food, energy, airtime and clothes.

#### 0.4.15.1 Socio-economic Impact Assessment

Most of the socio-economic impacts can be positive although some negative impacts typically associated with mining development are also expected. The most significant positive impacts include:

- Job creation, which will create better living standards and conditions;
- Skills development and transfer of skills;
- Contribution to social infrastructure development; and
- Regional economic development revenue and national contribution through taxes.

Potential negative socio-economic impacts include:

- Influx of job seekers into the area;
- Increase in social pathologies (teenage pregnancies, alcohol abuse, crime) and erosion of local values and morals; and
- Increased pressure on local services.

#### 0.4.15.2 Social Mitigation and Management

- Skills and transferable skills training and development;
- Formalise local SMME procurement procedures, company procurement policies and sub-contractors' agreements and make use of local labour and services as far as possible;
- Implement a HIV awareness campaign; and
- Work with the local municipalities to optimise local development initiatives.

#### 0.4.15.3 New vs Old BCM2 Portal Position

It is proposed to move BCM2 from the location where it was approved in the Section 24G EA to an area where the geology is more competent just south of BCM1. The assessment of potential impacts (refer to Section 10) associated with the two positions indicates that with mitigating measures the proposed New position is feasible. The risk to surface water and the aquatic environment of the proposed New position is high and therefore additional management and mitigating measures will be required.

## 0.5 Alternative Assessment

Three alternatives were assessed:

### 0.5.1 Booysendal North MR: Process and Potable Pipeline Route

Two alternatives were considered, namely alignment of the pipeline route along the main access road or next to the Groot Dwars River. It is recommended that the alternative routing along the main access road be approved, to avoid impacts on sensitive hydromorphic soils, the Dwars River riparian wetland, the Golden Mole population and CI vegetation species.

### 0.5.2 Booysendal North MR: Transport of Ore

Three alternatives for the transport of ore were considered between BN and BS1/2, namely road, conventional conveyor and a new section of the ARC.

- The ARC from BN to BS1/2 will result in new disturbances within 100m of drainage lines. The ARC also holds a risk to CI fauna and flora and will lead to additional habitat fragmentation and the creation of migration barriers.
- The impacts from a normal conventional conveyor system will, however, be more significant and will lead to more significant clearance, destruction of habitat, migration barriers, noise and the risk of ore spillage.
- Road transport could lead to road kills of fauna, but no additional clearance will be required.

It is proposed that an additional trade-off studies for ore transportation be done based on incorporation of environmental risk assessment and practical environmental impact avoidance and management measures.

### 0.5.3 Booysendal South MR: Backfill Technologies

Two backfill technologies were considered:

- Cemented tailings which will require a thickener to be added to the floatation tailings after which approximately 4% of cement will have to be added to the tailings as part of the backfill stream; and
- Flotation tailings - No additional additives are required for the flotation cyclone tailings.

Either of the two options are viable with the correct management measures.

## 0.6 Project Motivation: Need and Desirability

Booysendal indicated that at least 2,132 direct and contract employment opportunities will be created through the Booysendal South Expansion Project; with a further 13,750 indirect employment opportunities. With the high dependency ratio in the area, it is expected that a total of 49,476 people will benefit from the Project. Currently 60% of the workforce employed at Booysendal comes from local communities. This means that a significant amount of the current annual wages of R505,372,151 filters through to the local communities.

In addition, preferential procurement from Historically Disadvantaged South Africans ("**HDSA**") at Booysendal Mine is currently 87.18%. The Booysendal South Expansion Project will increase the demand for further procurement and will enhance benefits and business development in communities. In addition to the local economy, Booysendal also contributes R86,639,513 to Government revenues in the form of taxes.

Local Economic development spent by the mine since 2014 was R8,926,913. Booysendal indicated that the expansion of the Booysendal Mine will assist in continuous development spend, including investment into schools and development centres.

At the peak of construction, a labour force of up to 3,200 will be required. The Booysendal South Expansion Project (Phase 1 and Phase 2) has an estimated capital spend of R4,199,800,000 over 5 years. The projected turnover (2016 values) is R2.7 billion of which some 8-10% (about R250 million) will represent ongoing capital investment for the projected LoM.

The Booysendal South Expansion Project has economic benefits for South Africa due to increased platinum production and local socio-economic benefits because of job creation, capital expenditure on contractors, materials and equipment, and ensuring an extension of the LoM in the long term which will prevent retrenchments and early mine closure.

# 0.7 Public Participation Process

An integrated public participation process is being followed for the Phase 2 Project Applications. The Phase 1 Project stakeholder database was used as a basis to inform stakeholders of the Phase 2 Project.

## 0.7.1 Pre-consultation Meetings

Pre-consultation meetings either in person or telephonically were held with and correspondence sent to the relevant CAs, including:

### 7.5.6.1 DMR Limpopo Regional Office

Booysendal North MR: The Booysendal South Expansion Project was discussed with the officials at the DMR Limpopo Regional Office on 23 April 2017, 3 August 2017 and 7 August 2017. It was indicated that the DMR Limpopo Regional Office is the CA for only the Booysendal North MR. A letter was furthermore received from the DMR Mpumalanga Regional Office dated 25 May 2018 in which the Scoping Report was accepted and Booysendal instructed to proceed with the EIA based on the terms of reference (**"ToR"**) included in the Scoping Report.

### 7.5.6.2 DMR Mpumalanga Regional Office

Booysendal South MR: A letter was submitted to the DMR Mpumalanga Regional Office to request guidance on the CA in relation to the Booysendal South MR. This was followed with a telephonic conversation with Matshilele Ratsela, who confirmed telephonically that the DMR Mpumalanga Regional Office is the CA or the Booysendal South MR. The outcome of the communication was that the Scoping Report and Application form for the Booysendal South MR could be submitted simultaneously.

### 7.5.6.3 Department of Water and Sanitation

A pre-consultation meeting was held with the DWS on 26 March 2017. DWS advised that one IWULA covering all the Booysendal South Expansion Project: Phase 1 and Phase 2, as well as historic water uses associated with BS4, should be submitted.

## 0.7.2 Introduction to the Phase 2 Project

The Phase 2 Project was introduced to stakeholders and I&APs from 12 February 2018 onwards. Site notices were placed and background information documents ("**BIDs**") distributed by hand on the 15 February in the Project Area. An advertisement was placed in the Steelburger on the 23rd of February. Scoping Phase public, authorities and focus group meetings were held on the 21st, 22nd and 23rd of February 2018.

## 0.7.3 Scoping Phase Public Consultation

The Consultation Scoping Report was made available from 28 February until 30 March 2018.

The Final Scoping Report was submitted to the DMR Regional Offices of Limpopo and Mpumalanga on 13 April 2018. Registered I&APs were notified of the availability of the Final Scoping Report for a 30-day comment period from 14 April to 18 May 2018. Registered I&APs" are kept informed of the application processes as it progresses, including the availability of reports for review.

## 0.7.4 EIR and IWULA

This Consultation EIR will be made available to commenting authorities and I&APs from 6 June 2018 to 6 July 2018. All I&APs on the database will be notified of the availability of the Consultation EIR which will be made available at:

| **Printed Copies** |
|---|
| Lydenburg Public Library, 41 Viljoen Street, Lydenburg (Tel: 013 235 3700) |

| | |
|---|---|
| Maartenshoop Police Station, Naauwpoort Farm (Tel: 013 235 4041) | |
| Thusong Centre, Mashishing<br>*(Please note, this public place was included for the review of the Final Scoping Reports after a request from stakeholders at a meeting held in February 2018)* | |
| **Electronic Copies** | |
| **Website download** | www.amecfw.com/booysendal |
| **CD copy** | On request to the public participation office |
| **Hard copies and / or CDs** | To all commenting authorities except DWS who requested a hard copy |

### 0.7.5 Next Step

All registered I&APs will be notified of the availability of the Final EIR and IWULA for a 30 and a 60-day commenting period respectively. This will be followed with notifications on the outcome of the decision reach by the relevant CAs to grant or refuse authorisation.

### 0.7.6 Comments and Response Report

A summary of the main comments and concerns raised by commenting authorities and stakeholders are included below:

#### 0.7.6.1 Authorities

DWS:

- the need for a water use license ("**WUL**") is raised to make provision for the Phase 1 and Phase 2 activities;
- potential mining at BS3 and potential future opencast mining;
- potential release of process water / effluent into the Groot Dwars River and impacts on water quality;
- the following requirements amongst others must be addressed in the IWULA: assessment of alternatives based on the hierarchy of impacts; storm water management plan based on the separation of clean and dirty water; modelling of the pollution plume and cone of depression; assessment of water losses, discharge into the natural system and the impacts on the PES and the Environmental Importance and EIS; rehabilitation and plant species plan; and a plant and animal search and rescue plan; and
- the Environmental Management Framework for the Olifants CMA, the Limpopo Conservation Plan 2, the Mining & Biodiversity Guidelines and the Limpopo SDF need to be considered in the EIA and IWULA phases.

A summary of the main comments from the Mpumalanga Tourism and Parks Agency ("**MTPA**") include:

- The MTPA indicated that they have no objection to the Phase 2 Project;
- In terms of the freshwater assessment, there are FEPA Wetlands on the proposed mining area. Mining is a land use that would compromise the biodiversity objective of maintaining the wetland in a natural state with no loss of ecosystems, functionality or species. Care should be taken to adhere to the recommended wetland buffers; and
- All the negative environmental impacts that could arise as a result of this mining operation should be avoided, minimised, mitigated or rehabilitated to its pre-mining land use or to the standards agreed to with the land owner. It is thus imperative to have photographs taken before any work commences on the land or on the existing routes.

Limpopo Department of Economic Development, Environment and Tourism ("**LEDET**")

- LEDET recommended the involvement of CAs for Waste Management Licenses and Water Management Licenses to help map the "One Environmental System" route in dealing with the application; and
- Utilisation of the following tools to ensure an informed decision is undertaken – a) Environmental Management Framework for the Olifants and Letaba River Catchments Area b) Limpopo Conservation Plan, Version 2, c) Mining and Biodiversity Guidelines, d) Limpopo Spatial Development Framework.

#### 0.7.6.2 Comments from I&APs

Comments and concerns raised during the Scoping Phase meetings and Scoping Phase consultation period include amongst others:

- Concerns about the potential release of process water / effluent into the Groot Dwars River and impacts on water quality;
- the Phase 2 Project needs to benefit the local communities in terms of employment and business opportunities, services, infrastructure and empowerment;
- the need for fire breaks;
- concerns about mine employees travelling on local roads at high speeds and the increases in traffic in general;
- noise associated with the ventilation shafts;
- placement of public review documents at the Thusong Centre and other venues closer to the communities who may be impacted was requested; and
- educational support and health care to communities is required.

## 0.8 Gap Analysis

The EIA team is reliant on information provided by the Client (Booysendal) and the engineering team. No detailed designs were available at the time that the specialist studies and EIA was carried out, however, the footprint areas + a 10% buffer zone was surveyed by the specialists.

## 0.9 Conclusion and Reasoned Opinion

It is the EAPs opinion that irreversible damage will be caused to some sections of the SCPE CBA areas and to some of the CI fauna species. The Phase 2 Project at BN also holds significant risks to the aquatic biodiversity. Any change in water quality or flow could have significant risks to the CI species. Cumulative impacts can also occur on the riparian wetland of the Groot Dwars River as a result of siltation, pollutants and deterioration in water quality. It is imperative that the impacts be managed and mitigated.

For authorisation to be granted it is the EAP's opinion that a biodiversity off-set strategy for the Phase 2 Project must be concluded and implemented. The off-set needs to be agreed with the relevant authorities, meet the off-set requirements stipulated in the Draft National Biodiversity Off-set Policy (GG40733 GN276 of 31 March 2017) and must take consideration of the off-set requirements stipulated in the EMP and the specialist studies. The offset strategy must also consider the loss in habitat and habitat fragmentation of the *Pycna sylvia*. The successful conclusion of an implementation agreement (including reference to appropriate management plans for Mining Right area and Off-set area) with DMR, MTPA and DEA will be the only acceptable mitigation for the Phase 2 project. At the time of drafting this Consultation EIR, the Offset Report was still in the process of being finalised.

In addition, it is of the utmost importance that the management measures summarised in the EIA and detailed in the EMP are implemented and that compliance to these be externally audited monthly for the duration of the construction phase, should the project be authorised.

Due to the sensitivity of the potentially affected environment, robust risk assessments which takes consideration of the environmental sensitivities, method statements which ensures that the risks are avoided and pro-active management measures are required before construction commences. Commitment from all involved will be required to ensure that the impacts and risks of the proposed Phase 2 Project in this sensitive environment are successfully addressed to the benefit of the environment and the economy.

It is important that awareness training on the sensitivity of this environment be given to all to embed a better understanding of the sensitivity of the Project Area.

The Phase 2 Project design must be finalised taking cognisance of the specialist findings. Sensitive areas must be avoided and clearance must be limited to the absolute minimum to mitigate cumulative impacts. Encroachment outside of demarcated footprints must be avoided at all cost due to the sensitivity of the environment. Buffer zones outlined in the EMP must be adhered to.

The Phase 2 Project has the potential to significantly contribute to the improvement of local communities living standards, life standards, education and general socio-economic upliftment. The Project has the potential to create a significant amount of much needed local jobs, contribute to business development and social investment and be an economic impetus in an area where socio-economic conditions can be described as dire. The positive socio-economic trickle-down effect that a development of this nature can have, can be significant in terms of social upliftment, investment, skills development and investment into community infrastructure as stipulated in the SLP. The national and regional socio-economic advantages through tax contribution is also significance in an industry where it becomes increasingly difficult to operate in. With a LoM of more than 40 years, the long term positive socio-economic impacts are much needed. The potential negative social impacts which are normally associated with mining developments could be manged and mitigated but it will be necessary to take hands with local government and develop and implement strategies.

Should the management measures proposed in the EIA and EMP be implemented a balance between development and conservation can be achieved, it which case the development is supported.

## 0.10 Conditions for Authorisation

Due to the sensitivity of the environment in which the Phase 2 Project will be located together with the potential cumulative impacts that may result a comprehensive list of conditions for authorisation have been propose in this report, including amongst others the following:

- Activities on sensitive soil (see Figure 5-20) must be avoided;
- All specialist management plans, management measures and monitoring programmes included in the specialist reports and incorporated in the EMP (Annexure C) must be implemented;
- No further direct disturbances of the Groot Dwars River and associated riparian wetland should occur as a result of current or future Phase 2 activities to avoid any cumulative impacts.
- The Groot Dwars River and associated riparian wetland/habitat as well as a 100m buffer zone or any buffers included in the IWULA must be demarcated and treated as a no-go area for any of the Phase 2 Project activities and movement of vehicles or people;
- River crossings must be designed and constructed not to cause any flow modifications or migration barriers;
- The Groot Dwars River system is a FEPA system. DWS must be consulted to agree on appropriate buffer zones and to consult on permissible activities should it not be possible to maintain the proposed 1km buffer;

- The PES of the river downstream of the confluence with the Everest tributary should not drop below a Category C;
- Treated effluent from the Sewage Treatment Plants ("**STPs**"), PCDs, excess process water or any contaminated water source must be recycled in the process and not released into the environment;
- The current offset programme for the Phase 1 Project must be expanded to include offset for the residual impacts of the Phase 2 Project. The offset strategy and draft offset plan, including timelines for implementation must be agreed before authorisation is granted. This offset must be approved by relevant authorities, must be legally binding as stated in the Draft National Biodiversity Offset Policy (GG40733 GN276 of 31 March 2017), contain a comprehensive list of impact management, mitigation and monitoring measures and be enforced through annual inspections by relevant authorities;
- Offset of the *Vitex obovate* subsp. *wilmsii* must be considered as part of the offset strategy to make provision for the loss in the *Pycna sylvia* habitat and additional encroachment of the *Vitex obovate* subsp. *wilmsii* or any other know areas of occurrence of the *Pycna sylvia* must be avoided;
- To mitigate and manage the cumulative impacts and potential direct impacts of the Booysendal South Expansion Project Phase 2 on the Groot Dwars River FEPA system, impacts on the *Enteromius obevata* subs *motebensis* and the SCPE, offset must include the identification of pristine to largely pristine like for like catchments which will be formally conserved, preferably the upstream catchment of the Groot Dwars River;
- A Biodiversity Management and Action Plan must be developed and implemented in line with the recommendations in the specialist reports and the EMP;
- Chromium, nitrate and phosphate concentrations in the Groot Dwars River and Everest tributary must be carefully monitored to ensure compliance with the DWAF (1996) guidelines for aquatic ecosystems (0.007 mg/l for chromium, less than 0.5 mg/l inorganic nitrogen). Where levels are exceeded, management action must be taken;
- The chance-find procedure and heritage management plan must be updated to make provision for the Phase 2 Project;
- An alternative location for the Emergency Escape Portal must be considered; alternatively a Phase 2 Heritage Assessment must be undertaken before any construction activities in this area commences.

Conditions for Authorisation Specifically Applicable to the Booysendal North Mining Right:

- Alternative 2 of the BS1/2 to BN process and potable water pipelines. The pipelines will be constructed along the main access road and not along the Groot Dwars River. The pipeline will be constructed above ground in the road reserve and no additional clearance outside of the road reserve will take place.

## 0.11 Next Step in the Application Process

The Final EIA will be prepared once the comment period on the Consulting EIA expires on 6 July 2018. All comments received during this period 6 June to 6 July 2018 will be incorporated into the final EIA to be submitted to the Mpumalanga and Limpopo Regional Offices of the DMR.

Registered I&APs and commenting authorities will be notified of the availability of the Final EIR and Draft IWULA for comment.

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## Appendices



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# List of Abbreviations

| Abbreviation | Description |
|---|---|
| ABA | Acid Base Accounting |
| ABET | Adult Basic Education and Training |
| ADT | Average Daily Traffic Volumes |
| AEL | Air Emissions License |
| AIS | Alien and Invasive Species |
| AMD | Acid Mine Drainage |
| AoI | Area of Influence |
| AQIA | Air Quality Impact Assessment |
| ARC | Aerial Rope Conveyor |
| ARC | Agricultural Research Council |
| ARD | Adsorption /Regeneration/Desorption |
| ARP | Annual Rehabilitation Plan |
| ASPT | Average Score Per Taxon |
| BBBEE | Broad Black Based Economic Empowerment |
| BIC | Bushveld Igneous Complex |
| BID | Background Information Document |
| BN | Booysendal North – existing approved Booysendal Operation located *inter alia* on the Farm Booysendal 43JT and Portion 2 of the Farm Der Brochen 7JT |
| BODATSA | Botanical Database of Southern Africa |
| BS | Booysendal South (excluding Booysendal North) |
| BS1/2 | Main Booysendal Central Mining Complex on the Farm Buttonshope 51JT |
| BS4 | The old Everest Mine (which includes the Valley Boxcut) |
| CA | Competent Authority |
| CARA | Conservation of Agricultural Resources Act, No 43 of 1998 |
| CBA | Critical Biodiversity Areas |
| CEO | Chief Executive Officer |
| CI | Conservation Importance |
| CITES | Convention on International Trade in Endangered Species |
| CMA | Catchment Management Agency |
| CPA | Communal Property Association |
| CRR | Comments and Response Report |
| CSI | Corporate Social Investment |
| DEA | Department of Environmental Affairs |
| ºC | Degrees Centigrade |
| DBA | A-weighted decibels |
| DMR | Department of Mineral Resources |
| DMS | Dense Medium Separation |
| DWAF | Department of Water Affairs and Forestry (previous name) |
| DWS | Department of Water and Sanitation |
| EA | Environmental Authorisation |
| EAP | Environmental Assessment Practitioner |
| EC | Electrical Conductivity |
| ECO | Environmental Control Officer |
| ED | Ehlanzeni District Municipality |
| EIA | Environmental Impact Assessment |
| EIR | Environmental Impact Report |
| EIS | Ecological Importance and Sensitivity |
| EMP | Environmental Management Programme (in terms of section 24N and Appendix 4 of NEMA: EIA Regulations (GN R982 in GG 38282 of 4 December 2014, as amended) or previously approved under the MPRDA prior to the enactment of the 2014 EIA Regulations |
| EMS | Environmental Management System |
| EN | Endangered |
| ENPAT | Environmental Potential Atlas |
| EPCM | Engineering Procurement and Construction Management |

| Abbreviation | Description |
|---|---|
| EPS | Environmental Performance Standards |
| ES | Ecosystem Service |
| ESMS | Environmental and Social Management System |
| FEPA | Freshwater Ecosystem Priority Area |
| FS | Feasibility Study |
| GG | Government Gazette |
| GGP | Gross Geographic Product |
| GHG | Greenhouse Gas Emissions |
| GN | Government Notice |
| GN R | General Notice Regulation |
| GTLM | Greater Tubatse Local Municipality |
| GSDM | Greater Sekhukhune District Municipality |
| Ha | Hectares |
| H&S | Health and Safety |
| HDPE | High density polyethylene |
| HDSA | Historically Disadvantaged South Africans |
| IA | Impact Assessment |
| IDP | Integrated Development Plan |
| IEM | Integrated Environmental Management |
| IFC PS | International Finance Corporation Performance Standards on Environmental and Social Sustainability, 2012 |
| I&APs | Interested and Affected Party/ies |
| ISO | International Standards Organisation |
| IUCN | International Union for Conservation of Nature |
| IWUL | Integrated Water Use License |
| IWULA | Integrated Water Use License Application |
| IWWMP | Integrated Waste & Water Management Plan |
| JSE | Johannesburg Stock Exchange |
| kph | Kilometres per hour |
| ktpm | Kilo tonne per month |
| LCPE | Mashishing Centre of Plant Endemism |
| LED | Local economic development |
| LEDET | Limpopo Department of Economic Development, Environment and Tourism |
| LoM | Life of Mine |
| LOS | Level of Service |
| LSU | Large Stock Unit |
| mamsl | Metres above mean sea level |
| MAP | Mean Annual Precipitation |
| MAR | Mean Annual Runoff |
| Mbgl | Metres below ground level |
| mbs | Meters below surface |
| MDEDET | Mpumalanga Department of Economic Development and Tourism |
| MEL | Mechanical Equipment List |
| mg/l | Miligram per litre |
| MHSA | Mine Health and Safety Act, No 29 of 1996 |
| MPRDA | Mineral and Petroleum Resources Development Act, No 28 of 2002 |
| MR | Mining Right |
| MTPA | Mpumalanga Tourism and Parks Agency |
| MWP | Mining Works Programme |
| NEMA | National Environmental Management Act, No 107 of 1998 |
| NEMBA | National Environmental Management: Biodiversity Act, No 10 of 2004 |
| NEMAQA | National Environmental Management: Air Quality Act, No 39 of 2004 |
| NEMPAA | National Environmental Management: Protected Areas Act, No 57 of 2003 |
| NFA | National Forestry Act, No 84 of 1998 |
| NFEPA | National Freshwater Ecosystem Priority Area |
| NGO | Non-government organisation |
| NHRA | National Heritage Resources Act, No 25 of 1999 |

| Abbreviation | Description |
|---|---|
| NT | Near Threatened |
| NWA | National Water Act, No 36 of 1998 |
| OEL | Occupational Exposure Levels |
| PCD | Pollution Control Dam |
| PES | Present Ecological Status |
| PGM | Platinum Group Metal |
| $PM_{10}$ | Particulate matter with an aerodynamic diameter of less than 10 µm |
| $PM_{2.5}$ | Particulate matter with an aerodynamic diameter of less than 2.5 µm |
| OSHA | Occupational Health and Safety Act, No 85 of 1993 |
| RoM | Run of Mine |
| RSA | Republic of South Africa |
| SANBI | South African National Botanical Institute |
| SANRAL | South African National Road Agency |
| SAWIC | South African Waste Information System |
| SAWS | South African Weather Service |
| SAHRA | South African Heritage Resources Agency |
| SCPE | Sekhukhune Centre of Plant Endemism |
| SDF | Spatial Development Framework |
| Section 24G | Section 24G of NEMA |
| SEP | Stakeholder Engagement Plan |
| SER | Stakeholder Engagement Report |
| SHEQ | Safety, Health, Environment and Quality |
| SIA | Social Impact Assessment |
| SR | Scoping Report |
| SLP | Social and Labour Plan |
| SMP | Social Management Plan |
| SMME | Small, Medium and Micro-Sized Enterprises |
| SQR | Sub-quaternary Reach |
| SRO | Stakeholder Relations Officer |
| STP | Sewage Treatment Plant |
| SWMP | Storm Water Management Plan |
| TCLM | Thaba Chweu Local Municipality |
| ToR | Terms of Reference |
| TSF | Tailings Storage Facility |
| VAC | Visual Absorption Capacity |
| VIA | Visual Impact Assessment |
| VPL | Ventilated Pit Latrines |
| VIPT | Ventilated Improved Toilets |
| VOC | Volatile Organic Compounds |
| Waste Act | National Environmental Management: Waste Act, No 59 of 2008 |
| WESSA | Wildlife and Environment Society of South Africa |
| WMA | Water Management Area |
| WML | Waste Management Licence |
| WRD | Waste Rock Dump |
| WSDP | Water Service Development Plan |
| WUL | Water Use Licence |
| ZVI | Zone of Visual Influence |

# 1. Introduction

Booysendal Platinum (Pty) Ltd ("**Booysendal**"), a subsidiary of Northam Platinum Ltd ("**Northam**"), operates the Booysendal Mine, a Platinum Group Metals ("**PGM**") mine complex located in the Eastern Limb of the Bushveld Igneous Complex **(**"**BIC**"). Booysendal purchased the southern section of the Der Brochen Mine from Rustenburg Platinum Mines Ltd (Anglo Platinum) early in 2008. This section became the initial Booysendal Mine. Development of the Booysendal Mine commenced in 2010 in the area known as Booysendal North ("**BN**"). Booysendal also purchased the bordering old Everest Mine from Aquarius Platinum (Pty) Ltd in 2015.

The Booysendal Mine operates under two Mining Rights ("**MRs**"), namely the Booysendal North MR (Department of Mineral Resources ("**DMR**") reference number: LP 30/5/1/3/2/1 (188) MR) and the Booysendal South MR (DMR reference number: MP 30/5/1/2/3/2/1 (127) MR). Although the two MRs have not been consolidated, the Booysendal Mine is managed as one integrated operation ("**Booysendal Operations**").

The Booysendal Mine is located approximately 33km west of Mashishing (Lydenburg), 40km south-southwest of Steelpoort, 32km north of Dullstroom and 21km north-east of Roossenekal. It is situated in both the Limpopo and Mpumalanga provinces and, as a result, falls within the Greater Tubatse Local Municipality ("**GTLM**") of the Sekhukhune District Municipality ("**SDM**") in the Limpopo Province, and the Thaba Chweu Local Municipality ("**TCLM**") of the Ehlanzeni District Municipality ("**EDM**") of the Mpumalanga Province. The northern section of the Booysendal North MR falls in the Limpopo Province, while the southern section falls in the Mpumalanga Province. The entire Booysendal South MR falls within the Mpumalanga Province.

It is divided into two main operational areas, namely BN and Booysendal South ("**BS**"). BN falls in the Limpopo Province and consists of the northern section of the Booysendal North MR, while BS falls in the Mpumalanga Province and consist of the entire Booysendal South MR and the southern section of the Booysendal North MR. BN is a fully operational underground PGM and Merensky Mine, whilst the development of BS is ongoing. BS is further subdivided into the ongoing development in the Dwars River Valley ("**BS1/2**"), the old Everest Mine ("**BS4**"), the Valley Boxcut on the valley slopes and two new Booysendal Merensky Adits ("**BCM1 and BCM2**" or the "**Adits**") just north of BS1/2. BS1/2 and the BCM1 and BCM2 Adits form part of the Booysendal North MR, while BS4, the Valley Boxcut and its associated developments form part of the Booysendal South MR. Refer to Figure 1-1 for general location and Figure 1-2 for illustrations of the operational subdivision.

Booysendal has identified an opportunity to increase PGM production to meet short to medium term projected demands for platinum with the expansion of BS in two phases, cumulatively named the "**Booysendal South Expansion Project**". The Booysendal South Expansion Project: Phase 1 Project ("**Phase 1 Project**") involved the development of a portal complex at BS1/2, BCM1 and BCM2, upgrade of storm water management measures at BS4 and the Valley Boxcut, reprocessing of the tailings and backfilling of the underground workings at BS4 and linear infrastructure components (road, Aerial Rope Conveyor ("**ARC**") and 132kVA powerline) between the operational areas. A environmental authorisation ("**EA**") was granted in terms of section 24G of the National Environmental Management Act, No 107 of 1998 ("**NEMA**") for the Phase 1 Project on 5 January 2018 ("**Section 24G EA**").

Booysendal plans to further expand its current operations through further developments that pertain to both the Booysendal North MR and Booysendal South MR (being the "**Booysendal South Expansion Project: Phase 2**" or "**Phase 2 Project**". For this purpose, Booysendal has appointed Amec Foster Wheeler (now part of the Wood Group) to undertake the following necessary Phase 2 Project applications:

- An application for amendment of the Environmental Management Programme ("**EMP**") for approval of a substantive amendment to the Section 24G EA EMP in terms of NEMA and 2014 Environmental Impact Assessment Regulations ("**2014 EIA Regulations**");

- Two EA applications in terms of NEMA and the 2014 EIA Regulations ("**EA Applications**");
- An integrated water use licence ("**IWUL**") application ("**IWULA**") in terms of the National Water Act, No 36 of 1998 ("**NWA**") for the entire Booysendal South Expansion Project;
- A Waste Management Licence Application ("**WMLA**") in terms of the National Environmental Management Act, No 59 of 2008 ("**Waste Act**") and the 2013 List of Waste Management Activities that have or are likely to have, a Detrimental Effect on the Environment, published under GN 921 in GG 37083 of 29 November 2013 ("**Listed Waste Activities**"); and
- Additional permits such as biodiversity permits that may be required,

  (collectively the "**Phase 2 Project Applications**").

The EA Applications, WMLA and EMP Amendment Application (collectively the "**Phase 2 NEMA and Waste Act Applications**") for the Phase 2 Project are done as one consolidated, integrated application due to the interconnectivity of Booysendal Mine's activities. This approach was also followed for the Phase 1 Project and provides for a holistic view of the baseline conditions and identification of potential cumulative impacts; and one consolidated set of management measures, which is more practical to implement.

The Project application process followed thus far included:

- Submission of two separate applications to the two competent Regional Offices of the DMR as follows:
  - *DMR Limpopo Regional Office* - one EA Application and the EMP Amendment Application for the activities on properties held under the Booysendal North MR on 26 February 2018; and
  - *DMR Mpumalanga Regional Office* - the WMLA and one EA Application for the activities on properties held under the Booysendal South MR on 27 February 2018.
- Submission of the integrated Consultation and Final Scoping Report to:
  - *DMR Limpopo Regional Office* – Consultation Scoping Report for the Phase 2 Project submitted on 26 February 2018 and the Final Scoping Report on 13 April 2018; and
  - *DMR Mpumalanga Regional Office* – Consultation Scoping Report for the Phase 2 Project submitted on 27 February 2018 and the Final Scoping Report on 13 April 2018.
- This Consultation Environmental Impact Report ("**Consultation EIR**") is the next step in Phase 2 Project application process and will be made available for a 30-day commenting period to Interested and Affected Parties ("**I&APs**") and commenting authorities within the Limpopo and Mpumalanga provinces. The Consultation EIR contains the findings of the Environmental Impact Assessment ("**EIA**") process for the Phase 2 NEMA and Waste Act Applications required for the Phase 2 Project. The Consultation EIR is structured in such a manner that it distinguishes between the proposed activities pertaining to each of the MRs in separate sub-sections.

An IWULA is also being prepared for the water uses associated with the full Booysendal South Expansion Project (Phase 1 and Phase 2) and will be submitted to the Department of Water and Sanitation ("**DWS**"). The IWULA process runs concurrently with the integrated Phase 2 NEMA and Waste Act Applications.

## 1.1 Background

Booysendal identified an opportunity to expand its mining operations and increase production to meet the projected short- to medium-term platinum market demands. Having acquired the MRs for the full extent of the Project Area (as defined by the properties over which it extends – see Figure 1-4, Table 1-2 and Table 1-3) earmarked for the expansion (except for the Remaining Extent of the Farm Sterkfontein 52JT, which is included in the lease agreement with the Bakoni Communal Property Association ("**Bakoni CPA**")). The Booysendal South Expansion Project is divided into two phases:

- Booysendal South Expansion Project: Phase 1; and
- Booysendal South Expansion Project: Phase 2.

These phases are described further in this section.

### 1.1.1 Booysendal South Expansion Project: Phase 1

An integrated EA, EMP Amendment and WML was granted in terms of section 24G of NEMA (being the Section 24G EA) by the DMR Limpopo Regional Office on 5 January 2018 for this Phase of the Project. The Section 24G EA was granted for the following activities, which pertain to both the Booysendal North MR and the Booysendal South MR:

- The development of the BS1/2 portal and supporting infrastructure (consisting of a mining portal and terrace complex, seven adits, workshops, offices, water and related infrastructure and co-disposal stockpile);
- BCM1 and BCM2 without any surface infrastructure components;
- A 132kVA powerline from BN to BS1/2;
- Upgraded and new storm water management infrastructure at BS4;
- Reworking of existing tailings at BS4;
- Replacement of tailings on existing Tailings Storage Facility ("**TSF**") 1 at BS4;
- A Pollution Control Dam ("**PCD**") at the Valley Boxcut;
- Backfilling of the underground workings with tailings;
- The construction of associated surface and linear infrastructure, including a 13.2m wide bitumen access road, an ARC system, water pipelines between BS1/2 and the Valley Boxcut (which relate to the Booysendal South MR).

### 1.1.2 Booysendal South Expansion Project: Phase 2

#### 1.1.2.1 Booysendal North MR Activities

The following proposed activities are applicable to the Booysendal North MR:

- An Emergency Escape Portal just east of the BCM1 and BCM2 complexes and north of BS1/2, which will serve as an emergency escape way and return airway system for BCM 1, BCM2 and the BS1/2 underground complex;
- Portals with surface infrastructure at the BCM1 and BCM2 adits, including a terrace, conveyor systems, silo, crusher, workshops, offices, change house, transformer and substation, a PCD and settlers, clean and process water storage facilities, ore stockpiles, access roads, compressors, sewage treatment plant ("**STP**"), concrete bunded waste collection area and emulsion, oil and diesel storage bays;
- Retaining the 11kVA powerline from BN to BS1/2;
- Relocation of BCM2 from the footprint approved in the Section 24G EA;
- Potable and process water lines for BS1/2 and the BCM1 and BCM2, running along the existing gravel access road along the Groot Dwars River between BS1/2 and BN. The potable water will be sourced from the existing Lebalelo allocation; and

- An ARC system from BS1/2 to BN with associated roads to the ARC ("**ARC Roads**") and ARC towers.

1.1.2.2 Booysendal South MR Activities

The following proposed activities are applicable to the Booysendal South MR at BS4:

- Backfill Plant and access road;
- Slurry and process water pipelines between the Process and Backfill Plant, the Return Water Dam ("**RWD**") and the silt trap ("**BS4 Pipelines**");
- Three emergency backfill ponds along the tailings pipeline ("**Tailings Pipeline**").

Refer to Figure 1-1, Figure 1-2, Figure 1-3 and Figure 1-4 for location, layout and properties. Figure 1-5 and Figure 1-6 indicates the coordinates of the proposed expansion footprints associated with the Phase 2 Project.

Figure 1-1 Booysendal Mine - General Locality (Source: Booysendal Presentation, 2016)

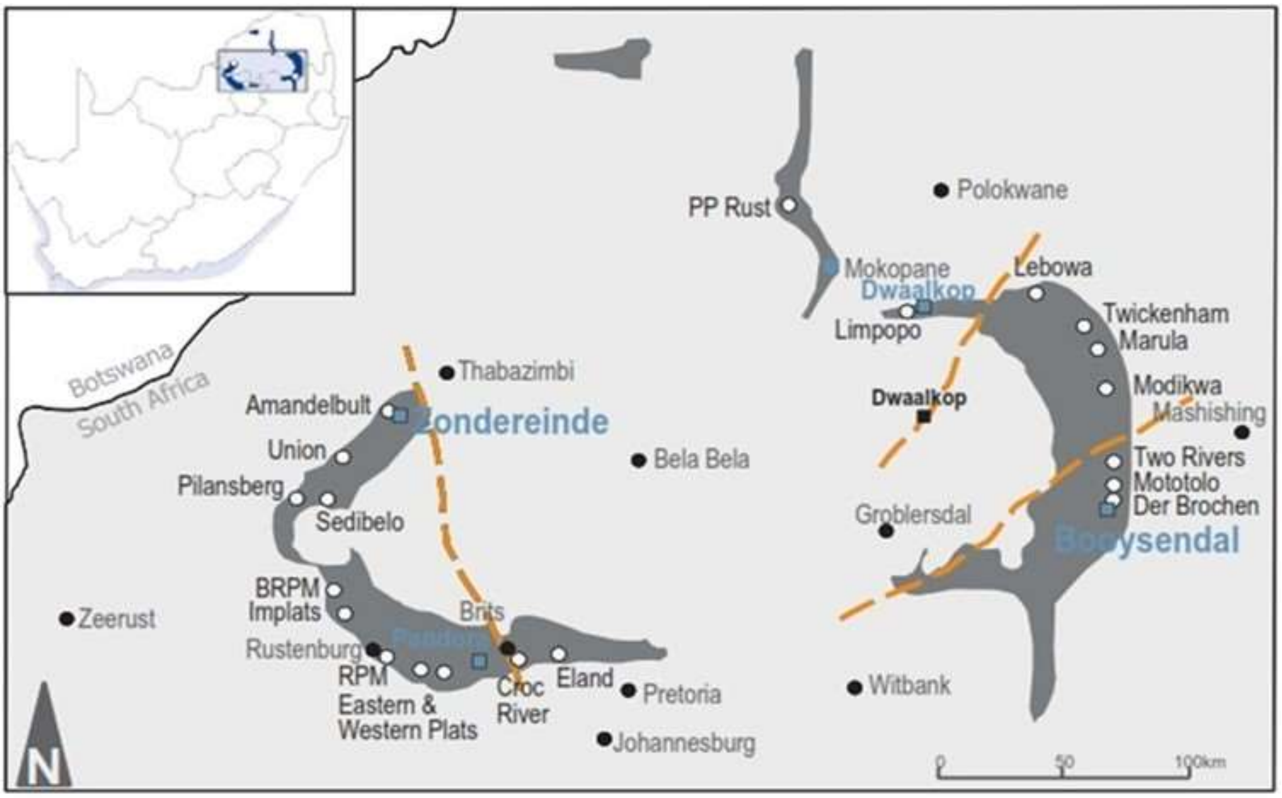
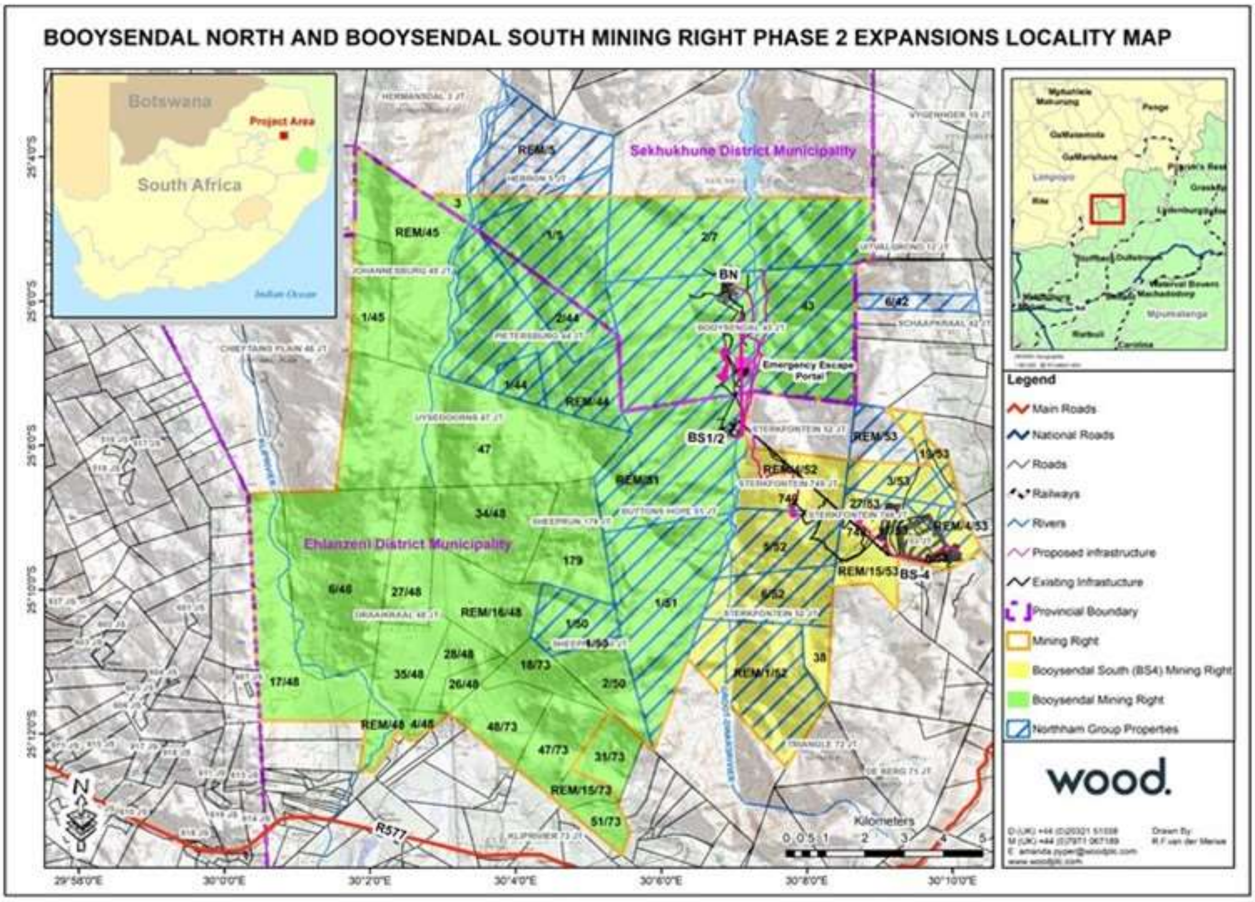


Figure 1-2 Booysendal Mine Location, Operational Division and Surface and Mining Rights




## 1.2 Location and Property Details

### 1.2.1 Location

BN falls within Ward 31 of the GTLM of the SDM in the Limpopo Province. BS is located in Ward 5 of the TCLM of the EDM in the Mpumalanga Province. The details of the applicable district and local municipalities are included in Table 1-1. The ward and municipal demarcations are indicated in Figure 1-3. The proposed expansion for the Booysendal North MR falls in both the district and local municipalities' jurisdictions.

Table 1-1 Local and District Municipalities

| | | |
|---|---|---|
| **Mpumalanga Province** | | |
| **District Municipality** | Ehlanzeni District Municipality | Acting Municipal Manager: Mr Hubert Shabangu<br>T: (013) 759 8531<br>M: 0825345653<br>E: hshabangu@ehlanzeni.gov.za |
| **Local Municipality** | Thaba Chweu Local Municipality | Municipal Manager: Mr Lesley Mokwena<br>T: (013) 235 7307<br>M: 0794977466<br>E: lesleymphaka@gmail.com |
| **Limpopo Province** | | |

| | | |
|---|---|---|
| **District Municipality** | Sekhukhune District Municipality | Manager : Ms Mapule Makoko<br>T : (011) 262 7300<br>M: 0823041629<br>E: Mahlangu@sekhukhune.gov.za |
| **Local Municipality** | Greater Tubatse Local Municipality | Municipal Manager : Mr JNT Mohlala<br>T : (013) 231 1121 / 1000<br>M: 0828031629<br>E: jntmohlala@tubatse.gov.za |

Figure 1-3 Towns, Wards and Municipalities of the Booysendal Operation


## 1.2.2 Property Details

The properties applicable to the Phase 2 Project are indicated in Table 1-2 and Table 1-3. The properties over which the Booysendal MRs are held and the relevant Competent Authority ("**CA**") for each of the MRs is detailed here.

*Limpopo Regional DMR Office*: The Farm Booysendal 43JT; and the Remaining Extent of the Farm Buttonshope 51JT (held under the Booysendal North MR) (the "**Booysendal North MR Phase 2 Project Area**"). Booysendal holds surface rights to these properties (refer to Figure 1-4, Figure 2-1, Figure 2-2 and Figure 2-3 and Table 1-2).

*Mpumalanga Regional DMR Office*: The Farm Sterkfontein 749JT; and Remaining Extents of Portions 4 and 15 and Portion 8, 17 and 27 of the Farm De Kafferskraal 53JT (held under the Booysendal South MR) (the "**Booysendal South MR Phase 2 Project Area**"). Booysendal and the Bakoni CPA hold surface rights to these properties (refer to Figure 1-4, Figure 2-4 and Table 1-3). Booysendal has entered into a lease agreement with the Bakoni CPA in respect of the properties the Bakoni CPA owns.

The Booysendal North MR Phase 2 Project Area and Booysendal South MR Phase 2 Project Area are collectively referred to in this Consultation EIR as the "**Phase 2 Project Area**" or "**Project Area**".

Other properties over which the Booysendal North MR and Booysendal South MR are held are also included in Figure 1-4 for reference purposes to specifically provide an understanding of the potential Area of Influence ("**AoI**") of the actual expansion.

Figure 1-4 Booysendal Operation Surface and Mining Rights

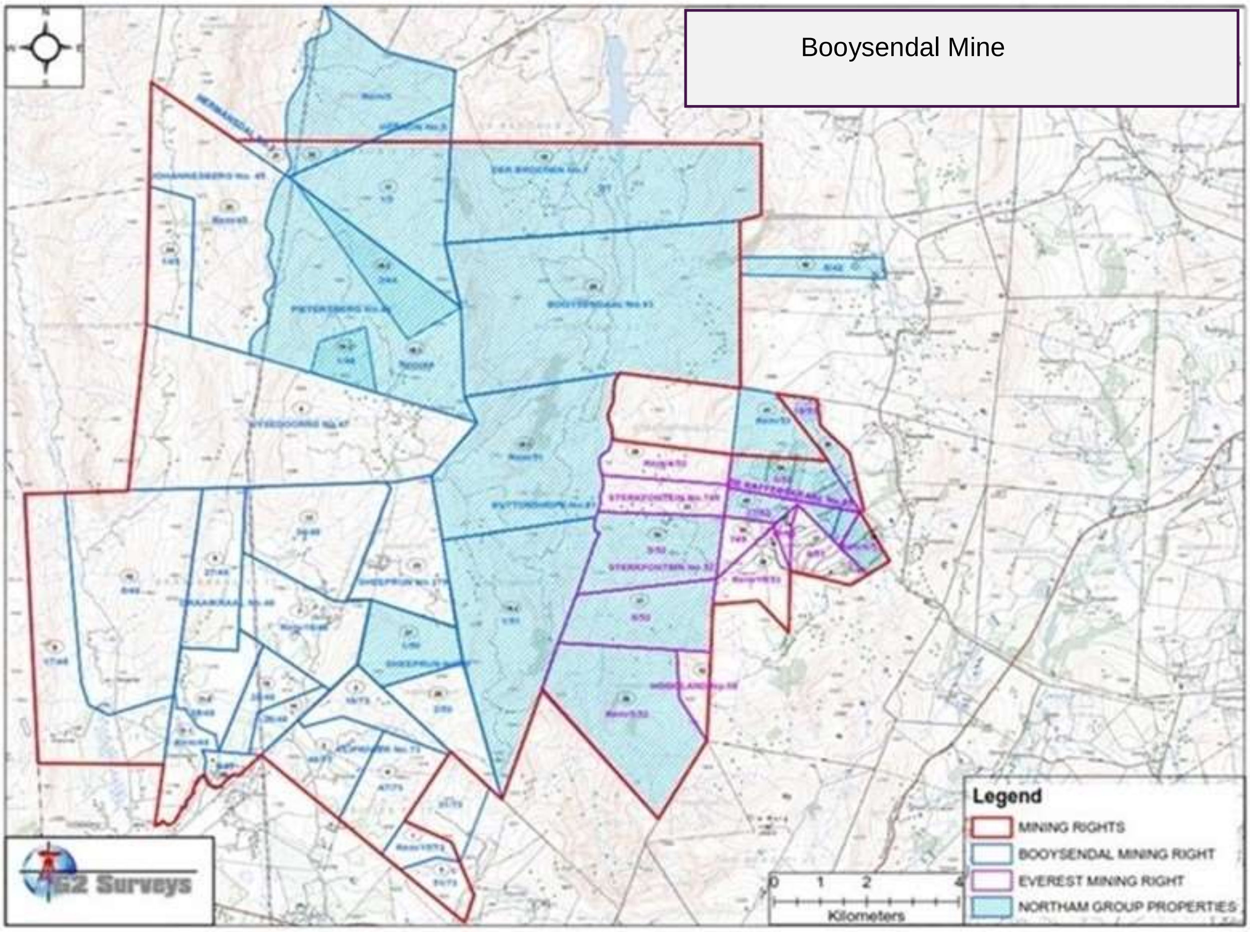


Table 1-2 Booysendal North MR - Property Details

| Farm | Property Description | Owner | Province | Title Deed Number | Surveyor General Code | Extent (ha) |
|---|---|---|---|---|---|---|
| Buttonshope 51JT | Remaining Extent | Booysendal | Mpumalanga | T6075/2009 | T0JT00000000005100000 | 934.8152 |
| Booysendal 43JT | Farm | Booysendal | Limpopo | T38487/2009 | T0JT00000000004300000 | 1807.2269 |

Table 1-3 Booysendal South MR - Property Details

| Farm | Property Description | Owner | Province | Title Deed Number | Surveyor General Code | Extent (ha) |
|---|---|---|---|---|---|---|
| Sterkfontein 749JT | Farm | Bakoni CPA | Mpumalanga | T171108/2006 | T0JT00000000074900000 | 248.5382 |
| De Kafferskraal 53JT | Remaining Extent of Portion 4 | Bakoni CPA | Mpumalanga | T173287/2006 | T0JT00000000005200004 | 178.6939 |
| De Kafferskraal 53JT | Remaining Extent of Portion 15 | Bakoni CPA | Mpumalanga | T7052/2016 | T0JT00000000005300015 | 179.8717 |
| De Kafferskraal 53JT | Portion 8 | Bakoni CPA | Mpumalanga | T7052/2016 | T0JT00000000005300008 | 131.9059 |
| De Kafferskraal 53JT | Portion 17 | Bakoni CPA | Mpumalanga | T7052/2016 | T0JT00000000005300017 | 24.9550 |
| De Kafferskraal 53JT | Portion 27 | Booysendal | Mpumalanga | T16257/2016 | T0JT00000000005300027 | 122.8744 |

The above properties collectively constitute the "**Project Area**" or "**Phase 2 Project Area**".

## 1.3 Purpose of the EIR

The purpose of this Consultation EIR is to provide the findings of the EIA process undertaken for the Phase 2 Project. The Consultation EIR provides:

- details of the proposed expansion activities;
- a summary of the environmental legal requirements associated with the Phase 2 Project;
- a summary of the findings of the various baseline specialist investigations for the wider Project Area and the Phase 2 Project AoI;
- a description of potential impacts which may result from the proposed expansions throughout the various phases of the Phase 2 Project;
- an assessment of the significance of potential Phase 2 Project impacts, including cumulative impacts;
- an assessment of Phase 2 Project alternatives;
- identified residual impacts after mitigation and recommends management requirements for these;
- recommendations on mitigating and management measures to avoid, reduce or manage potential impacts;
- a motivation of the need and desirability of the Phase 2 Project;

- a gap analysis and the materiality of the gaps in terms of the overall impact findings;
- a conclusion on whether the Phase 2 Project could be authorised, based on the outcome of the EIA; and
- recommendations for authorisation to ensure that potential impacts are avoided, reduced or managed.

### 1.3.1 Objectives of the EIR

The objectives of the Consultation EIR are to provide:

- commenting authorities, stakeholders and potential I&APs with the findings of the EIA and specialist investigations for the Phase 2 Project as contained in the EIR and Annexures;
- commenting authorities, stakeholders and potential I&APs with the opportunity to make meaningful and informed comments and recommendations;
- commenting authorities, stakeholders and potential I&APs an opportunity to raise concerns based on their local knowledge and information provided against the findings of the EIA and specialist investigations for the proposed Phase 2 Project which need to be considered by the CA; and
- to ensure that all comments received during the comment period on the Consultation EIR are incorporated into the Final EIR to assist in the decision-making process.

### 1.3.2 Applicable Competent Authorities

Although the Booysendal North MR falls within both the Limpopo and Mpumalanga provinces, the CA historically has been, and continues to be, the Regional Manager of the DMR Limpopo Regional Office (in Polokwane). The CA for the Booysendal South MR is the Regional Manager of the DMR Mpumalanga Regional Office (in Witbank).

The CA for the IWULA, which is done concurrently with the Phase 2 NEMA and Waste Act Applications, is the Olifants River Catchment Management Agency ("**CMA**") of the Department of Water and Sanitation (**DWS**") located in Mashishing (Lydenburg).

In terms of the provisions of Section 24K of NEMA the foundation for co-operative governance is laid where the CA should also *“consult with any organ of state responsible for administering the legislation relating to any aspect of an activity that also requires environmental authorisation under this Act in order to coordinate the respective requirements of such legislation and to avoid duplication.”*

With respect to the Phase 2 Project, the following authorities should therefore be consulted as a minimum, the:

- The National Department of Environmental Affairs ("**DEA**") Environmental and Waste Management Directorates;
- The Department of Agriculture, Forestry and Fisheries ("**DAFF**");
- The South African Heritage Resource Agency ("**SAHRA"**);
- DWS;
- Provincial Road Agency;
- Department of Rural Development and Land Reform;
- GTLM and TCLM;
- Ward Council for Ward 31 of the GTLM and the Ward Council of Ward 5 of the TCLM;

- EDM and SDM;
- Wildlife and Environment Society of South Africa ("**WESSA**");
- Olifants River CMA of the DWS;
- Limpopo Department of Economic Development, Environment and Tourism ("**LEDET**");
- Mpumalanga Department of Economic Development, Environment and Tourism ("**MDEDET**")**;**
- The Mpumalanga Tourism and Parks Agency ("**MTPA**")**;** and
- Eskom Holdings SOC Limited.

All the relevant stakeholders above have been notified and kept updated in the Phase 2 NEMA and Waste Act Applications process thus far. Refer to the Stakeholder Engagement Report ("**SER**") in Annexure B for details around the stakeholder engagement process.

## 1.4 Applicant Details

Although, Northam, a mid-tier mining company listed on the Johannesburg Stock Exchange, is the holding company of Booysendal, Booysendal is the registered holder of the Booysendal North and Booysendal South MRs. Booysendal's company details are included in Table 1-4.

Table 1-4 Booysendal Company Details

| | |
|---|---|
| **Name of Applicant** | Booysendal Platinum (Pty) Ltd |
| **Contact Person** | Willem Johannes Theron |
| **Company Registration No** | 2002/016771/07 |
| **Postal Address** | PO Box 412694, Craighall, 2024 |
| **Project Physical Address** | Farm Booysendal 43JT; the Remaining of the Farm Buttonshope 51JT; the Farm Sterkfontein 749JT; and Remaining Extents of Portions 4 and 15 and Portion 8, 17 and 27 of the Farm De Kafferskraal 53JT |
| **Telephone No** | 011 325 4795 |
| **Mobile No** | 0828088364 |
| **Email** | Willie.Theron@norplats.co.za |

## 1.5 Details of the Independent Environmental Assessment Practitioner

Amec Foster Wheeler was initially appointed by Booysendal as the independent Environmental Assessment Practitioner ("**EAP**") to undertake the integrated EA, WMLA and EMP Amendment processes and the IWULA for the Phase 1 Project for which the Section 24G EA was subsequently granted on 5 January 2018.

The scope of the Booysendal South Expansion Project has since been expanded to include the Phase 2 Project activities associated with both the Booysendal North MR and the Booysendal South MR. Amec Foster Wheeler was then appointed to revise the IWULA and to undertake the Phase 2 NEMA and Waste Act Applications. The IWULA process is being undertaken concurrently to these processes for all NWA section 21 water uses associated with the overall Booysendal South Expansion Project. The DWS advised during a pre-consultation meeting held on 28 Mach 2017 that an integrated application process should be followed.

The details of the EAP are included in Table 1-5. A declaration of independence by the EAP is included in Section 12.

Table 1-5 Details of the Environmental Assessment Practitioner

| | |
|---|---|
| Name of EAP | Amec Foster Wheeler South Africa Pty. Ltd (part of the Wood group) |
| Contact Person | Amanda Pyper |
| Postal Address | Building 2, Silver Stream Business Park, 10 Muswell Road South, Bryanston, 2021, South Africa |
| Physical Address | Second Road, Midrand, Gauteng 1683 |
| Telephone No | +27 (0)11 840 7457 |
| Mobile No | +44 (0) 7557 302252 |
| Email | Amanda.pyper@woodplc.com |

### 1.5.1 EAP Statement

Amec Foster Wheeler and the project team acts as an independent company in the Phase 2 NEMA and Waste Act Applications for the Booysendal South Expansion Project: Phase 2. We are performing the work relating to the Phase 2 NEMA and Waste Act Applications in an objective manner, even if this results in views and findings that are not favourable to the Applicant.

We declare that there are no circumstances that may compromise our objectivity in performing such work. We have expertise in conducting the Scoping Study, EIA process for the EAs and WML, EMP Amendment application process and the relevant reports. We confirm that we have knowledge of the relevant environmental acts, regulations and guidelines that have relevance to the proposed project and the various application processes will comply with the requirements therein.

We have no, and will not engage in, conflicting interests in the undertaking of the activity and:

- undertake to disclose to the Applicant and the CA all material information in our possession that reasonably has, or may have, the potential of influencing any decision to be taken with respect to the application by the CA; and
- Ensure the objectivity of any report, plan or document to be prepared by myself/ourselves for submission to the CA;

All particulars furnished by us in this report are true and correct. We realise that a false declaration is an offence in terms of section 49A of NEMA and is punishable in terms of section 24F of the Act.

## 1.6 EAP Credentials

Amanda Pyper is a Principal Environmental Scientist with 27 years' experience, of which the past 11 years have been as an environmental and social scientist. Her experience spans the whole project life cycle and includes strategic advisory roles; due diligence assessments; prefeasibility, feasibility and bankable feasibility input; environmental compliance audits; external IFC reviews; managing large international ESIAs and ESMPs, often in remote locations and involving large multidisciplinary specialist teams; and developing closure and rehabilitation plans. This experience gives her a detailed understanding of overall Project requirements through all stages of development.

Her experience includes roles in the extractive, linear infrastructure, water sector and industrial developments for both greenfields and brownfields projects. Her role furthermore involves business development and strategic advisory services. She has undertaken several EIAs in South Africa, amongst others the 2010 EMP Amendment for BN and the Section 24G for Phase 1 of the Booysendal South Expansion Project.

Amanda Pyper has worked on projects in Liberia, Côte d'Ivoire, Republic of Congo (Brazzaville), South Africa, Mozambique, Morocco, Guyana, Taiwan, Singapore, Malawi, Angola, Kyrgyzstan and the Kingdom of Saudi Arabia. She holds a Master's Degree in Environment and Society, completed at the University of Oulu (Finland) and the University of Pretoria, and an Honours Degree in Environmental Impact Assessment and Environmental Management. She is a qualified QEF for Chevron and holds an ISO 14001 Advanced EMS Lead Auditor qualification. Amanda Pyper's full CV is included as Annexure A.

### 1.6.1 EAP Definition

Any EMP Amendment and/or EIA process is required to be undertaken by an independent EAP and independent specialists. Regulations in terms of the registration of EAPs with an Environmental Assessment Practitioners Associated have been published.

An independent EAP is defined in terms of section 1 of NEMA as:

"*the individual responsible for the planning, management, coordination or review of environmental impact assessments, strategic environmental assessments, environmental management programmes or any other appropriate environmental instruments introduced through regulations*."

A specialist, in terms of Regulation 1 of the 2014 EIA Regulations, means:

"*a person that is generally recognised within the scientific community as having the capability of undertaking, in conformance with generally recognised scientific principles, specialist studies or preparing specialist reports, including due diligence studies and socio-economic studies.*"

Regulation 13 of the 2014 EIA Regulations outlines the general requirements for EAPs and specialists as follows:

"*(1) An EAP and a specialist, appointed in terms of regulation 12(1) or 12(2), must –*

- *(a) be independent;*
- *(b) have expertise in conducting environmental impact assessments or undertaking specialist work as required, including knowledge of the Act, these Regulations and any guidelines that have relevance to the proposed activity;*
- *(c) ensure compliance with these Regulations;*
- *(d) perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the application;*
- *(e) take into account, to the extent possible, the matters referred to in regulation 18 when preparing the application and any report, plan or document relating to the application; and*
- *(f) disclose to the proponent or applicant, registered interested and affected parties and the competent authority all material information in the possession of the EAP and, where applicable, the specialist, that reasonably has or may have the potential of influencing –*
  - *(i) any decision to be taken with respect to the application by the competent authority in terms of these Regulations; or*
  - *(ii) the objectivity of any report, plan or document to be prepared by the EAP or specialist, in terms of these Regulations for submission to the competent authority;*

*unless access to that information is protected by law, in which case it must be indicated that such protected information exists and is only provided to the competent authority.*"

### 1.6.2 Contributing Specialists

The specialist studies carried out in support of the Phase 2 Project of which the findings have been incorporated into the Consultation EIR is shown in Table 1-6. Each specialist has included a declaration of independence in their reports, in terms of Appendix 6 of the 2014 EIA Regulations, and a qualification of expertise to carry out the various studies.

Table 1-6 Specialists Contributing to the Booysendal Authorisation Processes

| Specialist Study | Specialist/ Specialist Team |
|---|---|
| Terrestrial Flora and Fauna | Natural Scientific Services CC ("**NSS**") |
| Aquatic Flora and Fauna | Clean Stream Biological Services (Pty) Ltd ("**Clean Stream**") |
| *Pycna Sylvia* | Richard D. Stephen |
| Water Quality | Aquatico Scientific (Pty) Ltd ("**Aquatico**") |
| Wetlands | Wetland Consulting Services (Pty) Ltd ("**WCS**") |
| Hydrology | Letsolo Water and Engineering Services CC ("**Letsolo**") |
| Hydrogeology | Future Flow Groundwater and Project Management Solutions CC ("**Future Flow**") |
| Soil, Land Use and Land Capability | Terra-Africa Consult CC ("**Terra-Africa**") |
| Air Quality and Greenhouse Gas Emission | Airshed Planning Professional (Pty) Ltd ("**Airshed**") |
| Noise | dBAcoustics CC ("**dBAcoustics**") |
| Traffic | Hamatino Consulting Engineers ("**Hamatino**") |
| Visual | GISM (Pty) Ltd ("**GISM**") |
| Social | Social Enterprise Solutions ("**SES**") |
| Cultural Heritage | Heritage Contracts and Archaeological Consulting cc ("**HCAC**") |
| Public Consultation | Anelle Lötter Communications ("**Anelle Lotter**") |
| Mine Waste Characterization | Jones & Wagener Engineering and Environmental Consultants (Pty) Ltd ("**Jones & Wagener**") |

## 1.7 Structure of the Consultation EIR

Section 1: Introduction and Background (this section)

Section 2: Project Description

Section 3: Legislation, Policies and Guidelines

Section 4: Environmental Impact Reporting Methodology

Section 5: Description of the Receiving Environment

Section 6: Project Area of Influence

Section 7: Public Participation Process

Section 8: Need and Desirability

Section 9: Alternative Assessment

Section 10: Impact Assessment, Impact Statement, Mitigating and Management Requirements

Section 11: Recommendations

Section 12: Conditions for Authorisation

Section 13: Declaration by the EAP

Section 14: Bibliography

Annexures

- Annexure A: EAP CV

- Annexure B: Stakeholder Engagement Report
- Annexure C: Environmental Management Programme
- Annexure D: Air Quality Impact Assessment
- Annexure E: Hydrogeological Assessment
- Annexure F: Hydrological Assessment
- Annexure G: Soil, Land Use and Land Capability Assessment
- Annexure H: Water Quality Assessment
- Annexure I: Wetland Assessment
- Annexure J: Aquatic Biodiversity
- Annexure K: Terrestrial Ecology
  - Annexure K1: NSS Terrestrial Ecology
  - Annexure K2: *Pycna sylvia*
- Annexure L: Social Study
- Annexure M: Cultural Heritage Assessment
  - Annexure M1: Cultural Heritage Phase 1
  - Annexure M2: Paleontological Assessment
- Annexure N:  Noise and Vibration Assessment
- Annexure O: Traffic Impact Assessment
- Annexure P: Visual Impact Assessment
- Annexure Q: A3 Drawings

Figure 1-5 Booysendal North Expansion Project Phase 2 Development Footprint

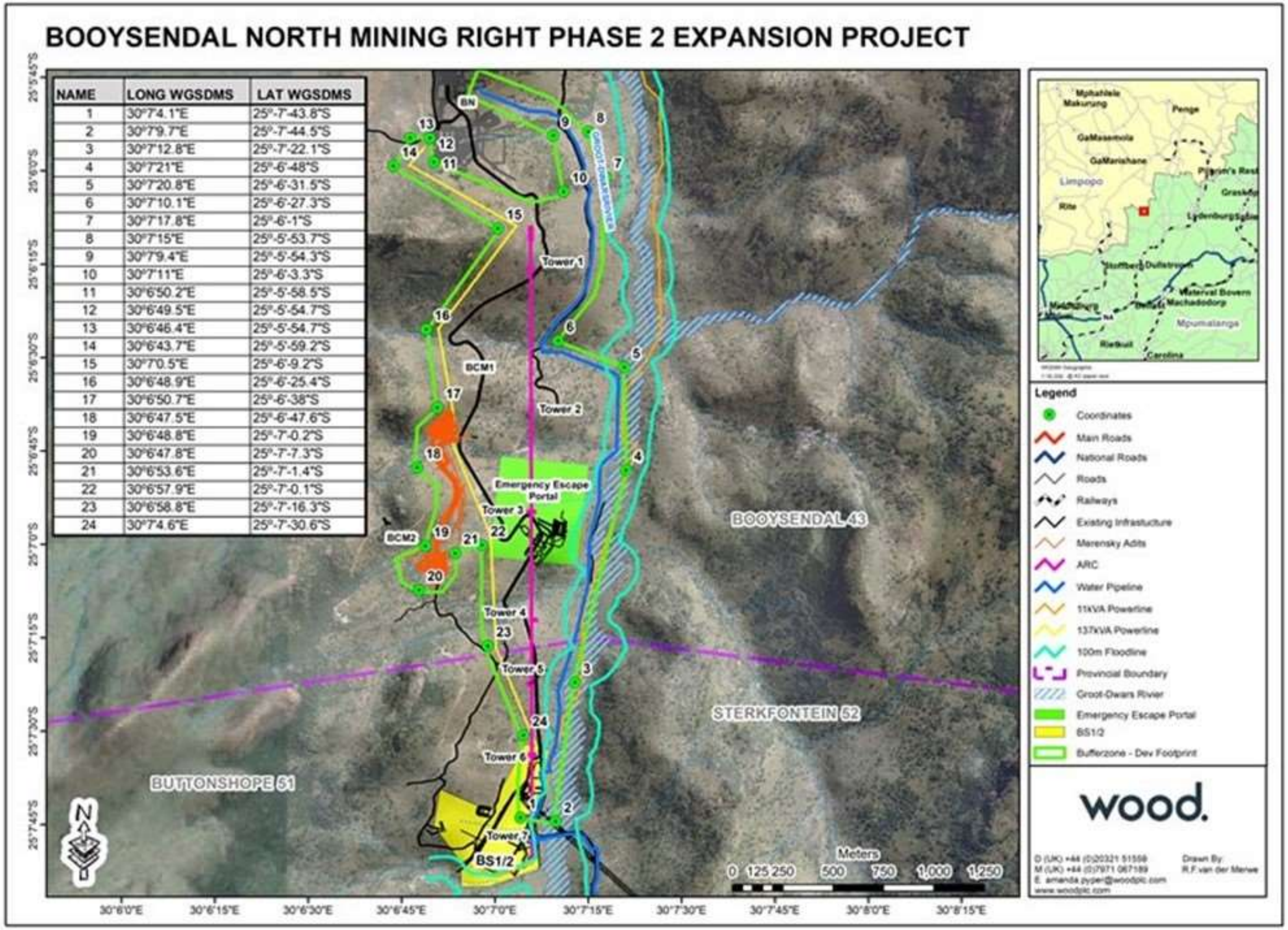
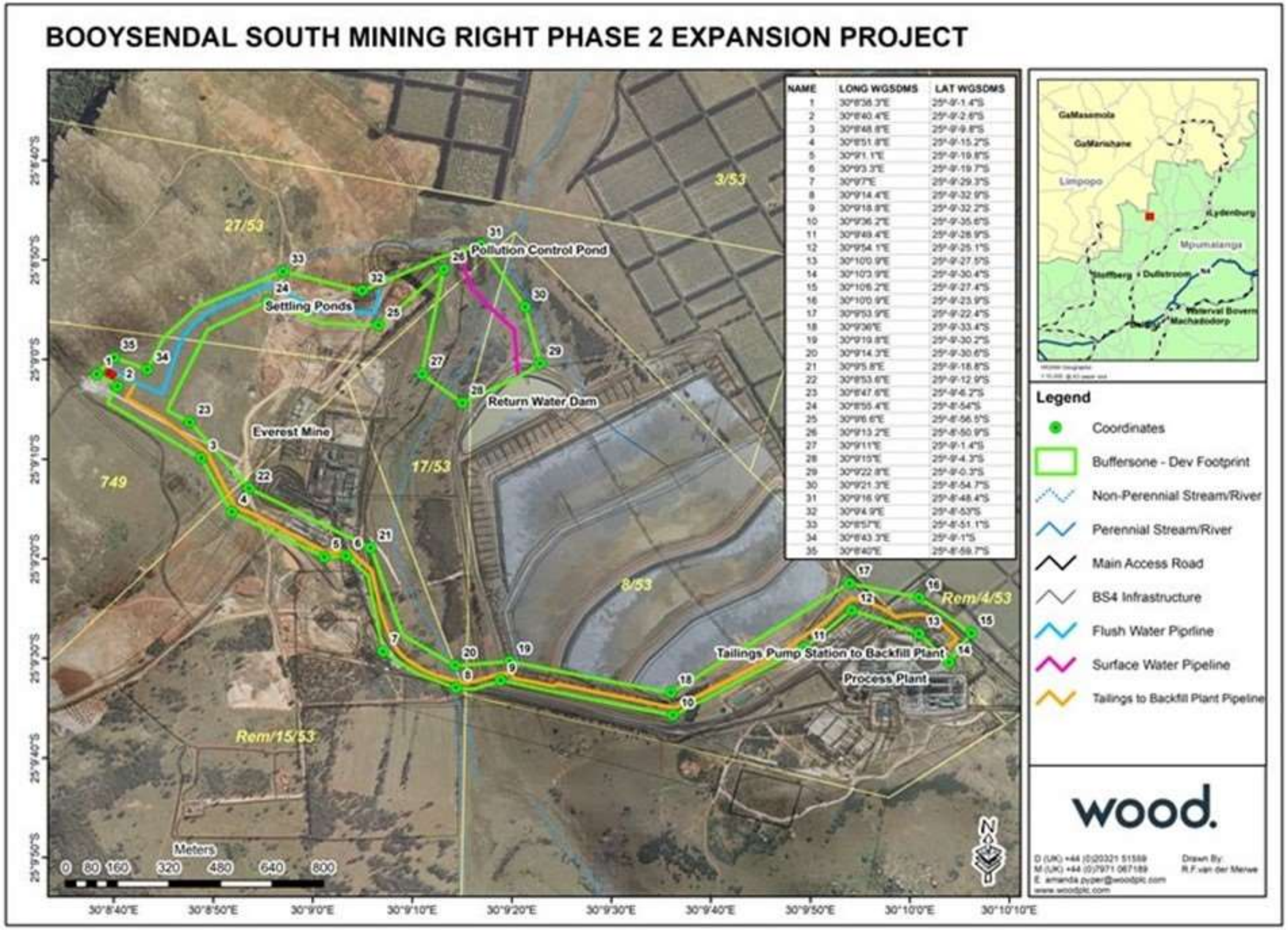


Figure 1-6 Booysendal South Expansion Project Phase 2 Development Footprint



# 2. Project Description

Booysendal embarked on expanding its Booysendal Mine through the Booysendal South Expansion Project with the aim to increase mining of the PGM minerals from the UG2 and Merensky Reefs. The Booysendal South Expansion Project specifically focusses on four development areas (BS1/2, BCM1 and BCM2, BS4 and Valley Boxcut) with linear and supporting infrastructure between the various development areas. The Section 24G EA for Phase 1 of this Project was granted on 5 January 2018 and construction activities are ongoing.

Booysendal has identified further expansion needs (the Phase 2 Project), for which the Phase 2 Project Applications are required. Listed activities in terms of the Waste Act are only applicable to the Booysendal South MR while other applicable waste management activities for the Booysendal South Expansion Project have been approved under the Section 24G EA. An IWULA under the NWA for all proposed future and current section 21 water uses is being carried out concurrently with the Phase 2 NEMA and Waste Act Applications.

The Life of Mine ("**LoM**") of the Booysendal South Expansion Project is approximately 40 years. The total BS reserve is estimated at 105.88Mt.

Phase 2 of the Booysendal South Expansion Project consists of activities in two MR areas as discussed below under the following headings:

- Booysendal North MR Activities; and
- Booysendal South MR Activities

The following sections provides further details around the Booysendal South Expansion Project: Phase 2. Detailed designs for some infrastructure components are still to be finalised as engineering work is ongoing.

## 2.1 Booysendal North Mining Right Activities

The layout of the proposed Booysendal North MR expansion is included in Figure 2-1 and involves:

- Development of surface infrastructure at BCM1 and BCM2, detailed further in sub-section 2.1.1. The layouts are included in Figure 2-2 and Figure 2-3 respectively;
- Development of an Emergency Escape Portal to serve BCM1, BCM2 and the BS1/2 underground complex, as an emergency escape way and return airway system;
- Retaining a 11kVA powerline from BN to BS1/2;
- Relocation of the BCM2 from the footprint approved in the Section 24G EA;
- Potable and process water lines for BS1/2, BCM 1 and BCM 2, running along the existing gravel access road along the Groot Dwars River between BS1/2 and BN. The potable water will be sourced from the existing Lebalelo allocation.;
- Access roads to the BCM1 and BCM2 Adits and the ARC towers; and
- An ARC system from BS1/2 to BN,

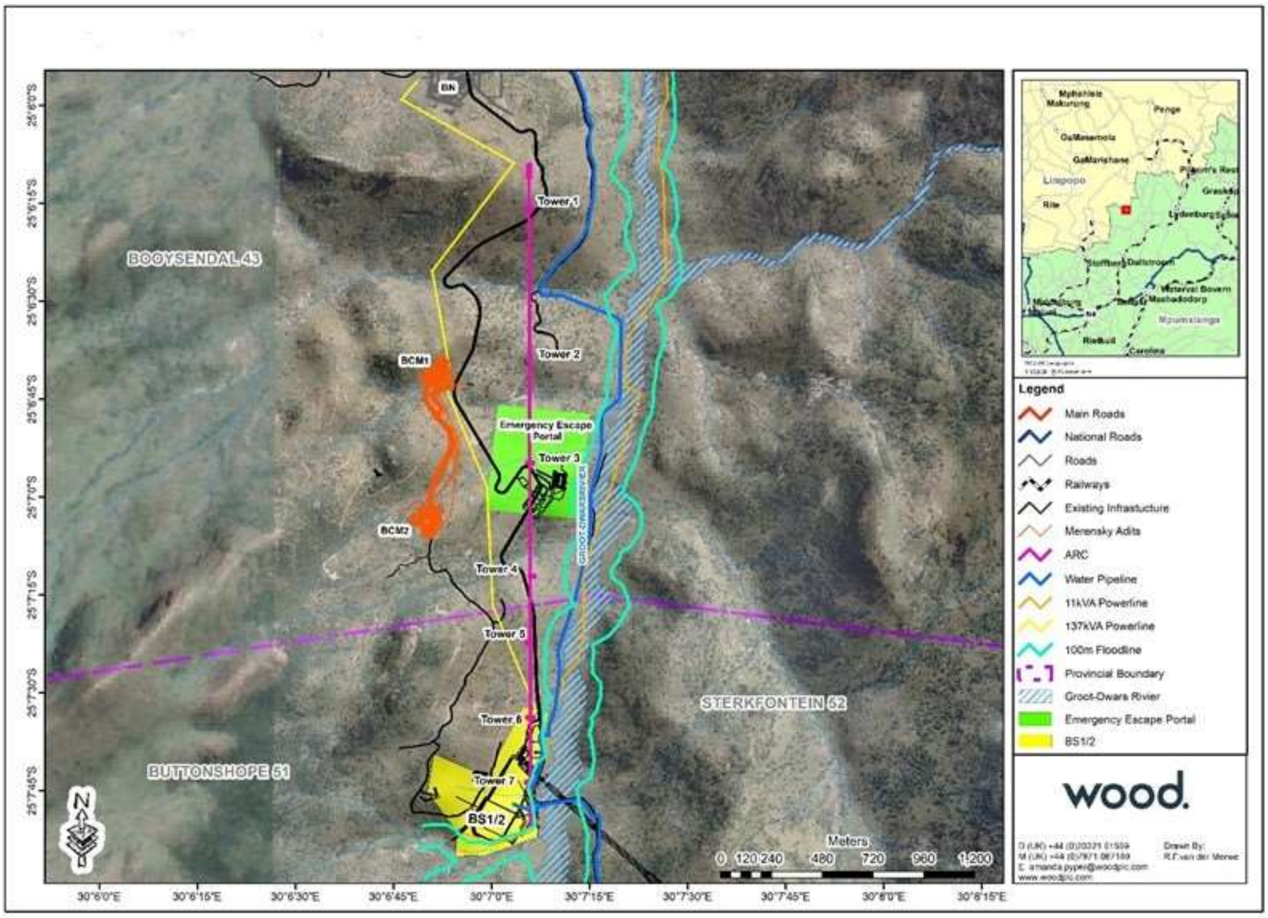
(collectively the "**Booysendal North MR Activities**")

### 2.1.1 BCM1 and BCM2 Surface Infrastructure

The BCM1 and BCM2 Adit development and associated mining was approved as part of the Section 24G EA. This included authorisation for: vegetation clearance of 4.5ha for the development of the two Adits; and on-reef, mechanised board-and-pillar mining at a rate of 22,500tpm.

As part of ongoing designs the location of BCM2 has since been moved further north from its approved location on the Remaining Extent of the Farm Buttonshope 51JT to a position next to BCM1 on the Farm Booysendal 43JT. The potential impacts related to this relocation has been included in the Consultation EIR and the Draft EMP, included in Annexure C, amended accordingly.

Figure 2-1 Booysendal North Mining Right Activities




As part of further Phase 2 Project developments, Booysendal identified the need for surface infrastructure components at BCM1 and BCM2 (both located on the Farm Booysendal 43JT). Surface infrastructure at each of the Adits include:

- Construction of a terrace: The terrace construction will require excavations and infilling of more than 10m$^3$ within 100m of two unnamed tributaries of the Groot Dwars River. The northern section of the BCM2 terrace will be within 32m from a drainage line, while both BCM1 and BCM2 are within 100m from drainage lines. 4.5 ha indigenous CBA vegetation clearance for BCM1 and BCM2 has been approved under the Section 24G EA;
- Conveyors:
  - A dip conveyor system, which will transport ore from underground to the crusher feed conveyor from where the ore will be transferred to the crusher plant located between BCM1 and BCM2.

The dip conveyor belts will be 1200mm wide with an electric drive of 2 x 132Kw. The conveyors will have a capacity of 450tph;

- The crusher ore will be transported via an overland conveyor to a silo just east of BCM2. From here the ore will be transferred via an ARC feed conveyor through a chute onto the ARC, which will transport the ore either to the process plant at BN or to the process plant at BS4;

- Silo with a capacity of 4,200t. The silo will be a concrete structure;
- Crusher: A grizzly crusher plant will be installed between the BCM1 and BCM2. The grizzly will reduce the particle size to -300mm and the crusher to -150mm. A dust suppression system will be installed at the crusher. It is indicated that maintenance and inspection procedures have been developed for the crusher. The crusher has a capacity of 50t;
- Infrastructure at the terrace areas will include the following:
  - An office complex, consisting of a combination of pre-fabricated containerised and brick buildings;
  - A workshop: the flooring will be concrete, with a combination of steel and brick building. Cut-off trenches will be constructed at the workshop's entrances. The areas surrounding the workshop will be paved. All run-off from the workshop will report to an oil separator. The workshop will be constructed with bunded areas, in which hydrocarbons and other chemicals will be stored separately. A temporary tyre bay will be provided at the workshop;
  - A brick change house (for 300 people), security fencing and access control building;
  - Transformer and substation;
  - Emulsion storage tanks: emulsion will be offloaded by tanker at an offloading containment area, which will be specifically bunded, provided with an impervious base and cut-off trenches on the open sides. The cut-off trenches will be sized to accommodate a 1:100-year flood event. There will be two tanks at each of the terraces. The volume of the two tanks will be 5,000l. Loading of the emulsion will be on a specially prepared loading area, which will have the same design parameters as the offloading containment area. The emulsion area will be fenced through security fencing with access control;
  - Oil and hydraulic fluids storage areas: all dangerous and hazardous goods will be stored in bunded areas. Diesel will be stored in containerised bunker and self-bunded storage areas. The volume of dangerous and hazardous material which will be stored at each of the portals are: 45,000l diesel; 5,000l hydraulic fluids, 5,000l engine oil, 5,000 l dirty oil;
  - A concrete bunded waste collection area;
  - Security fencing with access control;
  - A STP with a throughput capacity of 24m$^3$/day at BCM1 and 23m$^3$/day at BCM2. A modular package type potable STP will be installed to treat water to the special limits as the treated effluent will be discharged into the environment.
  - A high-density polyethylene ("**HDPE**") lined PCD and settler dam will be constructed at each of the Adit complexes. The combined capacity of the PCD (2,500m$^3$) and settler dam (1,000m$^3$) is 3,500m$^3$. The PCD and settler dam covers an area of 2,000m$^2$ (PCD 1,500m$^2$ and settler 500m$^2$) at each of the Adits;
  - Fire water and potable water storage tanks with a combined indicative volume of 80m$^3$ at BCM1 and 80m$^3$ at BCM2;
  - Compressors;
  - Hard top bus stop and parking bays;

- BCM1 and BCM2 will be accessed via 6m wide access roads off the main access road. All other access roads will be 4m wide; and
- Off-stream water storage which will be less than 50,000m$^3$.

*Construction Phase*:

During the construction phase, vegetation will be cleared along the conveyor routes, at the silo and crusher footprints, access roads and additional areas at the portals. Topsoil will be stripped and stored on designated topsoil stockpiles. Stockpiles will be placed on less sensitive areas based on the outcome of the specialist surveys. The topsoil will be used during final closure and rehabilitation.

There is a non-perennial drainage line to the south and north of the BCM1 terrace complex and south of the BCM2 terrace complex. The terrace area and some of the associated infrastructure will be constructed within 100m from both these unnamed tributaries of the Groot Dwars River. Refer to Figure 2-2 and Figure 2-3 for layout of the BCM1 and BCM2 Adit complexes respectively. Excavations and infilling will be done in this area for the establishment of the terraces. This will be followed by the construction of the surface infrastructure on the terrace.

The main 6m access roads to the Adits will be tarred. V-drains, culverts and erosion control measures will be put in place to protect the watercourses and sensitive soils. Tarring of the roads will assist in reducing dust mobilisation.

A STP will be constructed at each Adit. The STP will consist of in inlet works where upfront screening will take place. The screened effluent stream will report to a buffer tank, which will contain cutter pumps and submersible mixers. From here the effluent will be pumped to the biological reactor which consist of an anoxic and aerobic zone. Effluent will be mixed by mixers. Two pumps will transfer effluent from the anoxic zone to the aerobic zone. Diffusers in this unit will add oxygen for biological treatment. From the aerobic zone, the biologically treated effluent will flow to the clarifiers. Solids will return to the anoxic zone as activated sludge, while the rest of the solids will return to a sludge holding tank from where it will be removed for disposal at a licensed site. Water from the clarifiers will be directed for treatment, including chemical dosing pre-treatment, followed by a clarification phase in settlers, followed by filtration through pressure filters and final disinfection by chlorine dosing from where the water will be discharged into the environment.

The PCDs will be HDPE lined and need to be provided with Bird Balls. (In the US this is recommended by the U.S. Fish and Wildlife Service to prevent waterfowl from landing or residing in a pond receiving constant discharge from underlying mine operations).

*BCM1 and BCM2 Operational Phase:*

The BCM1 and BCM2 mines will operate on a 24-hour, 365 days per year basis, running on two 10-hour shifts. Every day logistics and administration will be take place from the offices at each of the operations.

Waste management will be done in terms of the existing waste management policy under the existing waste management license. Waste will be separated at source. Non-hazardous and hazardous waste will be stored separately and disposed of through the existing waste contractors who provide disposal certificates to Booysendal. Waste streams are expected to be the same as at BN and will likely include:

- Hazardous waste streams:
  - Fluorescent tubes
  - Printer cartridges
  - Sanitary waste (removed by cleaning company)
  - Lead batteries (returned to supplier)
  - Explosive packaging (burned in destruction bay)
  - Used oils and hydrocarbons (sold)

- Contaminated soil
- Empty hydrocarbon drums (reused on site)
- Reagent bags
- Sewage sludge and sewage
- Mixed waste (oil rags/ air filters/ aerosol cans/ empty paint and chemical containers
- Medical waste (removed by medical company's supplier)
- Lead couples

- General waste streams:
  - Domestic waste
  - Fat and wet waste
  - Conveyor belts (sold for reuse)
  - Building rubble
  - Copper (sold for reuse)
  - Garden refuse
  - HDPE and rubber (sold for reuse)
  - Wood (given to communities)
  - Scrap metal and aluminium (sold for reuse)
  - Vehicle tyres (returned to suppliers)

General waste which is not sold is collected by a waste contractor on a weekly basis and disposed at the Burgersfort Landfill site. Sewage is removed to the SDM waste water treatment works. Hazardous waste is disposed at Holfontein by the waste contractor.

Sludge from the sludge holding tank at the STP will be removed every three months. Maintenance of the STP will be done by the suppliers as prescribed.

All materials handing will be undertaken in terms of existing policies and in accordance with the existing integrated water and waste management plan ("**IWWMP**").

Mining activities and design of BCM1 and BCM2 have been approved as part of the Section 24G EA and will involve mechanical board and pillar mining. Up to a depth of 100 mbs, pillars will be 10m wide and 10m long. From 100 to 300mbs, pillars will be 13m wide and 12m long; from 300 to 500mbs, pillars will be 10m wide and 38m long; and deeper than 500mbs all pillars will be wider than 10m.

Ore will be transported from the underground via conveyor system. From here the ore will report to a transfer station from where it will be transported through a feed conveyor to the crusher plant, located between BCM1 and BCM2. The crushed ore will be transported via feed conveyor to a silo east of BCM2. From here the ore will be transferred via an ARC feed conveyor through a chute onto the ARC, which will transport the ore to the process plant at BS4.

PCDs will be operated to have a minimum freeboard of 0.8m under all circumstances. Any excess water which could pose a risk of spillage into the environment will be pumped to the 2.6 Ml dam at BN.

*BCM1 and BCM2 Decommissioning and Closure Phase*:

During the closure phase steal, conveyors, prefabricated buildings and equipment will be removed and sold where possible.

All surface infrastructure, above and underground pipes, cables and conveyors will be removed. All concreted, paved, and artificial surfaces will be removed. Where surfaces pose a contamination risk, it will be decontaminated or disposed of in accordance with best practice. Liners will be removed and disposed at a licensed landfill site.

The terrace area will be ripped, graded and shaped to blend in with the natural environment and to promote natural run-off and stream flow. A layer of 300mm of topsoil will be applied and the terrace will be seeded with a seed mix as proposed in the EMP (Annexure C) to ensure revegetation and rehabilitation. Erosion control measure will be put in place to assist in avoidance of concentration of run-off which could result on water channelling, erosion and jeopardising revegetation and rehabilitation.

All other footprints will be ripped and shaped, to enhance natural contouring and flow paths and patterns. Erosion control measures will be put in place. Topsoil will be applied and all footprint areas will be revegetated with an endemic seed mix, which excludes tef, alien, hybrid or cultivar seeds.

The Adits will be plugged to avoid decanting in the long term.

Figure 2-2 BCM1 Layout (Source: DRA, 2018)

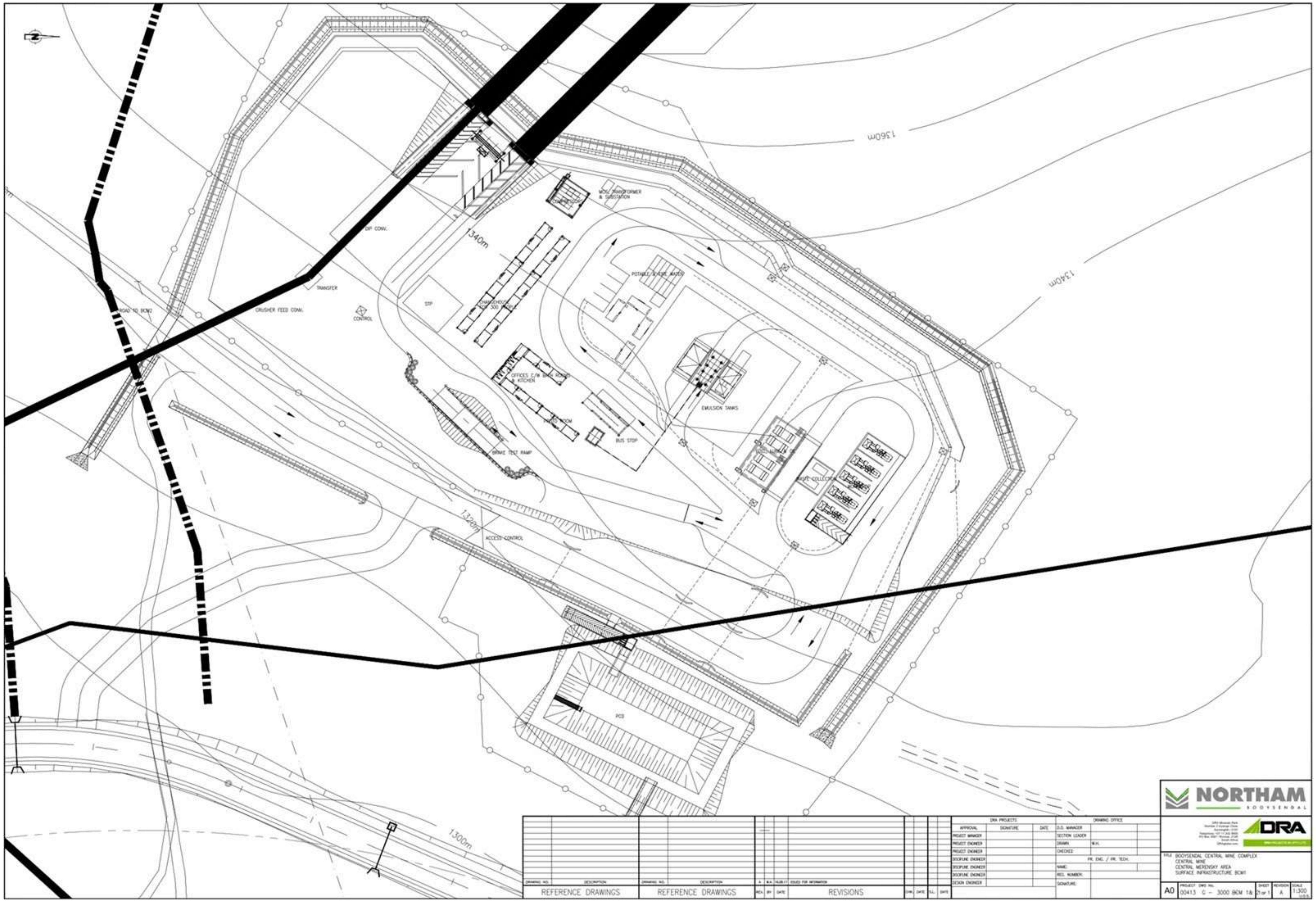
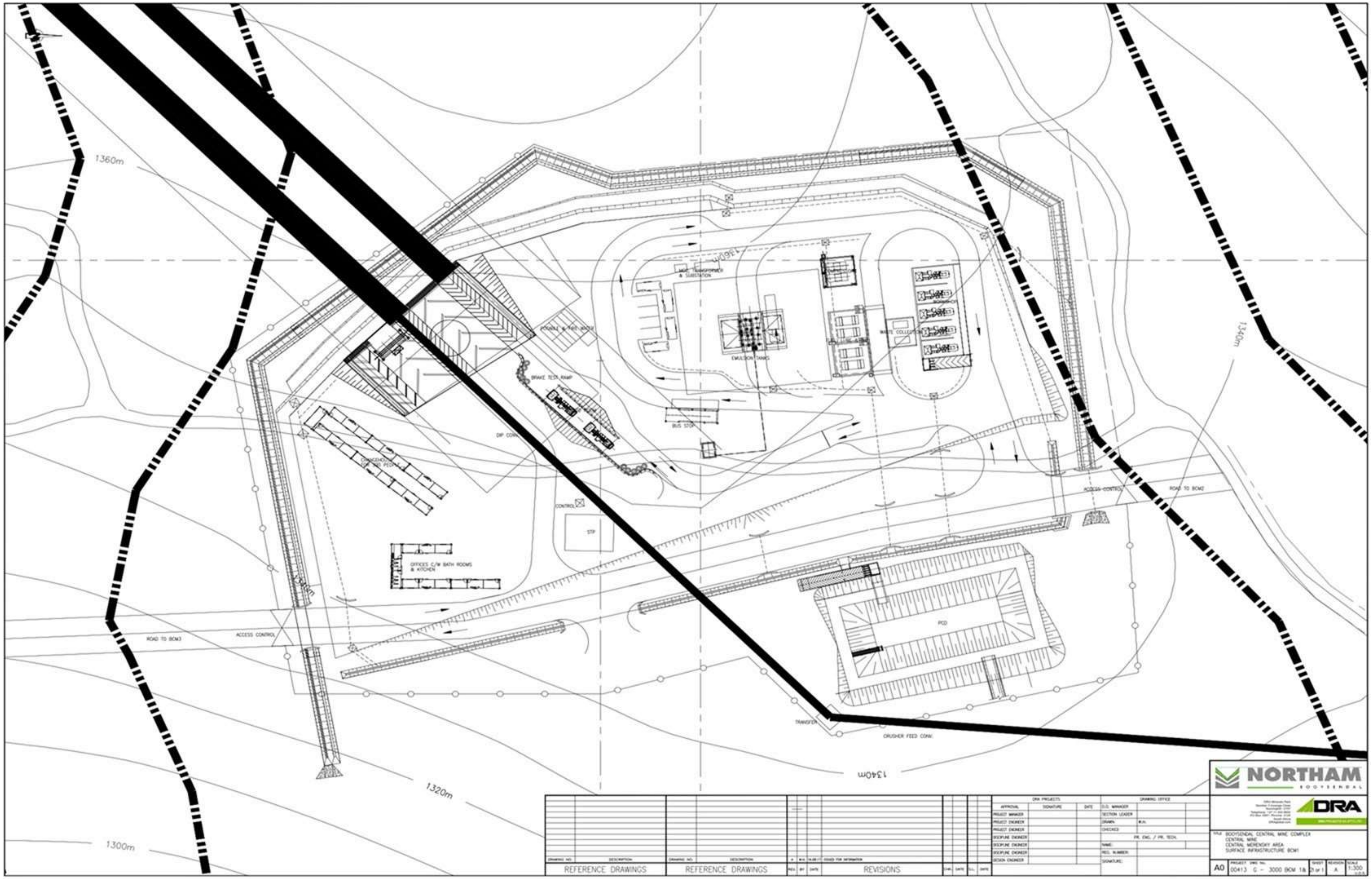


Figure 2-3 BCM2 Layout (Source: DRA, 2018)

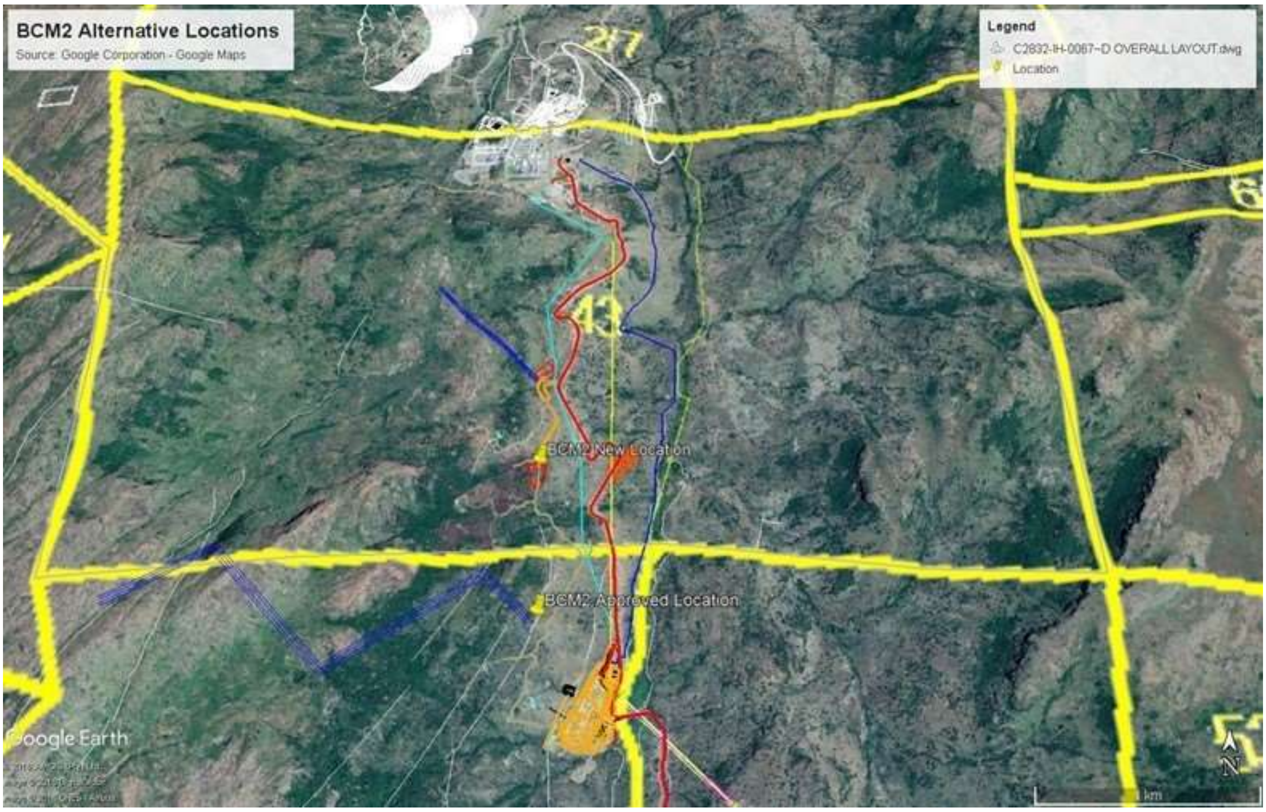


Erosion control measures at BCM1 and BCM2 will be put in place and storm water control measures will be retained until revegetation indicates 75% cover. Water quality monitoring will continue until the parameters indicate baseline conditions. Once 75% cover is achieved and water quality returns to baseline levels final rehabilitation of storm water measures will be done.

#### 2.1.1.1 BCM2 Approved and Proposed New Portal Positions

The location of the BCM2 Adit on the Remaining Extent of the Farm Buttonshope 51JT was approved as part of the Section 24G EA (refer to Figure 2-4). Due to the competency of the geology in the original position, which became apparent as a result of additional geotechnical investigations, in addition to the steepness of the terrain in the approved location, Booysendal proposed to move BCM2 to a position just south of BCM1 (refer to Figure 2-4) on the Farm Booysendal 43JT. The position was chosen due to the more competent geology, the more gradual topography and the potential for sharing of services between BCM1 and BCM2. The footprint size will remain the same as the approved footprint. An assessment of the potential impacts of the new and old BCM2 locations is included under Section10.18. For both options, the development will entail an on-reef adit through which mechanised board and pillar mining can take place at a rate of 22 500tpm. As described under section 2.1.1, additional surface infrastructure is also proposed with the Adit.

Figure 2-4 BCM2 Approved and Proposed New Location




### 2.1.2 Emergency Escape Portal

An Emergency Escape Portal is planned just east of the BCM1 and BCM2 complexes (see Figure 2-1) and north of BS1/2 on the Farm Booysendal 43JT. It will serve as a return airway system for BS1/2, BCM1 and BCM2 and as emergency escapeway. This is to comply with the mine health and safety requirements. The ventilation design and requirements are based on the mine design, production profile and underground equipment.

The Emergency Escape Portal will have a development footprint area of 1.3ha. Access will be gained from the main access road onto a 4m wide bitumen road.

*Construction Phase:*

During the construction phase vegetation at the portal will be cleared. Topsoil will be stripped and stockpiled and a designated specially prepared topsoil stockpile. A clean and dirty water cut-off trench will be constructed upstream of the portal to ensure that clean water is diverted around the portal. Excavations and infilling will be done to establish the portal. The faces will be stabilised through concrete and mesh. Rock from the portal excavation will be used to establish the portal and for the construction of associated infrastructure e.g. roads.

The return airways and ventilation system will be installed in the underground workings. Seepage water will be pumped out and collected in a sump, to ensure that there is no release into the environment.

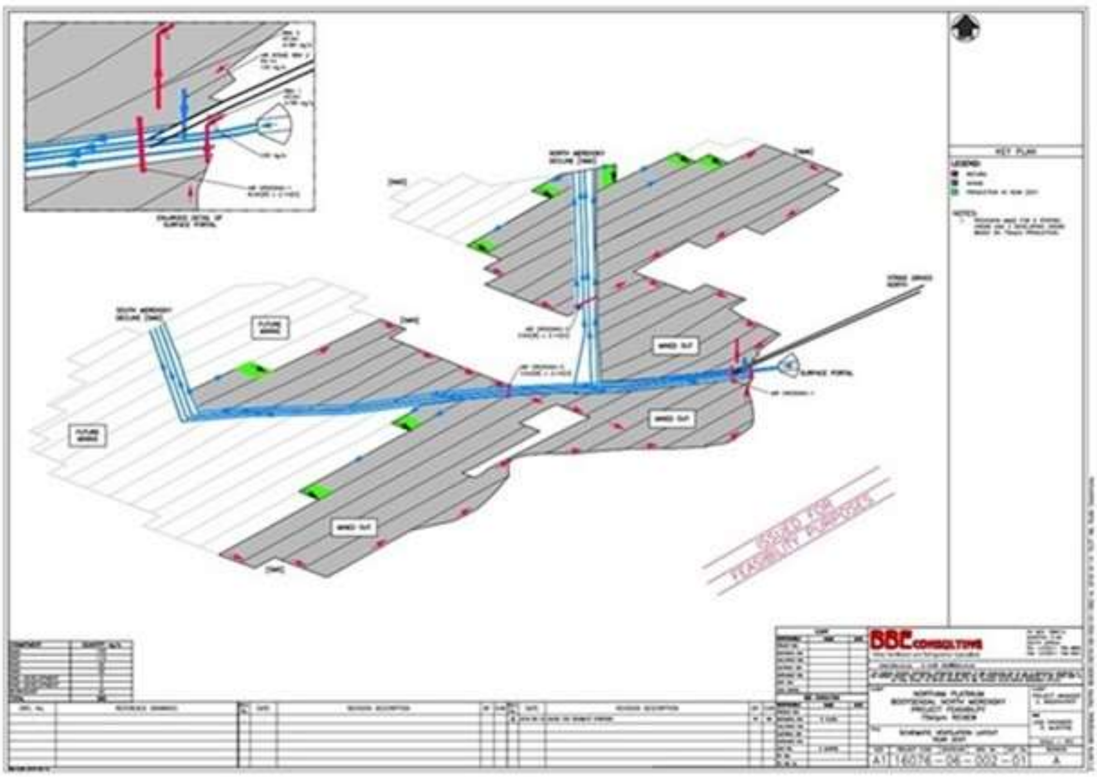
*Operational Phase*:

Activities at the Emergency Escape Portal will be limited to maintenance work on the ventilation system and the portal areas itself. The ultimate ventilation volume will be $360m^3/s$. The intake capacity at the Emergency Escape Portal will be $270m^3/s$ while the additional ventilation requirement ($90m^3/s$) will be provided by the ventilation shaft at BCM1. The ventilation design is included in Figure 2-5. Air will be returned on-reef through the Phase 1 Project ventilation shafts approved as part of the Section 24G EA.

*Decommissioning and Closure Phase*:

The vent pipes, cables and water pipelines will be removed and sold as scrap material or otherwise disposed. The portal will be sealed to avoid post-closure decanting. The areas around the portal and vent shaft will be ripped, contoured and graded to its natural pre-mining topographical character. A 300mm topsoil layer will be applied on all rehabilitated areas which will be revegetated with plants form the BS nursery and a seed mix which exclude tef, alien, hybrid, cultivar vegetation.

Figure 2-5 Emergency Escape Portal Ventilation Design (Source: BBE Consulting, 2016)



### 2.1.3 Aerial Rope Conveyor (ARC)

An ARC will be constructed from BS1/2 to BN on the Farm Booysendal 43JT and Remaining Extent of the Farm Buttonshope 51JT (refer to Figure 2-1). This will serve to transport ore from BCM1 and BCM2 to the process plant at BS4 (refer to Figure 2-6). Conveyor designs will be in accordance with international standard ISO 5048 and installation in terms of the Mine Health and Safety Act Regulation 8.9 (1-10). The ARC consists of seven towers, with the conveyor system strung in the air between the towers.

*Construction Phase:*

To develop the ARC vegetation clearance of more than 300m$^2$ in a CBA will be required at the tower footprints, access roads, anchor blocks, drive station areas and temporary laydown areas. The areas to be cleared for the ARC and associated infrastructure are included in Table 2-1 Clearance Requirements for the ARC Towers and Infrastructure (Source: Booysendal, 09 February 2018). The various tower components will be transported to the laydown and pre-assembly areas, in containers, for assembly.

The tower footprint areas will be excavated to an average depth of 2.0m, which may vary depending on the underlying geology. Once the excavation is done concrete foundations will be laid. 200 tonne cranes will be required for the assembling and installation of the towers. The height of the towers ranges between 2.36m to 37.50m from ground level. Once the towers are established, the conveyor system will be strung in the area, using cranes and trucks.

Infilling and excavations within a drainage line will be required at Tower 3 on the Farm Booysendal 43JT, which is in a non-perennial drainage line of the Groot Dwars River, and Towers 6 and 7 on the Remaining Extent of the Farm Buttonshope 51JT which are both located within 100m from the Groot Dwars River and delineated riparian wetland. For these three towers excavation and infilling of more than 10m$^3$ will be required.

Table 2-1 Clearance Requirements for the ARC Towers and Infrastructure (Source: Booysendal, 09 February 2018)

| Component | Clearance Area (Ha) | Component | Clearance Area (Ha) |
|---|---|---|---|
| Tower 1 | 0.056 | Tower 2 | 0.038 |
| Tower 3 | 0.1035 | Tower 4 | 0.1250 |
| Tower 5 | 0.1 | Tower 6 | 0.25 |
| Tower 7 | 0.045 | Anchor block | 0.04 |
| Anchor tower blocks | 0.065 | Drive station | 0.25 |
| **Total ARC Clearance Area (Ha)** | **1.072** | | |

Measures to minimise bird collision risk as a result of the ARC will be put in place. The principles and recommendations in The Birds and Wind-Energy Best-Practice Guidelines, South Africa by Jenkins et al. (2015) should be adapted where applicable, and adopted.

The construction process is illustrated in Figure 2-7 ARC Construction Activities.

*Operational Phase*:

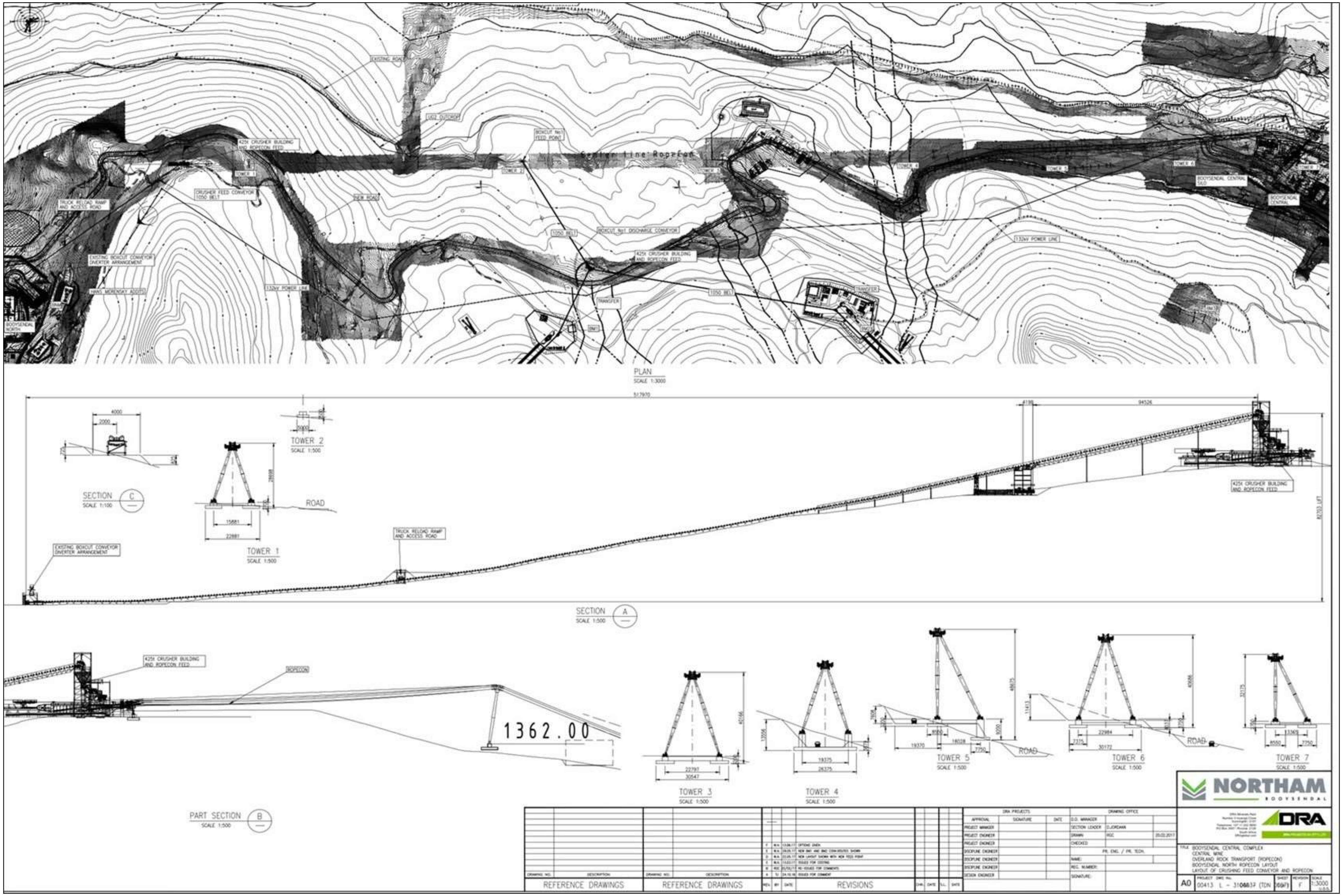
The conveyor system will run from the BCM1 and BCM2 underground workings to the feed silo; from here a supply conveyor will transfer the ore via a chute onto the ARC. Average tonnage to the silo will be 663tph, with a maximum tonnage of 1,977tph. A light spray will be installed at the tail of the ARC to bind the top layer when ore is transported. This, together with the existing 8% moisture content of the ore, should be sufficient to contain potential dust.

The ARC will be powered by two 2,000kVA transformers. It is indicated that the ARC will be operational for 17.1 hours per day and that ore will be transported from BN, BCM1 and BCM2 at rates of 1,150tph past BS1/2 to BS4. The monthly capacity of the ARC has been simulated at 464,225tpm. Ore will be tipped onto the stockpile at BS4.

In terms of the DRA Risk Assessment Review Report (JZASM0413-SHE-FO-36, 05/11/2015), the following operational measures will be put in place:

- The feed conveyors and the silos will be covered to avoid the mobilisation of dust particles;
- Dust suppression at the ARC loading points;
- Spillages will be avoided through vibrating feeders, with controlled feed to the conveyor, belts scales, feeder limits;
- A spillage conveyor with reloading facility onto the ARC will avoid spillages at the loading points;
- Where the ARC crosses roads and against steep gradients, a cover will be constructed to capture any potential spillages. The belt design also includes for skirts and cleats;
- To avoid runback of the belt, the ARC will be installed with multiple brake systems, an out-of-balance force and fail-to-safe breaks;
- The ARC will be provided with sufficient earthing to avoid lightning strikes;
- Visual markers will be added on the higher towers as warning system to aircraft, in accordance with the Civil Aviation Authority's requirements;
- Areas where the ARC is lower than 6m will be fenced, to avoid access and danger to communities; and
- A maintenance methodology will be developed, to ensure effective long-term maintenance and integrity of the system and will be undertaken using an aerial inspection car.

Figure 2-6 Phase 2 Project ARC and Conveyor Routes (Source: DRA, 2017)



Bi-weekly conveyor maintenance will be conducted, in accordance with the maintenance procedures implemented at BN.

*Decommissioning and Closure Phase*:

The ARC system (including silos, feed conveyors and ARC Roads) will be removed. Concrete anchor blocks will be removed. All disturbance footprints, including access roads and laydown areas, will be ripped and graded. Where towers are in streams or wetlands, the naturel flow regime will be reinstated and wetlands will be rehabilitated with the aid of a wetland specialist. A 300mm layer of topsoil will be applied to all disturbance areas and revegetated with plants form the BS nursery and a seed mix which exclude tef, alien, hybrid, cultivar vegetation.

Figure 2-7 ARC Construction Activities (Source: Doppelmayr, 2016)

| | |
|---|---|
|  |  |
| Laydown and pre-assembly area | Tower foundations |
|  |  |
| Tower placement | Conveyor belt installation equipment |

### 2.1.4 Water Pipeline

A HDPE process water pipeline will be constructed from the BS1/2 portal complex to BN on the Farm Booysendal 43JT and Remaining Extent of the Farm Buttonshope 51JT (see Figure 2-1) ("**BS1/2 / BN**

**Pipeline**"). The purpose of the pipeline will be to transfer excess water from the 14,000m$^3$ PCD at BS1/2 and the PCDs at BCM1 and BCM2 in the event of high rainfall to the 2.6 Ml cement dam at BN to avoid spillage of untreated process water into the Groot Dwars River. The pipeline is planned to run along the existing gravel access road next to the Groot Dwars River, although an alternative route along the main access road is also being considered. The pipeline will have a diameter of between 210mm and 250mm with a throughflow of less than 120l/s, therefore outside of the scope of the activities listed in 2014 EIA Regulations Listing Notices 1 and 2, published in terms of NEMA ("**NEMA Listed Activity**"). However, as it falls within a CBA and will require more than 300m$^2$ clearance it triggers a NEMA Listed Activity under Listing Notice 3.

Potable water will be provided from the 10M raw water reservoir ("**RWR**") at BN to BS1/2. Potable water will also be offtake at BCM1 and BCM2. The source of the potable water is the current Lebalelo pipeline, for which Booysendal holds an existing allocation. The pipeline will follow the same alignment as the process water pipeline. The pipeline will have a diameter of between 210mm and 250mm with a throughput of less than 120l/s, therefore also falling outside of thresholds of the NEMA Listed Activities. Water will be treated to drinking standards with either a filer or a water treatment plant system. Clearance will be alongside the process water line.

*Construction Phase:*

During the construction phase a corridor along the existing gravel access road running next to the Groot Dwars River will be cleared. The total pipeline footprint will be 7.5ha. The designs indicated that the pipeline will run above ground. This should assist in reducing environmental impacts. The potable water line will be a steel pipe with a diameter of between 210mm and 250mm. The alternative route will be along the existing main road, therefore in an already disturbed area reducing the need for additional vegetation clearance.

*Operational Phase*:

The water balance provided by DRA (GBP-ENG-REP-001(design) – Rev1 and PZASM0413 Booysendal Integrated Water Balance Analysis_Rev1, dated 06/11/2017) indicates that there will be the following offtakes from the Lebalelo source:

- BCM 1: average daily offtake of 108m$^3$/day;
- BCM2: average daily offtake of 107m$^3$/day; and
- BS1/2: 233m$^3$/day.

The offtake point is the 10Ml RWR at BN, from where the water will gravity flow and be pumped to the water treatment plant storage tanks at BS1/2, BCM1 and BCM2.

The estimated volume of process water which will be transported between BS1/2, BCM1 and BCM2 to BN as indicated on the water balance is 39 363m$^3$/month.

*Decommissioning and Closure Phase:*

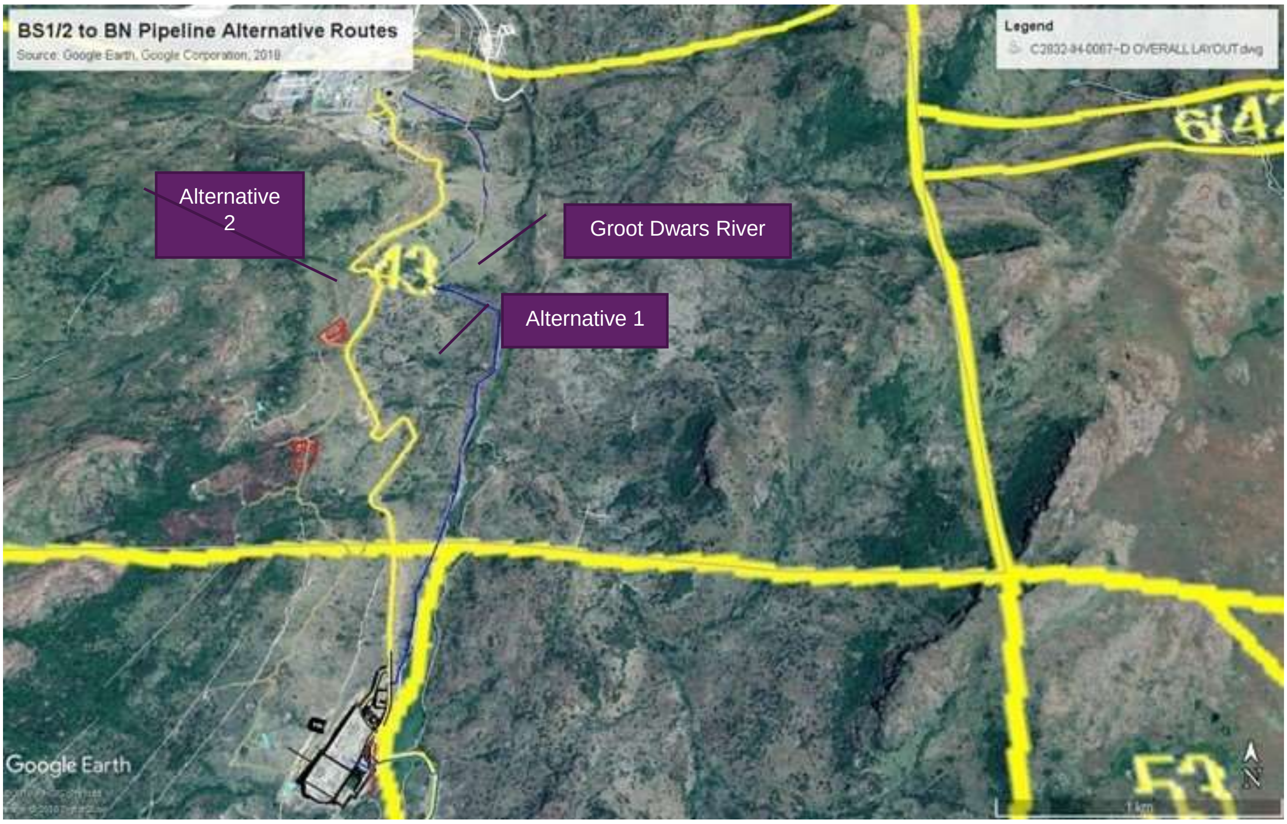
At the end of the Booysendal Mine LoM, the pipelines, booster pumps and air release valves will be removed and disposed, in accordance with best practice at that point in time. The corridor will be ripped and graded to support the natural flow regime and to avoid any concentration of water and erosion. A 300mm layer of topsoil will be applied and the footprint areas revegetated with plants form the BS nursery and a seed mix which exclude tef, alien, hybrid, cultivar vegetation.

#### 2.1.4.1 Pipeline Alternative Routes

Two alternative routings were considered for the process and clean water pipelines between BS1/2 and BN. The first following a routing along the Groot Dwars River and the second a routing along the main access road which is being constructed as part of the Phase 1 Project, and the second following the route along the Groot Dwars River. The alternative routings are indicated in Figure 2-8 while the potential impacts associated with the alternatives are assessed in Section 9 of this Consultation EIR. The route along the Groot Dwars

River will require clearing of approximately 7.5 ha, while the area along the main access road has already been disturbed and will require less clearance.

Figure 2-8 Alternative BS1/2 to BN Pipeline Routes




## 2.1.5 Access Roads

Access roads will be constructed to access the ARC towers (the ARC Roads) and the conveyors between BCM1 and BCM2 ("**Conveyor Roads**") on the Farm Booysendal 43JT. The Conveyor Roads to BCM1 and BCM2 will be 6m wide while all other access roads will be 4m wide. Roads for maintenance purposes will not be tarred while permanent roads at the operations will be tarred. The total clearance requirement was indicated as 1.03ha for access roads. Alignments are included in Figure 2-1, Figure 2-2 and Figure 2-3.

*Construction Phase:*

Vegetation clearance in the CBA will be required to establish the access roads and to a lesser extent to upgrade existing exploration of farm tracks where these will serve as construction or maintenance roads. The road designs will include the necessary storm water and erosion control measures and culverts where it crosses drainage lines.

*Operational Phase:*

The access roads will mainly be used for busses to transport employees during the two shifts, with some delivery vehicles and light vehicles of office and workshop personnel. Unpaved roads will be used for maintenance purposes of the ARC, powerline, pipeline etc. Culverts, v-drains and storm water management infrastructure will be cleaned and maintained in terms of the provisions included in the EMP (Annexure C). Dust suppression will be undertaken.

*Decommissioning and Closure Phase*:

The hard tops of the access roads will be ripped and removed. All access road surfaces will be ripped. Areas will be shaped to natural contouring and to avoid channeling of water and erosion. A 300mm topsoil layer will be applied for rehabilitation and re-vegetation. Revegetation with plants from the BS nursery and a seed mix which exclude tef, alien, hybrid, cultivar vegetation will be used for revegetation of areas impacted by the access roads.

### 2.1.6 11kVA Powerline

A temporary 11kVA powerline runs from BN to BS1/2 (see Figure 2-1). The purpose of this line was to provide temporary construction electricity to the BS1/2 operation during the construction phase. Booysendal wants to retain this powerline in the long term to make provision for potential future development at BS. The powerline routing and that of the water pipelines are approximately the same. The 11kVA powerline does not trigger a NEMA Listed Activity.

*Operational Phase:*

The powerline will provide permanent power to the BS1/2 complex, with potential off-take to other areas at BS.

*Decommissioning and Closure Phase:*

The powerline will be removed and areas along the pylons will be rehabilitated and revegetated.

## 2.2 Booysendal South Mining Right Activities

BS4 has been under care-and-maintenance since 2012 due to the collapse of a southern section off the main underground workings. Before ceasing operations, BS4 was a fully operational mine, consisting of two mine declines at the main operational area (from where mining took place prior to 2012) and a decline at the Valley Boxcut, for which an EA was obtained to develop proposed surface infrastructure at the Valley Boxcut. The ore was then transported via conveyor systems to an ore stockpile just south of the workshops at the conveyor loading point, from where it was then transported to the process plant. There are two silos on route to the process plant: a Run of Mine ("**RoM**") silo close the declines; and a crushed ore silo at the process plant. The ore was crushed through a single jaw crusher and then transported the RoM silo, while further crushing was done through a ball mill crusher at the process plant.

A conventional flotation process was then used to extract the PGMs from the ore. The concentrate was filtered to produce a filter cake with approximately 14% moisture contents. The fine factions (slime) resulting from the cyclone plant was sent to a spiral plant next to the process plant, from where chrome was recovered. The coarse tailings from the flotation circuit were thickened with thickeners, water recovered for re-use and the tailings pumped to the TSF1 via a slurry pipeline. Once the chrome was recovered from the fine tailings, it was also directed to the thickeners and pumped with the coarse tailings to the TSF1 via a slurry pipeline. Water from the tailings were drained to the RWD.

To support the mining facilities various auxiliary infrastructure was put in place, including workshops, offices, STP etc. The existing mine infrastructure has been maintained in an operational readiness state since 2012.

As part of the future Booysendal South Expansion Project: Phase 2, Booysendal has identified the need to rework the tailings from the existing TSF1 to recover PGMs and chrome and backfill the collapsed and worked out underground workings. This will assist in freeing up space on the existing TSF1, thereby extending its life and the immediate need for a new TSF. Reworking of the tailings and backfilling of the underground working has been authorised under the Section 24G EA. To enable the backfilling, the following additional infrastructure will also be required:

- A Backfill Plant;

- The associated BS4 Pipelines between the Process and Backfill Plant, underground workings and a sump, sump to the existing PCD (MCC1) and pipeline from MCC1 to the RWD; and
- Three emergency backfill ponds along the Tailings Pipeline between the Backfill Plant and Process Plant, and cut-off trenches along the slurry pipeline,

  (collectively, the "**Booysendal South MR Activities**").

The layout of this development is included in Figure 2-9. Figure 2-10 includes the locations of alternative rout options considered for the pipelines associated with the backfill process.

### 2.2.1 BS4 Backfill Plant, Tailings and Process Water Pipelines and Access Road

*Construction Phase*:

On the Process Plant side, a new pump station with a number of centrifugal pumps will be installed to pump the tailings to the Backfill Plant on the Farm Sterkfontein 749JT. It will also require the construction of a new seal water tank for water supply to enable the pumping of the tailings to the Backfill Plant.

The Backfill Plant will be established next to the existing compressor house, fuel farm and shaft at the western side of the main BS4 mining complex, approximately 2.9km from the Process Plant. This area is therefore already disturbed and is not a greenfields site. The Plant will consist of an agitated, backfill holding tank in which the tailings from the Process Plant will be received. The holding tank will be connected to the new pump station, consisting of six centrifugal pumps which will distribute the tailings to the underground workings. Underground pumps will be installed to pump the water filtering from the tailings back to surface. A water tank for flushing purposes will also be constructed as part of the Backfill Plant to flush the depositions pipes and avoid clogging and spillages.

The new BS4 Pipelines that will be constructed are as follows:

- The Tailings Pipeline between the Process Plant and the Backfill Plant, which will traverse the Farm Sterkfontein 749JT and Remaining Extents of Portions 15 and 4 and Portion 8 and 17 of the Farm De Kafferskraal 53JT and will consist of steel pipes of 250mm in diameter for the transport of the tailings between the two Plants. The pipeline will be contained in an emergency casing, which will contain spillages in the event of an emergency where it crosses drainage lines. A cut-off trench will also be constructed along the trench to ensure that in the event of an emergency, the tailings are diverted away from drainage lines. An emergency shut-off system will be provided for the pipeline, to ensure that in the event of spillage the feed to the pipeline is stopped. In addition, three emergency backfill ponds have been designed along the pipeline route to further contain spillages in the unlikely event that it should occur. Flow meters will be provided on the line to ensure that any losses in flow is picked up immediately.
- A 200mm HDPE water pipeline will be constructed from the sump located next to the northern decline to the water tank at the Backfill Plant, which will traverse the Farm Sterkfontein 749JT and Portion 27 of the Farm De Kafferskraal 53JT ("**BS4 Pipeline 1**"). This water will be used to flush the backfill pipelines before each shift.
- Next to this, a new 200mm HDPE pipeline will pump excess water from the underground back to the sump on Portions 27, 17 and 8 of the Farm De Kafferskraal 53JT ("**BS4 Pipeline 2**") from where it will gravity flow to the existing PCD to the north of the BS4 mine site ("**MCC1 PCD**").
- A new 200mm HDPE pipeline will also be constructed from the MCC1 to the RWD, which will traverse the Farm Sterkfontein 749JT and Portions 17 and 8 of the Farm De Kafferskraal 53JT ("**BS4 Pipeline 3**"). Excess water from the sump will flow into this PCD. From here the water will be pumped to the RWD for reuse in the process. Current designs indicated that none of the pipelines will have a throughput capacity exceeding 120l/s.

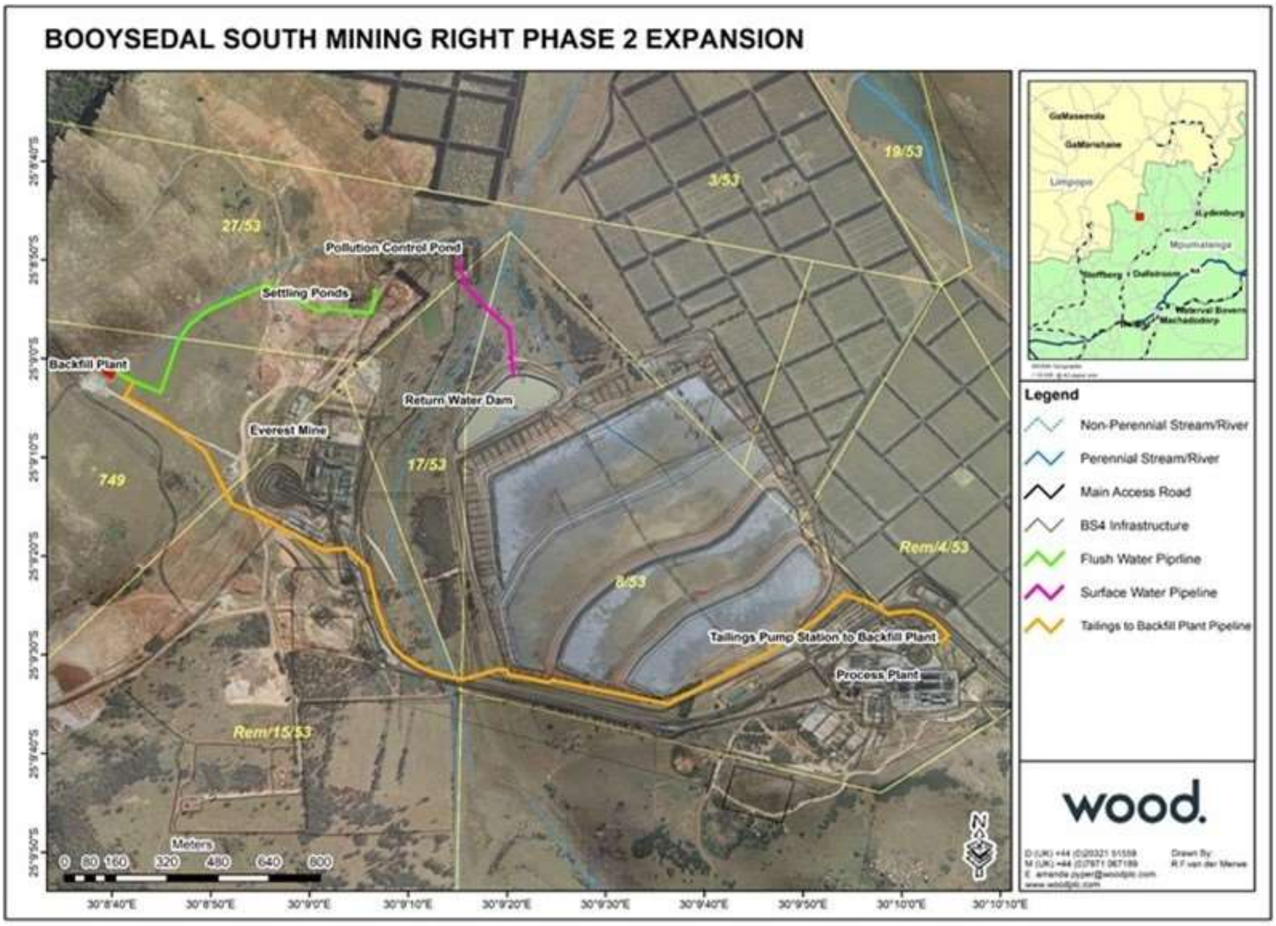
Existing underground pipelines will be used for the deposition of the tailings into the underground workings.

*Operational Phase:*

The operational life of the Backfill Plant will be approximately 2 years, after which the underground workings will reach its capacity. The Plant will no longer be required and concurrently rehabilitated. It will operate during day times for 16.2 hours per day, 360 days per year. There will be 3 six-hour shifts.

The backfill process is illustrated in Figure 2-11. The process will involve the mobilisation of tailings on the existing TSF1 through hydro-mining. The tailings will be pumped to the Process Plant where the tailings will be re-processed in the floatation (to recover PGMs) and spiral (to recover chrome) plants. Coarse tailings from the flotation plant will be pumped to the dewatering plant at the Process Plant and from here it will be pumped to the Backfill Plant. The fine tailings, which is a by-product from the flotation process, will be pumped to the spiral plant. The fine tailings will be redeposited on the existing TSF1.

Figure 2-9 Booysendal South Mining Right Phase 2 Activities




The coarse tailings will be transferred to the Backfill Plant at a rate of 247 dry tonne per hour ("**tph**") or a total volume of 250m$^3$ per day. Tailings will only contain flocculants and no cement, as deposition will take place hydraulically. The tailings will be received in the holding tank from where it will be pumped to the underground workings. Excess water filtrating from the tailings in the underground workings will be pumped to the sump, which gravity feeds into MCC1 PCD, from where it will be pumped to the RWD for reuse in the plant process. The average flow rates for the various pipelines during the operation phase is included in Table 2-2.

Figure 2-10 Backfill Pipeline Alternatives

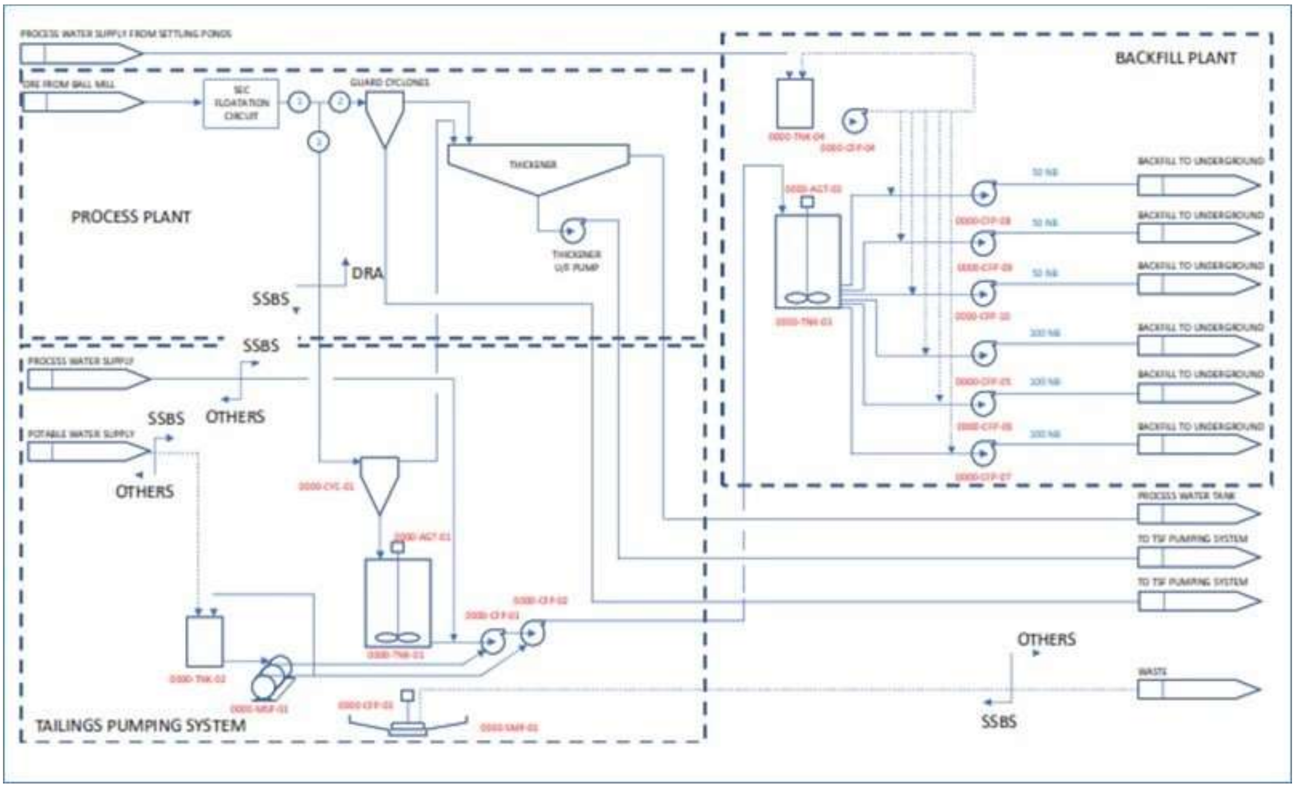

Table 2-2 Backfill Operations Pipeline Flow Rates (Source: Sustainable Slurry and Backfill Solutions, 2017)

| Pipeline | Operating Density | Solid Throughput (tonne per hour ("tph") | Average Volumetric Flow Rate |
|---|---|---|---|
| **Process Plant to Backfill Plant** | 1.86 t/m$^3$ | 235 dry tph | 194 m$^3$/h |
| **Backfill Plant to Underground Workings** | 1.86 t/m$^3$ | 78.3 dry tph | 64.6 m$^3$/h |
| **Settling Pond to Backfill Plant** | 1.00 t/m$^3$ | - | 232 m$^3$/h |
| **MCC1 to RWD** | 1.00 t/m$^3$ | - | 150 m$^3$/h |

*Decommissioning and Closure Phase*:

After two years the Backfill Plant and associated infrastructure will be dismantled and either sold or removed and disposed at a licenced landfill site. The liner in the emergency backfill ponds will be removed and disposed at a licenced landfill site. The ponds will be backfilled and the areas rehabilitated. The pipelines will be flushed to ensure that it contains no tailings, after which it will be removed. The footprint areas will be ripped, graded and revegetated.

Figure 2-11 Backfill Process (Source: Sustainable Slurry and Backfill Solutions, 2017)




## 2.2.2 Emergency Backfill Ponds

*Construction Phase:*

Three emergency backfill ponds will be constructed along the Tailings Pipeline on the Farm Sterkfontein 749JT and Remaining Extent of Portion 15 of the Farm De Kafferskraal 53JT between the Process Plant and Backfill Plant in areas which could be sensitive to emergency spillage, e.g. where the pipeline crosses drainage lines or wetlands. The purpose of these ponds is to contain any spillages, which may occur in the unlikely event of an emergency.

The ponds have been designed with a 1mm HDPE liner, but future source-pathway-receptor analysis will be carried out as part of the IWULA phase to inform liner requirements. The location of the emergency backfill ponds is included in Figure 2-12. The ponds will each be 3m x 3m.

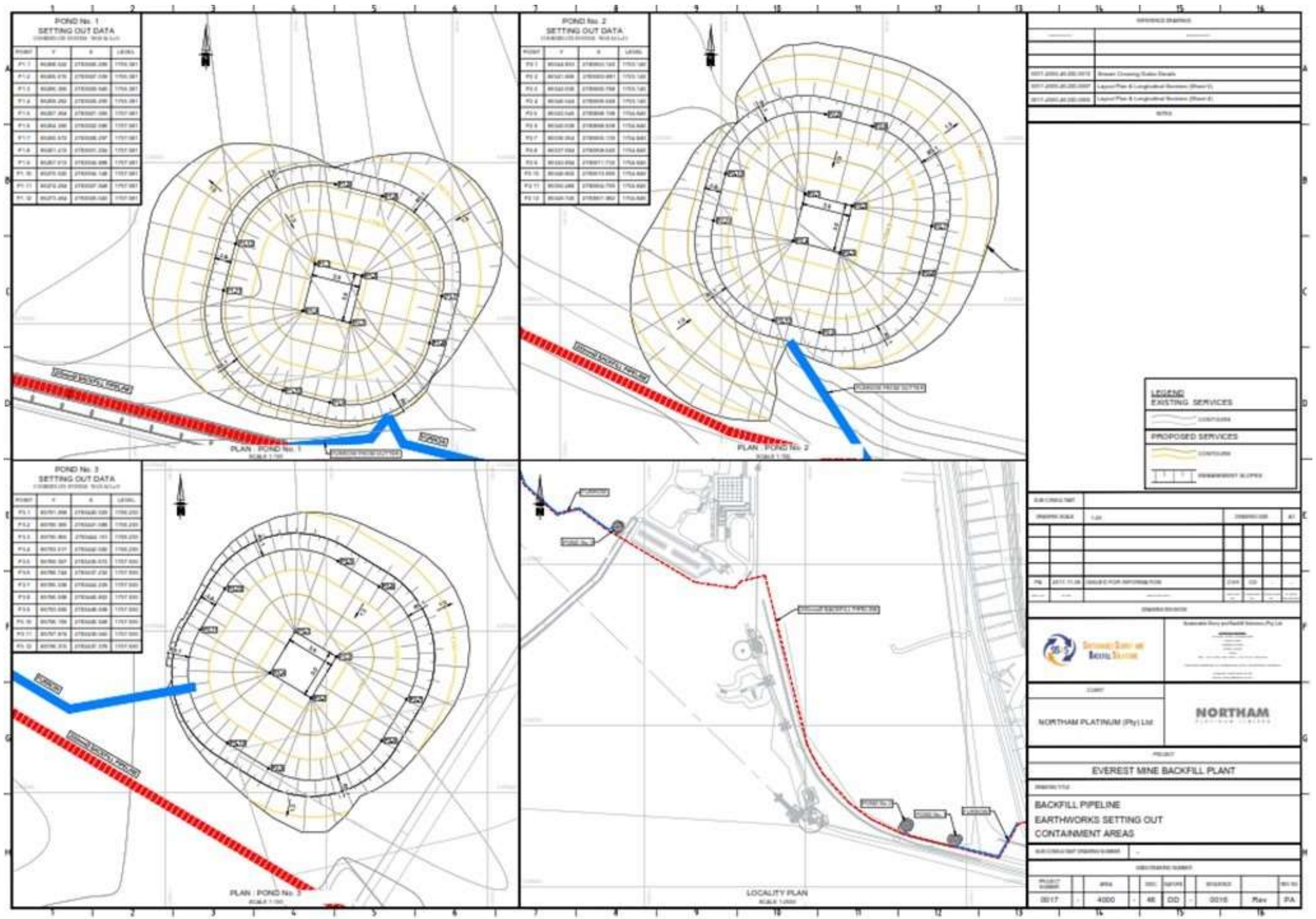
*Operational Phase*:

The ponds will serve as emergency containment structures, which will contain tailings spillages in the unlikely event that it could occur from the Tailings Pipeline. The integrity of the ponds will be monitored as part of the maintenance programme of the Booysendal Operation. The ponds will always be operated as empty.

*Decommissioning and Closure Phase*:

The liner will be removed and disposed of at a licensed landfill site. The excavation will be filled, compacted, graded and shaped to support natural run-off and to control erosion. The areas will be revegetated.

Figure 2-12 Emergency Backfill Ponds at Booysendal South MR (Source: Sustainable Slurry and Backfill Solutions, 2018)



# 3. Environmental Legal Framework

Various authorisations / permits / licenses ("**Environmental Consents**") are required in terms of South African environmental law to commence with the activities associated with Booysendal South Expansion Project: Phase 2, including:

- An EMP Amendment in terms of Chapter 5 of NEMA (previously under section 102 of the MPRDA) for all mining related activities;
- EAs in terms of Chapter 5 of NEMA for all activities listed under Listing Notices 1, 2 and 3 of the 2014 EIA Regulations ("**EIA Listing Notice**s") (published under GNs R983 ("**Listing Notice 1**"), R984 ("**Listing Notice 2**") and R985 ("**Listing Notice 3**") in GG 38282 of 4 December 2014, as amended under GN R324, GN R325 and GN R327 in GG 40772 of 7 April 2017);
- An IWUL for water uses listed under section 21 of the NWA and exemption for certain activities under GN 704 in GG of 4 June 1999 ("**GN 704**");
- A permit to remove protected species within the development footprints in terms of section 23 of the National Forests Act, No 84 of 1998 ("**NFA**"); and
- a WML under the Waste Act and the 2013 WML Regulations.

NEMA makes provision for an integrated environmental application process for a WML and EA but not an IWULA. The IWULA process is being undertaken in terms of the NWA and concurrently with the integrated application process (refer to Figure 3-1). This will ensure that a holistic understanding of the Phase 2 Project aspects and impacts are obtained and that all potential impacts are communicated to all I&APs.

This section of the Consultation EIR details the various environmental legislative and regulatory requirements applicable to Booysendal South Expansion Project: Phase 2. It includes a description of the EIA process (applicable to the Phase 2 NEMA and Waste Act Applications) and provides details on how the EIA process ties into the IWULA, which runs concurrently with this environmental authorisation process.

The South African environmental legislation that applies to the Booysendal South Expansion Project: Phase 2 and which are considered in the Phase 2 Project Applications is listed in Table 3-1. The requirements of the main acts are further described in this section.

Table 3-1 Applicable South African Environmental Legislation for Booysendal South Expansion: Phase 2

- The Constitution of South Africa Act, 1996
- Minerals and Petroleum Resources Development Act, No 28 of 2002
- National Environmental Management Act, No 107 of 1998
  - GNR 982 of 4 December 2014 – Environmental Impact Assessment Regulations
  - GNR 983 of 4 December 2014 – Listing Notice 1: List of Activities and Competent Authorities
  - GNR 984 of 4 December 2014 – Listing Notice 2: List of Activities and Competent Authorities
  - GNR 985 of 4 December 2014– Listing Notice 3: List of Activities and Competent Authorities
  - GN 1147 of 20 November 2015 – Financial Provisioning Regulations for Prospecting, Exploration, Mining or Production Operations ("**Financial Provisioning Regulations**")
- National Environmental Management: Biodiversity Act No, 10 of 2004
  - GNR 151 of 23 February 2007 – Lists of Critically Endangered, Endangered, Vulnerable and Protected Species
  - GNR 598 of 1 August 2014 – Alien and Invasive Species Regulations, 2014
  - GN 864 of 29 July 2016 – Alien and Invasive Species Lists, 2016
  - GNR 152 of 23 February 2007 – Threatened or Protected Species Regulations
  - GN 447 of 19 May 2015 – Bio-Prospecting, Access and Benefit-Sharing
- National Environmental Management: Waste Act, No 59 of 2008
  - GN 921 of 29 November 2013 – List of Waste Management Activities with a Detrimental Effect on the Environment
  - GNR 625 of 13 August 2012 – National Waste Information Regulations, 2012
  - GNR 634 of 21 August 2013 – Waste Classification and Management Regulations, 2013 ("**Waste Classification Regulations**")
  - GNR 635 of 23 August 2013 – National Norms and Standards for the Assessment of Waste for Landfill Disposal ("**Norms and Standards for Landfill Waste Assessment**")
  - GNR 636 if 23 August 2013 – National Norms and Standards for Disposal of Waste to Landfill ("**Norms and Standards for Disposal of Waste to Landfill**")
  - GN 926 of 29 November 2013 – National Norms and Standards for the Storage of Waste
  - GN 331 of 2 May 2014 – National Norms and Standards for Screening and Assessing Contaminated Sites
- National Environmental Management: Air Quality Act, No 39 of 2004
  - GN 1210 of 24 December 2009 – National Ambient Air Quality Standards
  - GN 486 of 29 June 2012 – National Ambient Air Quality Standard for Particulate Matter <PM2.5
  - GNR 827 of 1 November 2013 – National Dust Control Regulations, 2013
  - GN 351 of 8 May 2014 – Phasing-out and Management of Ozone-depleting Substances
  - GNR 533 of 11 July 2014 – Regulations regarding Air Dispersion Modelling
- Environment Conservation Act, No 73 of 1989
- National Water Act, No 36 of 1998 (NWA)
  - GNR 704 of 4 June 1999 – Regulations on Use of Water for Mining and Related Activities
  - GNR 267 of 24 March 2017 – Water Use License Application and Appeals Regulation. 2017
- South African National Standards (SANS)
  - 10210:2004 – Standard for Road Traffic Noise
  - 10103:2008 – Guidelines for Prevailing Noise Levels
  - 241:2011 - Water Quality Guidelines
- National Forests Act, No 84 of 1998
- National Heritage Resources Act, No 25 of 1999
- Removal of Graves and Dead Bodies Ordinance, 7 of 1925
- National Health Act, No 61 of 2003
- Mountain Catchment Areas Act, No 63 of 1970
- National Veld and Forest Fire Act, No 101 of 1998
- Conservation of Agricultural Resources Act, No 43 of 1983
- Hazardous Substance Act, No 15 of 1973
- Mine Health and Safety Act, No 29 of 1996
- Provincial Legislation –
  - Mpumalanga Nature Conservation Act, No 10 of 1998
  - Mpumalanga Tourism and Parks Agency Act, No 5 of 2005
  - Limpopo Environmental Management Act, No 7 of 2003.

## 3.1 Existing Environmental Authorisations

Several Environmental Consents are in place or have been submitted for the Booysendal North MR and Booysendal South MR. Table 3-2 provides a summary of Environmental Consents granted for the Booysendal North MR. Table 3-3 provides a summary of the Environmental Consents that are in place for the Booysendal South MR.

Table 3-2 Environmental Authorisations and EMPs for Booysendal North Mining Right

| Approval | Activities | Status |
|---|---|---|
| 2003 EMP | Shafts and surface infrastructure (access road, services, water pipeline, conveyor system) on the Farms Booysendal 43JT and Buttonshope 51JT. Total area of 81.2ha. | Approved 20 June 2003 |
| 2008 EMP Addendum | Repositioning of mine portal on the Farm Booysendal 43JT | Approved 3 February 2009 |
| 2009 EMP Amendment | 150kt/month PGM underground mine with expansion up to 240kt/month and associated surface infrastructure on the Farm Booysendal 43JT and the Farm Der Brochen 7JT. | Approved 14 September 2010 |
| 2015 EMP Amendment | A new shaft area (extent of 0.4 ha) that will fall outside of the current disturbed area but within the approved mining area;<br><br>Extension to the existing plant area within the approved footprint to include:<br>• Additional conveyors;<br>• Ore processing facilities and<br>• Expansion of the existing TSF by approximately 12.7ha to increase the current capacity and life of the TSF. | Approved 11 August 2017 |
| Section 24G EA | Phase 1 of the Booysendal South Expansion Project to increase production from 220,000ktpm to 450,000ktpm focussing on three development areas:<br>• The development of the BS1/2 portal and supporting infrastructure consisting of a mining portal and terrace complex, seven adits, workshops, offices, water and related infrastructure, co-disposal stockpile;<br>• BCM1 and BCM2 Adits without any surface infrastructure components;<br>• A 132kVA powerline from BN to BS1/2;<br>• Upgrade and new storm water management infrastructure at BS4;<br>• Reworking of tailings at the current BS4;<br>• Replacement of tailings on existing TSF1 at BS4;<br>• Backfilling of the underground workings with tailings;<br>• The construction of associated surface and linear infrastructure, including a 13.2m wide bitumen access road, an ARC, water pipelines between BS1/2 and BS4 (which relates to the Booysendal South MR); and | Granted 5 January 2018 |

| Approval | Activities | Status |
|---|---|---|
| | • Valley Boxcut PCD | |

Table 3-3 Environmental Authorisations and EMPs for the Booysendal South Mining Right

| Approval | Activities | Status |
|---|---|---|
| 2003 EMP | Original EMP for the mine | Approved June 2003 |
| 2009 EMP Addendum and EA | Valley Project approved by DMR and an EA granted by MDEDET | Approved May 2010 |
| 2009 EMP Amendment | Decline project | Approved December 2009 |
| 2018 Section 24G EA EMP | See Table 3-2 | Approved December 2018 |

## 3.2 The Constitution of South Africa, 1966

Environmental legislation is shaped by the Bill of Rights of the Constitution of the Republic of South Africa ("**Constitution**"). Section 24 of the Constitution, known as the 'environmental right,' guarantees every person the right to an environment that is not harmful to their health or well-being, provides for the protection of the environment against pollution and degradation and centres sustainable development as the cornerstone of South Africa's environmental law regime. This right is binding on the state and people, both natural and juristic.

In fulfilment of its constitutional mandate to take reasonable legislative measures that gives effect to Section 24 of the Constitution, the government has promulgated several environmental laws. These laws provide a legal framework that embodies internationally recognised legal principles.

The principal act governing activities that affect the environment is NEMA.

## 3.3 Minerals and Petroleum Resources Development Act, No 28 of 2002

The MPRDA aims at the equitable access and the sustainable development of the country's mineral resources. It provides mechanisms that will ensure the protection of the environment throughout the LoM.

Social and environmental sustainability is enhanced through the requirement to submit a Social and Labour Plan ("**SLP**"), which records a company's commitment to sustainable social development. This includes a commitment to training and social investment with the goal of transferring skills that can be used after mine closure.

Section 5A of the MPRDA indicates that: "*No person may prospect for or remove, mine, conduct technical co-operation operations, reconnaissance operations, explore for and produce any mineral or petroleum or commence with any work incidental thereto on any area without – (a) an environmental authorisation*".

Section 37 of the MPRDA requires all mining and prospecting operations and related activities to be carried out in terms of the environmental management principles set out in section 2 of NEMA.

Section 102(1) of the MPRDA states that:

"*(1) A reconnaissance permission, prospecting right, mining right, mining permit, retention permit, technical corporation permit, reconnaissance permit, exploration right, production right, prospecting work programme, exploration work programme, production work programme, mining work programme environmental management programme or an environmental authorisation issued in terms of the National Environmental Management Act, 1998, as the case may be, may not be amended or varied (including by extension of the* *area covered by it or by the additional of minerals or a shares or seams, mineralised bodies or strata, which are not at the time the subject thereof) without the written consent of the Minister.*"

Approvals for amendments of EMPs were previously required under section 102 of the MPRDA. The DMR now requires EMPs to be amended in terms of Chapter 5 of the 2014 EIA Regulations.

The Booysendal South Expansion Project: Phase 2 will require approval for the amendment to the existing Section 24G EMP in respect of properties held under the Booysendal North MR.

Booysendal will request approval that the EMP Amendment Application may proceed in terms of Chapter 4 of the 2014 EIA Regulations, to allow for one streamlined process for the Phase 2 NEMA and Waste Act Applications.

## 3.4 National Environmental Management Act, No 107 of 1998

In terms of sections 24(2) and 24D of NEMA the Minister of Environmental Affairs promulgated certain activities that may not commence without an EA. Activities promulgated in terms of Listing Notice 1 and Listing Notice 3 require a basic assessment process, while activities promulgated in terms of Listing Notice 2 require that a full Scoping and EIA process be conducted. The requirements for an EIA and EMP are clearly stated in Appendix 3 and Appendix 4 of the 2014 EIA Regulations.

Section 24C(2A) of NEMA indicates that where listed activities are directly related to the extraction and primary processing of a mineral or petroleum resource the Minister of Mineral Resources is the CA or officials at the DMR to whom he has delegated his authority, being the Regional Managers. The approval of the Phase 2 NEMA and Waste Act Applications will thus be made by both the Regional Managers of DMR Limpopo Regional Office for the Booysendal North MR and the DMR Mpumalanga Regional Office for the Booysendal South MR (unless agreed to otherwise with the Regional Managers). Reference is made to what has been stated above as to which Regional Manager is the CA in respect of each of the Phase 2 NEMA and Waste Act Applications. The relevant authorities under NEMA must be consulted in the process.

The Financial Provisioning Regulations, published under GN R1147 under GG 39425 of 20 November 2015, set out the requirements for the development of a closure and rehabilitation plan; and the financial provision for rehabilitation and closure (which will only be applicable to Booysendal from 2019). A closure and rehabilitation plan will be developed as part of the EIA process and submitted with the EIR and EMP.

### 3.4.1 2014 EIA Regulations

Chapter 6 of the 2014 EIA Regulations provides for the requirements for public consultation, which must be carried out as part of the Phase 2 NEMA and Waste Act Applications process. In terms of Regulations 21 and 23, the outcome of the public consultation process must be reported in the Scoping Report and EIR submitted to the CA. This process "*must give all potential or registered interested and affected parties, including the competent authority a period of at least 30 days to submit comments on each of the basic assessment report, EMP, scoping report and environmental impact assessment report, and where applicable the closure plan, as well as the report contemplated in regulation 32, if such reports or plans are submitted at different times*" (Regulation 40 (1)).

The public participation process (**"PPP"**) must also:

- Provide access to all information that reasonably has or may have the potential to influence any decision regarding an application;
- Consult with the CA, every state department that relates to the environment relevant to the application, all relevant organs of state and all potential and registered I&APs; and
- Provide opportunity for I&APs to comment on reports and plans prior to submission of an application.

The process must include:

- Notification of the application to all I&APs, as stipulated in Regulation 41;
- Registration of all I&APs, as required in Regulations 42 and 43; and
- A record of comments and responses and records of meetings, as outlined in Regulation 44.

For the Phase 2 Project, an integrated PPP will be undertaken to make provision for the consultation process during the Phase 2 NEMA and Waste Act Applications and IWULA for both the Booysendal North and Booysendal South MRs. The integrated and concurrent application process for the Booysendal South Expansion Project: Phase 2 is illustrated in Figure 3-1.

Regulation 39 of the 2014 EIA Regulations requires that:

"*(1) If the proponent is not the owner or person in control of the land on which the activity is to be undertaken, the proponent must, before applying for an environmental authorisation in respect of such activity, obtain the written consent of the landowner or person in control of the land to undertake such activity on that land.*"

All land related to the activities associated with the Booysendal North MR is owned by Booysendal. The properties held under the Booysendal South MR activities are owned by the Bakoni CPA and one by Booysendal. Booysendal has concluded a lease agreement with the Bakoni CPA in respect of the properties the Bakoni CPA owns, which allows Booysendal to conduct mining and mining related activities on these properties. The Bakoni CPA were consulted during a focus group meeting with the main community forums on 23 February 2018.

### 3.4.2 NEMA Listed Activities

The EIA Listing Notices list the activities that require a Basic Assessment and a Scoping Report/EIR.

The listed activities applicable to the Booysendal North MR are given in Table 3-4. The listed activities applicable to the Booysendal South MR are included in Table 3-5.

Table 3-4 Listed Activities Applicable to the Booysendal North Mining Right

| **NEMA Listed Activities** | |
|---|---|
| **Activity No(s):** | **Government Notice No. R983 Listing Notice 1 As Amended in GNR327 of 7 April 2017**<br>**Details of Activity(ies) requiring Basic Assessment** |
| 12 | The development of –<br>(i) dams or weirs, where the dam or weir, including the infrastructure and water surface area, exceeds 100 square metres; or<br>(ii) infrastructure or structures with a physical footprint of 100 square metres or more;<br>where such development occurs-<br>(a) within a watercourse;<br>(b) in front of a development setback; or<br>(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse<br><u>Applicable activities</u> –<br>• Portions of the BCM1 and BCM2 associated infrastructure;<br>• ARC towers 3, 6 and 7;<br>• BS1/2 / BN Pipeline crossings between BS1/2 and BN; and<br>• ARC and Conveyor Roads at BS1/2, BCM1, BCM2 and BN;<br><br>(on the Farm Booysendal 43JT and the Remaining Extent of the Farm Buttonshope 51JT). |
| 14 | The development and related operation of facilities or infrastructure, for the storage, or for the storage and handling, of a dangerous good, where such storage occurs in containers with a combined capacity of 80 cubic metres or more but not exceeding 500 cubic metres;<br><u>Applicable activity</u> – At BCM1 and BCM2 the storage of an estimated 150 cubic meters of dangerous goods including - emulsion, diesel, oil, dirty oil and hydraulic oils (5,000l). |
| 19 | The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of inter alia soil, sand, pebbles or rock of more than 10 cubic metres from a watercourse<br><u>Applicable activities</u> – |

| | |
|---|---|
| | • Possibly infilling and excavation for the establishment of the BCM1 and BCM2 terraces and Conveyor Roads (on the Farm Booysendal 43JT);<br>• Excavation and infilling for ARC Tower 3 on the Farm Booysendal 43JT and Towers 6 and 7 on the Remaining Extent of the Farm Buttonshope 51JT; and<br>• Excavation and infilling for the conveyor and ARC access roads. |
| 27 | The clearance of an area of between 1 and 20 hectares of indigenous vegetation<br>*Applicable activity:*<br>• Clearance for the Emergency Escape Portal and infrastructure components around BCM1 and BCM2, including crusher plant, conveyors, Conveyor Roads and silos on the Farm Booysendal 43JT;<br>• Clearance for the BS1/2 / BN Pipeline between BN to BS1/2 on the Farms Booysendal 43JT to the Remaining Extent of the Farm Buttonshope 51JT; and<br>• ARC Roads and ARC towers on the Farms Booysendal 43JT and Remaining Extent of the Farm Buttonshope 51JT. |
| 30 | Any process or activity identified in terms of section 53(1) of the National Environmental Management: Biodiversity Act, No 10 of 2004<br>*Applicable activity* – All the associated mining activities will take place in the Sekhukhune Centre of Endemism which is classified as a threatened ecosystem. |
| **Activity No(s):** | **Government Notice No. R984 Listing Notice 2 as Amended by GNR 325 of 7 April 2017**<br>**Details of Activity(ies) requiring a Scoping / EIA Report** |
| 6 | The development of facilities or infrastructure for any process or activity which requires a permit or licence or an amended permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent, excluding: activities which are identified in Listing Notice 1 of 2014 EIA Regulations; activities which are included in the list of waste management activities published in terms of section 19 of the Waste Act in which case the Waste Act applies; or the development of facilities or infrastructure for the treatment of effluent, wastewater or sewage where such facilities have a daily throughput capacity of 2, 000 cubic metres or less, as contained in 2014 Listing Notice.<br>*Applicable activity* –<br>• PCDs and settlers at BCM1 and BCM2; and<br>• STPs at BCM1 and BCM2 with treated effluent to be discharged into the environment at a throughput rate of 100m$^3$/day, on the Farm Booysendal 43JT. |
| 7 | The development and related operation of facilities or infrastructure for the bulk transportation of dangerous goods –<br>(i) in liquid form, outside an industrial complex, using pipelines, exceeding 1000 metres in length, with a throughput capacity of more than 50 cubic metres per day;<br>*Applicable activity* –<br>BS1/2 / BN Pipeline from the BS1/2 portal complex to BN on the Farm Booysendal 43JT and Remaining Extent of the Farm Buttonshope 51JT at a rate of 100m$^3$ per day. |
| 17 | Any activity including the operation of that activity which requires a mining right as contemplated in section 22 of MPRDA including associated infrastructure, structures and earthworks directly related to the extraction of a mineral resource, including activities for which an exemption has been issued in terms of section 106 of MPRDA.<br>*Applicable activity* –<br>Emergency Escape Portal (on the Farm Booysendal 43JT) |
| 19 | The removal and disposal of minerals in terms of section 20 of the MPRDA, including –<br>(b) the primary processing of mineral resources including winning, extraction, classifying, concentrating, crushing, screening or washing.<br>*Applicable activity* –<br>Crusher plant between BCM1 and BCM2 which has a capacity 50t (on the Farm Booysendal 43JT) |
| **Activity No(s):** | **Government Notice No. R985 Listing Notice 3 as Amended by GNR 324 of 7 April 2017**<br>**Details of Activity(ies) requiring Basic Assessment Report** |
| 4 | *The development of a road wider than 4 metres with a reserve less than 13,5 metres*<br>*f) Mpumalanga and Limpopo*<br>*Outside urban areas:*<br>*(ee) CBAs as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans.*<br>*Applicable activities:*<br>• BS is in a CBA in terms of the Terrestrial Assessment (2014) of the MTPA ("**MTPA Terrestrial Assessment**") and the Sekhukhune Mountainlands are listed as an endangered ecosystem in terms of Regulation GN 1002 of 9 December 2011 promulgated in terms of section 52 of NEMBA ("**GN 1002**");<br>• On the Farm Booysendal 43JT and Remaining Extent of the Farm Buttonshope 51JT the permanent and temporary ARC Roads to the ARC will be 4m wide; and<br>• the Conveyor Roads at BCM1 and BCM2 will be 6m wide on the Remaining Extent of the Farm Buttonshope 51JT. |
| 8 | The development and related operation of above ground cableways and funiculars<br>e. Limpopo and f. Mpumalanga<br>i. All areas outside urban areas;<br>*Applicable activity* –<br>ARC from BS1/2 to BN on the Farms Booysendal 43JT and Remaining Extent of the Buttonshope 51JT |

| | |
|---|---|
| 12 | The clearance of an area of 300 square metres or more of indigenous vegetation, except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan.<br>e. Limpopo and f. Mpumalanga<br>ii. Within CBAs identified in bioregional plans;<br>_Applicable activities_ –<br>• BS is in a CBA in terms of the Terrestrial Assessment (2014) of the MTPA Terrestrial Assessment and the Sekhukhune Mountainlands are listed as an endangered ecosystem in terms of GN 1002; and<br>• BS Emergency Escape Portal, silos and surface infrastructure at BCM1 and BCM2 (including conveyors, ARC towers, pipeline and Conveyor Roads and ARC Roads) exceed 300 square meters. |
| 14 | The development of-<br>(i) dams or weirs, where the dam or weir, including infrastructure and water surface area exceeds 10 square metres; or<br>(ii) infrastructure or structures with a physical footprint of 10 square metres or more;<br>Where such development occurs -<br>(a) within a watercourse;<br>(b) in front of a development setback; or<br>(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse<br>e. Limpopo and f. Mpumalanga<br>i. Outside urban areas, in:<br>(ff) CBA or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;<br>_Applicable activities_ –<br>• ARC Tower 3, 6 and 7 within watercourses exceeding 10 square meters each in size;<br>• Conveyors;<br>• On the Farm Booysendal 43JT and Remaining Extent of the Farm Buttonshope 51JT the permanent and temporary ARC Roads to the ARC will be 4m wide;<br>• The Conveyor Roads at BCM1 and BCM2 will be 6m wide on the Remaining Extent of the Farm Buttonshope 51JT; and<br>• BS1/2 / BN Pipeline watercourse crossings between BS1/2 and BN will cross drainage lines. |

## Table 3-5 NEMA Listed Activities Applicable to the Booysendal South Mining Right

| NEMA Listed Activities | |
|---|---|
| **Activity No(s):** | **Government Notice No. R983 Listing Notice 1 As Amended in GNR327 of 7 April 2017**<br>**Details of Activity(ies) requiring Basic Assessment** |
| 12 | The development of –<br>(i) dams or weirs, where the dam or weir, including the infrastructure and water surface area, exceeds 100 square metres; or<br>(ii) infrastructure or structures with a physical footprint of 100 square metres or more;<br>where such development occurs-<br>(a) within a watercourse;<br>(b) in front of a development setback; or<br>(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse<br>_Applicable activity_ –<br>The three BS4 Pipelines and the Tailings Pipelines crossing watercourses on Sterkfontein 749JT; and the Remaining Extents of Portions 4 and 15 and Portions 8, 17 and 27 of the Farm De Kafferskraal 53JT. |
| 27 | The clearance of an area of between 1 and 20 hectares of indigenous vegetation<br>_Potential applicable activity -_<br>Clearance for the Backfill Plant Road, Tailings Pipeline and the three BS4 Pipelines and emergency backfill ponds on Sterkfontein 749JT; and the Remaining Extents of Portions 4 and 15 and Portions 8, 17 and 27 of the Farm De Kafferskraal 53JT (activity to be confirmed based on the specialist investigation findings). |
| 30 | Any process or activity identified in terms of section 53(1) of NEMBA<br>_Applicable activity_ –<br>All the associated mining activities will take place in the Sekhukhune Centre of Endemism which is classified as a threatened ecosystem. |
| **Activity No(s):** | **Government Notice No. R984 Listing Notice 2 as Amended by GNR 325 of 7 April 2017**<br>**Details of Activity(ies) requiring a Scoping / EIA Report** |
| 6 | The development of facilities or infrastructure for any process or activity which requires a permit or licence or an amended permit or license in terms of national or provincial legislation governing the generation or release of emissions, pollution or effluent, excluding: activities which are identified in Listing Notice 1 of 2014 EIA Regulations; activities which are included in the list of waste management activities published in terms of section 19 of the Waste Act in which case the Waste Act applies; or the development of facilities or infrastructure for the treatment of effluent, wastewater or sewage where such facilities have a daily throughput capacity of 2, 000 cubic metres or less, as contained in 2014 Listing Notice.<br>_Applicable activities_ – |

| | |
|---|---|
| | • Emergency backfill ponds and the Tailings Pipeline (section 21(g) water uses); and<br>• The three BS4 Pipelines (section 21(g) water uses), on the Farm Sterkfontein 749JT; and the Remaining Extents of Portions 4 and 15 and Portion 8, 17 and 27 of the Farm De Kafferskraal 53JT. |
| 7 | The development and related operation of facilities or infrastructure for the bulk transportation of dangerous goods –<br>(i) in liquid form, outside an industrial complex, using pipelines, exceeding 1000 metres in length, with a throughput capacity of more than 50 cubic metres per day;<br>*Applicable activities* -<br>• The Tailings Pipeline will exceed 1km in length and have a throughput capacity of 250 cubic metres per day; and<br>• The three BS4 Pipelines on the Farm Sterkfontein 749JT; and the Remaining Extents of Portions 4 and 15 and Portions 8, 17 and 27 of the Farm De Kafferskraal 53JT. |
| **Activity No(s):** | **Government Notice No. R985 Listing Notice 3 as Amended by GNR 324 of 7 April 2017**<br>**Details of Activity(ies) requiring Basic Assessment Report** |
| 12 | The clearance of an area of 300 square metres or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan.<br>e. Mpumalanga<br>ii. Within CBAs identified in bioregional plans;<br>*Potential applicable activity* –<br>*At* BS4 - clearance for the Tailings Pipeline and three BS4 Pipelines on Farm Sterkfontein 749JT exceeds 300 square meters. |
| 14 | The development of-<br>(iii) dams or weirs, where the dam or weir, including infrastructure and water surface area exceeds 10 square metres; or<br>(iv) infrastructure or structures with a physical footprint of 10 square metres or more;<br>Where such development occurs -<br>(a) within a watercourse;<br>(b) in front of a development setback; or<br>(c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse<br>e. Mpumalanga<br>i. Outside urban areas, in:<br>(ff) CBA or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans;<br>*Applicable activity* –<br>three BS4 Pipelines and Tailings Pipeline crosses watercourses in various areas on the Farm Sterkfontein 749JT; and the Remaining Extents of Portions 4 and 15 and Portions 8, 17 and 27 of the Farm De Kafferskraal 53JT. |

### 3.4.3 Financial Provisioning Regulations

The purpose of the Financial Provisioning Regulations is the determination and making of financial provision for the costs associated with the undertaking of management, rehabilitation and remediation of environmental impacts through the lifespan of operations and latent or residual environmental impacts that may become known in the future. These regulations replace section 41 of the MPRDA and regulations 53 and 54 of the Mineral and Petroleum Resources Development Regulations, published under GN R527 in GG 26275 of 23 April 2014. Draft Regulations were published on 10 November 2017 that may significantly change the requirements for financial provision.

Regulation 4 of the Financial Provisioning Regulations require:

"*An applicant or holder of a right or permit must determine and make financial provision to guarantee the availability of sufficient funds to undertake rehabilitation and remediation of the adverse environmental impacts of prospecting, exploration, mining or production operations, as contemplated in the Act and to the satisfaction of the Minister responsible for mineral resources*."

Under Regulation 5, financial provision must be made for:

"*(a) rehabilitation and remediation;*
*(b) decommissioning and closure activities at the end of prospecting, exploration, mining or production operations; and*
*(c) remediation and management of latent or residual environmental impacts which may become known in future, including the pumping and treatment of polluted or extraneous water.*"

The Financial Provisioning Regulations provide:

- the method of determining financial provision through detailed itemisation of all activities and costs for annual and final rehabilitation and remediation of latent or residual impacts determined by means of an environmental risk assessment;
- financial provision vehicles;
- the need for a specialist(s) to determine, review and assess the financial provision and to submit this as part of an application for an EA, with proof of payment or arrangements prior to commencing mining or production operations;
- for an annual review, assessment and adjustment of financial provision, audited by an independent auditor included in the environmental audit report as required in terms of the 2014 EIA Regulations and an increase in the financial provision should there be a shortfall;
- the contents of the annual rehabilitation plan, final rehabilitation, decommissioning and mine closure plan and environmental risk assessment report;
- the responsibility to make the EMP submitted in terms of section 24N of NEMA and any approved amendment available to the public;
- for the chief executive officer or designated person to be responsible for implementing the approved plans; and
- the EA by the Minister once the financial provision is determined, checked and proof of payment is provided.

Booysendal is currently only required to submit an assessment of the rehabilitation and closure costs liability required under the Financial Provision Regulations in February 2019 and update its financial provision once this assessment has been reviewed by the DMR. It will include the activities included in the Phase 2 Project in such assessment, or a later assessment, dependant on when the Phase 2 NEMA and Waste Act Applications are granted.

## 3.5 National Environmental Management: Waste Act, 59 of 2008

The purpose of the Waste Act is to assist in regulating waste management, to ensure the protection of human health and to prevent pollution and environmental degradation through sound waste management principles and guidelines. It furthermore provides for:

- National norms and standards for regulating the management of waste by all spheres of government;
- licensing and control of waste management activities;
- remediation of contaminated land;
- a national waste information system; and
- provision for compliance and enforcement.

The Waste Act defines waste broadly as "*any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered*". It regulates mining residue deposits or stockpiles.

The Waste Act imposes a general duty upon waste holders to take reasonable measures to avoid waste generation and, where this is impossible, to: minimise the toxicity and quantities of waste generated; re-use, reduce, recycle and recover waste; and ensure that it is treated and disposed of in an environmentally-sound way. Failure to do so is a criminal offence, with a maximum fine of R10 million or imprisonment of up to 10 years, or both.

It is necessary to hold a WML for defined waste management activities.

The DEA promulgated the 2013 WML Regulations, which provides that a WML is required for undertaking certain waste management activities ("**Waste Listed Activities**"). The Waste Listed Activities are separated into three categories, namely Category A, Category B and Category C. Category A and B Waste Listed Activities require a WML, for which either a Basic Assessment or an EIA process needs to be undertaken that complies with the 2014 EIA Regulations. The procedures for licensing Waste Listed Activities are stipulated in Chapter 5 of Waste Act and will have to be considered in the overall EIA process.

Category C activities do not require a WML but must comply with *inter alia* the Norms and Standards for Storage of Waste, 2013. Such facilities need to be registered with the DEA 90 days before construction commences.

Classification of certain waste streams is required in terms of the Waste Classification and Management Regulations, published under GN R634 in GG 36784 of 23 August 2013, to ensure that the correct waste management standards and disposal methods are implemented.

The National Norms and Standards for the Assessment of Waste for Landfill Disposal, published under GN R635 in GG 36784 of 23 August 2013, and the National Norms and Standards for the Disposal of Waste to Landfill, published under GN R636 in GG 36784 of 23 August 2013, provide the norms and standards for disposal of waste to landfill. This includes liner requirements and design specifications.

In 2014 the National Environmental Management: Waste Amendment Act, No 26 of 2014 was promulgated to include residue deposits and residue stockpiles from:

- Mineral excavation;
- Physical and chemical processing of metalliferous minerals;
- Physical and chemical processing of non-metalliferous minerals; and
- Drilling operations.

Residue deposits are defined as "*any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right*".

Residue stockpiles, in turn, are defined as "*any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, beneficiation plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated for potential re-use, or which is disposed of, by the holder of a mining right, mining permit, production right or an old order right*".

The Regulations regarding the Planning and Management of Residue Stockpiles and Residue Deposits ("**Residue Regulations**"), published under GN R632 in GG 39020 of 24 July 2015, provide for the planning, management and reporting of residue stockpiles and residue deposits, which obligations include:

- The assessment of impacts and analyses of risks relating to the management of residue stockpiles and residue deposits;
- Characterisation of residue stockpiles and residue deposits;
- Classification of residue stockpiles and residue deposits;
- Investigation and the selection of site for residue stockpiling;
- Design of the residue stockpiles and residue deposits;
- Impact management;
- Duties of the holder of right or permit;

- Monitoring and reporting system for residue stockpiles and residue deposits;
- Dust management and control; and
- Decommissioning, closure and post closure management of residue stockpiles and residue deposit.

The Residue Regulations provide the tools for and correspond to the statutory provision relating to managing residue stockpiles and residue deposits in the manner prescribed in Section 43A of the Waste Act.

A WML under the Waste Act is not required for activities undertaken as part of the Phase 2 Project in relation to the Booysendal North MR. Waste Listed Activities applicable to the Booysendal South Expansion Project: Phase 1 were applied for and authorised under the Section 24G EA. This included:

- Category B, Activity 3: the recovery of waste including the refining, utilisation or co-processing of the waste at a facility that processes in excess of 100 tons of general waste per day or in excess of 1 ton of hazardous waste per day;
- Category B, Activity 9: the disposal of inert waste to land in excess of 25 000 tons; and
- Category B, Activity 11: the disposal of tailings at BS4.

As part of Phase 2 Project the three emergency backfill ponds require a WML. The activities are included in Table 3-6.

Table 3-6 Booysendal South Mining Right Waste Management Activities

| GN R921 of 29 November 2013 Listed Waste Management Activities | |
|---|---|
| **Category B, Activity 10** | Construction of a facility for a waste management activity listed in Category B<br>*Applicable activities –*<br>Construction of the three emergency backfill ponds at BS4 |
| **Category B, Activity 11** | The establishment of a residue stockpile or residue deposit resulting from activities which require a mining right in terms of MPRDA<br>*Applicable Activities –*<br>The three emergency backfill ponds at BS4 |

The rest of the Waste Listed Activities will be undertaken in terms of the existing WML for BN and Section 24G EA.

## 3.6 National Environmental Management Biodiversity Act, No 10 of 2004

The purpose of the National Environmental Management: Biodiversity Act, No 10 of 2004 ("**NEMBA**") is to ensure the sustainable management and conservation of biodiversity in South Africa. It also provides for the protection of species and ecosystems and sustainable use of indigenous biological resources. Certain portions of the activities of the Phase 2 Project fall within the SCPE and CBAs, as identified in the Mpumalanga Biodiversity Sector Plan. The impact assessment therefore should consider the following regulations promulgated in terms of NEMBA:

- National List of Ecosystems that are Threatened and in need of Protection ("**TOPS List**"), published under GN 1002 in GG 34809 of 9 December 2012, which contains the National List of Ecosystems that are threatened and in need of protection;
- Threatened and Protected Species Regulations, published under GN R152 in GG 29657 of 23 February 2007. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function and composition of threatened ecosystems and preserving witness sites of exceptionally high conservation value;

- Lists of Critically Endangered, Endangered, Vulnerable and Protected Species, published under GN R151 in GG 29567 of 23 February 2007; and
- Alien and Invasive Species Regulations ("**A&IS Regulations**"), published under GN R598 in GG 37885 of 12 February 2014, read with the Alien and Invasive Species List, published under GN 864 in GG 40166 of 29 July 2016. Sections 70 to 77 of NEMBA specifically deals with the control of species which could pose a threat to biodiversity. The A&IS Regulations, which separate alien and invasive species ("**A&IS**") into different categories requires the:
    - immediate eradication of Category 1a listed invasive species;
    - control of Category 1b listed species;
    - management of Category 2 listed species in the same manner as Category 1b species, except where a permit was granted to allow for these species, in which case the spreading of the species must be controlled; and
    - control of Category 3 listed species, where species within riparian zones must be controlled as per Category 1b.

An A&IS management programme must be put in place for all categories of A&IS. Any A&IS found in the Booysendal South Expansion Project Area will be managed in accordance with the A&IS Regulations.

South Africa has ratified the Convention on International Trade in Endangered Species ("**CITES**") and has published the CITES Regulations, published under GN R173 in GG 33002 of 5 March 2010, which regulate the import and export of endangered species.

The sensitivities around the biodiversity of the area will have to be considered during the life of the Project.

## 3.7 National Environmental Management: Protected Areas Act, No 57 of 2003

Certain areas are protected from development under the National Environmental Management: Protected Areas Act, No 57 of 2003 ("**NEMPAA**"), including those declared national parks, nature reserves, protected environments and world heritage sites.

NEMPAA provides that, despite other legislation, no person may conduct prospecting or mining activities in certain protected areas without the prior consent of the Minister of Mineral Resources and Minister of Environmental Affairs. NEMPAA binds all state organs and trumps other legislation, including the MPRDA in the event of a conflict concerning the development of protected areas.

The Booysendal South Expansion Project, including the Phase 2 Project, though situated in a CBA, will not traverse any area protected under NEMPAA and consent is therefore not required.

## 3.8 National Environmental Management: Air Quality Act, No 39 of 2004

The National Environmental Management: Air Quality Act, No 39 of 2004 ("**NEMAQA**") was promulgated to ensure the protection and regulation of air quality and to provide measures that will prevent pollution and sustainability. Under NEMAQA, the Minister of Environmental Affairs must identify substances in ambient air which present a threat to health, well-being or the environment and establish national standards for ambient air quality, including the permissible quantity or concentration of each substance in ambient air.

The following regulations promulgated under NEMAQA were considered for the Phase 2 Project:

- Listed Activities and Associated Minimum Emission Standards, published under GN 893 in GG 37054 of 22 November 2013, which lists activities that could result in atmospheric emissions requiring an Atmospheric Emissions Licence ("**AEL**") before being undertaken. Examples of such activities include: the use of combustion installations; storage of petroleum products; slag processes; carbonisation and coal gasification; mineral processing and disposal of hazardous and general waste by way of incineration. An Air Quality Impact Assessment ("**AQIA**") was undertaken for the entire Booysendal South Expansion Project to determine whether the Project involves any listed activities under NEMAQA and if any of its emissions exceed the allowable thresholds. The AQIA indicates that an AEL under NEMAQA is not required.

- National Dust Control Regulations, published under GN R827 in GG 36974 of 1 November 2013, which provide that an acceptable dust fall rate for a non-residential area is considered to be more than 600 mg/m2/day but less than 1200 mg/m2/day (30-day average), with maximum allowable two exceedances per year, provided these exceedances do not take place in consecutive months. A dust fall monitoring programme as prescribed in terms of the Regulations must include:
  - the establishment of a network of dust monitoring points using method ASTM D1739:1970 (or equivalent), sufficient in number to establish the contribution of the person to dust fall in residential and non-residential areas in the vicinity of the premises, to monitor identified or likely sensitive receptor locations, and to establish the baseline dust fall for the district; and
  - a schedule for submitting to the air quality officer, dust fall monitoring reports annually or at more frequent intervals if so requested by the air quality officer.

The Phase 2 Project Area does not fall within an air quality priority area contemplated in section 18(1) of NEMAQA.

Greenhouse gases have been declared priority pollutants under the Declaration of Greenhouse Gases as Priority Air Pollutants published GN 710 in GG 40996 of 21 July 2017 in terms of NEMAQA, with potential reporting requirements for the mine.

## 3.9 National Water Act, No 36 of 1998

The purpose of the NWA is to ensure that the country's water resources are allocated, protected, used and managed to the benefit of current and future generations taking into consideration the growing demand, the human and ecological reserve needs whilst promoting economic development to the benefit of all. The DWS and relevant delegated Regional Managers of the DWS and WMAs have been appointed as the national trustees to oversee the governance of the country's water resources.

In terms of section 21 of the NWA, certain consumptive and non-consumptive water uses are identified and can only commence once authorised. Where a water use constitutes a Scheduled 1 use, permissible water use in terms of section 22 of the NWA or is authorised in terms of a General Authorisation ("**GA**"), a water use licence is not required.

The consumptive and non-consumptive water uses specifically applicable to the Booysendal South Expansion Project (Phase 1 and Phase 2) which requires an IWULA in terms of Section 21, are include in Table 3-7.

Detail around the water uses will be included in the IWULA, which will be made available to the public for a 60-day comment period.

Table 3-7 Booysendal South Expansion Project Water Uses

| Section 21 Water Use | Description of the Water Uses |
|---|---|
| **Section 21 (a) taking water from a water resource** | • Associated with dewatering at BCM1, BCM2, BS1/2 and BS4 |
| **Section 21 (b) storing water** | • Potable water and fire water storage tanks at the BS1/2 and BCM1 and BCM2<br>• Potable and make-up water storage at BS4 |
| **Section 21 (c) impeding or diverting the flow of water in a watercourse** | |

| | |
|---|---|
| **Section 21 (i) altering the beds, banks, course or characteristics of a water resource** | • Six of the ARC towers are located on the edge of watercourses (21 i) and one in a wetland (21 c and i), where excavations will be made for the base on the towers<br>• Drainage line crossings for the main access road, including the Groot Dwars River crossing. Culverts will be installed (21 c and i)<br>• Main access road wetland crossings (21 c and i)<br>• Diversion of two streams upstream of the portal complex at the Remaining Extent of Buttonshope (21 c and i)<br>• Several internal access road crossings which will be provided with culverts (21 c and i) at BN and BS<br>• Water and process water pipelines crossing drainage lines on the BN and BS4 (21 c and i) |
| **Section 21 (f) discharging of waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit** | • Discharging of water from the BCM1 and BCM2 STPs into the environment |
| **Section 21 (g) disposing of waste in a manner which may detrimentally impact on a watercourse** | • 14,000m$^3$ PCD BS1/2<br>• PCDs at the BCM1 and BCM2<br>• STPs for the BCM1 and BCM2<br>• Mine PCD at BS4<br>• Process water tank at the BS1/2<br>• 2.6Ml concrete process water dam at BN<br>• PCD BS4 Valley Boxcut<br>• Ore stockpile at BS4<br>• ROM stockpile at the BS1/2<br>• Reworking of tailings at BS4<br>• Backfilling of tailings into the underground workings at BS4<br>• RWD at BS4<br>• 2 Plant PCDs at BS4<br>• Erickson dam at the north decline (343m$^3$) at BS4<br>• Four settling ponds at the north decline (350m$^3$ each) at BS4<br>• Sink dam at the north decline (286m$^3$) at BS4<br>• BCM1 and BCM2 sewage treatment plants<br>• Three emergency backfill ponds along the backfill line at BS4 |
| **Section 21 (j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity of for the safety of people** | • Removing of groundwater from the underground workings at BS1/2, BCM1, BCM2, and BS4 |

The NWA further requires that:

- a motivation in terms of section 27 be submitted as part of the IWULA. This will be included in the main application report;
- the necessary water use application forms be compiled and submitted in support of the IWULA;
- the requirements of GN 704 and detail surrounding these activities will be considered in the IWULA; and
- an IWWMP be submitted in support of the IWULA. For this purpose, the existing IWWMP for BS4 will be updated to make provision for new waste streams or changes in waste streams associated with BS4.

The IWULA process timelines will be integrated with the overall EIA process. An IWULA will be prepared to make provision for all water uses related to the Booysendal South Expansion Project (Phase 1 and Phase 2) and some historic water uses associated with BS4.

### 3.9.1 GN 704

GN 704 was promulgated in terms of section 26(1) of the NWA, specifically aimed at the protection of water resources associated with mining related activities. GN 704 provides minimum requirements which need to be adhered to in aid of the protection of the water resources on a mine. It regulates the use of water, management of dirty and clean water infrastructure and related activities at mines. This includes minimum requirements for infrastructure that holds dirty water. A mine can apply for exemptions of these requirements and could be granted approval should sufficient management measures be put in place to ensure the protection of the environment.

Regulation 4 of GN 704 places some restrictions in terms of the locality of certain infrastructure which could have an impact on water resources. The activities applicable to the Booysendal South Expansion Project from which exemption will be applied for as part of the IWULA include:

"*(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100-year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water logged, undermined, unstable or cracked;*

*(b) Place or dispose of any residue or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation, prospecting diggings, pit or any other excavation*."

The BN and BS4 sections each hold an IWUL. The BS4 IWUL was automatically transferred to Booysendal in 2016 when Booysendal became the successor-in-title to the Booysendal South MR. As such, the water uses of the whole of the Booysendal Mine is now managed as one integrated entity. The current status is:

- BN IWUL was issued in May 2011 and amended in November 2011, with a further amendment application submitted in 2015 for the Merensky Expansion. The latter amendment was approved on 4 April 2018 and supersedes the previous IWULA; and
- BS4 IWUL was issued in 2006.

Detail around the existing lawful water uses will be included in the IWULA. IWWMPs have been approved for the BN section (2011) and the BS4 section (2010). This will be updated as part of the overall IWULA.

## 3.10 National Forestry Act, No 84 of 1998

Section 12 of the NFA gives power to the Minister of Agriculture, Forestry and Fisheries to declare certain trees as protected species. A list has been promulgated under GN R908 in GG of 21 November 2014. There are several known protected tree species in the Phase 2 Project Area, which have been or will have to be removed as part of the development. Section 15 of the NFA indicates that no protected species may be cut, disturbed, damaged or destroyed without a license granted by the DAFF.

For this purpose, it will be necessary to submit an "Application for a License Regarding Protected Trees" to the DAFF.

## 3.11 National Heritage Resources Act, No 25 of 1999

The purpose of NHRA is to ensure that the heritage resources of cultural significance, as described in section 3 of the Act, will be protected. The protection of heritage resources is overseen nationally by SAHRA, with delegated powers to provincial heritage resources authorities.

Section 38 of the NHRA requires that any proposed development that exceeds 5000m$^2$ must be communicated to SAHRA prior to the undertaking of the development. SAHRA may advise that a heritage impact assessment ("**HIA**") be conducted before it consents to the development.

The NHRA states that human remains older than 60 years and younger than 100 years are protected by the NHRA with reference to section 36. Procedures for the removal of graves are clearly delineated in section 36 which includes procedures for consultation regarding burial grounds and graves where such graves are situated outside a formal cemetery administrated by a local authority. If the grave is not situated inside a formal cemetery, but is to be relocated to one, permission from the local authority is required and all regulations, laws and by-laws, set by the local authority, must be adhered to.

Booysendal was granted authorisation to move graves which were associated with the BS1/2 portal. This was process was conducted in consultation with the relevant families as required under the NHRA.

Under section 34 of the NHRA, structures which are older than 60 years may not be demolished without a permit issued by the relevant provincial heritage resources authority. No structures older than 60 years were recorded in the HIA for the Phase 2 Project Area.

Section 35 of the NHRA deals with archaeological, paleontological and meteorite heritage resources and requires that for any archaeological or paleontological objects that are found the sites must be reported to the provincial heritage resources authorities. The discovered archaeological or paleontological objects may not be removed, damaged or destroyed without obtaining a permit from the heritage resources authority.

Due to the heritage rich nature of the Phase 2 Project Area, the Heritage Phase 1 assessment have been undertaken as part of the Phase 2 NEMA and Waste Act Applications process.

## 3.12 Conservation of Agricultural Resources Act, No 43 of 1998

In terms of the Conservation of Agricultural Resources Act, No 43 of 1998 ("**CARA**"), landowners are legally responsible for the control of weeds and alien vegetation. The Act makes provision for three categories of A&Is:

- Category 1a A&IS must immediately be removed and destroyed;
- Category 1b A&IS need to be immediately be removed and contained;
- Category 2 A&IS require a permit to retain the species on site and it must be ensured that they do not spread. All category 2 plants in riparian zones need to be removed; and
- Category 3 A&IS require a permit to retain these species. All category 3 plants in the riparian zone need to be removed.

CARA is also clear in terms of the conservation of soil and states that degradation of the agricultural potential is illegal. It furthermore requires the protection of land against soil erosion and the prevention of water logging and associated salinization.

## 3.13 Noise Control Bylaws

Noise Control Bylaws, published by the municipalities in Limpopo and Mpumalanga, provide the limit of exceedance at which noise levels becomes a disturbance. According to the bylaws, an exceedance of 7.0dBA above the prevailing ambient noise levels is allowed before a noise disturbance is created.

## 3.14 Spatial Development Policies

### 3.14.1 The National Development Plan 2030

The National Development Plan ("**NDP**") is a long-term development framework and plan for South Africa, and was released in August 2012. All major development policies and strategies of district and local municipalities find expression in the NDP and it must be referred to when determining the socio-economic impacts of a development or project on the surrounding area.

### 3.14.2 Mpumalanga Economic Growth and Development Plan

The primary objective of the Mpumalanga Economic Growth and Development Plan ("**MEGDP**") is to foster economic growth that creates jobs and reduces poverty and inequality in the Province. The objectives of the MEGDP has been considered in the Social Impact Assessment ("**SIA**") (Annexure L).

### 3.14.3 Mpumalanga Integrated and Spatial Development Plans

The Mpumalanga Spatial Development Framework ("**SDF**") serves as a guideline for the following: land-use management systems, infrastructure investment directive, address socio-economic inequalities, effective and efficient land use and land use integration. The SDF is a road map for all infrastructural development and it must inform all infrastructure projects. Three town planning schemes relevant to the Booysendal South Expansion Project include:

- Lydenburg Town Planning Scheme, 1995;
- Sabie Town Planning Scheme, 1984; and
- Graskop Town Planning Scheme, 1992.

Local Economic Development ("**LED**") is central to the Integrated Development Plan ("**IDP**") of a municipality. The aim of the LED process is to create employment, alleviate poverty, redistribute resources and most importantly keep money generating in the Local Municipality. Mines are expected to take into consideration the LED strategies of the local municipalities when developing programmes for their SLPs.

### 3.14.4 Sekhukhune Integrated Development Plan 2016/2017 – 2020/21

This IDP sets out the strategies, plans, budget and staffing requirements to achieve the development imperatives set by the municipality, and identifies specific development needs.

### 3.14.5 District Rural Development Plan, Sekhukhune District Municipality 2016

The Sekhukhune District Rural Development Plan ("**DRDP"**) is a strategic spatial planning instrument aimed at the transformation of the rural economy mainly through the improvement of the agricultural sector to combat poverty, unemployment and socio-economic inequalities.

### 3.14.6 Ehlanzeni District Municipality Integrated Development Plan 2016/2017 and 2017/22

The EDM IDP identifies the service delivery requirements and the five-year service delivery strategies and plans for the EDM. It highlights the specific needs of the various local municipalities.

### 3.14.7 Thaba Chweu Local Municipality Integrated Development Plan 2017 - 2022

The strategies presented in the TCLM IDP are based on an analysis of the population and needs within the population which need to be addressed. The IDP also contains the spatial development framework ("**SDF**") to be considered in future development.

### 3.14.8 Greater Tubatse Local Municipality Integrated Development Plan 2016/2017 – 2020/21

The GTLM IDP focusses on the development of programmes and projects whereby poverty could be alleviated and socio-economic conditions can be improved.

The spatial development policies were taken into consideration in the mitigating and management measures for the Phase 2 Project and the overall Booysendal South Expansion Project.

## 3.15 Other Legislation, Policy & Guidelines

Other legislation and associated regulations (where applicable) considered as part of the EA process include:

- Hazardous Substance Act, No 15 of 1973, which is aimed at the requirements related to hazardous substances, including the need for licensing;
- Mine Health and Safety Act, No 29 of 1996, which is administered by the Mine Health and Safety Inspectorate of the DMR;
- the DMR Consultation Guidelines, which have been compiled for use by applicants for prospecting and mining rights. The Guidelines give a broad and general definition of what constitutes consultation, namely *"a two-way communication process between the applicant and the community or interested and affected party wherein the former is seeking, listening to, and considering the latter's response, which allows openness in the decision-making process*". They also provide that I&APs include, but are not limited to: host communities; landowners; traditional authorities; land claimants; lawful occupiers; the Department of Land Affairs; any other person (including on adjacent and non-adjacent properties) whose socio-economic conditions may be directly affected by proposed prospecting or mining operations; the relevant local municipality; and the relevant government departments, agencies and institutions responsible for the various aspects of the environment and for infrastructure which may be affected by the proposed project (Sibisi & Tucker, 2012);
- the Extension of Security of Tenure Act, No 62 of 1997, which confers certain rights to non-landowning residents of a property, which such rights are linked to the period in which persons have been resident on the land;
- the Spatial Planning and Land Use Management Act, No 16 of 2013, which provides the framework for spatial planning and land use management in South Africa, including norms and standards, policies, principles for spatial planning and development and the monitoring, coordination and review of spatial planning and land use management system;
- Traditional Leadership and Governance Framework Amendment Act, No 41 of 2003 and National House of Traditional Leaders Act, No 22 of 2009. These acts provide for the recognition and establishment of traditional communities and councils, as well as to provide a framework for leadership and the roles and responsibilities of traditional leadership;
- Municipal Systems Act, No 32 of 2000, which amongst other things, provides for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities, and ensure universal access to essential services that are affordable to all;
- Provincial Legislation and Policy:
  - Mpumalanga Nature Conservation Act, No 10 of 1998 and the Mpumalanga Tourism and Parks Agency Act, No 5 of 2005. The former sets out how wild species are to be managed in terms of human use, such as collecting, fishing, hunting, capture, transport and trade. It deals with rare and endangered species and the powers needed to protect them, and the protection of sensitive natural sites from damage and exploitation. The latter establishes the MTPA and governs its

mandate of managing and promoting the sustainable use of natural resources, tourism and conservation of biodiversity;

- Limpopo Environment Act, No 7 of 2003, which makes provision for the protection of terrestrial and aquatic biodiversity;
- Limpopo Environmental Implementation Plan 2015-2020 (published under Provincial Notice (“"**PN”**) 64 in Provincial Gazette (**“PG”**) 2715 of 10 June 2016). Describes policies, plans and programmes of the department that perform functions that may impact on the environment and how this department's plans will comply with the NEMA principles and national environmental norms and standards;
- Mpumalanga Environmental Implementation Plan 2015-2020, published under PN 15 in PG 2657 of 29 February 2016), which identifies the policies, plans and programmes within each of the provincial and relevant national departments in the province that could have significant impacts on the environment, and indicates measures that these departments are putting into place or planning to put in place, to improve their environmental performance and co-operative environmental governance; and
- Various municipal by-laws.

## 3.16 Standards and Guidelines

### 3.16.1 South African National Standards – SANS 10103 of 2008

SANS 10103 provides the requirements for noise measurement and rating of environmental noise with respect to annoyance and to speech communication.

### 3.16.2 South African National Standards – SANS 10210 of 2004

This national standard is used when calculating or predicting increased road traffic noise during new developments International Finance Corporation Environmental, Health and Safety Guidelines for Mining ("**IFC Guidelines**").

The IFC Guidelines' recommended noise levels for noise sensitive areas is 55.0dBA during the day and 45.0dBA during the night.

### 3.16.3 United States Bureau of Mines – USBM 1980. Structure response and damage produced by ground vibration from surface mine blasting.

USBM 1980 provides limits for ground vibration levels resulting from blasting. Ground vibration levels as a result of blasting should not exceed 10,0m/s for clay huts and 25.0mm/s for brick or formally constructed buildings.

### 3.16.4 NEMA Implementation Guidelines: Sector Guidelines for Environmental Impact Assessment Regulation (published under GN 654 in GG 3333 of 29 June 2010).

These guidelines provide guidance on how to compile EIAs containing information and analysis of a high quality and which is sufficiently comprehensive to enable the decision-maker to make a well-informed decision. It explains the requirements in the EIA Regulations and provides practical guidance and tools for the EIA process.

### 3.16.5 Department of Environmental Affairs and Tourism (2004); Cumulative Effects Assessment, Integrated Environmental Management, Information Series 7, Department of Environmental Affairs and Tourism (DEAT), Pretoria

This document provides information on cumulative effect assessments, integrated environmental management, and highlights the potential approaches for incorporating cumulative effects into EIAs.

### 3.16.6 Department of Environmental Affairs (2011); A user friendly guide to the National Environmental Management: Waste Act, 2008. South Africa, Pretoria

This guide gives a simplified overview of the contents and application of the Waste Act. It also covers processes or directions on how to manage polluted land and develop industry waste management plans. It provides guidance and information on the licensing of waste management activities, waste information, compliance and the consequences for non-compliance the Waste Act.

### 3.16.7 DEAT (2004): Criteria for determining Alternatives in EIA, Integrated Environmental Management, Information Series 11

This document provides an overview of the key criteria for determining project alternatives, in the EIA process.

### 3.16.8 Guideline for Implementation: Public Participation in the EIA Process (published in under GN 807 in GG 35769 of 10 October 2012)

Assists applicants, I&APs and EAPs to undertake their roles in the PPP. It provides information on the benefits of the PPP and guidance on conducting the PPP.

### 3.16.9 DEA Integrated Environmental Management Guideline: Guideline on Need and Desirability (2017)

Sets out a list of questions that should be considered when determining the need and desirability of a propose project or development. Assists applicants and EAPs to conduct the application process in accordance with best practice methods and meet the peremptory requirements prescribed under NEMA and the 2014 EIA Regulations.

### 3.16.10 International Finance Corporation Standards, Guidelines and Requirements

During the SIA, IFC Performance Standards were taken into consideration. These standards articulate a company's strategic commitment to sustainable development, and are an integral part of the IFC’s approach to risk management.

## 3.17 Integrated Authorisation Processes

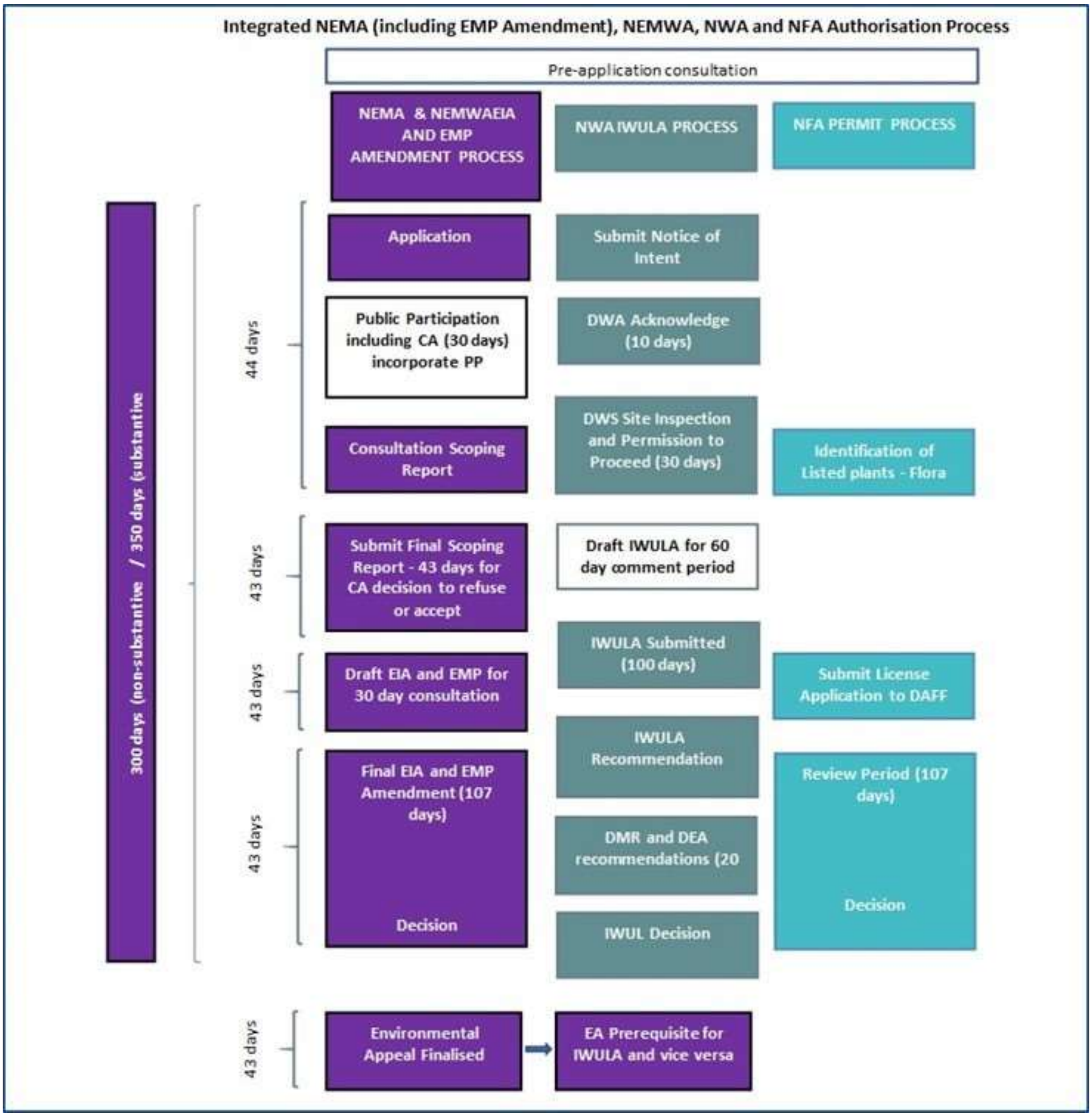
Before the enactment of the 2014 EIA Regulations, separate EAs for environmental and mining related activities were required from the DEA. Co-operative governance and the integration of previously separate applications has now been streamlined through Section 24C of NEMA where it states that:

"*2A The Minister responsible for mineral resources must be identified as the competent authority in terms of subsection (1) where the listed or specified activity is directly related to –*

*(a) extraction and primary processing of a mineral or petroleum resource*."

The integrated application process set out in Figure 3-1 makes provision for the WMLA, EA Applications and EMP Amendment Application, the IWULA process in terms of the NWA and permits in terms of the NFA.

Figure 3-1 Integrated and Concurrent Phase 2 NEMA and WML Application Process for Booysendal Expansion



# 4. Environmental Impact Assessment Methodology

In terms of section 24 of NEMA the potential consequences or impacts of listed activities or specified activities for or on the environment must be considered, investigated, assessed and reported to the CA. The 2014 EIA Regulations govern the procedure and criteria for the preparation, evaluation, submission, processing and consideration for, and decision on, applications for EAs for the commencement of activities subjected to an EIA. Due to the nature of the NEMA Listed Activities to be undertaken as part of the Phase 2 Project, a scoping, environmental impact reporting ("**S&EIR**") and EMP process was followed.

The Integrated Authorisation Process in Figure 3-1 shows the steps of the different processes to meet the requirements of the:

- NEMA and Waste Act EA Applications;
- IWULA; and
- NFA application.

The main phases of the process undertaken for this project are:

- Phase 1: Pre-application
- Phase 2: Application
- Phase 3: Public Participation throughout S&EIR Process
- Phase 4: Develop and Submit Scoping Report
- Phase 5: Undertaken Specialist Studies
- Phase 6: Develop and Submit Consultation EIR & EMP (this report);
- Phase 7: Submit Final EIR & EMP subsequent to public comments (Refer to Section 7 of this Report for detailed description of the consultation process followed).

These phases are described in more detail in the following sub-sections.

## 4.1 Phase 1: Pre-application Consultation

Due to the complexities of the Phase 2 Project, specifically in terms provincial cross-boundary and NEMA-Waste Act-NWA process integration, pre-application meetings were held from 21 to 23 February 2018. These meetings ensured that the processes were streamlined and agreed to in writing; and the requirements and recommendations of all I&APs are incorporated into the concurrent process.

The outcomes of the pre-application meetings are reported in Section 7.

## 4.2 Phase 2: Application

At a pre-consultation meeting held with the DMR Limpopo Regional Office on 18 August 2017, as part of the submission of the Section 24G EA application, it was indicated that, as the Phase 2 Project activities are dealt with by two Regional Offices under the respective Booysendal MRs, one Regional Manager does not have the authority to process this application as the sole CA. The DMR Mpumalanga Regional Office, indicated telephonically that the application forms and Scoping Report for the Booysendal South MR and Booysendal North MR can be submitted concurrently for the Phase 2 NEMA and Waste Act Applications and the regulated process followed as set out in the NEMA Regulations.

The application process involved:

- For the Booysendal North MR, an integrated EA and the Section 24G EMP Amendment Application and Consultation Scoping Report was submitted to the DMR Limpopo Regional Office on 26 February 2018. Booysendal received a letter from the DMR Limpopo Regional Office dated 25 May 2018 confirming that the Consultation Scoping Report for the Booysendal North MR has been accepted;
- For the Booysendal South MR, an integrated WMLA and EA Application and Consultation Scoping Report was submitted to the DMR Mpumalanga Regional Office on 27 February 2018. A response to either proceed with the EIA or to amend the Consultation Scoping Report has not yet been received; and
- Notice of Intent to apply for an IWUL is to be submitted to the DWS in May 2018. A Notice of Intent acknowledgement is expected within 10 days of submission.

## 4.3 Phase 3: Public Participation

Public consultation was undertaken throughout the scoping phase and will continue throughout the Phase 2 NEMA and Waste Act Applications and IWULA. Consultation will only end when final notification of the decisions of the applications has been received from the respective CAs.

The most important objective of the PPP is to provide sufficient and accessible information to assist I&APs in an objective manner to:

- raise issues of concern and suggestions for enhanced benefits and commenting on reasonable alternatives;
- verify that their issues have been recorded in the Comments and Responses Report ("**CRR**") and considered in investigations; and
- contribute relevant local information and traditional knowledge to the process.

The process followed thus far and the proposed process for the next phases is described in Section 7 of this report.

## 4.4 Phase 4: Develop and Submit Final Scoping Report

According to Appendix 2 of the 2014 EIA Regulations, the objective of scoping, through a consultative process, is to achieve the following:

- an understanding of the policies and legislation relevant to the activity;
- identification the AoI of the Phase 2 Project;
- a motivation for the need and desirability of the proposed activity and its desired location;
- identification of the preferred activity and technology alternatives;
- confirmation of the preferred site through a detailed site selection process;
- identification of key issues to be addressed in the assessment phase;
- agreement on the level of assessment to be undertaken, including the methodology to be applied; the expertise required; and the extent of further consultation to be undertaken to determine the impacts and risks of the activity;
- development of the ToR for the EIA phase based on the outcome of the scoping phase; and

- identification of suitable measures to avoid, manage or mitigate identified impacts and to determine the extent of the residual risks that need to be managed and monitored.

The focus in the scoping phase was to identify environmental issues and concerns (biophysical and socio-economic) related to the Phase 2 Project. It assisted in focussing the specialist study ToR and the EIA.

The outcome of the scoping study was a Consultation Scoping Report which was distributed for a 30-day public comment period (refer to Section 7 for details around the PPP). The comments received during the consultation period were incorporated in the Final Scoping Report submitted to the DMR Limpopo Regional on 13 April 2018 and to the DMR Mpumalanga Regional Office on 12 April 2018. All commenting authorities and I&APs on the I&AP register were informed of the availability of the Final Scoping Report for a 30-day commenting period from 14 April to 18 May 2018. The Consultation and Final Scoping Reports were compiled in conformance with Appendix 2 of the 2014 EIA Regulations.

## 4.5 Phase 5: Specialist Studies

The specialist investigation phase followed the scoping phase. As part of the scoping study, the need to undertake or update the following specialist studies were identified:

| | |
|---|---|
| Biodiversity and terrestrial ecology | Aquatic ecology and wetlands |
| Soil, land use and land capability | Surface water hydrology |
| Surface water quality | Ground water quantity and quality |
| Climate and air quality | Greenhouse gas emissions |
| Noise and vibration | Traffic |
| Archaeology and cultural heritage | Socio-economic situation |
| Visual aspects | Mine closure |

The specialist investigations, of which the findings are included in this Consultation EIR, included field surveys, data analysis and interpretation, impact assessment, management planning, monitoring recommendations and reporting requirements. The AoI applicable to the various specialist studies is defined in Section 6 of this Consultation EIR.

The complete specialist reports are included as Annexures to this Consultation EIR, all of which were prepared according to the requirements stipulated in Appendix 6 of the 2014 EIA Regulations and, as such, contain:

- details of the specialist and a declaration of independence;
- the scope of the report and details of the investigations undertaken and methodology;
- the sensitivity of the site and area to be avoided or buffered, with maps;
- description of the findings, impacts and mitigation measures;
- any conditions and monitoring requirements;
- a description and record of any consultation process undertaken; and
- an opinion on whether the proposed activity should be authorised.

The information obtained from the relevant specialist studies will assist the Client with the application for a license regarding protected trees. This will be submitted in terms of the NFA to DAFF to obtain permission to remove protected trees in the Phase 2 Project Area, where applicable.

## 4.6 Phase 6: Consultation EIR and EMP Reports

This Consultation EIR and EMP are based on the outcome of the impact assessment phase and were prepared according to requirements included in Appendices 3 and 4 of the 2014 EIA Regulations. The Consultation EIR and EMP will be made available to commenting authorities, stakeholders and I&APs for a 30-day comment period from the 6 June 2018 to 6 July 2018.

## 4.7 Phase 7: Final EIR and EMP Reports

The comments received during the commenting period on the Consultation EIR and EMP will be incorporated into the final reports which will be submitted to the two relevant DMR Regional Offices. All commenting authorities, stakeholders and I&APs will be notified of the availability of the final reports and will be requested to submit comments on these reports directly to the CAs.

# 5. Description of the Receiving Environment

This section contains the findings of the baseline physical, social and heritage specialist investigations for the Phase 2 Project. It details the methodologies used by the specialists, summarises the current baseline conditions and highlights sensitivities applicable to each field of study. Although the specialist investigations focussed on the Phased 2 Project Area, they also aimed to consolidate specialist findings for the overall Booysendal Operation as far as possible, especially where they could build on the findings of the studies pertaining to the Phase 1 Project. This overall view of the baseline environment should serve as an important planning tool for Booysendal going forward.

## 5.1 Climate

The Booysendal Mine is located on the eastern escarpment, on the border of the Highveld and Northern Transvaal climatic zones of South Africa (Schulze, 1974). The area is a summer rainfall area with most of the rainfall occurring from October to March as showers and thunderstorms. The winter months are normally dry. The area is characterised by a temperate climate with warm summers and cold winters.

Most of the Phase 2 Project Area is in the Groot Dwars River valley where temperatures are characteristic of valley climates, while BS4 is mainly on the plateau. Daily temperatures can be high and winds are localised within the valley.

Although weather data has been recorded by the BN weather station since 2014, the data is not available for a long enough period to be reliable for the calculation of climate and seasonal averages, therefore climate data was sourced as follows:

- long term data sets on wind and temperature from the South African Weather Service ("**SAWS**") station at Lydenburg (WO554816), Mpumalanga Province, 35 km east of the site as the crow flies;
- mean annual precipitation, general precipitation and evaporation data was sourced from the Water Resources of South Africa (WR2005) Water Research Commission (reports TT380 to 382/08) and from the DWS Hydrological Information Systems for Station B4E003 (Buffelshoek Dam) (1 October 1971 to 1 January 2016) approximately 25 km to north east of the site;
- monthly evaporation was sourced from the Roossenekal weather station (DWS No B4E004; SAWS No. 553762 W);
- short term data set (two years) taken from the Booysendal Weather Station located at BN; and
- where data had to be supplemented, Mesoscale Model version 5 ("**MM5**") data was used.

### 5.1.1 Regional Temperature

Lydenburg has average temperatures ranging between highs of 18.3ºC and 25.9ºC in the warmer summer months and lows of 2.7ºC and 14.7ºC in the winter months (Table 5-1). The annual average temperatures range between 9.5ºC and 22.9ºC. Extreme temperatures of 34.5ºC have been experienced in summer and lows of 5.9ºC in winter.

Table 5-1 Average, Minimum and Maximum Daily Temperatures (˚C) for Lydenburg (SAWS, 1962-1990)

| MONTH | TEMPERATURE | | |
|---|---|---|---|
| | **Average maximum (ºC)** | **Average minimum (ºC)** | **Average (ºC)** |
| January | 25.9 | 14.7 | 20.3 |
| February | 25.5 | 14.2 | 19.8 |
| March | 24.8 | 12.9 | 18.8 |
| April | 22.6 | 10.0 | 16.3 |
| May | 20.8 | 6.0 | 13.4 |
| June | 18.3 | 2.8 | 10.6 |
| July | 18.8 | 2.7 | 10.7 |
| August | 20.9 | 4.8 | 12.8 |
| September | 23.6 | 8.1 | 15.9 |
| October | 24.0 | 10.8 | 17.4 |
| November | 24.2 | 12.7 | 18.4 |
| December | 25.2 | 14.1 | 19.6 |

### 5.1.2 Regional Precipitation and Evaporation

The Mean Annual Precipitation ("**MAP**") calculated from the closest weather station being Buffelskloof is 730mm. The Mean Annual Evaporation ("**MAE**") ranges between 1800 and 2000mm (A-Pan estimate) and between 1400 and 1500mm (S-Pan estimate). From Table 5-2 it is clear that evaporation greatly exceeds rainfall in the area both on a monthly and annual basis, making the Phase 2 Project Area a water deficit area. The more significant rains occur in summer in the form of thunderstorms, resulting in high volume run-off events over relative short time periods.

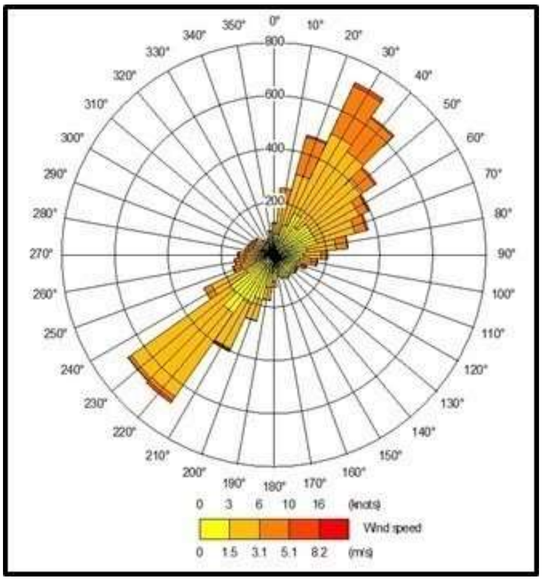
Table 5-2 Average Rainfall and Evaporation (DWS Station No. B4E003 – Buffelshoek Dam: Oct 1971 to 1 Jan 2016, taken from Letsolo, 2018))

| Month | Average Monthly Rainfall (mm) | Average Evaporation (mm) |
|---|---|---|
| January | 133.4 | 182.1 |
| February | 82.1 | 157.5 |
| March | 70.8 | 150.5 |
| April | 49.1 | 122.1 |
| May | 14.7 | 105.9 |
| June | 7.2 | 89.4 |
| July | 5 | 104.9 |
| August | 9.7 | 139.2 |
| September | 24.4 | 169.6 |
| October | 71.4 | 185.9 |
| November | 133.3 | 167.6 |
| December | 128.9 | 181.6 |
| **Total** | **730** | **1756.3** |

### 5.1.3 Regional Wind Speed and Direction

Regional wind flow can be characterised by the wind data from Lydenburg, although these winds will not indicate the local wind flows in the valley where the Phase 2 Project Area is located. The dominant regional winds, portrayed in Figure 5-1, are from the north east and the south west with wind speeds over 8 m/s for short periods of time. Most wind speeds are low, mainly below 6 m/s.

Figure 5-1 Annual Wind Rose for Lydenburg (SAWS, hourly data, 2014)




Seasonal variations in the regional wind characteristics (represented by the Lydenburg weather station) are illustrated in Figure 5-2. Winds during summer (January) are predominately from the north east and from the south west in winter (July). Highest wind speeds are experienced during the summer (3 - 8 m/s), probably associated with thunderstorm activity. Temperature inversions are likely during the cooler months of winter with a stable atmosphere and low wind speeds. At these times pollutants can be trapped in the atmospheric layer close to the earth's surface (boundary layer) and concentrated with minimal vertical mixing and dilution.

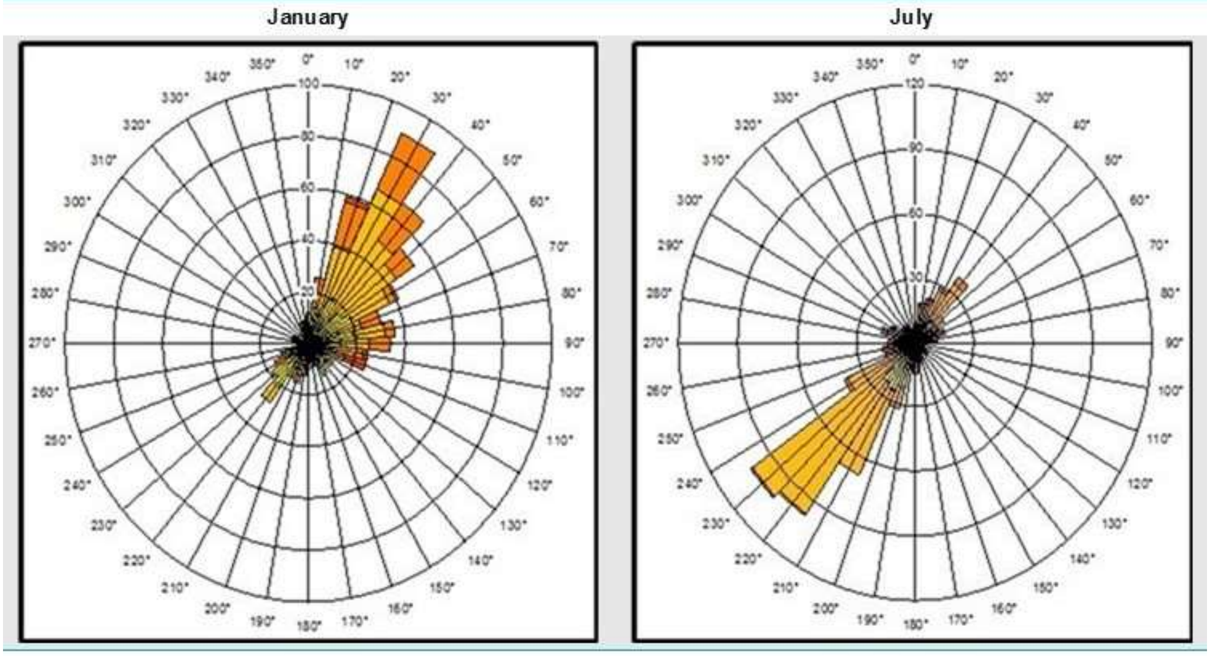
### 5.1.4 Local Climate

The local climate data was obtained from Booysendal's on-site weather station at BN which was established in 2014 and has collected data for over four years. Winds were calculated from MM5 data. Its location at the top of the Groot Dwars River valley means that the weather station is outside the valley itself and the micro climate of the valley experienced by the Phase 2 Project will not be recorded. It will, nonetheless, provide a more relevant description of the area's climate than a regional station over 30 km distant.

#### 5.1.4.1 Temperature and Relative Humidity

The average temperatures for Booysendal as per the onsite weather station are shown in Figure 5-3. This is taken from two years' data (with a data availability of greater than 99%). The overall average temperature for the two years is 19.7ºC. The highest maximum over the two-year period was 35.3ºC (November 2015) and the lowest minimum was 4.4 ºC (June 2014).

Figure 5-2 Wind Rose for January (summer) and July (winter) for Lydenburg (SAWS, hourly data, 2014)




### 5.1.4.2 Local Rainfall and Evaporation

Rainfall measured at the Booysendal Station for the years 2014 and 2015 indicates an annual average rainfall of 691.7mm (Figure 5-3 and Table 5-4). Little to no rain is experienced in the winter months with most of the rainfall between December and March.

Table 5-3 Average, Maximum and Minimum Temperatures (˚C) and Relative Humidity – Booysendal Weather Station

| Month | 2014 | | | | 2015 | | | |
|---|---|---|---|---|---|---|---|---|
| | Temperature (ºC) | Temperature (ºC) Maximum | Temperature (ºC) Minimum | Relative Humidity | Temperature (ºC) | Temperature (ºC) Maximum | Temperature (ºC) Minimum | Relative Humidity |
| January | 23.43 | 31.32 | 16.14 | 71.71 | 22.47 | 31.46 | 15.41 | 69.99 |
| February | 22.73 | 30.97 | 15.14 | 64.58 | 23.15 | 32.97 | 14.23 | 66.22 |
| March | 20.97 | 31.09 | 13.12 | 74.56 | 21.56 | 30.93 | 11.81 | 64.29 |
| April | 18.48 | 28.48 | 10.60 | 62.08 | 18.90 | 27.88 | 10.99 | 70.67 |
| May | 17.51 | 27.60 | 8.78 | 52.69 | 19.06 | 25.72 | 10.80 | 48.50 |
| June | 15.05 | 27.21 | 4.37 | 43.59 | 14.46 | 18.68 | 5.71 | 49.50 |
| July | 14.24 | 24.63 | 4.70 | 46.35 | 15.13 | 24.77 | 6.10 | 52.08 |
| August | 16.83 | 29.30 | 4.49 | 39.02 | 18.25 | 30.96 | 5.46 | 46.54 |
| September | 20.07 | 33.92 | 6.89 | 42.93 | 19.67 | 33.52 | 8.71 | 54.35 |
| October | 19.53 | 33.32 | 9.93 | 57.07 | 22.64 | 34.48 | 10.55 | 51.67 |
| November | 20.76 | 30.61 | 10.21 | 65.47 | 22.25 | 35.31 | 10.40 | 51.48 |
| December | 22.05 | 33.15 | 13.78 | 70.02 | 24.39 | 33.95 | 10.40 | 62.39 |

Figure 5-3 January 2014 to December 2015 Rainfall (Booysendal Weather Station)

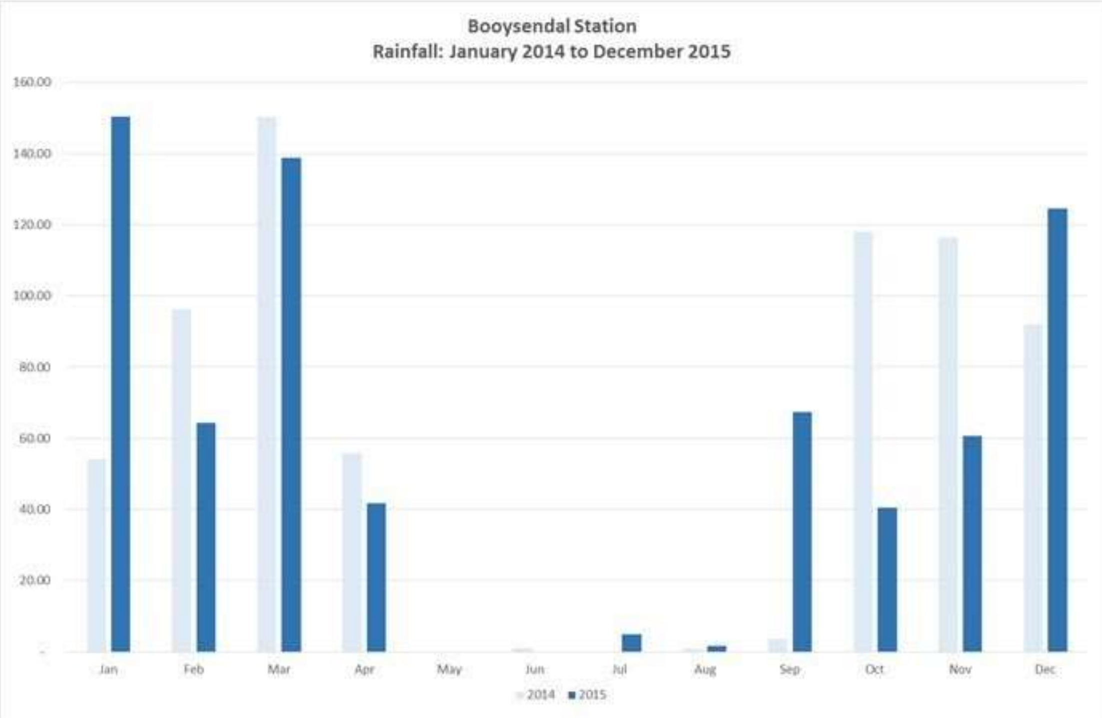


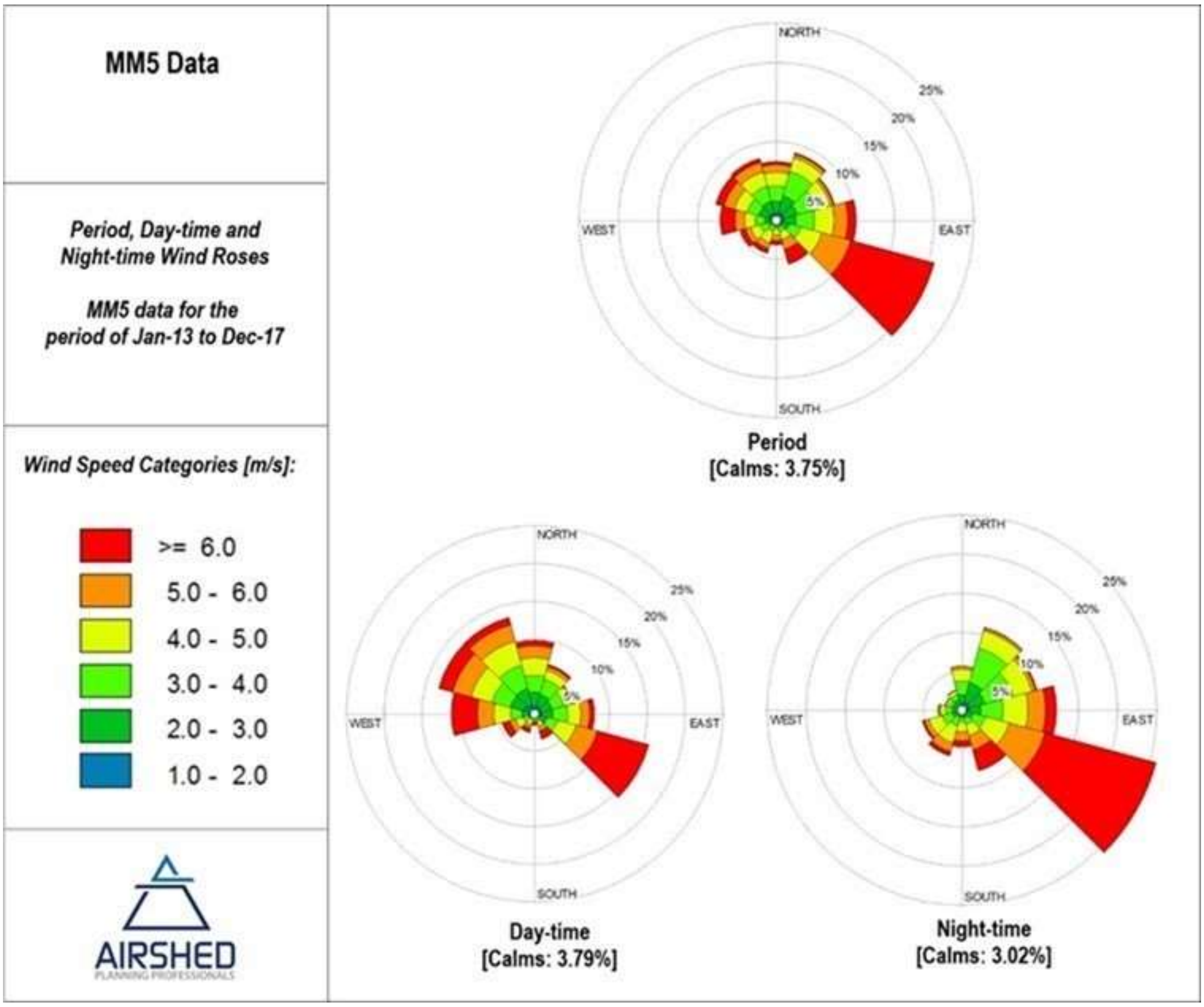

Table 5-4 Monthly Rainfall Distribution for Booysendal Mine (DWAF B4004 and Booysendal Weather Stations)

| Month | Rainfall (mm) | | Lake Evaporation (mm) |
|---|---|---|---|
| | DWAF Station No.4004 | Booysendal Station | DWAF Station No.4004 |
| January | 120.9 | 102.3 | 118.2 |
| February | 93.4 | 80.3 | 110.4 |
| March | 74.0 | 144.6 | 103.1 |
| April | 34.6 | 48.8 | 83.8 |
| May | 13.4 | 0.0 | 71.2 |
| June | 7.3 | 0.5 | 56.4 |
| July | 3.1 | 2.4 | 58.4 |
| August | 7.4 | 1.2 | 73.9 |
| September | 17.4 | 35.5 | 94.1 |
| October | 68.8 | 79.3 | 107.9 |
| November | 123.8 | 88.5 | 108.0 |
| December | 117.0 | 108.3 | 116.0 |
| Total | 683.0 | 691.7 | 1101.4 |

### 5.1.4.3 Local Wind Speed and Direction

Winds will be topographically induced due to the steep valleys encountered at the Phase 2 Project Area. Anabatic and katabatic flows will be present. Wind speed of these winds will be influenced by the degree of heating and cooling of the valley sides and the gradient of the valley floor. Figure 5-4 provides and incitation variation in daily wind direction and speed as modelled by Airshed in 2018 and Figure 5-5 provides an indication of the seasonal variations in wind.

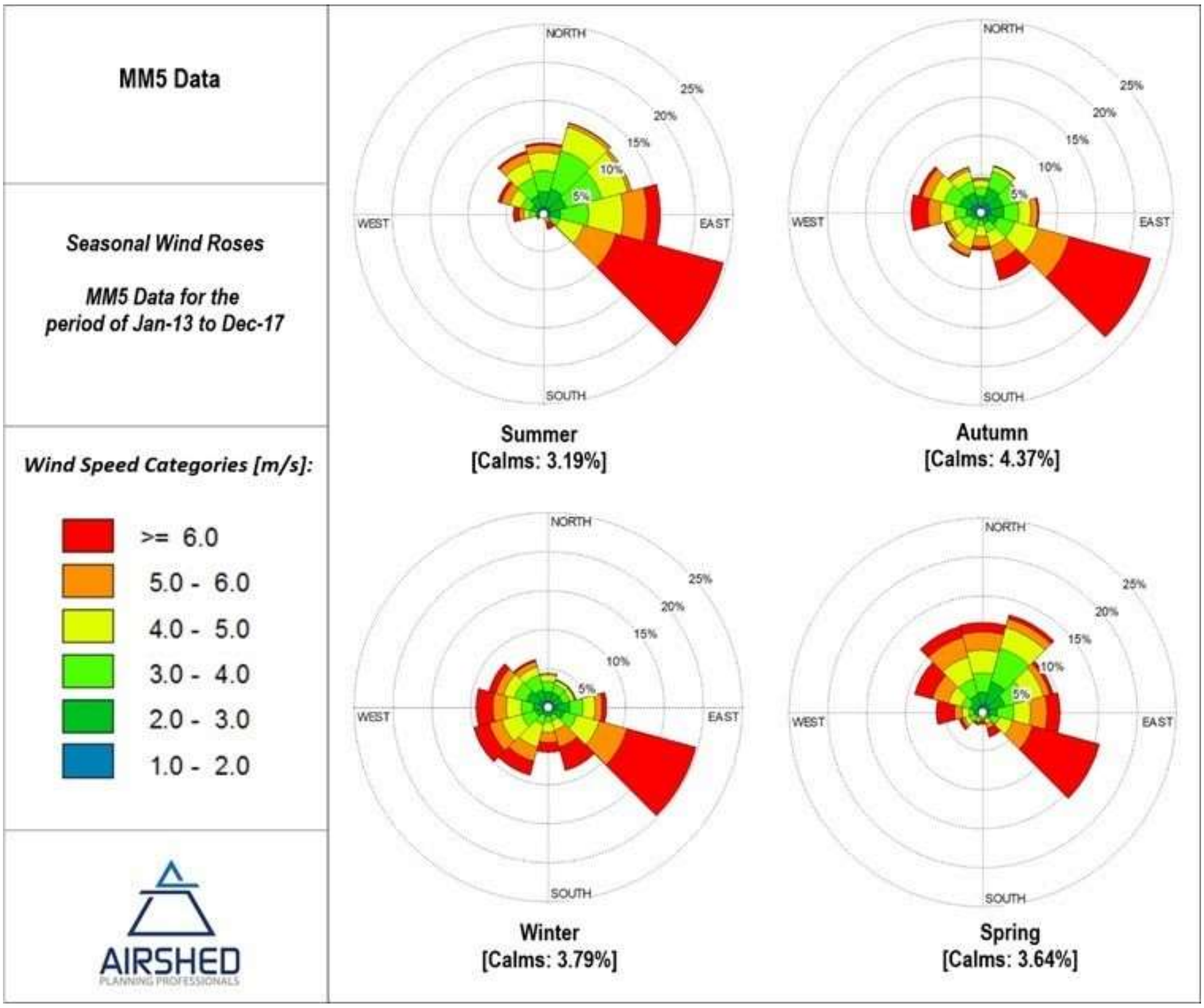
Figure 5-4 Local Wind Rose for Booysendal Mine (MM5 data) for Jan 2013 to December 2017 (Source: Airshed, 2018)




In general, the wind-field is dominated (>20% frequency) by south-easterly winds, with calms of between 3.02 and 3.79% of the time (Figure 5-4). The slope of the terrain accounts for the increased frequency of occurrence of northerly and north-westerly wind during the day-time and increased south-easterly winds during the night-time. The differential heating and cooling of the air along a slope typically results in down-slope flow at night (from BS4 into the valley and down along the Groot Dwars River valley in a northerly direction), with low-level up-slop airflow occurring during the day (from the Der Brochen Dam area southwards BCM complexes and out of the valley direction BS4). Winds are mainly south easterly in the winter and changes to north east and northerly in the summer. Calms increase to 4.39% in winter as opposed to 1.71% in summer. Wind speeds between 3 and 10 m/s dominate with exceedances of 10 m/s occurring less than 1% of the time.

The main part of the Phase 2 Project Area is situated in the secluded Groot Dwars River valley with minimal development and no other activities. Potential sensitive receptors have been identified as occupants of the dwellings near BS4 (homesteads, schools and educational centres) and individual homesteads to the east of the Phase 2 Project Area in the higher land above the Klein Dwars River valley (refer to Figure 5-6).

Figure 5-5 Seasonal Variations in Wind Speed and Direction at Booysendal Mine as Modelled from MM5 Data, January 2013 to December 2017 (Source: Airshed, 2018)




## 5.2 Air Quality

The air quality impact assessment ("**AQIA**") was done by Airshed. The scope of the study was to determine current baseline air quality; identify potential sensitive receptors; develop an emissions inventory for Booysendal Mine and the Phase 2 Project based on the existing and potential future sources of emission and dust outfall; and to assess the potential cumulative air quality impacts which may result from the Phase 2 Project. The AQIA is specifically focussed on $PM_{2.5}$, $PM_{10}$ and dust fallout impacts. Airshed furthermore recommended mitigating and management (including monitoring) requirements.

### 5.2.1 Methodology

#### 5.2.1.1 Determine Baseline

The baseline study included the analysis of current available dust monitoring data for BN and BS4 to understand the existing air quality. This was followed by an analysis of meteorological data (refer to Section 5.1). Metrological data plays an important factor in determining the behaviour of pollutant. Climate factors taken into consideration in the model include wind speed, wind direction and influence of temperature on air movement.

Another important input factor in a dispersion model is emissions and particles which could result from the Booysendal Operations. The mechanical equipment lists, fleet lists and parameter of other potential emission sources i.e. the crusher and conveyors were analysed and an emissions inventory developed to input as source into the air dispersion model.

#### 5.2.1.2 Impact Prediction and Reporting

The United States Environmental Protection Agency approved AERMET/AERMOD dispersion modelling suit was used to model particulate concentrations and dust outfall. Ambient concentrations were simulated to determine the highest hourly, daily and annual averaging levels. The dispersion of pollutants was modelled for an area covering 15.3km (north-south) by 14.4km (east-west). These areas were divided into a grid with a resolution of 102m (north-south) by 96m (east-west). AERMOD simulates ground-level concentrations for each of the receptor grid points. MM5 modelled climate data for the period 2013 to 2017 was used in the model.

The impacts were assessed against the South African National Ambient Air Quality Standards issued by the DEA (2009 and 2012). The limits of the two pollutants of concern and the outcome of the air dispersion model are discussed under Section 10. The results of the air quality impact assessment culminated in the AQIA report (see Annexure D).

### 5.2.2 Baseline Air Quality

Current sources of air pollutants in the Project Area are mainly dust particles in the range of $PM_{10}$ and $PM_{2.5}$. These sources can be attributed to dust from construction activities, windblown dust and mobilisation of dust through vehicle movement, equipment and machinery.

Emission sources including sources of $CO_2$, CO, C, $SO_2$, volatile organic compounds ("**VOCs**"), ammonia ($NH_3$) and NO from vehicles, agricultural fertilizers, pesticides, manures, biomass burning and industrial emissions in the wider AoI were determined to be negligible

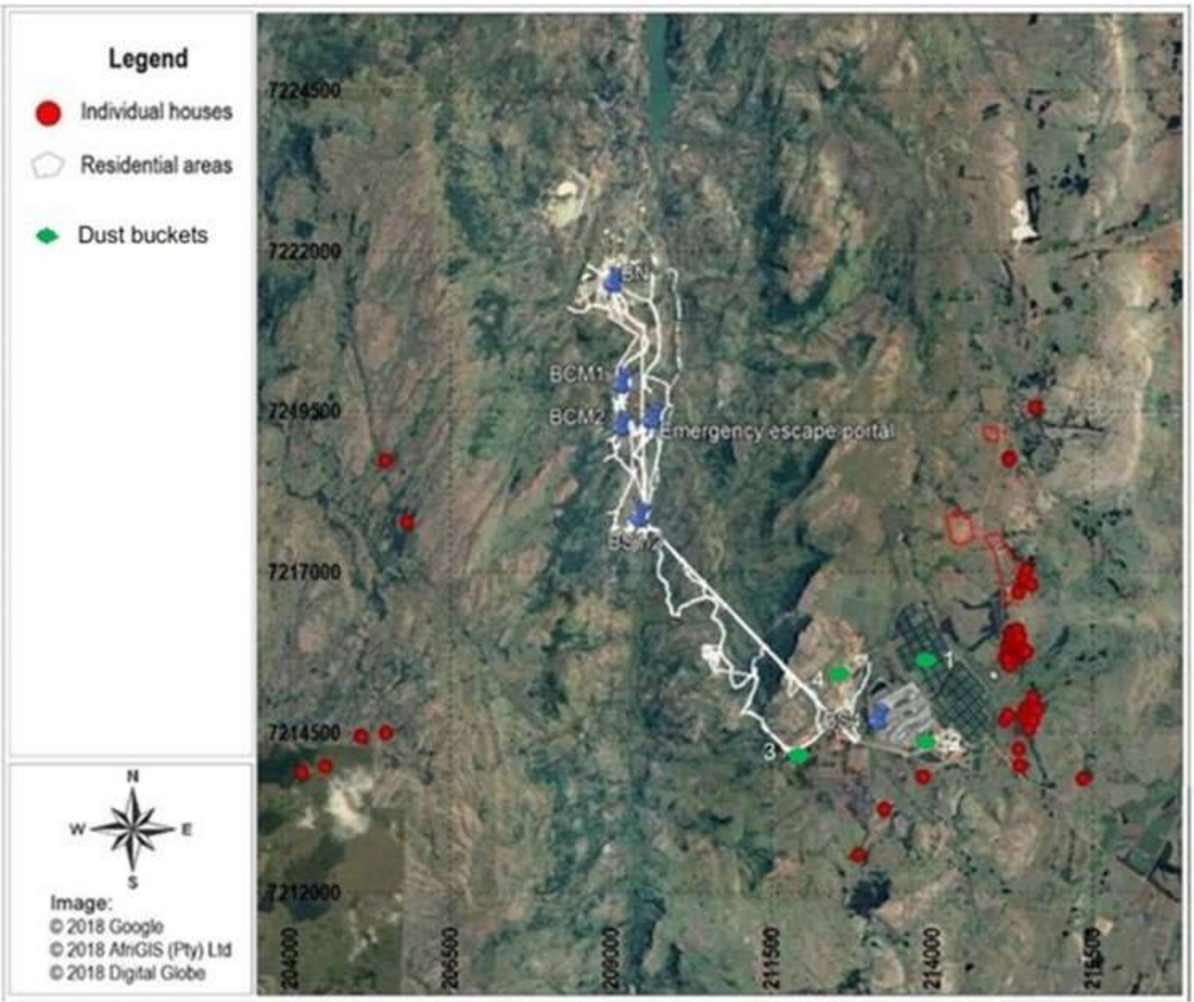
Booysendal commenced with dustfall monitoring at four monitoring points at and around BS1/2 in October 2015. Dustfall is also monitored at BS4 since October 2015, while an existing monitoring network exists at BN since 2009. The locations of the network are included in Figure 5-6 for BS4 and Figure 5-7 for BN (including BS1/2). The results for BS4 indicates that outfall levels are low except for one exceedance of the National Dust Control Regulations ("**NDCR**") of 600mg/m$^2$/day. This occurred in March 2016 at the quarry area (monitoring point 3 in Figure 5-6) when the dust outfall was 716mg/m$^2$/day. The NDCR stipulates that an exceedance of 600mg/m$^2$/day may not occur more than two days in a calendar year. As exceedance at BS4 only occurred once dust outfall is within compliance with NDCR. The results for BS4 are included in Table 5-5.

BN has a dust fallout network consisting of fifteen single dust buckets. Dust fallout measured during the period September 2015 and August 2016 was all below the NDCR for residential areas (600 mg/m$^2$/day) except for BN11 which measured 619 mg/m$^2$/day in September 2015 and 1691 mg/m$^2$/day in October 2015. BN11 is directly associated with the Phase 1 Project construction activities at BS1/2, indicating that additional dust abatement measures may be required. Refer to Table 5-6 for monitoring results.

### 5.2.3 Air Quality Sensitive Receptors

Airshed identified receptors which could potentially be impacted by a change in air quality should the Phase 2 Project lead to an increase in dust outfall or emissions. Potential receptors are restricted to the east and farmers directly to west of the Phase 2 Project (refer to Figure 5-6).

Figure 5-6 Sensitive Air Quality Receptors and Dust Monitoring Points at BS4 (Source: Airshed, 2018)




## 5.2.4 Climatic Conditions and Air Quality Relationship

Climatic conditions play an important determining factor in the potential behaviour of air pollutants. Flow, climatic and stability climatic conditions are important baseline factors to be considered in potential air quality dispersion:

a. Local Wind Fields

Thermo-topographical induced flow is anticipated to represent an important component in the airflow over the Project Area with significant differences evident between day-time and night-time wind field characteristics. The slope of the terrain accounts for the increased frequency of occurrence of northerly and north-westerly wind during the day-time and increased south-easterly winds during the night-time. The differential heating and cooling of the air along a slope typically results in down-slope (katabatic) flow at night, with low-level up-slope (anabatic) airflow occurring during the day. These types of flows generally contribute to trapping of pollutants in valley areas during night times and dispersion of pollutants out of valley areas during the day.

b. Ambient Temperature, Atmospheric Stability and Mixing Depth

Temperature is an important factor in air buoyancy, formation of inversion layers and mixing of air. These factors are important components when it comes to dispersion modeling.

Figure 5-7 Dust Monitoring Network at BN (Source: Airshed, 2017)

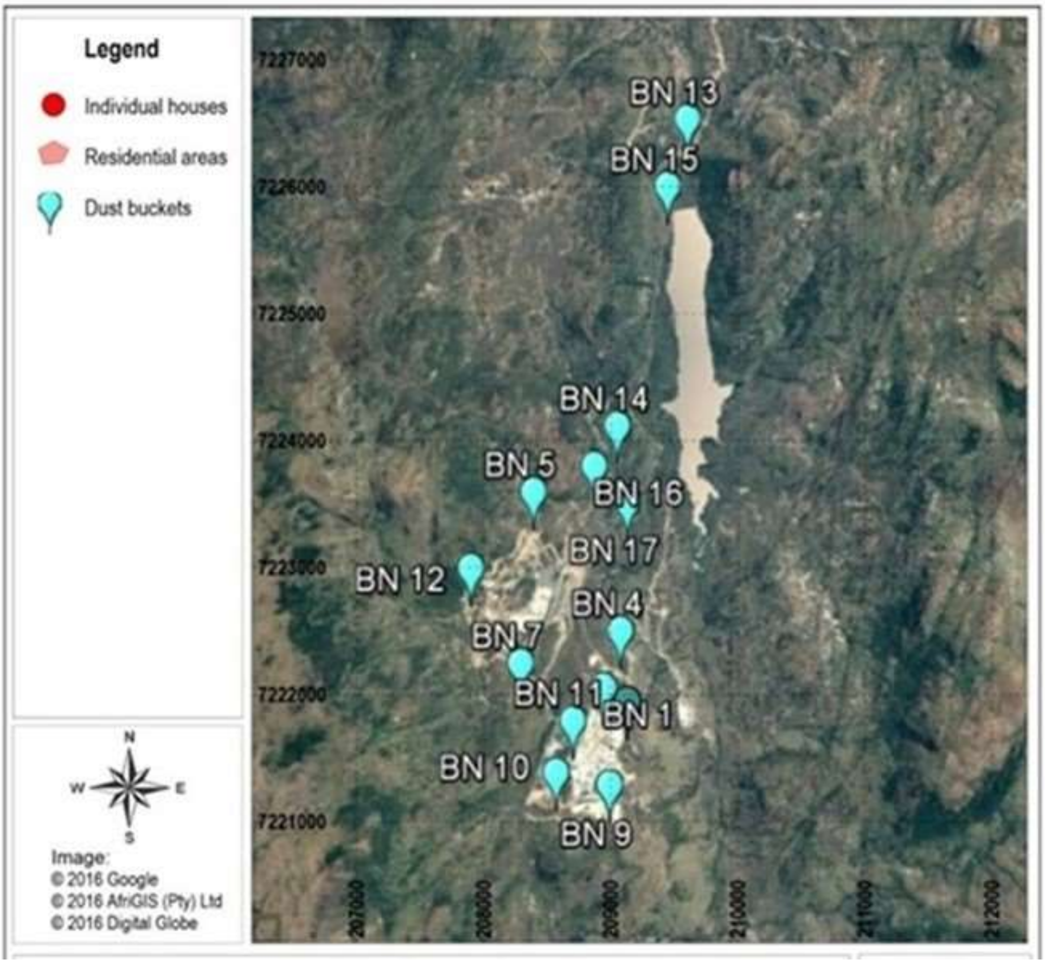



Table 5-5 Baseline Air Quality Monitoring Results for Dust Outfall at BS4 (Source: Airshed, 2017)

| Sampling month | Dustfall levels (mg/m²/day) | | | |
|---|---|---|---|---|
| | NBSD01 | NBSD02 | NBSD03 | NBSD04 |
| | Kiwi | Central | North Quarry | South Quarry |
| | 25.1508°S; 30.1622°E | 25.1587°S; 30.1629°E | 25.1484°S; 30.1503°E | 25.1594°S; 30.1448°E |
| Oct-15 | 50 | 55 | 89 | 97 |
| Nov-15 | 135 | 54 | 60 | 72 |
| Dec-15 | 171 | 176 | 88 | 104 |
| Jan-16 | 74 | 122 | 96 | 130 |
| Feb-16 | 93 | 18 | 20 | 56 |
| Mar-16 | 65 | 12 | 716 | 6 |
| Apr-16 | 107 | 23 | 5 | 95 |
| May-16 | 40 | 0 | 0 | 0 |
| Jun-16 | 57 | 11 | 4 | 24 |
| Jul-16 | 94 | 61 | 105 | 81 |
| Aug-16 | 10 | 120 | 104 | 11 |
| Sep-16 | 16 | 17 | 28 | 17 |

Table 5-6 Baseline Air Quality Monitoring Results for Dust Outfall at BN (Source: Airshed, 2017)

| Site | | | Sep-15 | Oct-15 | Nov-15 | Dec-15 | Jan-16 | Feb-16 | Mar-16 | Apr-16 | May-16 | Jun-16 | Jul-16 | Aug-16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | West | 25° 5.550' S; 30° 6.800' E | 31 | 32 | 13 | 27 | 12 | 41 | 9 | 9 | 21 | 21 | 19 | 43 |
| 2 | East | 25° 5.610' S; 30° 6.922' E | 22 | 36 | 23 | 32 | 43 | 5 | 48 | 10 | 36 | 17 | 25 | 26 |
| 4 | Cemetery | 25° 5.308' S; 30° 6.882' E | 33 | 32 | 30 | 16 | 11 | 120 | 15 | 8 | 20 | 23 | 15 | 32 |
| Site | | | Sep-15 | Oct-15 | Nov-15 | Dec-15 | Jan-16 | Feb-16 | Mar-16 | Apr-16 | May-16 | Jun-16 | Jul-16 | Aug-16 |
| 5 | Tailings North | 25° 4.718' S; 30° 6.435' E | 12 | 35 | 19 | 16 | 16 | 20 | 36 | 16 | 17 | 8 | 20 | 17 |
| 6 | Tailings East | 25° 5.610' S; 30° 6.922' E | 16 | 63 | 20 | 57 | 98 | 29 | 53 | 36 | 19 | 20 | 14 | 57 |
| 7 | Tailings South | 25° 5.450' S; 30° 6.378' E | 9 | 18 | 18 | 25 | 15 | 20 | 17 | 5 | 19 | 8 | 9 | 177 |
| 9 | Eskom South | 25° 5.963' S; 30° 6.837' E | 47 | 72 | 43 | 53 | 19 | 17 | 37 | 11 | 67 | 91 | 208 | 213 |
| 10 | DMS Stockpile | 25° 5.913' S; 30° 6.567' E | 30 | 29 | 60 | 46 | 27 | 27 | 11 | 17 | 30 | 36 | 44 | 26 |
| 11 | Plant | 25° 5.693' S; 30° 6.647' E | 619 | 1691 | 323 | 84 | 48 | 59 | 134 | 41 | 139 | 69 | 38 | 148 |
| 12 | Tailings West Waterdam | 25° 5.047' S; 30° 6.123' E | 12 | 19 | 26 | 22 | 172 | 26 | 8 | 161 | 12 | 11 | 7 | 33 |
| 13 | Bridge | 25° 3.092' S; 30° 7.192' E | 18 | 14 | 25 | 19 | 20 | 24 | 19 | 13 | 23 | 16 | 9 | 26 |
| 14 | Powerline | 25° 4.430' S; 30° 6.853' E | 60 | 44 | 26 | 19 | 31 | 8 | 32 | 20 | 26 | 18 | 21 | 32 |
| 15 | Main Road Dam | 25° 3.387 'S; 30° 7.093' E | 16 | 21 | 33 | 16 | 18 | 23 | 18 | 16 | 34 | 24 | 14 | 27 |
| 16 | 1.8 Line | 25° 4.603' S; 30° 6.738' E | 14 | 107 | 46 | 50 | 41 | 34 | 20 | 25 | 24 | 19 | 22 | 13 |
| 17 | Helipad | 25° 4.753' S; 30° 6.905' E | 38 | 55 | 21 | 41 | 40 | 16 | 27 | 9 | 39 | 150 | 21 | 23 |

### 5.2.5 GHG Assessment

A greenhouse gas (**"GHG"**) emissions assessment was undertaken by Kirjani in October 2016. The Kirjani study is included with the Airshed AQIA Report in Annexure D. The purpose of the assessment was to gain an understanding of the of the potential GHG emissions which may result from the Booysendal South Expansion Project and to establish to what extent the Booysendal South Expansion Project will lead to enhanced GHG emissions and thereby contribute to global warming.

#### 5.2.5.1 Methodology

*Emission types*: The first step was to identify the emission types which may be associated with the Booysendal South Expansion Project. These include: include carbon dioxide ($CO_2$); methane ($CH_4$), and nitrous oxide ($N_2O$).

*Emission factors*: An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. In this case, emissions are inferred from the total volume of fuel purchased.

Emissions that will originate from Booysendal Mine are associated with the burning of fossil fuels mainly from vehicles, machinery and generators and include $CO_2$, $CH_4$ and $N_2O$. The emission factors for the Project Area were modelled.

*Reporting:* The GHG study reported on Scope 1 emissions for which the Booysendal Mine is directly responsible as result of the burning of fossil fuels from vehicles and machinery used on site

#### 5.2.5.2 Sensitive Receptors

GHG emissions have a global impact as climate change is a phenomenon which impacts on everybody and all ecosystems.

### 5.2.6 Ecosystem Services

Air regulates climate and weather patterns disturbance of the compositions, which leads to climate change. Air is also a provisional service providing oxygen to all living creatures. A reduction of plants potential to breathe as a result of dust deposition not only inhibits growth but can be fatal.

## 5.3 Topography

The terrain surrounding the Phase 2 Project can be best described as mountainous traversed by steep and deep river valleys. The Steenkampsberge is the main mountain range in the area varying in height from 1 500 to 2 400 mamsl. The main river system is the Steelpoort River, a tributary of the Olifants River. The Steelpoort River is a perennial river with its origin on the western slopes of the north-south trending Drakensburg Mountains.

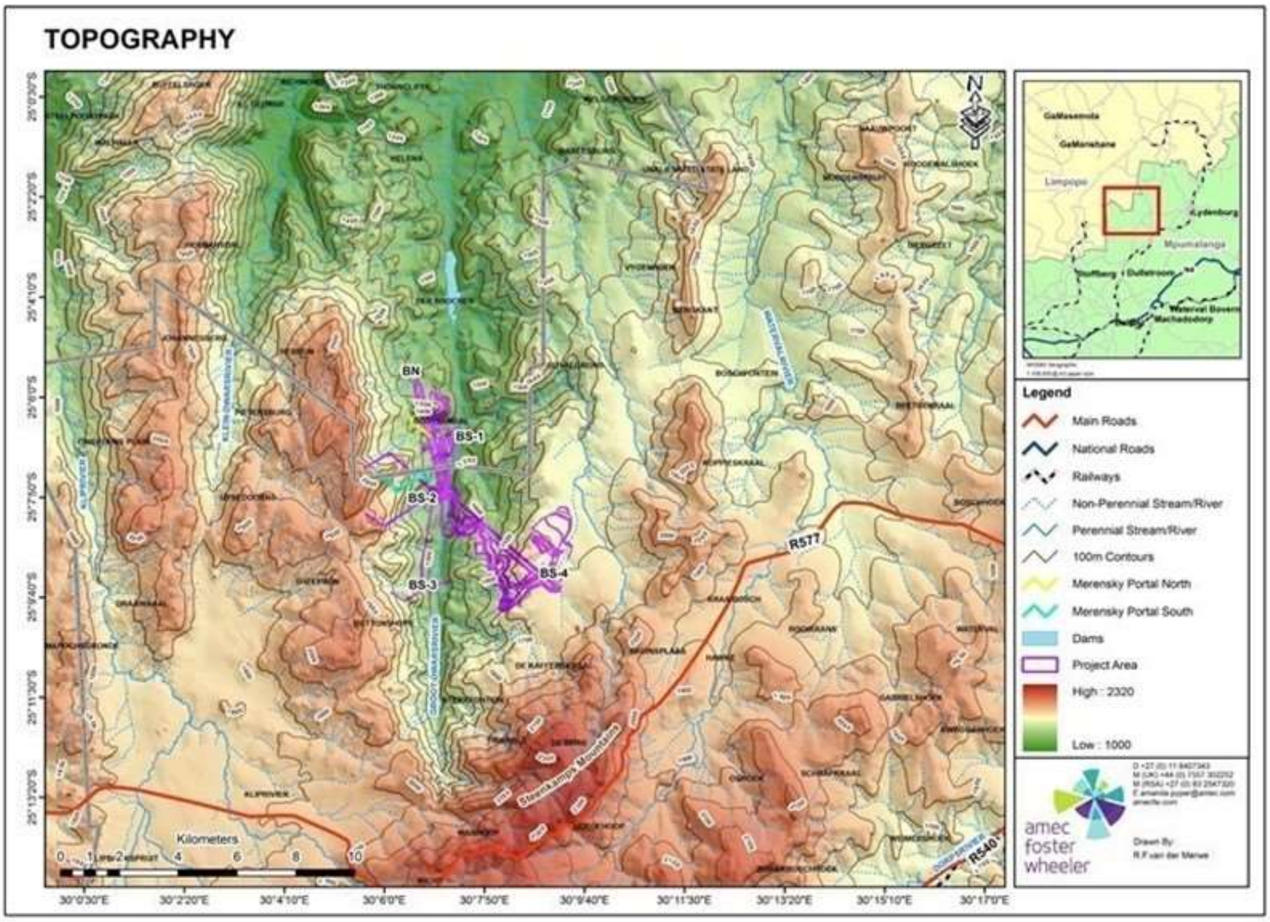
The topography of the Phase 2 Project comprises of the Steenkampsberge which stretches from east of BS4 to the south after which it turns in a northwesterly direction where it rises to 2 024 mamsl. The Groot Dwars River is one of the perennial rives which has its origin in this mountainous terrain. It runs through the Booysendal Operation and is responsible for the steep and rugged valley terrain which makes out the majority of the Booysendal Operation. The topography of the Phase 2 Project areas can be described as follows:

- Booysendal North MR: BCM1 and BCM2, the associated services and infrastructure and the ARC are located in the upper steep valley reaches of the Groot Dwars River. This valley has a north-south direction and stretches past BN to the north with BS4 located on the eastern terrace above the valley. From west to east, the Groot Dwars River valley a ranges in altitude from 1 052 mamsl at the valley bottom to 1 760 mamsl at the edge of the ridges on the eastern and western side of the valley.
- Booysendal South MR: BS4 is located on a terrace of the Steenkampsberge at a height of between 1 600 and 1 700 mamsl near the foot of the De Berg peak and east of the Booysendal North MR. The mountain range is a curvilinear erosional feature over 25 km long, located up to 7 km east of the Groot Dwars River.

The steep Klein Dwars River valley runs parallel and to the west of the Groot Dwars River and the Phase 2 Project. The existing BN mine is located on a terrace of the Groot Dwars River to north of the Phase 2 Project Area at a height of between 1 300 and 1 400 mamsl.

The ruggedness of the terrain increases further south of the Phase 2 Project Area. The general steep gradient, the lack of availability of large gently sloped areas and the many drainage lines restricts land use and also presents several challenges in terms of the construction and placement of mining and mining related infrastructure. The topography of the Project Area is shown in Figure 5-8.

Figure 5-8 Topography of the Project Area




## 5.4 Geology

### 5.4.1 Regional Geology

Booysendal is set in the BIC, an intrusive igneous body extending approximately 400 km from east to west and about 350 km from north to south. There are two lithologically distinct units: a lower sequence of layered ultramafic-mafic layers, known as the Rustenburg Layered Suite; and an overlying unit of granites, known as the Lebowa Granite Suite. BIC consists of four main geological limbs, namely the Northern Limb, the Eastern Limb, the Southern Limb and the Western Limb. The Phase 2 Project is located on the Eastern Limb.

The Rustenburg Layered Suite is subdivided into the Marginal, Lower, Critical, Main and Upper zones. Rocks in the Suite range from ultravasic pyroxenites and norites in the lower parts to norite, gabbro and magnetite gabbro in the upper parts. The Critical Zone pyroxenites, norites and anorthosites host all the significant PGMs and chromite deposits. The Lower, Critical and Main Zones become attenuated towards the southern end of the Eastern Limb. Booysendal has been the focus of intensive recent exploration for both UG2 and Merensky Reef Platinum Group Element bearing horizons.

On a regional level, there are two major lineaments (geological structures) in the Eastern Bushveld being the Steelpoort and Wonderkop faults, which divide the Eastern Bushveld into three zones: the southern, central and western zones. The surface expression of the Steelpoort fault occurs 40 km to the north of the Phase 2 Project Area.

### 5.4.2 Local Geology

Approximately 12.5 km of Merensky and UG2 Reef strike outcrops in the Groot Dwars River valley in the area in which the Booysendal South Expansion Project mining areas are located. The strike is in a north-south direction on the Farm Booysendal 43JT in the north and the Remaining Extent of the Farm Buttonshope 51JT and the Farm Sterkfontein 52JT in the south. The mineralogical outcrop dips between 10° and 12° to the west. The main economic horizons in the Southern Upper Critical and Main Zones are the PGMs located in the Merensky Reef and the underlying UG2 Chromitite Reef. Refer to Figure 5-9 for an illustration of the Critical Zone and associated economic horizons.

The igneous rocks in the Project Area consist of gabbro, norite, anorthosite, pyroxenite and chromitite which form part of the Dwars River Suite and the Dsjate Sub-suite (Main Zone) of the BIC. From BS4, the ore body forms an elongated erosional remnant that projects eastwards under the Groot Dwars River and is preserved within a basin-like structure on the eastern site of the valley. The reef outcrops and sub-crops around almost the entire perimeter of the basin except for the western part of the southern flank, where the UG2 reef is downthrown along a fault, and the western side of the ore body where the reef passes under the Groot Dwars River and merges with the rest of the UG2 reef that underlies the entire western side of the river valley.

#### 5.4.2.1 BS4

At BS4, the Bushveld floor geology consists mainly of sandstone of the Steenkampsberg Formation, Transvaal Supergroup. These erosion resistant rocks form much of the Steenkampsberg mountain range located to the east of the Project Area. Pre-Bushveld sills and the Marginal Zone have intruded these rocks in places. A large sill (over 200 m thick) forms part of the Steenkampsberg. The underlying geology of the south concentrator plant and TSF1 areas consist mainly of the Marginal Zone and Critical Zone rocks of the Rustenburg Layered Suite. The Marginal Zone consists of fine-grained gabbro and norite. Large detached fragments of Transvaal Supergroup sediments are locally present in this unit. To the north of the main BS4 complex, the geology is mainly comprised of Quaternary surficial deposits, alluvium and scree, while to the west of the valley there is medium- to coarse-grained gabbro and norite with subordinate anorthosite of the Dsjate Subsuite.

According to the Future Flow Hydrogeological Study for the Booysendal South Expansion Project (Phase 1 and Phase 2) 2018 ("**2018 Future Flow Report**"), which was undertaken as part of the Phase 2 Project Applications, the structural geology shows the presence of several significant regional structures that could act as groundwater flow paths. Several dolerites, diabase, and syenite intrusions form the dykes that intersect the area.

GCS (Pty) Ltd (2009) found that the faults are represented by two prominent strike directions e.g. north-northwest and north-northeast. From experience and previous investigations in the Project Area, it is known that the north-northeast faults are normally associated with open fractures and brittle deformation, indicating that they are of a much younger age.

#### 5.4.2.2 BCM1, BCM2 and Emergency Escape Portal

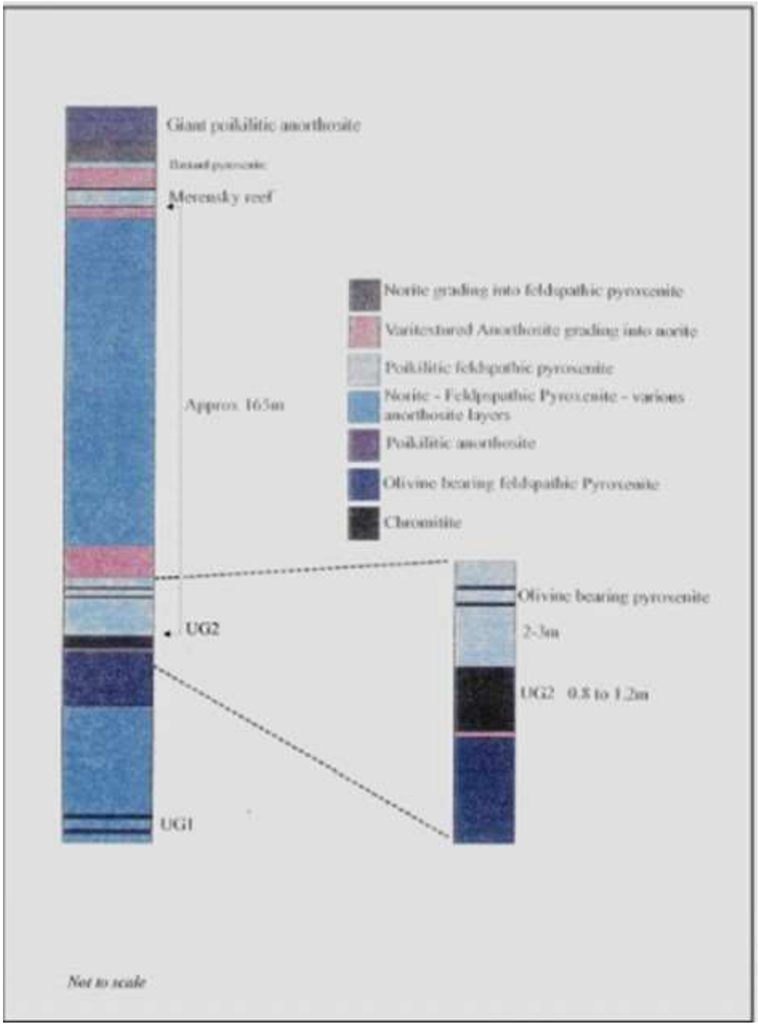
The Merensky Reef is located at the top of a thick pyroxenite (-5m) sequence and is consistent with a thin chromitite stringer (marker) located about 30cm from the top of the Merensky pyroxenite. The mineralised layer is characterised by an abrupt transition from norite to pyroxenite, a single narrow chromitite stringer, coarser semi-pegmatoidal textures and the presence of visible base metal sulphides.

The Merensky Reef hanging wall is geotechnically competent, with gradational contacts between the handing wall lithologies. Although rare, jointed reef and poorer hanging wall conditions are normally associated with faulting, dykes and potholes. This is also the case at BCM1 and BCM2.

The UG2 Reef is strikingly different, with a single thick chromitite layer followed stratigraphically in its immediate hanging wall with pyroxenite and a series of chromitite stringers classified as the Triplet chromitite stringers. In most instances, these chromitite stringers are located more than 1m above the top of the UG2

Reef and hence do not pose a threat to safety or UG2 Reef dilution. Conversely, jointed reef and poorer hanging wall conditions are commonly associated with faulting, dykes, potholes and slump features. Typically, the areas near the Farms Helena 6JT and Buttonshope 51JT slumps have a higher incidence of low angle, thrust type shear or joint planes.

Figure 5-9 Longitudinal Representation of the Rustenburg Layered Suite in the Phase 2 Project Area




### 5.4.2.3 Structural Geology

Several faults and dolerite dykes have been identified in the area, generally associated with higher yielding ground water occurrences (refer to Figure 5-10). Packer testing performed on exploration boreholes in the valley also confirmed the presence of zones of high hydraulic conductivity associated with these structures. The implication of this is that the faults and dykes can serve as preferential flow paths for contaminants should it enter the groundwater regime.

There is some evidence of minor faulting. The dominant fracture zone is a north-south trending zone underlying the Groot Dwars River. There is some suggestion that a fractured zone up to 900m wide is extensively intruded by dolerite dykes, narrowing southwards.

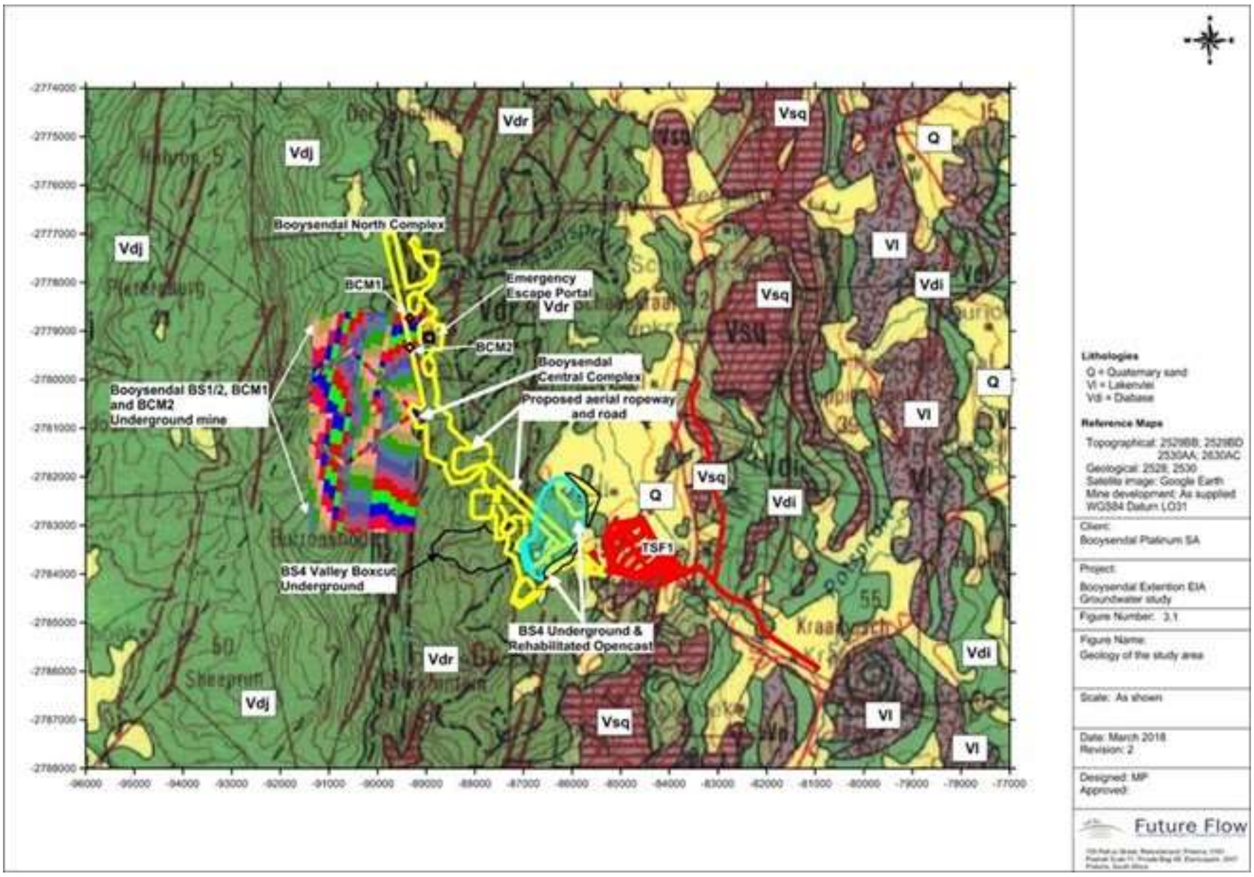
<u>BCM1, BCM2 & Emergency Escape Portal</u>: There are two major faults associated with this area, the first major fault, namely the St. Georges fault, has a down-throw of an unknown quantity towards the east and the second is a graben structure with a down-throw of 100m. Towards the south of BS1/2, the geological structure is extremely complex with development of several synforms and antiforms.

In addition to this, the ground geophysical survey performed during the 2011 Future Flow Fairway study in the Groot Dwars River valley shows the presence of several geological structures that could act as preferential groundwater flow paths. Packer testing performed on exploration boreholes in the valley also confirmed the presence of zones of high hydraulic conductivity associated with these structures.

BS4: According to the 2018 Future Flow Report, the existing TSF1 area shows the presence of a number of fault zones, dyke, and weathering zones that could act as preferential groundwater flow and contaminant transport pathways.

The rest of the BS4 and Valley Boxcut geology shows the presence of several significant regional structures that could act as groundwater flow paths. Several dolerite, diabase, and syenite intrusions form the dykes that intersect the area. Desktop findings captured in the 2018 Future Flow Report, states that the faults in these areas are represented by two prominent strike directions e.g. north-northwest and north-northeast. Experience and previous investigations shows that the north-northeast faults are normally associated with open fractures and brittle deformation, indicating that they are of a much younger age.

Figure 5-10 Geology and Structural Geology of Booysendal Mine and the Phase 2 Project Area



## 5.5 Hydrogeology

The hydrogeological study for the Phase 2 Project was carried out by Future Flow Groundwater (report included in Annexure E). The study built on the findings of the Phase 1 Project as it was done by the same specialist.

### 5.5.1 Methodology

The Phase 1 Project hydrogeological assessment was updated to assess the potential impacts of the Phase 2 Project on the groundwater regime. As all baseline information was available and a hydro-census in the AoI was already carried out, the contamination transport model and the model to determine the potential drawdown cone related to the Phase 2 Project activities. Waste characterisation of the applicable waste streams and ore bodies was carried out as part of the Phase 1 Project and were used to update the models.

A three-dimensional numerical groundwater flow and contaminant transport model was constructed. The model was constructed using MODFLOW, which is internationally developed and recognised. MODFLOW is widely used to simulate the impacts of mining activities on the groundwater environment, including groundwater inflow volumes into the underground mines, groundwater level drawdown in the aquifers due to mine dewatering and the associated changes in groundwater flow patterns. The MT3DMS add-on package was used to simulate the contaminant migration through the study area. Parameters that were quantified include:

- Mine inflow volumes into the various mining areas over the LoM (BS1/2, BCM1, BCM2, BS4 and the Valley Boxcut area);
- Impacts on the surrounding groundwater levels, flow patterns and groundwater users due to mine dewatering and seepage from the various surface infrastructure;
- Impact of backfilling of the underground area with tailings material on groundwater and pollution migration patterns;
- Impacts on the Groot Dwars River due to mine dewatering and the associated reduced baseflow contribution;
- Groundwater level recovery after mine closure;
- Contaminant migration away from the mining areas and surface infrastructure, and the associated impacts on the surrounding groundwater quality; and
- Impacts on the surface water bodies due to contaminant migration.

### 5.5.2 Baseline

#### 5.5.2.1 Aquifer Classification

There are two types of aquifers in the project area namely the Weathered Zone Aquifer and Fracture Rock Aquifer.

<u>Weathered Zone Aquifer:</u> The upper aquifer resulted from the vertical infiltration of recharging rainfall through the weathered material being retarded by the underlying lower permeability material. Groundwater collecting above the contact migrates down gradient along the contact to lower lying areas. In places where the contact is near surface the groundwater can daylight on surface as one of the many springs that occur in the area, or seep as baseflow into the surface water bodies. This aquifer therefore plays an important role in water provision to communities within 2km from the Project Area; it furthermore contributes to recharge of surface water resources. The shallower weathered zones are associated with the steep valley sides. Because of the steep valley sides the recharge of the aquifer is low. The depth to groundwater/ water table ranges between surface and 12m below ground level ("**mbgl**"), while the groundwater is contained at levels up to depths of 35m. The following is of specific reference to the Phase 2 Project regarding the weathered zone aquifer:

- Weathering at BCM1, BCM2 and the Emergency Escape Portal and related infrastructure is expected at 5 to 20m below surface ("**mbs**"). Borehole data indicates that groundwater levels occurring within this weathered zone is encountered at levels < 5mbgl;
- The extrapolation of available borehole data at BS4 indicates that the weathered zone associated with TSF1 should be at levels of 11 to 15m. Borehole data indicates that groundwater in this aquifer is encountered at depths between 1.4 to 14mbgl and that it is rising. The concern with the rising groundwater levels is that it is indicative of seepage from TSF1 and RWD1; and
- The weathering of material at the BS4 underground works is expected to be between 25 to 35mbs and in the backfill area at around 20mbs.

Fractured Rock Aquifer

The Fractured Rock Aquifer is an underlying competent and fractured rock aquifer. This aquifer is found under the weathered zone aquifer. Groundwater flows in the lower aquifer are associated with the secondary fracturing in the competent rock and, as such, will be along discrete pathways associated with the fractures. The depth of the water table/ groundwater level in the fractured aquifer ranges between 22 and 42 mbgl. Most groundwater flows in this aquifer are expected to be along the upper 40 to 50m. It is expected that groundwater will not be encountered below 80m. The fractured aquifers are mainly associated with flat and valley areas. The following groundwater levels are applicable the Phase 2 Project:

- The lower lying areas at the Emergency Escape Portal and the ARC towers, silo, and main access road across the Groot Dwars River. Borehole data indicated that groundwater is encountered at levels between 5 and 10mbgl;
- The depth to groundwater level in steeper areas e.g. BCM1 and BCM2 is expected to be around 5mbgl;
- Borehole data indicates the presence of dykes and lower levels of weathering associated with this aquifer. Transmissivity in this aquifer ranges between 0.001 and 4.3 m/day; and
- Previous studies undertaken at BS4 indicate that the underground workings are associated with a prominent shear zone. The flows which continue along the shear zones could result in underground subsidence and collapse of the underground workings. Water levels in the underground workings are rising and at times lead to natural decanting around the Valley Boxcut.

#### 5.5.2.2 Groundwater Flow

There is a strong correlation between groundwater flow and the topography as groundwater flow is directed from higher laying areas to valleys. Preferential flow paths are created where geological structures are present. A conceptual groundwater model for the Phase 2 Project is included in Figure 5-11.

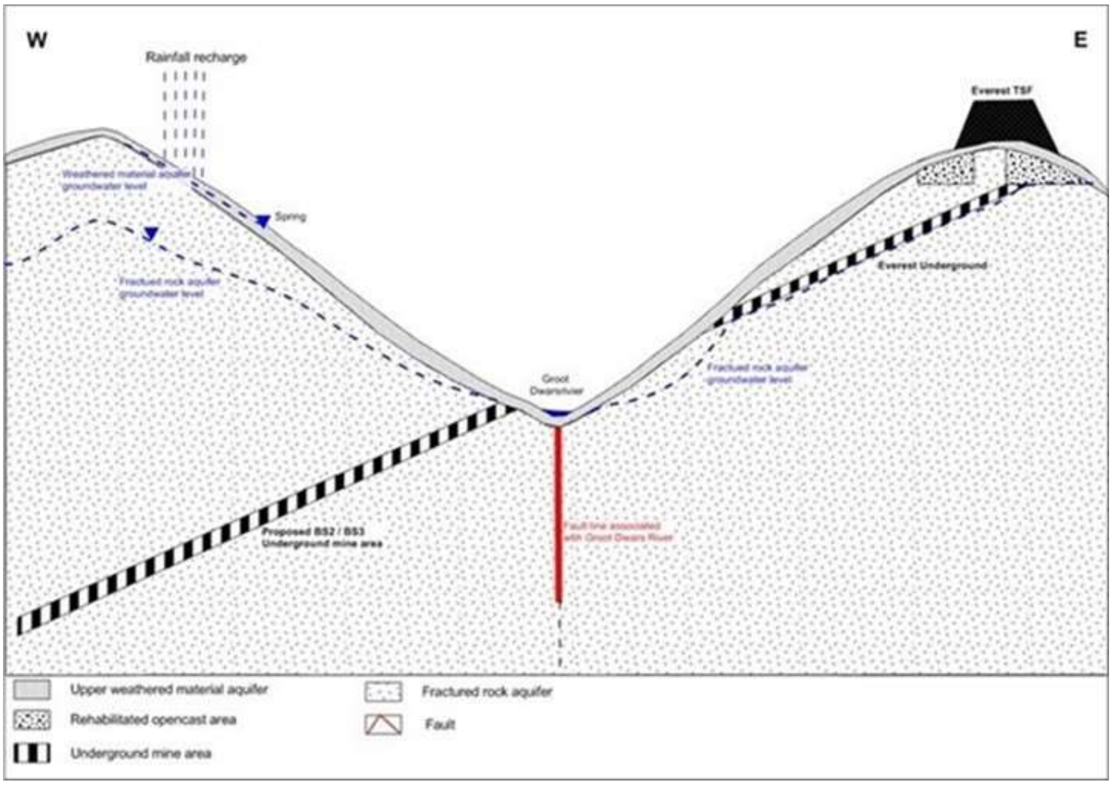
#### 5.5.2.3 Hydraulic Conductivity and Classification

The hydraulic conductivity for the aquifers in the Project Area ranges between 0.001 and 4.3 m/day while recharge at BS4 is in the order of a three magnitude.

#### 5.5.2.4 Groundwater Recharge

Various groundwater studies of the Project Area have been undertaken. The sub-catchments within which the Booysendal Operation falls span approximately 812 $Mm^2$. Previous studies indicate a recharge value percentage of up to 5% of MAR using an average annual rainfall value of 709 mm (0.709m). Per these values, aquifer recharge has been calculated at 28.754 $Mm^3$/a in the local sub-catchments.

Figure 5-11 Conceptual Groundwater Model (Source: Future Flow: 2018)




### 5.5.3 Hydro-census

Several hydro-censuses were undertaken in the Project Area over time as part of various hydrogeological investigations. This data was updated as part of the overall Booysendal South Expansion Project. The findings of the hydro-census are presented in Table 5-7. Landowners and other occupants in the area are dependent on groundwater for water supply. The water is used for a variety of purposes, including domestic use, stock watering and artisanal mining. Hydro-census surveys show that, together with surface water, groundwater is abstracted for domestic and stock water use through boreholes, as well as the damming of springs.

Approximately 24 boreholes or springs are used by the surrounding land owners. An estimated average volume of 1 000l/day is abstracted from each point. This equates to a total estimated abstraction volume of $24m^3$ per day or 8 $760m^3$/annum. Using the recharge value of 28.754 $Mm^3$ the calculated groundwater abstracted by land owners equates to less than 1% of the average annual ground water recharge. The importance of the groundwater ecosystem is described in Table 5-8.

### 5.5.4 Groundwater Quality

In general the groundwater in the Phase 2 Project Area is representative of recently recharged water where little to no ion exchange associated with contamination from external sources has taken place. The water quality is homogenous and very good. The Piper diagrams are included in the Hydrogeological assessment in Annexure E.

Groundwater quality was assessed against the South African National Standards ('**SANS**") 241:2015 water quality guidelines for domestic use. The assessment included an analysis of the trends from the current groundwater monitoring campaign for Booysendal and analysis of seven water samples taken from six hydro-census points and the underground water at BS4. The study indicated that at most of the sampling points, background water quality falls within SANS 241:2015 drinking water limits. The exceptions are:

- Nitrates levels in the groundwater of the BS4 underground workings exceed the SANS 241:2015 drinking water limit of 11 mg/l. This can be attributed to the blasting agents used; and
- The iron levels in borehole BH5 was 3.76 mg/L against the SANS 241:2015 limit of 2 mg/l. This could potentially be attributed to rusting of the casting.

The average baseline groundwater quality results are described in more detail under the water quality Section 5.8.

### 5.5.5 Sensitive Receptors

Sensitive receptors are limited to the groundwater users to the east of BS4 (see Figure 5-12) . Any other impacts will be contained within the MR areas. Potential sensitive groundwater users include four farmers within 2km and four communities within 3km from the existing BS4 TSF1.

### 5.5.6 Ecosystem Services

Groundwater in the Phase 2 Project Area has two main ecosystem services:

- Provisional service: The surrounding land owners, occupiers and communities have a high dependency on surface and groundwater for domestic and live stock use. The importance of groundwater is further highlighted as there is no municipal water provision to the area; and
- Regulatory and supporting service: Groundwater seepage supports some of the FEPA wetland systems in the Phase 2 Project Area and contributes to the baseflow to the Groot Dwars River which is important in maintaining flow rates and levels for the various aquatic species which are sensitive to fluctuations in water levels and quality.

The importance of the groundwater ecosystem is illustrated in Table 5-8.

Figure 5-12 Groundwater Users (Source: Future Flow, 2018)

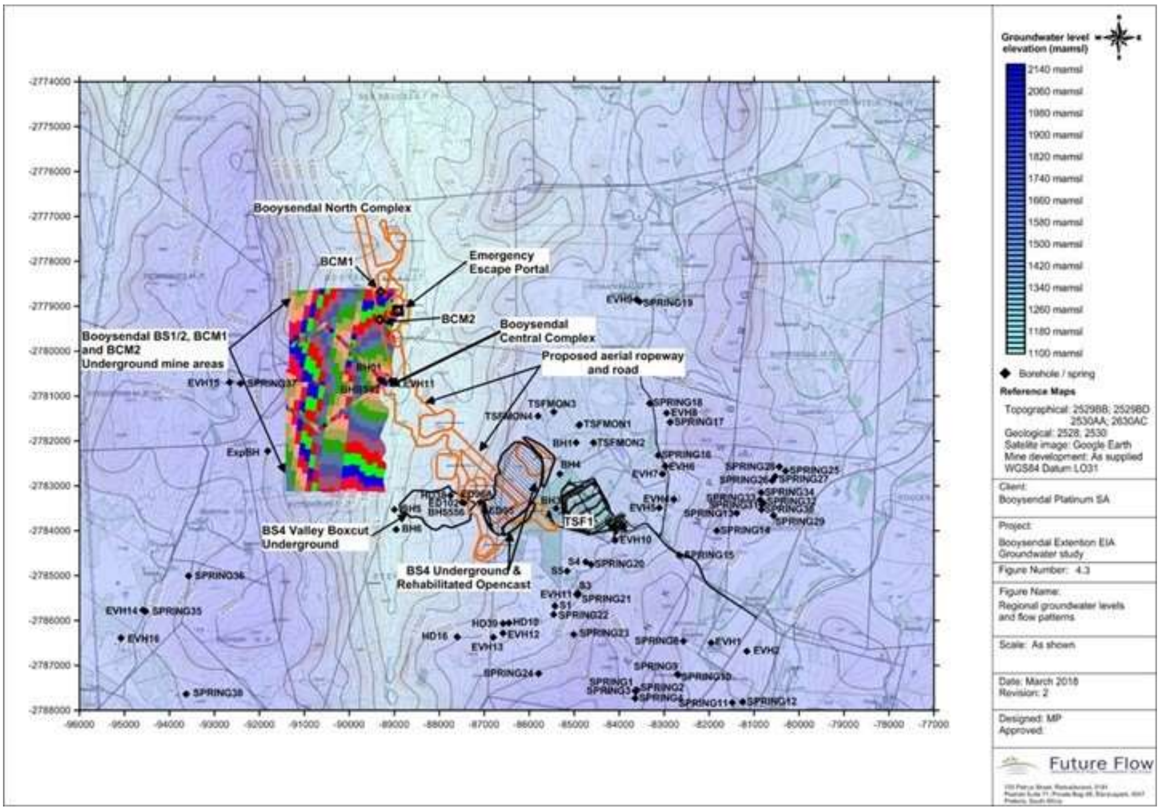


Table 5-7 Booysendal South Expansion Project Hydro-census Results (Source: Future Flow, 2018)

| Study | ID | Easting | Northing | Elevation | Date | SWL | | Equipped | Use | Sampled | Owner | Farm Name | Contact Number | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (WGS84 LO31) | (WGS84 LO31) | (mamsl) | | (mbgl) | (mamsl) | | | | | | | |
| Future Flow 2016 BS1/2 and BS4 EIA study | BH45 | -89068 | -2780658 | 1221.10 | 01/06/2016 | 10.28 | 1210.82 | - | N/A | N | Booysendal | Sterkfontein 52 JT | 011 759 6000 | - |
| | BH01 | -89317 | -2780636 | 1288.51 | 01/06/2016 | 41.63 | 1246.88 | - | Monitoring | N | Booysendal | Buttonshope 51 JT | 011 759 6000 | - |
| | BHBS02 | -89265 | -2780671 | 1265 | 01/06/2016 | 33.54 | 1231.46 | - | N/A | N | Booysendal | Buttonshope 51 JT | 011 759 6000 | - |
| | ExpBH | -91816 | -2782221 | 1910.37 | 01/06/2016 | 22.67 | 1887.70 | - | Not used | N | Booysendal | Buttonshope 51 JT | 011 759 6000 | - |
| | BH1 | -84963 | -2782043 | 1678.77 | 01/06/2016 | 1.78 | 1676.99 | - | Monitoring | N | Booysendal | De Kafferskraal 53 JT | 011 759 6000 | - |
| | BH2 | -84890 | -2781643 | 1674.74 | 01/06/2016 | 2.27 | 1672.47 | - | Monitoring | Y | Booysendal | De Kafferskraal 53 JT | 011 759 6000 | - |
| | BH3 | -85402 | -2783499 | 1707.19 | 01/06/2016 | 2.67 | 1704.52 | - | Monitoring | Y | Booysendal | De Kafferskraal 53 JT | 011 759 6000 | - |
| | BH4 | -85317 | -2782732 | 1690.75 | 01/06/2016 | 4.25 | 1686.50 | - | Monitoring | N | Booysendal | De Kafferskraal 53 JT | 011 759 6000 | - |
| | EVH06 | -82973 | -2782567 | 1779 | 01/06/2016 | 13.01 | 1765.99 | Y | Domestic | N | Kiwi Community | De Kafferskraal 53 JT | 0722126402 | Located inside pump house |
| | BH5 | -88992 | -2783528 | 1245.66 | 01/06/2016 | 6.4 | 1239.26 | - | Monitoring | Y | Booysendal | Sterkfontein 52 JT | 011 759 6000 | - |
| | BH6 | -88959 | -2783973 | 1247.88 | 01/06/2016 | 8.99 | 1238.89 | - | Monitoring | N | Booysendal | Sterkfontein 52 JT | 011 759 6000 | - |
| | EVH11 | -89068 | -2780658 | 1791 | 01/06/2016 | N/A | N/A | N | Domestic | N | Ria Groenewald | De Kafferskraal 53 JT | 0835965975 | Borehole collapsed |
| | Spring20 | -89317 | -2780636 | 1748 | 01/06/2016 | 0 | 1748 | N | Domestic | N | Ria Groenewald | De Kafferskraal 53 JT | 0835965975 | Small capture dam exists on the down gradient side of seepage zone |
| | Spring21 | -89265 | -2780671 | 1797 | 01/06/2016 | 0 | 1797 | N | Domestic | N | Ria Groenewald | De Kafferskraal 53 JT | 0835965975 | A 3m deep pit has been dug out and a channel directs water to the house |
| BN Monitoring Program | NBGW01 | -88398 | -2778311 | N/A | N/A | N/A | N/A | N | Monitoring | N | Booysendal | Booysendal 43 JT | 011 759 6000 | Monitoring borehole |
| | NBGW02 | -88452 | -2778529 | 1162.00 | 09/02/2016 | 0.18 | 1161.82 | N | Monitoring | N | Booysendal | Booysendal 43 JT | 011 759 6000 | Monitoring borehole |
| | NBGW03 | -88373 | -2777878 | 1149.10 | 11/05/2016 | 8.25 | 1140.85 | N | Monitoring | N | Booysendal | Booysendal 43 JT | 011 759 6000 | Monitoring borehole |
| | NBGW04 | -88357 | -2777503 | N/A | N/A | N/A | N/A | N | Monitoring | N | Booysendal | Booysendal 43 JT | 011 759 6000 | Monitoring borehole |
| | NBGW05 | -88417 | -2776989 | 1141.20 | 11/05/2016 | 8.09 | 1133.11 | N | Monitoring | N | Booysendal | Booysendal 43 JT | 011 759 6000 | Monitoring borehole |
| | NBGW06 | -90072 | -2776389 | 1298.00 | 10/05/2016 | 3.63 | 1294.37 | N | Monitoring | N | Booysendal | Der Brochen 7 JT | 011 759 6000 | Monitoring borehole |
| | NBGW07 | -89914 | -2776169 | 1280.70 | 10/05/2016 | 10.52 | 1270.18 | N | Monitoring | Y | Booysendal | Der Brochen 7 JT | 011 759 6000 | Monitoring borehole |
| | NBGW08 | -89745 | -2775937 | 1266.20 | 10/05/2016 | 24.67 | 1241.53 | N | Monitoring | N | Booysendal | Der Brochen 7 JT | 011 759 6000 | Monitoring borehole |
| | NBGW09 | -89591 | -2775418 | 1248.30 | 10/05/2016 | 11.05 | 1237.25 | N | Monitoring | N | Booysendal | Der Brochen 7 JT | 011 759 6000 | Monitoring borehole |
| | NBGW10 | -89118 | -2776433 | 1303.40 | 10/05/2016 | 6.36 | 1297.04 | N | Monitoring | N | Booysendal | Der Brochen 7 JT | 011 759 6000 | Monitoring borehole |
| | NBGW12 | -89835 | -2776581 | 1292.70 | 10/05/2016 | 6.59 | 1286.11 | N | Monitoring | N | Booysendal | Der Brochen 7 JT | 011 759 6000 | Monitoring borehole |
| | NBGW13 | -89744 | -2777215 | 1349.90 | 10/05/2016 | 7.93 | 1341.97 | N | Monitoring | Y | Booysendal | Booysendal 43 JT | 011 759 6000 | Monitoring borehole |
| | NBGW14 | -89672 | -2776174 | N/A | N/A | N/A | N/A | N | Monitoring | N | Booysendal | Der Brochen 7 JT | 011 759 6000 | Monitoring borehole |
| Future Flow 2011 Fairway groundwater study | EVH1 | -81947 | -2786495 | 1820 | 10/10/2011 | 9.12 | 1810.88 | Y | Domestic | Y | Jan Blake | Oshoek 69 JT | 0832870712 | Use about 10 000 L/day |
| | EVH2 | -81162 | -2786680 | 1865 | 10/10/2011 | N/A | N/A | Y | Livestock | N | Jan Blake | Oshoek 69 JT | 0832870712 | Not currently in use |
| | EVH3 | -81754 | -2788153 | 1839 | 10/11/2011 | 19.85 | 1819.15 | Y | Domestic | N | Andrew Fussel | Oshoek 69 JT | 0836302233 | Supplies 4 houses and labourers. Approx. 40m deep. SWL estimated. |
| | EVH4 | -82785 | -2783302 | 1746 | 10/11/2011 | N/A | N/A | Y | Domestic | N | Aquarius | De Kafferskraal 53 JT | 0768347430 | Dip meter probe lodges on something in the BH |
| | EVH5 | -83101 | -2783494 | 1742 | 10/11/2011 | 17.58 | 1724.42 | N | Domestic | Y | Aquarius | De Kafferskraal 53 JT | 0768347430 | Recovering water level |
| | EVH6 | -82973 | -2782567 | 1779 | 10/11/2011 | N/A | N/A | Y | Domestic | N | Kiwi Community | De Kafferskraal 53 JT | 0722126402 | Pump house locked. Pump broken. Lucky Malati is the contact person. |
| | EVH7 | -83034 | -2782734 | 1761 | 10/11/2011 | 14.71 | 1746.29 | Y | Domestic | N | Aquarius | De Kafferskraal 53 JT | 0722126402 | Supplies the Cotlands nursery school |
| | EVH8 | -82944 | -2781379 | 1772 | 10/11/2011 | N/A | N/A | Y | Domestic | N | Kiwi Community | De Kafferskraal 53 JT | 0722126402 | Windmill |
| | EVH9 | -83609 | -2778859 | 1681 | 10/11/2011 | N/A | N/A | N | Not used | N | Unknown | Schaapkraal 42 JT | N/D | Behind empty farm house, filled with rocks |
| | EVH10 | -84079 | -2784215 | 1806 | 10/11/2011 | N/A | N/A | Y | Domestic | N | Aquarius | De Kafferskraal 53 JT | N/D | Inside the shaft area boundary fence. No access due to strike |
| | EVH11 | -84949 | -2785424 | 1791 | 10/11/2011 | 6.95 | 1784.05 | N | Not used | Y | Ria Groenewald | De Kafferskraal 53 JT | 0835965975 | BH depth was 75m deep but has caved in around 10 mbgl |
| | EVH12 | -86577 | -2786286 | 1753 | 10/11/2011 | N/A | N/A | N | Monitoring/Exploration | N | Danie Nel | De Kafferskraal 53 JT | 0132353118 | Locked |
| | EVH13 | -86790 | -2786378 | 1757 | 10/12/2011 | N/A | N/A | N | Monitoring/Exploration | N | Danie Nel | De Kafferskraal 53 JT | 0132353118 | Locked |
| | EVH14 | -94601 | -2785770 | 1772 | 10/12/2011 | 1.49 | 1770.51 | N | Monitoring | N | Benja Grobler | Draaikraal 48 JT | 0823994282 | Adjacent to a localized wetland |
| | EVH15 | -92666 | -2780702 | 1900 | 10/13/2011 | 10.08 | 1889.92 | N | Domestic | N | RSA Goevernment | Uysedoorns 47 JT | 0828110022 | Gets used in June, July and August |
| | EVH16 | -95071 | -2786389 | 1793 | 10/13/2011 | 12.72 | 1780.28 | Y | Domestic | N | Johannes Boshoff | Draaikraal 48 JT | 0132737005 | Gets used every 2nd day. BH is about 36 m |
| | EVH17 | -94249 | -2788509 | 1790 | 10/13/2011 | 5.29 | 1784.71 | N | Not used | N | Jaapie Grobler | Kliprivier 73 JT | 0828950491 | Not used for more than 2 years |
| | SPRING1 | -83623 | -2787568 | 1989 | 10/10/2011 | 0.00 | 1989.00 | N | Not used | N | Jan Blake | Skuinsplaas 56 JT | 0832870712 | Slow moving water, very saturated area |
| | SPRING2 | -83616 | -2787544 | 1990 | 10/10/2011 | 0.00 | 1990.00 | N | Not used | N | Jan Blake | Skuinsplaas 56 JT | 0832870712 | Slow moving water, very saturated area |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPRING3 | -83646 | -2787576 | 1989 | 10/10/2011 | 0.00 | 1989.00 | N | Not used | N | Jan Blake | Skuinsplaas 56 JT | 0832870712 | Saturated ground, no running water |
| | SPRING4 | -83640 | -2787739 | 1997 | 10/10/2011 | 0.00 | 1997.00 | N | Not used | N | Jan Blake | Skuinsplaas 56 JT | 0832870712 | Running water approx. 0.5 L/s |
| | SPRING5 | -84366 | -2788394 | 2032 | 10/10/2011 | 0.00 | 2032.00 | N | Not used | N | Jan Blake | De Berg 71 JT | 0832870712 | Very slow flow, almost stagnant |
| | SPRING6 | -84344 | -2788456 | 2050 | 10/10/2011 | 0.00 | 2050.00 | N | Not used | N | Jan Blake | De Berg 71 JT | 0832870712 | Very slow flow, almost stagnant |
| | SPRING7 | -84314 | -2788491 | 2052 | 10/10/2011 | 0.00 | 2052.00 | N | Not used | N | Jan Blake | De Berg 71 JT | 0832870712 | Slow flow |
| | SPRING8 | -82567 | -2786457 | 1872 | 10/10/2011 | 0.00 | 1872.00 | N | Not used | N | Jan Blake | Skuinsplaas 56 JT | 0832870712 | Slow flow |
| | SPRING9 | -82699 | -2787195 | 1909 | 10/10/2011 | 0.00 | 1909.00 | N | Not used | N | Jan Blake | Skuinsplaas 56 JT | 0832870712 | Two smaller springs adjacent. Slow flow |
| | SPRING10 | -82692 | -2787211 | 1903 | 10/10/2011 | 0.00 | 1903.00 | N | Not used | N | Jan Blake | Skuinsplaas 56 JT | 0832870712 | Slow flow |
| | SPRING11 | -81480 | -2787828 | 1847 | 10/10/2012 | 0.00 | 1847.00 | N | Domestic | N | Andrew Fussel | Oshoek 69 JT | 0836302233 | Saturated ground, slow flow |
| | SPRING12 | -81256 | -2787809 | 1850 | 10/10/2013 | 0.00 | 1850.00 | N | Domestic | N | Andrew Fussel | Oshoek 69 JT | 0836302233 | Dry in winter, used in summer |
| | SPRING13 | -81381 | -2783613 | 1883 | 10/11/2011 | 0.00 | 1883.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826 | Slow trickle |
| | SPRING14 | -81834 | -2784005 | 1879 | 10/11/2011 | 0.00 | 1879.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826 | Saturated seepage zone |
| | SPRING15 | -82661 | -2784548 | 1833 | 10/11/2011 | 0.00 | 1833.00 | N | Domestic | N | Ezekiel Malatjie | De Kafferskraal 53 JT | 0792516138 | Small community relies on this water. Very slow trickle |
| | SPRING16 | -83129 | -2782321 | 1761 | 10/11/2011 | 0.00 | 1761.00 | N | Domestic | N | Kiwi Community | De Kafferskraal 53 JT | 0792516138 | Lucky Malati is the contact person. |
| | SPRING17 | -82859 | -2781578 | 1793 | 10/11/2011 | 0.00 | 1793.00 | Y | Domestic | N | Khotsong Community | De Kafferskraal 53 JT | 0792516138 | Capture dams built around the eye with PVC pipes channelling water downhill |
| | SPRING18 | -83326 | -2781167 | 1735 | 10/11/2011 | 0.00 | 1735.00 | N | Domestic | N | Khotsong Community | De Kafferskraal 53 JT | 0792516138 | People wash clothes here and drink the water |
| | SPRING19 | -83554 | -2778900 | 1684 | 10/11/2011 | 0.00 | 1684.00 | N | Not used | N | Unknown | Schaapkraal 42 JT | N/D | Seepage area with slow flow |
| | SPRING20 | -84622 | -2784748 | 1748 | 10/11/2011 | 0.00 | 1748.00 | Y | Domestic | N | Ria Groenewald | De Kafferskraal 53 JT | 0835965975 | Small capture dam exists on the down gradient side of seepage zone |
| | SPRING21 | -84917 | -2785428 | 1797 | 10/11/2011 | 0.00 | 1797.00 | Y | Domestic | N | Ria Groenewald | De Kafferskraal 53 JT | 0835965975' | A 3m deep pit has been dug out and a channel directs water to the house |
| | SPRING22 | -85452 | -2785870 | 1762 | 10/11/2011 | 0.00 | 1762.00 | N | Not used | N | Danie Nel | De Kafferskraal 53 JT | 0132353118' | Slow moving water, very saturated area |
| | SPRING23 | -85010 | -2786306 | 1870 | 10/11/2011 | 0.00 | 1870.00 | N | Livestock & Domestic | N | Danie Nel | De Kafferskraal 53 JT | 0132353118' | High yield, fast flowing |
| | SPRING24 | -85783 | -2787181 | 1920 | 10/11/2011 | 0.00 | 1920.00 | N | Livestock & Domestic | N | Danie Nel | De Kafferskraal 53 JT | 0132353118' | Medium yield, moderate flow |
| | SPRING25 | -80294 | -2782667 | 1838 | 10/12/2011 | 0.00 | 1838.00 | N | Livestock & Domestic | Y | George Malatjie | Kraaibosch 55 JT | 0783044430' | Perennial |
| | SPRING26 | -80599 | -2782885 | 1851 | 10/12/2011 | 0.00 | 1851.00 | N | Not used | N | George Malatjie | Kraaibosch 55 JT | 0783044430' | Moderate flow, perennial |
| | SPRING27 | -80526 | -2782785 | 1845 | 10/12/2011 | 0.00 | 1845.00 | N | Not used | N | George Malatjie | Kraaibosch 55 JT | 0783044430' | No flow but the ground is saturated and stagnant water exists on surface |
| | SPRING28 | -80440 | -2782573 | 1849 | 10/12/2011 | 0.00 | 1849.00 | N | Not used | N | George Malatjie | Kraaibosch 55 JT | 0783044430' | Very slow flow, almost stagnant |
| | SPRING29 | -80566 | -2783667 | 1804 | 10/12/2011 | 0.00 | 1804.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826' | Abundant water, slow flow |
| | SPRING30 | -80835 | -2783524 | 1824 | 10/12/2011 | 0.00 | 1824.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826' | No flow but the ground is saturated and stagnant water exists on surface |
| | SPRING31 | -80822 | -2783416 | 1832 | 10/12/2011 | 0.00 | 1832.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826' | No flow but the ground is saturated and stagnant water exists on surface |
| | SPRING32 | -80799 | -2783377 | 1834 | 10/12/2011 | 0.00 | 1834.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826' | No flow but the ground is saturated and stagnant water exists on surface |
| | SPRING33 | -80861 | -2783314 | 1850 | 10/12/2011 | 0.00 | 1850.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826' | Dry, slightly wet soil |
| | SPRING34 | -80838 | -2783158 | 1865 | 10/12/2011 | 0.00 | 1865.00 | N | Not used | N | Piet Rabie | Kraaibosch 55 JT | 0833576826' | Very slow flow |
| | SPRING35 | -94532 | -2785802 | 1772 | 10/12/2011 | 0.00 | 1772.00 | N | Not used | N | Benja Grobler | Draaikraal 48 JT | 0833576826' | Saturated, not flowing |
| | SPRING36 | -93579 | -2785008 | 1831 | 10/12/2011 | 0.00 | 1831.00 | N | Livestock & Domestic | Y | Benja Grobler | Draaikraal 48 JT | 0833576826' | Flows perennially, main source of water for the farm |
| | SPRING37 | -92426 | -2780716 | 1935 | 10/13/2011 | 0.00 | 1935.00 | Y | Livestock & Domestic | N | RSA Government | Uysedoorns 47 JT | 0828110022' | Flows perennially, main source of water for the farm |
| | SPRING38 | -93631 | -2787640 | 1804 | 10/13/2011 | 0.00 | 1804.00 | Y | Livestock & Domestic | N | Jaapie Grobler | Kliprivier 73 JT | 0828950491' | Flows perennially, main source of water for the farm. Also fills dams |
| | TSFMON01 | -84883 | -2781642 | 1672 | | 1.40 | 1670.60 | N | Monitoring | Y | AQPSA | De Kafferskraal 53 JT | | Newly drilled monitoring borehole at proposed TSF site |
| | TSFMON02 | -84564 | -2782043 | 1688 | | 1.73 | 1686.27 | N | Monitoring | Y | AQPSA | De Kafferskraal 53 JT | | Newly drilled monitoring borehole at proposed TSF site |
| | TSFMON03 | -85457 | -2781356 | 1674 | | 6.24 | 1667.76 | N | Monitoring | Y | AQPSA | De Kafferskraal 53 JT | | Newly drilled monitoring borehole at proposed TSF site |
| | TSFMON04 | -85809 | -2781449 | 1686 | | 14.42 | 1671.58 | N | Monitoring | Y | AQPSA | De Kafferskraal 53 JT | | Newly drilled monitoring borehole at proposed TSF site |
| **GCS 2011 Hoogland study** | ED95 | -86981 | -2783575 | 1599 | N/D | 11.49 | 1587.51 | N/D | N/D | N/D | N/D | N/D | N/D | |
| | ED96A | -87093 | -2783364 | 1594 | N/D | 15.36 | 1578.64 | N/D | N/D | N/D | N/D | N/D | N/D | |
| | BH5556 | -87435 | -2783381 | 1584 | N/D | 3.96 | 1580.04 | N/D | N/D | N/D | N/D | N/D | N/D | |
| | ED102 | -87488 | -2783374 | 1590 | N/D | 39.05 | 1550.95 | N/D | N/D | N/D | N/D | N/D | N/D | |
| | HD16 | -87606 | -2786369 | 1681 | N/D | 15.23 | 1665.77 | N/D | N/D | N/D | N/D | N/D | N/D | |
| | HD39 | -86584 | -2786074 | 1739 | N/D | 4.00 | 1735.00 | N/D | N/D | N/D | N/D | N/D | N/D | |
| | HD38 | -87751 | -2783216 | 1552 | N/D | 4.09 | 1547.91 | N/D | N/D | N/D | N/D | N/D | N/D | |
| | HD10 | -86451 | -2786048 | 1738 | N/D | 4.20 | 1733.80 | N/D | N/D | N/D | N/D | N/D | N/D | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | -85433 | -2785676 | 176.87 | N/D | 0 | 1768.87 | N/D | N/D | N/D | Nel | N/D | 0132353118 | Water from various springs. Domestic use |
| S2 | -85932 | -2791280 | 2264.33 | N/D | 0 | 2264.33 | N/D | N/D | N/D | Breytenbach | N/D | 0828261058 | Spring for domestic supply |
| S3 | -84914 | -2785376 | 1789.36 | N/D | 0 | 1789.36 | N/D | N/D | N/D | Groenewald | N/D | 0828163677 | Excavated spring for potable water supply |
| S4 | -84749 | -2784703 | 1737.18 | N/D | 0 | 1737.18 | N/D | N/D | N/D | Groenewald | N/D | 0828163677 | Eastern spring and tributary for irrigation |
| S5 | -85152 | -2784897 | 1737.73 | N/D | 0 | 1737.73 | N/D | N/D | N/D | Groenewald | N/D | 0828163722 | Western spring and tributary for irrigation |
| S6 | No coordinates – cluster of springs | | | N/D | 0 | N/D | N/D | N/D | N/D | van der Merwe | N/D | 0132354092 | Several springs on the property. Used for livestock watering |

Table 5-8 Groundwater Ecosystem Services (Source: Future Flow, 2018)

| Service | ES Category | Description | Additional information (including threats, and availability of alternatives to ES) | Relevant habitats | Importance to Beneficiaries | Replicability |
|---|---|---|---|---|---|---|
| Water supply to private groundwater users for domestic and agricultural use. Seep and baseline contributions | Provisional, regulatory and supporting | Groundwater is one of the main sources of water supply in the area. It assists in regulating seep wetlands and provides run-off to the Groot Dwars River | Dewatering of the aquifers due to mine dewatering, or contamination of the groundwater resource due to contaminant migration away from pollution sources (underground mining areas, TSF, PCD, stockpiles, workshops, etc.) pose a risk to the sustainability of utilising the groundwater resource and could impact negatively on the aquatic environment while also reduce seep wetland functionality | Aquifers<br>Wetlands<br>Aquatic | Groundwater, together with surface water, is the sole source of water supply for domestic and agricultural use in the area.<br>Seep wetlands depend on seep zones.<br>Groundwater is an important contributor to base flow | **Low** – the impact assessment shows that it will take around 72 years after mine closure for the water levels in the area to recover to (near) pre-mining levels at BCM1 and BCM2, while it will take at least 62 years at BS1/2. Once contamination has entered the aquifers, it will be almost impossible to remediate the impacts through mechanical, chemical, or engineering processes. Natural attenuation will take many, possibly hundreds, of years. |

## 5.6 Geochemical Analysis

Two waste characterisation studies were carried out as part of the Booysendal South Expansion Project applicable to the Phase 1 and Phase 2 Projects. The original hydrogeological assessment, undertaken by Future Flow (2017), included an assessment of rock samples from BN, BS4 and samples from the current tailings from the TSF at the BN location. The Future Flow study also included the results of previous studies performed on samples from four exploration boreholes from BN and BS4. The objective of this test work was to gain an understanding of the net leachate potential from stockpiles, waste rock and tailings which will originate from future ore to be mined at BS1/2, BCM1 and BCM2. This material is considered to be representative of the tailings, ore and waste rock of the future mining and tailings. The results are important to inform potential groundwater contamination which may result from tailings, slurry and backfill material at BS4.

A second set of geochemical test work was undertaken by Jones and Wagner (2016) on the tailings of TSF1 at BS4 to gain an understanding of potential leachate impacts associated with the reworking of the tailings and backfilling of the tailings into the underground workings at BS4.

### 5.6.1 Methodology

The geochemical study by Future Flow (2017) and the separate study undertaken by Jones and Wagener (2016) include the following analyses and test work:

- Sulphur content, as Total Sulphur % and Sulphur Speciation %, to determine the extent of Acid Generating Potential from sulphides present;
- Neutralisation tests to determine Neutralisation Potential ("**NP**");
- Acid Base Accounting ("**ABA**") assessment combining the above results to determine Net Neutralisation Potential ("**NNP**") and Neutralisation Potential Ratio ("**NPR**");
- Paste pH to examine the acidity or alkalinity of the samples;
- X-Ray Diffraction ("**XRD**") analysis to determine the mineralogical composition of the materials and assist in interpretation;
- Elemental analysis by aqua regia digestion of samples and analysis for metals and anions listed by the DEA (National Norms and Standards for the Assessment of Waste for Landfill Disposal published under GNR 635 in GG 36784 of 23 August 2013 ("**GN 635**")) to determine Total Concentrations (mg/kg); and
- Distilled water leach testing of samples followed by the analysis of the resulting leach solution for all metals and anions listed by the DEA (as above) to determine Leachate Concentrations (mg/l).

ABA results are compared with international standards to define net acid generation potential.

Elemental analysis and leach testing results are compared with DEA waste classification guidelines based on the various Total Concentration Thresholds ("**TCT**") for key elements in mg/kg and Leachable Concentration Thresholds ("**LCT**") for key elements in mg/l to determine Waste Type and Class of disposal requirement.

### 5.6.2 Geochemical Baseline

Leach testing results of the tailings of BS4 has been assessed by Jones and Wagner (2016) to be non-acid forming. This can be attributed to low sulphide levels, which are below the limits (<0.01%(m/m)). ABA results furthermore demonstrated a NP of 5.96 kg $CaCO_3$ per tonne resulting in a NPR of 19. This can be compared with a ratio of 4 used in international standards as a threshold for non-acid forming material. A paste pH of 8.7 confirms the low alkalinity indicated by the NP result.

Elemental analyses were compared with Alloway Earth's Crustal Abundance concentrations, with arsenic and cadmium both 44 times and chromium 480 times the concentration of Crustal Abundance. In the case of chromium, this is consistent with the XRD results showing a chromite mineral content of 15.5% (m/m). Elemental analyses were also compared with their respective TCT. In terms of TCTs, the concentrations of arsenic, cobalt, chromium, nickel, vanadium and fluoride exceed their respective TCT0 values, such that on this basis the tailings are classified as a Type 3 (low hazardous) waste which must be disposed of on a Class C landfill.

The results obtained from leachate test work, however, demonstrate that none of the constituents exceed the lowest LCT, LCT0, such that only the Total Concentration values have resulted in the tailings being assessed as a Type 3 waste.

Geochemical analysis was also carried out on the ore bodies by Future Flow (2017). Sulphur analyses indicated detection limit of 0.01% total sulphur. Based on these low sulphur values alone, these samples are defined as Non-Acid forming, although no NP test work data was available.

Leach testing performed on the samples showed exceedances in LCT0 values only for chromium, antimony and vanadium, with detection limits for arsenic, nickel, lead and selenium above the LCT0 values but below LCT1 values.

Elemental analysis using aqua regia digestion and leach testing based on a 20:1 liquid to solid ratio was performed on the six rock samples and two tailings samples, following the GN 635 guidelines to include metals, anions and key organics relevant to the operation. From the results of this test work, the elemental concentration of cadmium, cobalt, copper, manganese, nickel, lead, antimony, vanadium and fluoride exceeds the TCT0 guidelines in most of the samples but all samples comply with TCT1 guidelines.

From the leachate test work, total chromium exceeds the LCT0 guideline concentration of 0.1 mg/l for one of the two ore samples and both tailings samples by a factor of 3, with the other ore sample showing a chromium concentration of <0.025 mg/l. All leachates were below the LCT1 guideline concentration.

Based on these results, from the set of samples from BN, these materials are classified as Type 3 Waste following the Waste Classification and Management Regulations (published under Government Notice R634 in *Government Gazette* 36784 of 23 August 2013) ("**GN 634**") classification requiring disposal at a site complying with Class C landfill regulations.

### 5.6.3 Sensitive Receptors

Metal leachate or the formation of ABA has the potential to impact on surface and groundwater resources. Potential sensitive receptors include surface-and groundwater users downstream of the mining activities (refer to Figure 5-12). The aquatic environment (FEPA system) is also a sensitive receptor due to the conservation important species and species sensitivity to change in water quality and levels.

### 5.6.4 Ecosystem Services

Refer to Section 5.5.6.

## 5.7 Hydrology

The hydrology assessment, including a storm water management plan and a water and salt balance for the Phase 2 Project was undertaken by Letsolo ("**Letsolo Hydrology Assessment**"). However, for the purposes of the IWULA, the hydrological assessment made provision for Booysendal South Expansion Project Phase 1 and Phase 2. The purpose of the hydrological assessment is to provide an analysis of the various catchments applicable to the Phase 2 Project Area, to inform the design and storm water control requirements and to assess potential impacts on the surface water regime throughout the various phases of the LoM.

### 5.7.1 Methodology

#### 5.7.1.1 Desktop Review

The Letsolo Hydrological assessment incorporates the findings of various hydrological assessments carried out for the Booysendal South Expansion Project. SNA Civil and Structural Engineers ("**SNA**") conducted an initial hydrological assessment of the main access road to delineate catchment, determine flood calculations and to size the culverts, which was updated in October 2016 and again in May 2017. ("**DRA**") updated the integrated water balance for all areas of the Booysendal Mine in November 2017 (Ref No.GBP-ENG-REP-001). SLR Consulting (Pty) Ltd ("**SLR**") conducted a hydrological assessment specifically for BS4 in June 2016 and Letsolo conducted a comprehensive hydrological assessment which incorporated all the various hydrological assessments into one report and expanded on the hydrological assessment for areas which were not covered and addressed in the other specialist studies. The Letsolo Hydrological Assessment further included a water and salt balance and a storm water management plan. The Letsolo Hydrological Assessment Report is included as Annexure F.

#### 5.7.1.2 Site Investigation

Site investigations were carried out on four separate occasions, namely 2 December 2015, 16 October 2016, 16 January 2017 and 8 February 2017. The purpose was to identify streams relevant to the Booysendal South Expansion Project, collect water samples for water quality analysis, logging the areas of interest to be include in the hydrological assessment, gather onsite information and to establish the characteristics of potential affected tributaries.

#### 5.7.1.3 Analysis of Hydrological Data

The data analysis included:

- Laboratory analysis of water quality samples at a SANS accredited laboratory and trend analysis of long term water quality monitoring results;
- Catchment delineation;
- Flood calculations for the various applicable sub-catchments using the Rational Method to assist in the sizing of storm water management infrastructure;
- Floodline delineations for the Groot Dwars River, the southern stream located next to BS1/2 and the Everest stream were conducted by DRA and SNA Civil and Structural Engineers. The methodology used was assessed, however the floodlines were not remodelled. The HEC-RAS software package was used to delineate the floodlines. The model requires catchment analysis, flood peak analysis and flood peak assessment;
- Development of a storm water management plan based on the outcome of the catchment analysis, infrastructure requirements, flood risks etc; and
- Developing an initial water and salt balance. The purpose of the water and salt balance was to calculate potential changes in salt loads taking consideration of predicted salt concentrations x annual flow $m^3$. The water and salt balance is a basis from where the environmental managers can monitor changes in water quality through regular update of the water and salt balance.

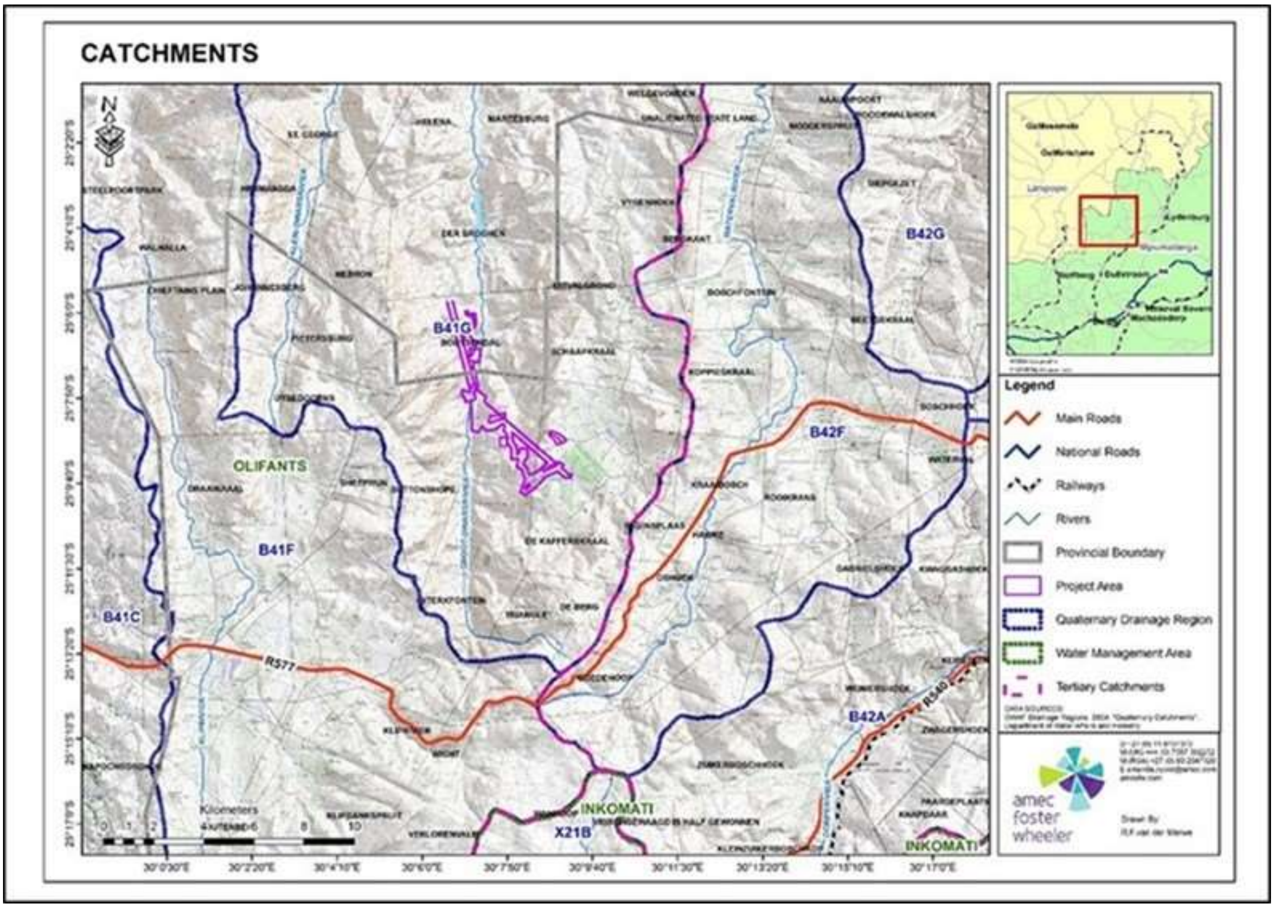
#### 5.7.1.4 Reporting

Refer to the Letsolo Hydrological Assessment Report in Annexure F.

## 5.7.2 Baseline

The Booysendal South Expansion Project (Phase 1 and Phase 2) falls within quaternary catchment B41G of the Olifants River WMA (refer to Figure 5-13).

Figure 5-13 Booysendal Mine Quaternary Catchment Delineation




### 5.7.2.1 Phase 2 Project - Booysendal North MR

<u>Main water resources</u>:

The Groot Dwars River is the main river in the vicinity of BCM1, BCM2 and the other Phase 2 Project infrastructure components. The Waterfall tributary runs along the northern section of BCM1 terrace, while the a non-perennial drainage line runs along the northern terrace of BCM2.

Several smaller non-perennial drainage lines will also be crossed by other Phase 2 Project infrastructure components pertaining to the Booysendal North MR (refer to Figure 5-14).

<u>Floodline Delineation:</u>

The floodline delineation for the Booysendal North MR Phase 2 Project Area is included on Figure 5-14. The figure indicates the calculated 1:100year floodline for the Groot Dwars River and the 100m buffer zones for the Dwars River tributaries. The northern sections of both BCM1 and BCM2 falls within 100m from the non-perennial drainage line and Waterfall tributary respectively. Several sections of the BS1/2 to BN pipeline route runs within the 1:100year floodline of the Groot Dwars River.

<u>Catchment delineation</u>:

The proposed Phase 2 Project will take place across 12 sub-catchments. Refer to Figure 5-15. The sub-catchments relevant to the Booysendal North MR expansion are catchments 13, 19 and 20. The flood calculations for the catchments are included in Table 5-9.

### 5.7.2.2 Phase 2: Booysendal South Mining Right

<u>Main water resources:</u>

The main water resources at BS4 is the Everest tributary which runs from south to north with the workshop and portal to the west and the TSF1 and Process Plant to the east. The De Kafferspruit runs to the west of the Process Plant. The drainage lines at BS4 are mainly associated with mine infrastructure and are therefore susceptible to contamination. The slurry pipeline crosses the Everest stream to the south on route to the Backfill Plant, while the process water line crosses the stream from the MCC1 PCD to RWD.

<u>Floodline delineation</u>:

The floodline delineation for BS4 is included in Figure 5-16. Where the slurry pipeline and MCC1 PCD pipeline cross the Everest tributary, they will fall within the 1:100year floodline.

<u>Catchment delineation</u>:

The BS4 expansion activities fall in sub-catchment 18 (refer to Figure 5-15). The 1:100year peak flow in this sub-catchment is 151.5m$^3$/s.

Figure 5-14 Booysendal North MR Streams and Floodline Delineation

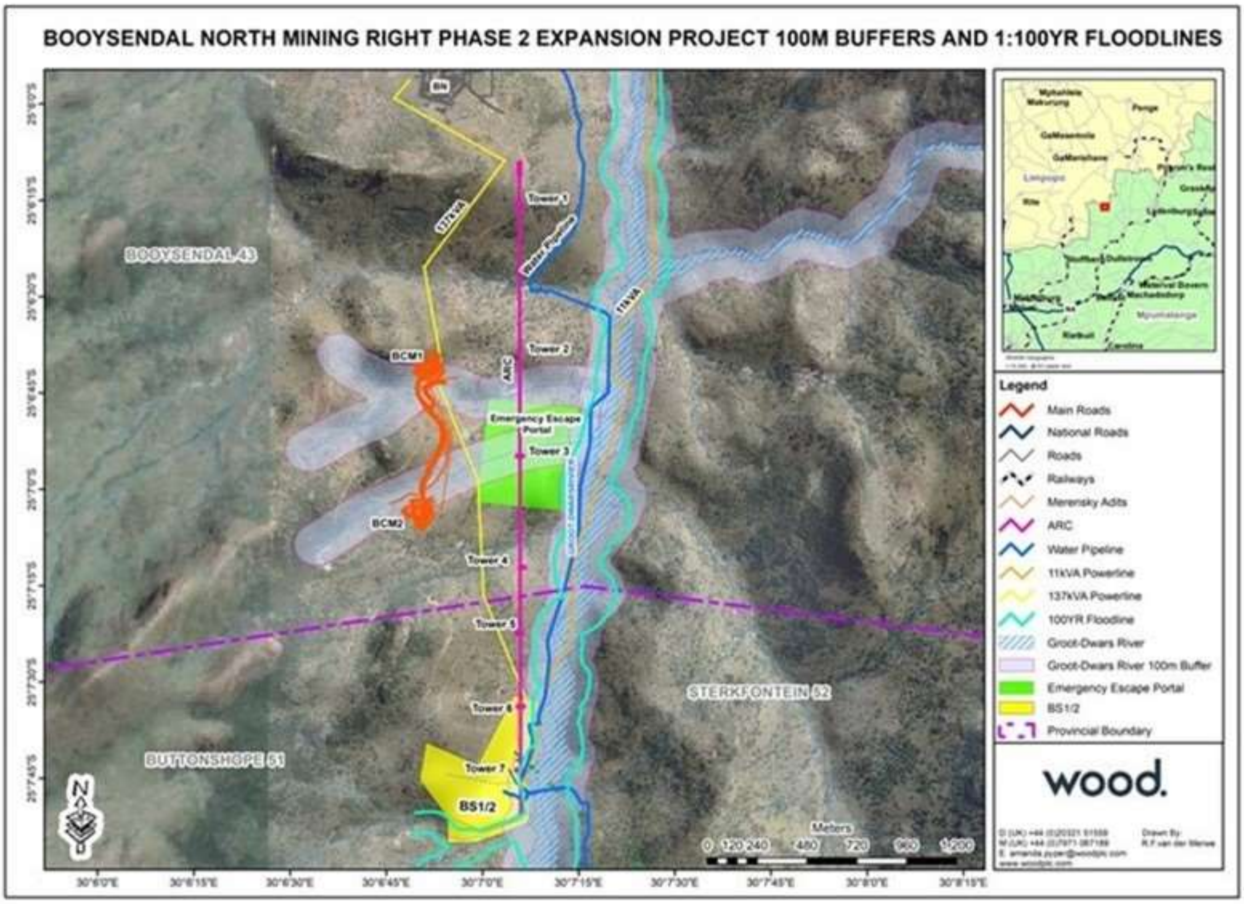


Figure 5-15 Sub-catchment Delineation of the Booysendal South Expansion Project (Source: Letsolo, 2018)

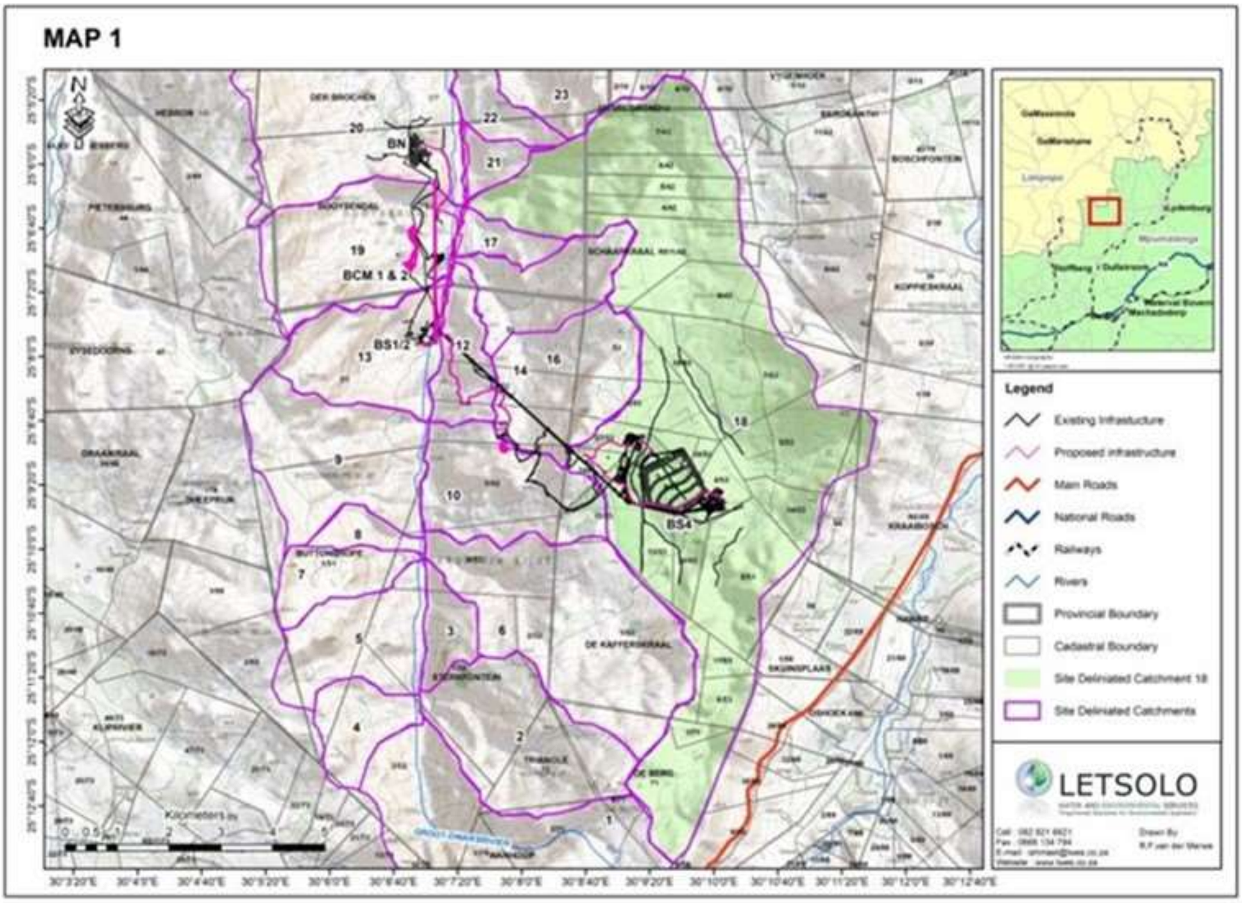
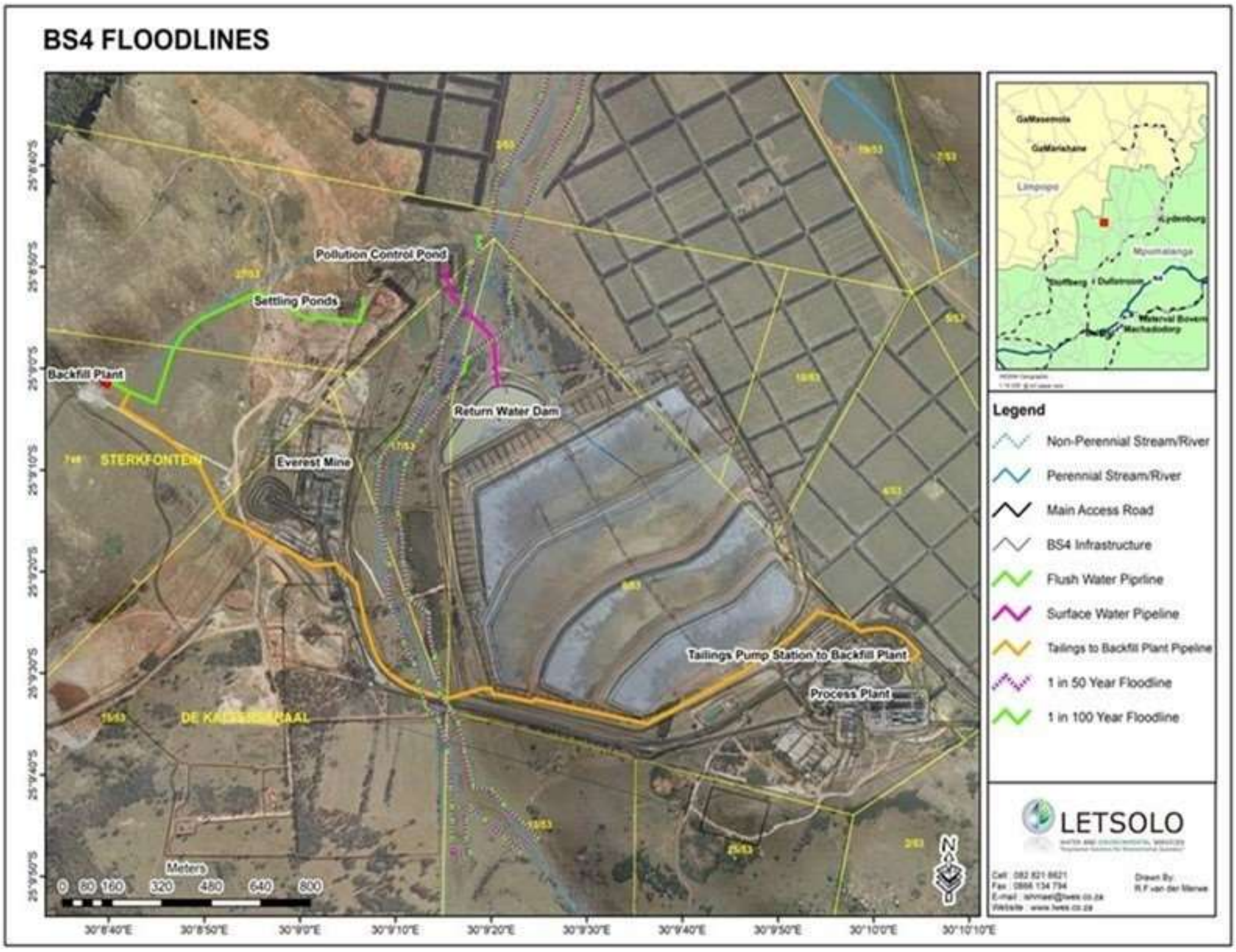



Table 5-9 Sub-catchment Flood Calculations Booysendal North and Booysendal South Mining Right Areas

| Catchments | Area (km²) | 1:100 years Peak flow $(m^3/s)$ | Associated infrastructure |
|---|---|---|---|
| | | **Booysendal North MR Phase 2 Project Catchments** | |
| **13** | 5.1 | 20.2 | Water lines, 11kVA powerline, ARC |
| **19** | 7.39 | 29.3 | BCM1, BCM2, Emergency Escape Portal, ARC, water lines, 11kVA powerline |
| **20** | 11.4 | 45.2 | Water lines, 11kVA powerline, ARC |
| | | **Booysendal South MR Phase 2 Project Catchments** | |
| **18** | 38.2 | 151.5 | Backfill Plant, slurry and process water pipelines and emergency ponds |

Figure 5-16 Booysendal South Mining Right 1:100year Floodline Delineation (Source: Letsolo, 2018)




## 5.7.3 Water and Salt Balance

The water-and salt balance was conducted for selected variables, including Total Dissolved Solids ("**TDS**"), sulphate and nitrates. The salt load calculations of the study concluded that there is an increase in salt loads downstream in the Groot Dwars River where the stream coming from Everest ties into it. The study indicated that this can mainly be attributed to discharge from the Valley Boxcut underground water.

## 5.7.4 Water Quality

An analysis of water quality is addressed in Section 5.9.

## 5.7.5 Sensitive Receptors

The most prominent river in the Phase 2 Project Area is the Groot Dwars River (Quaternary Catchment B41G). As previously indicated this system has been classified as a FEPA.

The De Brochen Dam is furthermore located downstream of BN on the Farm De Brochen 7JT. This dam is a significant surface water body located downstream of the Project Area. The Groot Dwars River and the De Brochen Dam are the most sensitive surface water resources due to their close proximity to the proposed Phase 2 Project activities and current activities at Booysendal Operations.

The provisions of the NWA require that no development may take place within the 1:100yr floodline or 100m from the edge or drainage line and further prescribes that a water use licence needs to be applied for within a 500m buffer between wetland areas and areas of where development is set to commence. These buffers are therefore deemed as sensitive areas from a hydrological perspective. The 100m buffer for the smaller drainage lines and the buffers for the wetland sensitivities have been be determined as part of the hydrological assessment in the EIA phase.

The upstream catchment of the Groot Dwars River is also considered as a sensitive environment due to the pristine nature of the surface water resource. The whole of the Groot Dwars River system is regarded as a FEPA.

### 5.7.6 Ecosystem Services

Surface water in the Phase 2 Project Area has two main ecosystem services:

- Provisional service: The surrounding land owners, occupiers and communities have a high dependency on surface water for domestic and livestock use. The importance of surface water is further highlighted as there is no municipal water provision to the area; and
- Regulatory and supporting service: Surface water is important in maintaining the aquatic environment and the associated wetlands. The aquatic biodiversity in the system is dependent on the water quality and flow rates in the systems.

## 5.8 Soil, Land Use and Land Capability

The soil, land use and land capability assessment for the Booysendal South Expansion Project was carried out by Terra-Africa ("**Terra-Africa Soil Study**").

### 5.8.1 Methodology

Although the specialist was involved in the consolidated soil investigation for both Phases of the Booysendal South Expansion Project, the following methodology is applicable to the Phase 2 Project specifically:

#### 5.8.1.1 Desktop Review

The purpose of the desktop review was to gain an understanding of the Phase 2 Project footprints against the soil studies undertaken to date, thereby identifying gaps in information to plan for additional field survey. As part of the desktop review data on the Agricultural Research Council ("**Agri Council**") website and the Environmental Potential Atlas ("**ENPAT**") was reviewed.

#### 5.8.1.2 Field Survey

The field survey for the Phase 2 Project was undertaken between 6 and 19 December 2017. Systematic soil sampling was done at 100m to 250m apart. Field analysis of soil profiles, texture, structure and color was done and soils were mapped according to the South African Soil Classification Taxonomic System, 1991.

#### 5.8.1.3 Laboratory Analysis

Nineteen soil samples (twelve topsoil and seven subsoil) were collected in the entire Project Area during the different site visits. Sampling points were evenly distributed throughout the sites in order to be representative of the different soil forms identified (therefore representing modal soil profiles). Soil samples were sealed in soil sampling plastic bags and sent to Nvirotek Labs at Hartbeespoort Dam for analyses. The samples were analysed for pH (KCl and $H_2O$), phosphorous (Bray 1), exchangeable cations (calcium, magnesium, potassium, sodium), organic carbon (Walkley-Black) and texture classes (relative fractions of sand, silt and clay).

#### 5.8.1.4 Soil Mapping

Once the Phase 2 Project layout was finalised, predictive soil mapping techniques were used to include small portions of land on the periphery of the direct area of influence to ensure all areas are covered. The data used include existing soil classification data as well as land type data as obtained from the Agri Council.

#### 5.8.1.5 Reporting

The Phase 2 Project reporting was incorporated into the overall Booysendal South Expansion Project Terra-Africa Soil Study report. Refer to Annexure G.

### 5.8.2 Baseline Soil Forms

There are fourteen soil forms in the Booysendal South Expansion Project area. Due to the topography within the area, the soil forms are highly variable. In the flatter areas, soil forms are dominated by clay-loams with a weak to moderate structure. These soils are suitable for agricultural production. The hill slopes contain young soils characterised by shallow, rocky lithic soils. The soils in the area are generally susceptible to erosion when disturbed. The soil types and characteristics of the soils are included in Table 5-10. The distribution of the soil forms at the Booysendal North MR Phase 2 Project Area is included in Figure 5-17 and for the Booysendal South MR Phase 2 Project Area in Figure 5-18.

Table 5-10 Soil Forms in the Cumulative Booysendal South Expansion Project Area

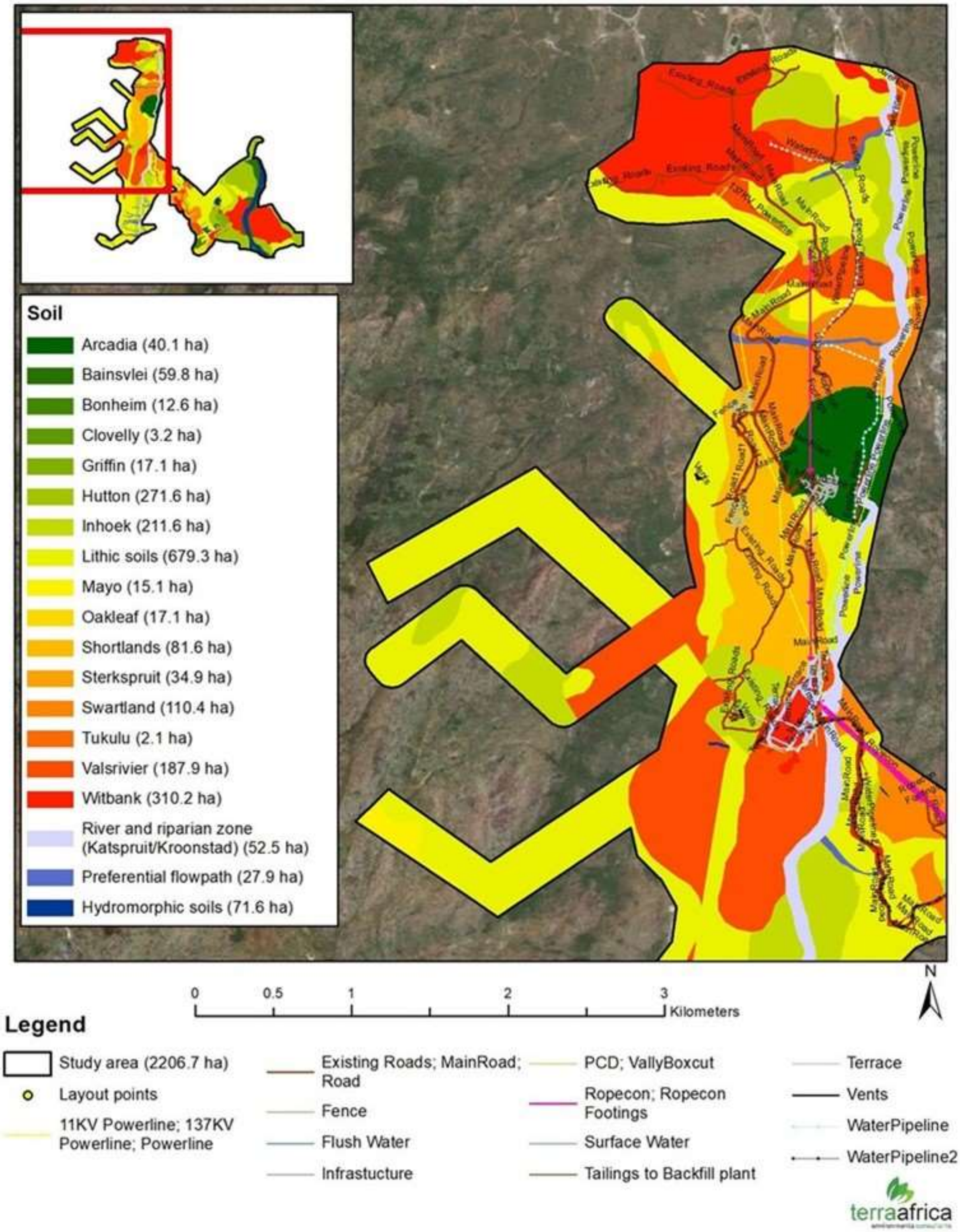
| Soil Form | Characteristics |
|---|---|
| Arcadia | The Arcadia soils are mainly associated with the BCM portals, which is high in clay content with shrinking-swelling properties, typical of vertic soils with a depth of approximately 80cm.<br>Land capability: high grazing potential. |
| Bainsvlei | The Bainsvlei soils consist of an orthic A horizon up to a depth of 35cm and a red apedal B horizon up to depths of 120cm. The oxides in the soil provide a macro-aggregating effect which reduces the soil erosion potential. The soil thus, is highly suitable for rehabilitation purposes. Bainsvlei soils are located next to the Everest tributary and areas directly alongside it.<br>Land capability: arable land. |
| Bonheim | The Bonheim soil form is limited to an upper slope of the road going down to the BS4 valley. The soil form consists of a 15cm melanic A horizon and a B-horizon with a higher clay content. The soil structure is strong and less susceptible to erosion.<br>Land capability: grazing land capability. |
| Clovelly | The soils consist of a sandy-loam orthic A-horizon and a well-drained apedal B-horizon and are 100cm deep. The soils are highly susceptible to erosion.<br>Land capability: Suitable for arable crop production and for use as topsoil. |
| Griffin | The soils are well-developed soils with an orthic A-horizon of 20-45cm depth and an apedal yellow-brown to red B-horizon. The soils have a loamy texture, well drained, usually acidic, low phosphate status and moderate organic matter. This soil form is less prone to erosion.<br>Land capability: arable land capability but will required fertilizer. |
| Hutton | The soils have a range of red colours and a well-developed orthic A-and B-Horizon of between 130cm - 150cm. The soil form is less sensitive and susceptible to erosion because of the relative high clay content of between 10% and 25%.<br>Land capability: This soil form has high arable land capability. |
| Hydromorphic Soils | The soils are indicative of temporary and permanent periods of water saturation. The soils have a blue-greyish colour and consist of a vertic, melanic or orthic A-horizon followed by a G-horizon. The soils are highly sensitive to development.<br>Land capability: Wetland (no-go areas). |

| Soil Form | Characteristics |
|---|---|
| Inhoek | The Inhoek soil form is associated with areas along the Groot Dwars River, Inhoek are younger soils with 35cm-45cm depth overlying unconsolidated sediments in which soil formation has not progressed sufficiently to form diagnostic horizons. The soil form is sensitive to erosion mainly because of the topography and young nature of the soil.<br>Land capability: Grazing. |
| Lithic Soils | Lithic soils (Glenrosa and Mispah) are associated with the steeper valley areas and consists of rock and weathered rocky sections. This soil form is easily visible as rocky areas with very little soil formation. Very little topsoil is associated with this soil form; thus, the soil form is susceptible to erosion.<br>Land capability: Wilderness. |
| Katspruit/Kroonstad | The riparian zone of the Groot Dwars River Valley is associated with dark grey, saturated Katspruit and Kroonstad soils. These soil forms are enriched with a clay layer of 15cm. These soil forms are highly sensitive.<br>Land capability: Wetland. |
| Mayo | The Mayo soil forms contains strong structured Melanic A horizon of between 15cm to 25cm deep, on top of a hard bedrock B-horizon.<br>Land capability: Grazing or wildlife conservation. |
| Oakleaf | The Oakleaf soil form contains well developed (80cm) orthic A-horizon. The high sandy-loam contents of the soils make it susceptible to wind and water erosion.<br>Land capability: High agricultural production and grazing capability. |
| Shortlands | The Shortlands soil forms contain well developed A-horizon and are susceptible to erosion.<br>Land capability: Grazing. |
| Sterkspruit | The Sterkspruit soil form contains well-developed orthic A-horizon overlaying a B-horizon with relatively high clay content. Clay dispersion in the A-horizon makes the soil highly susceptible to erosion.<br>Land capability: Grazing land capability. |
| Swartland | The Swartland soil has a 20cm orthic A-horizon. The B-horizons consist of blocky, structured pedocutanic B-horizon. The shallow soil depth and composition make the soil form significantly susceptible to erosion.<br>The Swartland soil form is associated with the second section of the powerline and road from BN, a section of the ARC, sections on of the main access road on the eastern slope of BS4.<br>Land capability: Grazing land capability. |
| Tukulu | The Tukulu soil consists of a well-drained orthic A-horizon of approximately 35cm. The soil has a pedocutanic B-horizon portray, although it portrays signs of wetness, making it a deep, fertile soil.<br>Land capability: Arable land. |
| Valsrivier | The Valsrivier soils are a duplex soil with a well-developed A-and B-horizon. The soil has a depth of between 50 to 70cm. The B-horizon is clay enriched containing characteristics of wetness. Therefore, the soil from is susceptible to erosion, therefore, topsoil stockpiling should take these erosion sensitivities into consideration.<br>Land capability: Grazing land capability. |
| Witbank | The Witbank soil form is associated with areas previously impacted by mining related activities, including roads, drill pads etc. and has been disturbed with associated erosion eminent in most areas.<br>Land use: Due to the disturbed nature, this soil form is classified as wilderness. |

#### 5.8.2.1 Booysendal North MR Phase 2 Project Area Soil Forms

BCM1 and BCM2 and most of the associated surface infrastructure is located on Shortland soils, while the Emergency Escape Portal lies on Arcadia soils. The linear infrastructure components crosses several soil types of which the sensitivities are indicated on Section 5.8.5.

Figure 5-17 Booysendal North Mining Right Phase 2 Project Area Soil Types and Distribution (Source: Terra-Africa, 2018)

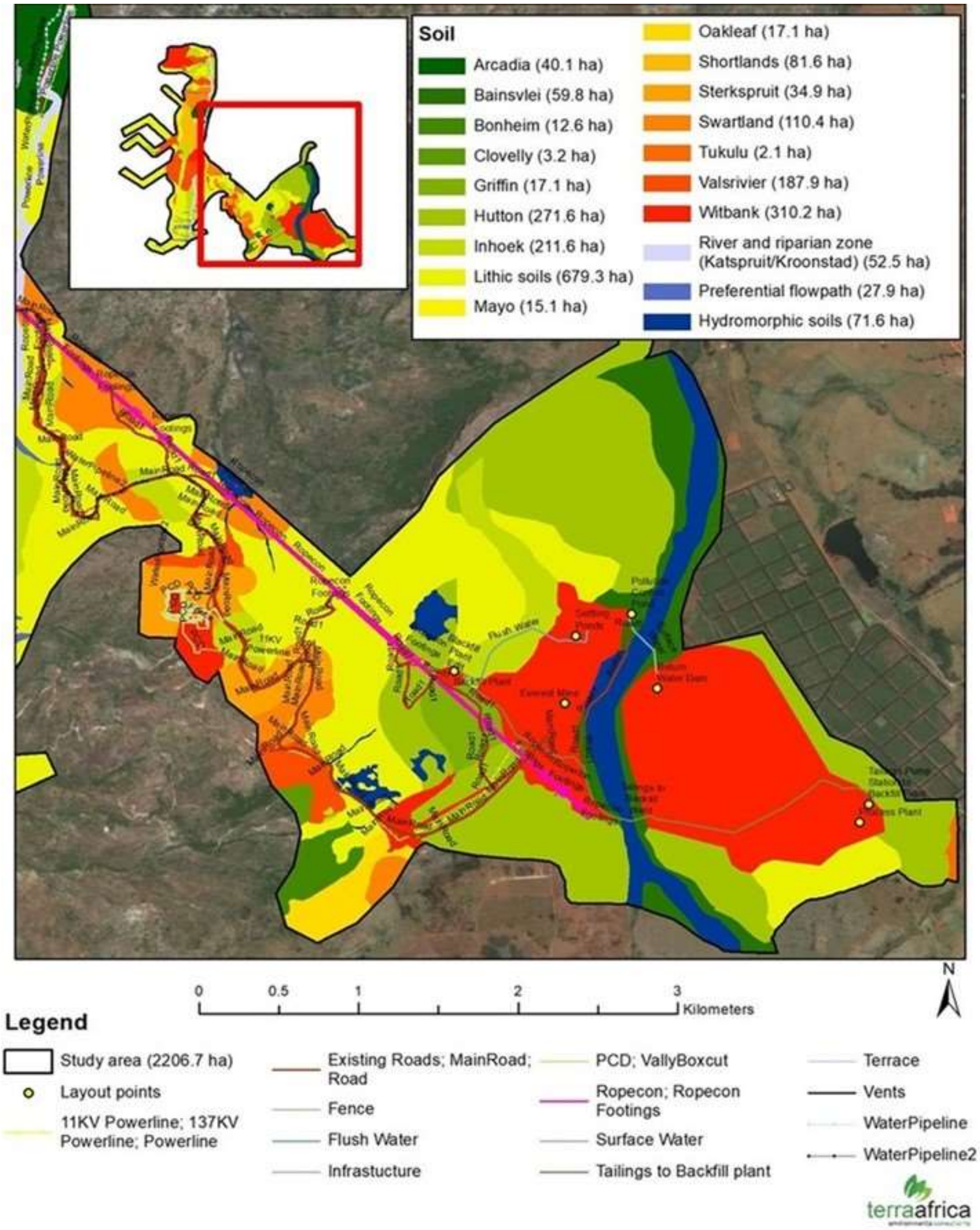


#### 5.8.2.2 Booysendal South MR Phase 2 Project Area Soil Forms

The Phase 2 Project activities pertaining to the Booysendal South MR will mainly take place on already disturbed Witbank soils. Where the slurry pipeline and MCC1 PCD pipeline crosses the Everest tributary there are Bainsvlei and Hydromorphic soils present, giving these areas wetland characteristics.

A section of the process water pipeline from the Backfill Plant to the settling ponds cross over Inhoek soil.

Figure 5-18 Booysendal South Mining Right Phase 2 Project Area Soil Types and Distribution (Source: Terra-Africa, 2018)



### 5.8.3 Baseline Land Capability

Land capability is the inherent capacity of land to be productive under sustained use and specific management methods. The land capability of an area is the combination of the inherent soil properties, the climatic conditions and landscape properties such as slope and drainage patterns that may have resulted in the development of wetlands as an example. Even though land use is intrinsically linked to soil and land capability of an area, it is also largely a function of the economic climate and availability of resources additional to productive land. Land capability has strong influence on socio-economic aspects of human settlements.

Baseline land capabilities are used as a benchmark for rehabilitation of land in the case of project decommissioning. If utilised it is valuable to guide closure and rehabilitation plans and closure objectives. The proper management of topsoil in many instances is overlooked and can add significantly to closure and rehabilitation cost. Land capability classes for the Phase 2 Project were determined in terms of Section 7 of The Chamber of Mines Handbook of Guidelines for Environmental Protection (Volume 3, 1981), included in Table 5-11.

Table 5-11 Booysendal South Expansion Project Land Capability Classes

| | |
|---|---|
| **Criteria for Wetland** | Land with organic soils or<br>A horizon that is gleyed throughout more than 50% of its volume and is significantly thick, occurring within 750mm of the surface. |
| **Criteria for Arable Land** | Land, which does not qualify as a wetland,<br>The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm,<br>The soil has a pH value of between 4,0 and 8.4,<br>The soil has a low salinity and SAR (Sodicity Ratio),<br>The soil has a permeability of at least 1.5-mm per hour in the upper 500-mm of soil<br>The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 10-mm in diameter in the upper 750mm,<br>Has a slope (in %) and erodibility factor (K) such that their product is <2.0,<br>Occurs under a climatic regime, which facilitates crop yields that are at least equal to the current national average for these crops, or is currently being irrigated successfully. |
| **Criteria for Grazing Land** | Land, which does not qualify as wetland or arable land,<br>Has soil, or soil-like material, permeable to roots of native plants, that is more than 250mm thick and contains less than 50% by volume of rocks or pedocrete fragments larger than 100mm,<br>Supports, or can support, a stand of native or introduced grass species, or other forage plants, utilizable by domesticated livestock or game animals on a commercial basis. |
| **Criteria for Wilderness Land** | Land, which does not qualify as wetland, arable land or grazing land. |

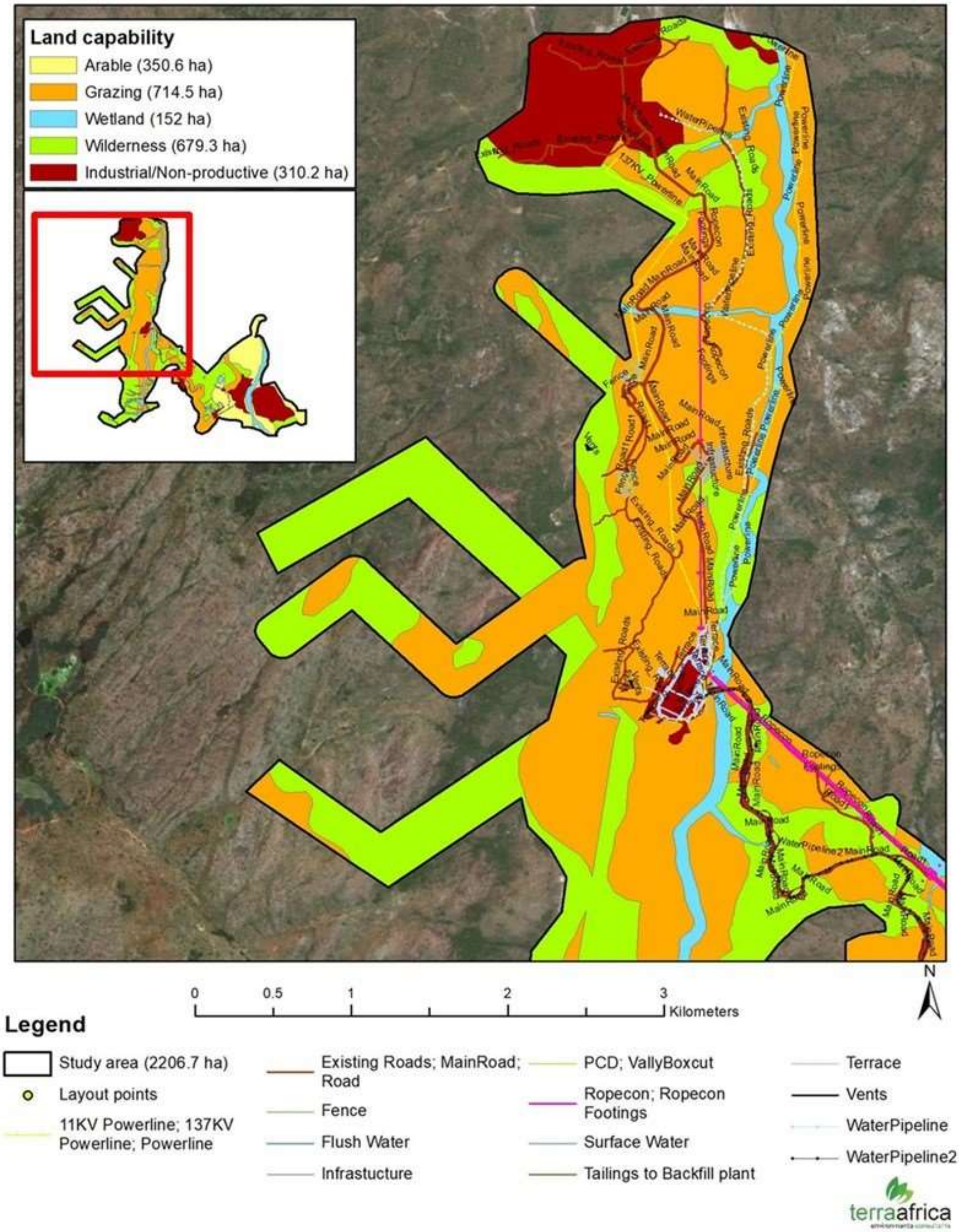
#### 5.8.3.1 Booysendal North MR Phase 2 Project Area Land Capability

The land capability of the majority of the Booysendal North MR Phase 2 Project infrastructure footprint areas has grazing land capability (see Figure 5-19). Small sections of the pipeline route, close to BS1/2 has wilderness capability.

#### 5.8.3.2 Booysendal South MR Phase 2 Project Area Land Capability

The majority of the Booysendal North MR Phase 2 Project infrastructure will be located on industrial, non-productive land (see Figure 5-19). Small sections of the process water pipeline from the Backfill Plant to the settling ponds crosses sections which have grazing and wilderness capability. The slurry and MCC1 PCD pipeline crosses wetland sections.

Figure 5-19 Phase 2 Project Land Capability Classes



### 5.8.4 Land Use and Agricultural Potential

Current land use of the Phase 2 Project Area (BN and BS) is mining. Due to the rocky nature of the majority of the Phase 2 Project Area, it lends itself to post-closure game farming. Areas around BS4 were previously cultivated. This land use can be reinstated post-closure.

The grazing capacity of a specified area for domestic herbivores is given either in large stock units per hectare or in hectare per large stock unit ("**LSU**"). One LSU is regarded as a steer of 450kg whose weight increases by 500g per day on veld with a mean energy digestibility of 55%. The grazing capacity of the veld for the study area is 7 to 10 hectares per large stock unit. The proposed Project Area can thus provide grazing for 78 head of cattle or large stock units.

#### 5.8.4.1 Booysendal North MR Phase 2 Project Agricultural Potential

The agricultural potential of the Booysendal North MR Phase 2 Project Area is mainly suitable for game farming. Small sections along the Groot Dwars River has crop farming potential.

#### 5.8.4.2 Booysendal South MR Phase 2 Project Agricultural Potential

The BS4 area of the Phase 2 Project Area showed evidence of grain and fruit crop production. The north-eastern portion of the BS4 are under kiwi fruit orchards and although it has been neglected, some of the trees have survived. On the southern side of the BS4 area and neighbouring farms, some dryland production of maize was evident. The BS4 area is highly suitable for dryland and irrigated crop production due to the fertile soils, climate and relative high rainfall.

For the remainder of the site, there was no evidence of historical or current crop production. Although some of the soils in this area are well-drained and deep enough for tillage, the slope of the land is in most parts greater than 12% which is not suitable for crop production because of the sensitivity of the soils and the risk of soil erosion.

### 5.8.5 Soil Sensitivities

The nature of the Phase 2 Project terrain, the soil characteristics and the presence of wetland soils result in some soils being more sensitive than others. Disturbance of these soils can lead to significant indirect impacts on the surface water hydrology, aquatic, terrestrial and wetland environments. Some soils are so sensitive that they have been classified as no-go areas. The soil sensitivities and no-go areas are illustrated in Figure 5-20.

Grazing and wilderness land capability soils around BCM1 and BCM2 have a high sediment delivery potential due to the erodibility thereof. These soils are best left untouched or will require the exceptional implementation of soil conservation measures included in Appendix 5 of the Terra-Africa Soil Study.

### 5.8.6 Ecosystem Services

The three main ES identified at the Phase 2 Project Area are:

- Soil provides nutrients to plants through complex nutrient cycles including the carbon and nitrogen cycle that is dependent on soil microorganisms. The Project Area is located in the sensitive Sekhukhune Centre of Endemism, therefore the soil nutrient cycle to support this is important.
- Soil has a water storage function that is affected by the structural and textural properties of the soil. Hydromorphic soils have been identified in areas in the landscape that store large volumes of water and support wetland habitats. Other roles related to water management include the purification of water as well as flood mitigation (a very important feature on the proposed Project Area, especially also in terms of water retention during heavy rainfall events).

- In a structural role, the soil surface provides physical support to living organisms including microorganisms, plants, animals and humans.

The importance of the ES in the Phase 2 Project area is included in Table 5-12.

Figure 5-20 Phase 2 Project Soil Sensitivities and No-go Areas (Source: Terra-Africa, 2018)

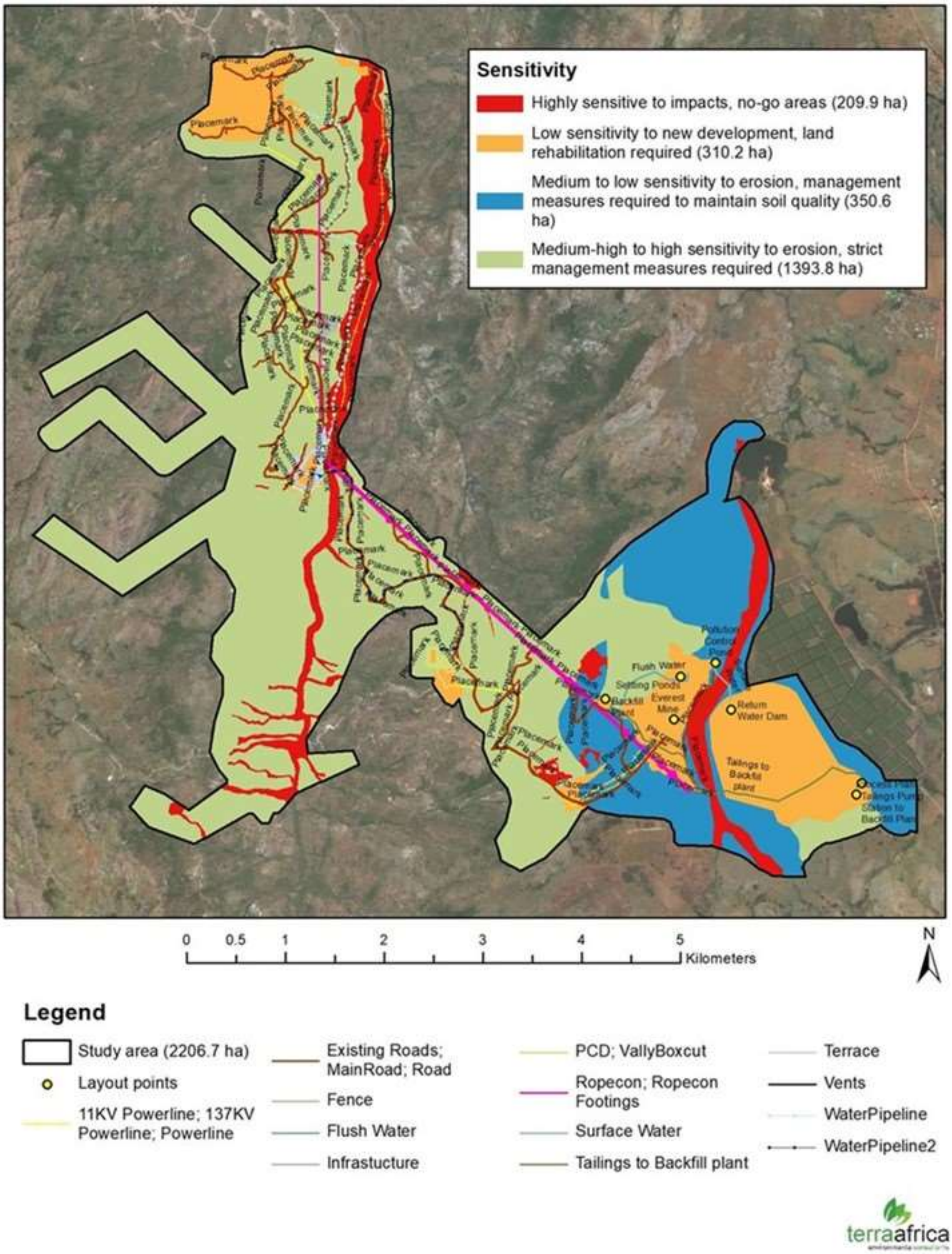


Table 5-12 Phase 2 Project Soil Ecosystem Services Analysis

| ES Service | ES Category | Description | Additional Information (threats, availability) | Relevant Landscape | Importance of the ES | Replicability |
|---|---|---|---|---|---|---|
| Flood retention and water storage | Regulating | Hydromorphic soils allows for infiltration of rainwater especially against steep slopes and forms a buffer for run-off | Large areas of clearance in the area results in reduced flood attenuation | Steep slopes and valley bottoms | High – water storage is important to maintain ecosystems | Low – water storage function is near impossible to restore especially where compaction occurred |
| Nutrient cycle | Supporting | Soil provides nutrients to plants, maintain the nutrient cycles and micro-organisms | The soils have a unique mineral and metal contents which supports the SCPE | All soils | High – altering the nutrient cycle can lead to a loss in SCPE | Moderate – topsoil storage, effective rehabilitation and addition of nutrients could assist in rehabilitation |

## 5.9 Water Quality

Aquatico is responsible for the monthly monitoring program at Booysendal Mine and were also responsible for the trend analysis for the Phase 2 Project. The Aquatico Water Quality Assessment ("**Aquatico WQA**") is included in Annexure H.

### 5.9.1 Methodology

Aquatico did a desktop trend analysis on available surface-and groundwater monitoring results (January 2015 to February 2018) for the Booysendal Operation. The water quality data was compared against applicable water quality limits included in the existing IWULs, SANS drinking water standards, special limits published in terms of Classes and Resources Quality Objectives of Water Resources for the Olifants Catchment (published under GN 466 in GG 39943 of 22 April 2016) or the upper reaches of the Olifants WMA. Water quality limits applicable to the Phase 2 Project is included in Table 5-13.

Current impacts on water quality and potential future risks and threats were identified.

Surface and groundwater points which could potentially be affected by the Phase 2 Project were identified to assess potential future impacts based on current mining impacts on water quality.

### 5.9.2 Baseline Surface Water Quality

There is an overall connectivity between the streams and rivers in the Phase 2 Project Area, therefore an integrated approach was followed for the Booysendal North MR an Booysendal South MR surface water quality analysis. The aquatic ecosystems within the direct AoI is included in Figure 5-21. The following AoI is applicable to the Phase 2 Project:

- The Groot Dwars River – direct AoI of the Booysendal North MR Phase 2 Project and indirect AoI of the Booysendal South MR activities;
- Various perennial and non-perennial drainage lines and wetlands that drains into the Groot Dwars River. The drainage lines include:

- Tributaries (tributary 1-2) between NBS GD04 and NBS GD03 which will receive water from BS4 and the Valley Boxcut;
- Tributary 3, which receives run-off from BS4, the ARC, 11kVA powerline and BN pipelines; and
- The Waterfall tributary (NBC SW3) which is a mountain stream running past the BCM2 complex.

- The Everest tributary will receive run-off from the BS4 Phase 2 Project development areas, which eventually flows into the Groot Dwars River.

The surface water quality was analysed against the SANS 241:2015 drinking water standards, the SAWQG limits for aquatic ecosystems due to the sensitivity of the ecosystem, the special limits of authorisation in the 2011 BN IWUL and the SQWQG limits for drinking water (refer to Table 5-13).

Table 5-13 Surface Water Quality Limits Considered in the Phase 2 Project Water Quality Analysis

| VARIABLE | UNITS | Water Resource Protection - Dwars River Instream Water quality; WUL 2006 | Special Authorisation Limit, Section 21f and h, 2013 | SAWQG Volume 4, Agricultural Use Irrigation TWQGR for Crop Yield; DWAF (1996) | SAWQG Volume 5, Agricultural Use, Livestock Watering, Cattle; DWAF (1996) | SAWQG Volume 7, Aquatic Ecosystems; DWAF (1996) |
|---|---|---|---|---|---|---|
| pH @ 25°C | pH | - | 5.5/7.5 | 6.5/8.4 | - | - |
| Electrical conductivity (EC) @ 25°C | mS/m | - | 100 | 40 | - | - |
| Total dissolved solids (TDS) | mg/l | 520 | - | - | 2000 | - |
| Calcium (Ca) | mg/l | 25 | - | - | 1000 | - |
| Magnesium (Mg) | mg/l | 25 | - | - | 500 | - |
| Sodium (Na) | mg/l | 9 | - | 70 | 2000 | - |
| Potassium (K) | mg/l | 46 | - | - | - | - |
| Chloride (Cl) | mg/l | 62 | - | 100 | 3000 | - |
| Sulphate ($SO_4$) | mg/l | 70 | - | - | 1000 | - |
| Nitrate ($NO_3$) as N | mg/l | 6 | 1.5 | - | 45 | - |
| Ammonium ($NH_4$) as N | mg/l | - | 2 | - | - | - |
| Orthophosphate ($PO_4$) as P | mg/l | - | 2.5 | - | - | - |
| Fluoride (F) | mg/l | - | 1 | 2 | 4 | 0.75 |
| Aluminium (Al) | mg/l | - | - | 5 | 5 | 0.005 |
| Boron (B) | mg/l | - | 0.5 | 0.5 | 5 | - |
| Cadmium (Cd) | mg/l | - | 0.001 | 0.01 | 0.01 | 0.00015 |
| Hexavalent chromium ($Cr^{6+}$) | mg/l | 0.014 | 0.02 | 0.1 | 1 | 0.0007 |
| Chromium (Cr) | mg/l | - | - | - | - | 0.007 |
| Copper (Cu) | mg/l | - | 0.002 | 0.2 | 0.5 | 0.0003 |
| Iron (Fe) | mg/l | - | 0.3 | 5 | 10 | - |
| Manganese (Mn) | mg/l | - | 0.1 | 0.02 | 10 | 0.18 |
| Lead (Pb) | mg/l | - | 0.006 | - | 0.1 | 0.0002 |
| Vanadium (V) | mg/l | - | - | 0.1 | 1 | - |
| Zinc (Zn) | mg/l | - | 0.04 | 1 | 20 | 0.002 |
| Total suspended solids (TSS) | mg/l | - | 10 | 50 | - | - |
| Chemical oxygen demand (COD) | mg/l | - | 30 | - | - | - |
| Oil and grease (SOG) | mg/l | - | 0 | - | - | - |
| Sodium Adsorption Ratio | SAR | - | - | 2 | - | - |
| Dissolved Oxygen | mg/l | - | - | - | - | - |

Figure 5-21 Streams and Rivers in the AoI of the Phase 2 Project (Source: Aquatico, 2018)


It is important to analysis the background surface water qualities against the process water qualities and potential decant qualities to understand potential impacts on surface water resources should spillages into the natural environment occur. Figure 5-22 indicates the locations of the surface and process water monitoring points and Table 5-14 a description of the locations which were considered in the assessment.

#### 5.9.2.1 Booysendal South Mining Right Surface Water Qualities

The findings of the trend analysis indicate that the water qualities in the process water dams at BS4 is comparatively better than that of BN. This can be attributed to the fact that BS4 has been under care and maintenance since 2012 and therefore mainly receives run-off water. Process water dams at BN provides an indication of expected water qualities for the Phase 2 Project PCDs.

<u>BS4 PCDs</u>: In general, the water qualities in the PCDs at BS4 indicates:

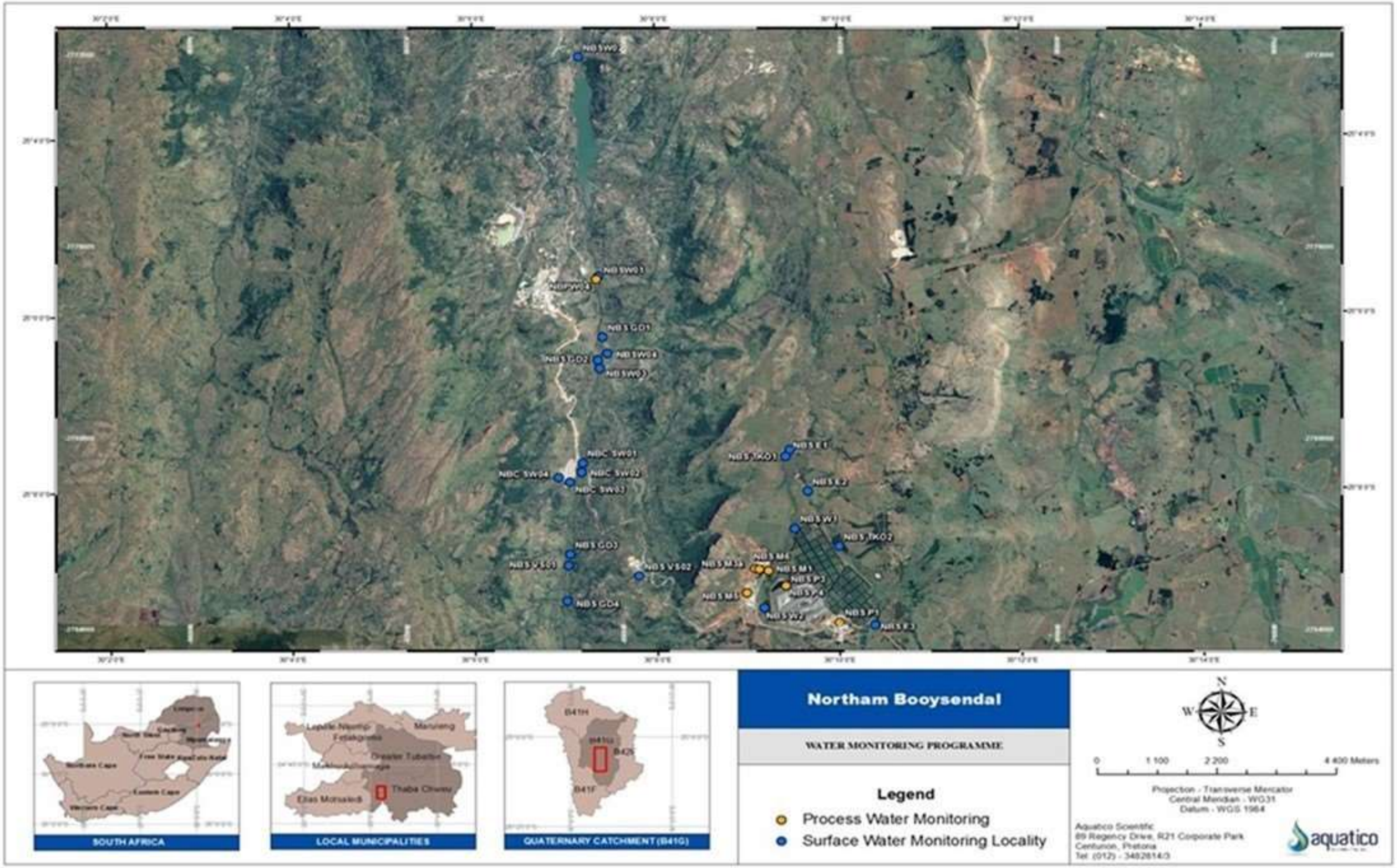
- The pH of the process water dams varies between 7 and 10. The special limits for pH is 5.5 to 7.5, while the industrial limits are between 7 and 8;
- EC values are below the special limit of 100 mS/m;
- Calcium ("**Ca**"**)** and Magnesium ("**Mg**") at some of the mentoring points exceeded the 25 mg/l limit during several monitoring periods, indicating that historic mining activities still had an impact on water quality;
- Sodium ("**Na**") exceeded the special limit of 9.0 mg/l at several of the monitoring points ranging between 1.04 to 107 mg/l;
- Potassium ("**K**") monitoring results were all below the special limit of 46 mg/l;
- TDS results were mainly below the special limit of 520 mg/l although some months indicated exceedance;
- Chloride ("**Cl”**") monitoring results were all below the special limit of 62 mg/l ranging between <0.776 to 35.4 mg/l;

- The Sulphide ("**$SO_4$**") limit of 70 mg/l is exceeded at the inflow point of the RWD;
- At most of the process water dams Nitrate ("**$NO_3$**") limits are below the special limit of 6 mg/l except for the inlet point to the RWD which varied between <0.459 and 21.2 mg/l; and
- Chromium ("**Cr**") levels in the process water dams were all below the special limit of 0.014mg/l.

Table 5-14 Description of Booysendal Mine Surface Water Monitoring Points

| Reference | Description | Locality | |
|---|---|---|---|
| | | Latitude | Longitude |
| | **River or stream at Booysendal Central** | | |
| **NBC SW01** | Central Dwars River Downstream | S25.12794 | E30.11974 |
| **NBC SW02** | Central Dwars River Midstream at SW03 Confluence | S25.12970 | E30.11949 |
| **NBC SW03** | Central South Stream Tributary before Confluence with Dwars River | S25.13160 | E30.11744 |
| **NBC SW04** | Central South Stream Tributary Upstream | S25.13065 | E30.11535 |
| | **Dwars River and Tributaries** | | |
| **NBS GD1** | Groot Dwars River, downstream of East Stream confluence | S25.10419 | E30.12360 |
| **NBS GD2** | Groot Dwars River, upstream of East Stream confluence | S25.11011 | E30.12293 |
| **NBS GD3** | Groot Dwars River, downstream of mining area | S25.14514 | E30.11735 |
| **NBS GD4** | Groot Dwars River, upstream of mining area | S25.15403 | E30.11678 |
| **NBSW01** | Groot Dwars River (G-DRS 1) | S25.09276 | E30.12285 |
| **NBSW02** | Groot Dwars River below the De Brochen Dam | S25.05148 | E30.11938 |
| **NBSW03** | Everest (Eastern) Tributary | S25.10738 | E30.12443 |
| **NBSW04** | Groot Dwars River Upstream B/C | S25.10585 | E30.12272 |
| **NBS E1** | East stream + West stream, after TKO1 dam | S25.12567 | E30.16084 |
| **NBS E2** | East stream (Everest tributary) downstream of mining area, before TKO1 dam | S25.13349 | E30.15761 |
| **NBS E3** | East stream (Everest tributary) upstream of mining area, at main tar road crossing | S25.15875 | E30.17309 |
| **NBS W1** | West stream (Kraalspruit) downstream of mining area, before TKO1 dam | S25.14051 | E30.15846 |
| **NBS W2** | West stream (Kraalspruit) upstream of mining area | S25.15546 | E30.15283 |
| | **TKO Dams** | | |
| **NBS TKO1** | TKO1 - big TKO (Transvaal Kiwi Orchards) | S25.12693 | E30.15691 |
| **NBS TKO2** | TKO2 - big TKO (Transvaal Kiwi Orchards) | S25.14391 | E30.16654 |
| | **Return water dam** | | |
| **NBS M1** | Excess water dam - MCC1 | S25.14847 | E30.15367 |
| **NBS M3a** | Settler No.1 | S25.14808 | E30.15114 |
| **NBS M5** | Erickson Dam | S25.15263 | E30.14966 |
| **NBS M6** | Sink Dam | S25.14816 | E30.15190 |
| **NBS P3** | Tailings Return Water Dam | S25.15132 | E30.15679 |
| **NBS P4** | Inflow to Return Water Dam (Tailings) | S25.15135 | E30.15678 |
| | **Seepage** | | |
| **NBS VS01** | Valley boxcut stream | S25.14731 | E30.11709 |
| **NBS VS02** | Valley boxcut | S25.14929 | E30.12994 |
| | **Process water dam** | | |
| **NBS P1** | Concentrator Plant Process Water Dam | S25.15823 | E30.16660 |
| **NBPW04** | Frog Pollution Control Dam | S25.09335 | E30.12238 |

Figure 5-22 Surface Water Monitoring Locations (Source: Aquatico, 2017)



Surface water quality of streams and dams at BS

The Everest Stream (NBS W1 & NBS W2) and De Kafferspruit tributaries (NBS E3, NBS E2 and NBS E1) flow around the BS4 operations, where both flow towards the TKO1 and TKO2 dams downwards to confluence with the Everest tributary (NBSW03) into the Groot Dwars River. This locality is vital as any spills or seepage that occurs at BS4 will be picked up at this downstream locality. The map indicating the water monitoring localities is depicted in Figure 5-22.

- The baseline data for the tributaries and dams around the new and old mining activities were added with data from January 2015 to February 2017;
- The receiving environment localities which include the TKO dams, Everest and De Kafferspruit tributaries, indicated neutral pH-values which fluctuate between 7 and 8.5;
- The EC had high levels at NBSW03 during January 2015 – March 2015 with concentrations that decreased and remained stable (between 4.5 and 25 mS/m) towards the end of 2017. This is below the special limit of 100mg/l;
- All the selected variables had indicated the same spike in concentrations at NBSW03 with only slight variations recorded towards 2017. The concentrations mainly complied with the Instream Dwars River values for Ca *25 mg/l), Mg (25 mg/l), K (46 mg/l) and Na (9 mg/l). Locality NBS W1 was recorded as dry October 2016, after which slightly higher $SO_4$ concentrations were measured during November 2016 and December 2016;
- The Cl concentrations were slightly higher than the baseline at NBS W1 during 2016. Fluctuating Al concentrations were recorded at NBS TK01, NBS E1, NBSW03, NBS W1, NBS TKO02 and NBS E2. In general, the Cl concentrations varies between 1.5 to 10 mg/l which is below the special limit of 62 mg/l; and
- The water quality measured in the tributaries and dams vary during seasonal changes as the up-and downstream localities has similar trends throughout the assessment period. Trend analysis indicates that water qualities generally improved over time as mining impacts decreased.

#### 5.9.2.2 Booysendal North Mining Right Surface Water Qualities

BN PCDs: The Frog PCD at BN contains dirty water originating from the underground workings and the dirty water areas around the mining portal. This water is recycled in the process and therefore represents worst case scenario water qualities. It must be noted that all the concentrations at the Frog PCD will naturally be highly concentrated as it forms part of a single closed water system.

- The pH for the BN Frog Dam also varies between 7.6 and 8.24;
- EC values for the Frog Dam ranges between 39.9 to 475 mS/m;
- Ca and Mg monitoring results ranged between 27.6 to 252 mg/l and 13.1 to 96.7 mg/l. The Ca and Mg values exceeded the Groot Dwars River water resource protection limit of 25 mg/l most of the times;
- Na values ranged between 27 to 260 mg/l exceeding the limit of 9.0 mg/l;
- K values ranged between 4.3 and 29.4 mg/l which is within the Groot Dwars River water resource protection limit;
- The Groot Dwars River water resources protection limit for TDS is 520 mg/l. The monitoring values from 2015 to 2017 ranged between 270 and 3044 mg/l;
- Cl values mainly exceeded the Groot Dwars River protection limit of 62 mg/l ranging between 26.7 to 218 mg/l;
- $SO_4$ ranged between 29.2 to 410 mg/l exceeding the special limit of 70 mg/l;
- $NO_3$ is of concern as it could lead eutrophication of water resources. The $NO_3$ monitoring results varied between 14 to 432 mg/l with most values exceeding 300 mg/l;

- Aluminium (**"Al"**) monitoring results varied between <0.005 and 0.186 mg/l.
- Fluoride (**"F"**) monitoring results were mainly below 0.75 mg/l.

Although a closed process water system is operated, from the above analysis it is important that discharge into the environment during storm events of incidents be avoided;

<u>Groot Dwars River water quality</u>

Surface water drainage from the Phase 2 Project Area will drain directly via the valley areas to reach the Groot Dwars River. Water quality in the Groot Dwars River indicates that:

- The pH-values in the Groot Dwars River were neutral to alkaline during the baseline assessment (between 7.1 and 8.6) and correlates with the other natural water systems (refer to Appendix H);
- The EC levels varies between 10 and 60 mS/m which is below the special limit of 100 mS/m;
- Ca, Mg, Na, K and $NO_3$_N recorded very low concentrations at all the Groot Dwars River localities, however, at times there were exceedance of the limits;
- The Al concentrations at all the localities in the Groot Dwars River indicated seasonal fluctuations with exceedance of the aquatic limits of 0.005 mg/l during December 2016 to February 2017 after which it again stabilised below the aquatic limit;
- After heavy rainfall in December 2016 and January 2017, the water quality improved in the entire river system, with only NBSW02, the Der Brochen dam downstream area which remained the same. The water quality in the Groot Dwars River catchment varies during seasonal changes as the up-and downstream localities displayed similar trends throughout the assessment period.

There is also a definite deterioration in water quality from the upstream to downstream monitoring points.

<u>Central tributaries water quality</u>

The Central Tributaries currently consist of 4 monitoring localities up-and downstream of the construction areas at the Phase 1 Project, covering the Phase 2 Project Area and the Groot Dwars River – Everest tributary confluence (Figure 5-22). The localities included in this section are NBC SW01, NBC SW02, NBC SW03 and NBC SW04.

- The pH-values fluctuated between 8 and 8.7, which is in the alkaline ranges;
- The EC-values were mostly stable from May 2016 to September 2016, with slight increase in October 2016, after which the concentrations decreased to concentrations lower than the initial data measured during the first part of the monitoring period. EC-values were continuously below the special limit of 100 mg/l;
- The same trend was observed from Ca, Mg and Na whereas the K concentrations increased during November 2017 at NBC SW01 and NBC SW02 with some exceedance in the special limits;
- The changes in EC-values could indicate possible influence from the Phase 1 Project construction operations. The K concentrations decreased again during January 2017 to similar concentrations measured before heavy construction started. The Na concentration at the downstream area returned to normal quicker than that of the upstream areas, which can indicate changes in the natural geology with regards to Na;
- The $NH_4$_N measured at NBC SW01 were slightly higher concentrations at July 2016 and December 2017 compared to the upstream localities which remained stable during the same period. Sulphate ($SO_4$) concentrations at all the monitoring localities increased during July 2016 and January 2017, with locality NBC SW01 that increased during October 2016. The concentrations were, however, below the special limit of 70 mg/l;
- The Al trends observed around BCM1 and BCM2 exceeded the aquatic limit of 0.005 mg/l during the end of November 2016 and beginning of 2017. This could be attributed to the Phase 1 Project construction activities; and
- In general, the water quality in the Groot Dwars River catchment varies during seasonal changes as the up-and downstream localities displayed similar trends throughout the assessment period.

In summary; the natural water systems within the Booysendal Operations indicated water quality with a fairly neutral to alkaline pH-value as well as very low to low anion and cation loads. The natural water quality fluctuates with the changes in seasons as well as rainfall in the area. Slightly higher aluminium concentrations were recorded at several of the natural water systems. However, this seems to be a natural occurrence and the measured Al concentrations are most likely to be in a suspended state (due to the neutral pH at all the localities) rather than in solution as would be the case under more acidic pH conditions.

The process water quality at BS4 indicates similar water quality to that measured at the natural water systems, as the process facilities have not been operational because of the BS4 mining operations being under care and maintenance. The NBPW03, FROG PCD, is a process water locality situated in the valley and process water from BN is stored for re-use. The water quality at the aforementioned process water locality is an indication of typical process water, with very high to elevated anions and cations, and more alkaline pH-values.

### 5.9.3 Baseline Groundwater Quality

The groundwater quality analysis presented in this section is based on a comparison of the monitoring results against the South African National Standards for drinking water *(*SANS 241:2015). Parameters of concern which were highlighted in the analysis included TDS, $SO_4$, pH, Mg and $NO_3$. Two types of groundwater monitoring are done:

- Regional monitoring – this is focussed on unaffected, baseline groundwater monitoring locations; and
- Pollution plume monitoring – where monitoring is taking place in potentially affected groundwater locations.

<u>Booysendal South MR groundwater quality</u>

The BS groundwater monitoring locations and results are included in Table 5-15 and the locations in Figure 5-23. The complete set of monitoring results is included in Annexure H. Background groundwater quality for BS cumulatively is indicated in Table 5-17.

- *Process Plant*: There is a slight exceedance (3.620 mg/l) of the Fe limit of 0.3 mg/l. Mn (1.874 mg/l) and F (1.181 mg/l) limits of 1.5 mg/l and 0.4 mg/l respectively are also exceeded. Other groundwater parameters are within the SANS 241:2015 drinking water limits. The groundwater is characterised by fresh, clean and relatively young groundwater dominated by Mg cations.
- *TSF 1*: Groundwater within the immediate vicinity of the tailings dam is of good quality per guidelines stipulated in the IWUL and the SANS 241:2015 drinking water limits. The $NO_3$ content of groundwater from monitoring borehole NBSESM3 at times exceeded the WUL guideline value of 6 mg/l, which is believed to be seasonally driven. The TSF1 is the most obvious source of the $NO_3$ contamination, which was originally introduced to the mining environment through the usage of nitrate based explosives. However, the seasonally driven trend observed for NBSESM3 is not shared by the two-other down gradient monitoring boreholes (NBSESM2 and NBSESM7), which suggests that the TSF1 may not be the only source contributing to the groundwater nitrate content of monitoring borehole NBSESM3.The TSF1 area is mainly dominated by fresh, clean, relatively young groundwater that has started to undergo Mg ion exchange. The groundwater is consequently dominated by Mg cations, while bicarbonate alkalinity dominates the anion content.

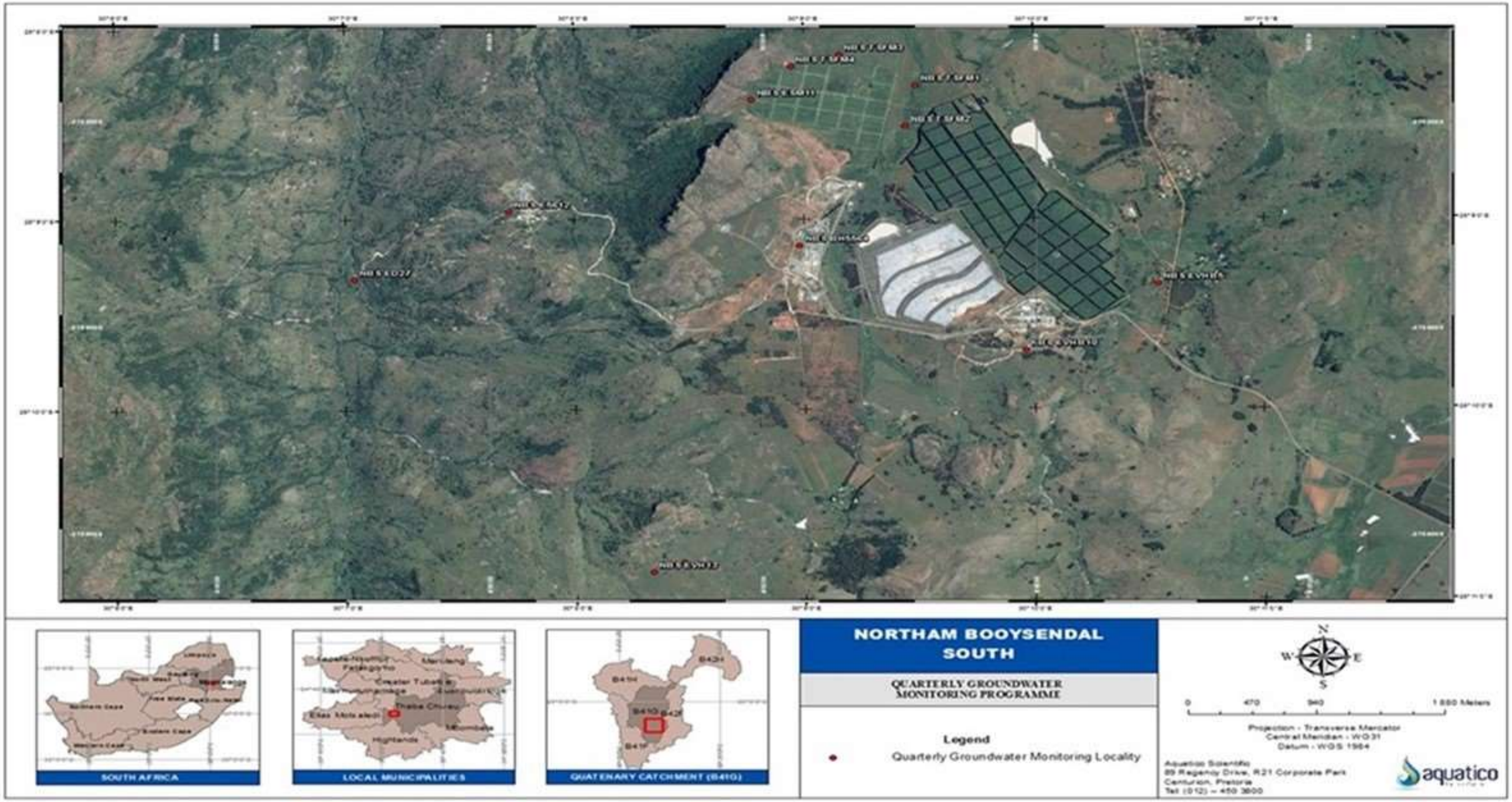
*Downstream of MCC1 PCD*: The quality of the downstream groundwater monitoring points north of MCC1 is good. The WUL guideline concentration for calcium is 35 mg/l, was exceeded in monitoring borehole NBSTSFM4. Borehole NBSTSFM2 displayed high $NO_3$ content in October 2016, which according to historical monitoring data is not uncommon for this borehole. The overutilization of $NO_3$-containing fertilisers by the nearby kiwi orchard is believed to be responsible for this phenomenon. It is also possible that seepage from upstream groundwater could have impacted on the $NO_3$ concentrations.

Table 5-15 Booysendal South Mining Right Representative Groundwater Monitoring Locations and Results (Source: Aquatico, 2018)

| Borehole ID | Location | pH | EC mS/m | TDS mg/l | Ca mg/l | Mg mg/l | Na mg/l | K mg/l | Cl mg/l | $SO_4$ mg/l | $NO_3$ mg/l | F mg/l | Al mg/l | Fe mg/l | Mn mg/l | $NH_4$ mg/l | $PO_4$ mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Monthly Monitoring** | | | | | | | | | | | | | | | | |
| **NBSESM2** | TSF1 Monitoring | 7.6 | 16.5 | 124.8 | 11.9 | 10.9 | 3.9 | 0.5 | 4.0 | 0.8 | 0.8 | 0.083 | <0.005 | 0.244 | 0.484 | 0.265 | 0.025 |
| **NBSESM3** | TSF1 Monitoring | 8.1 | 29.3 | 203.5 | 19.0 | 24.6 | 5.5 | 1.3 | 9.3 | 5.9 | 4.1 | <0.472 | <0.005 | <0.009 | <0.001 | 0.427 | 0.025 |
| **NBSESM5** | Workshop and MCC1 | 8.8 | 31.7 | 211.4 | 8.4 | 31.9 | 8.9 | 1.0 | 6.3 | 3.1 | 19.6 | <0.472 | <0.005 | <0.009 | <0.001 | 0.525 | 0.027 |
| **NBSESM6** | Process Plant | 7.4 | 11.8 | 87.9 | 8.1 | 7.4 | 2.7 | 1.5 | 5.3 | 1.6 | 0.4 | 0.511 | <0.005 | 1.169 | 0.411 | 0.254 | 0.005 |
| **NBSESM7** | TSF1 Monitoring | 7.7 | 16.6 | 102.6 | 9.5 | 10.5 | 5.7 | 0.5 | 10.9 | 0.8 | 1.9 | <0.472 | <0.005 | 0.017 | 0.007 | 0.905 | 0.023 |
| **NBSESM8** | Process Plant | 6.7 | 5.8 | 37.1 | 3.2 | 1.6 | 1.3 | 0.5 | 0.8 | 0.6 | 0.4 | 1.871 | <0.005 | 3.620 | 1.874 | 0.110 | 0.008 |
| | **Quarterly Monitoring** | | | | | | | | | | | | | | | | |
| **NBSE5612** | Valley Boxcut | 8.2 | 47.2 | 318.3 | 47.7 | 29.1 | 14.5 | 1.4 | 3.7 | 20.8 | 2.7 | <0.472 | <0.005 | <0.009 | <0.001 | 0.568 | 0.018 |
| **NBSED27** | Valley Boxcut | 8.2 | 55.7 | 284.8 | 18.6 | 2.4 | 87.0 | 3.5 | 106.3 | 1.7 | 0.2 | <0.472 | <0.005 | <0.009 | 0.135 | 2.935 | 0.016 |
| **NBSEVH12** | Regional | 7.9 | 12.9 | 80.0 | 10.6 | 6.4 | 5.2 | 0.8 | 7.2 | 1.7 | 0.6 | <0.472 | <0.005 | <0.009 | <0.001 | 0.373 | 0.017 |
| **NBSEVH13** | Regional | 8.1 | 21.1 | 153.5 | 21.1 | 10.9 | 6.6 | 0.7 | 11.9 | 1.7 | 1.1 | <0.472 | <0.005 | <0.009 | <0.001 | 0.034 | 0.019 |
| **NBSEVHB10** | Process Plant | 6.5 | 3.0 | 19.5 | 1.4 | 1.1 | 0.8 | 0.2 | 0.5 | 1.5 | 0.6 | <0.472 | <0.005 | <0.009 | <0.001 | 0.045 | 0.018 |
| **NBSEVHB5** | Regional | 7.6 | 26.3 | 199.5 | 26.0 | 17.7 | 5.7 | 0.9 | 10.8 | 5.2 | 1.7 | <0.472 | <0.005 | <0.009 | <0.001 | 0.038 | 0.028 |
| **NBSTSFM1** | TSF* | 7.8 | 20.0 | 148.8 | 15.9 | 13.9 | 6.9 | 0.4 | 1.4 | 2.7 | 0.3 | <0.472 | 0.022 | <0.009 | 0.299 | 0.044 | 0.019 |
| **NBSTSFM2** | TSF* | 8.1 | 23.0 | 151.0 | 18.0 | 14.1 | 10.3 | 0.5 | 3.5 | 1.8 | 3.8 | <0.472 | <0.005 | <0.009 | <0.001 | 0.040 | 0.016 |
| **NBSTSFM3** | TSF* | 7.6 | 16.2 | 124.5 | 12.6 | 10.5 | 3.6 | 0.2 | 3.4 | 1.7 | 0.4 | <0.472 | <0.005 | <0.009 | <0.001 | 0.096 | 0.019 |
| **NBSTSFM4** | TSF* | 7.6 | 26.8 | 174.0 | 37.9 | 9.3 | 5.5 | 2.6 | 11.2 | 12.8 | 0.5 | <0.472 | <0.005 | <0.009 | 0.009 | 0.069 | 0.017 |

Values in red indicates exceedance of SANS 241:2015 water quality standards
* This is associated with the Fairway Project baseline monitoring

Figure 5-23 Booysendal South Mining Right Groundwater Monitoring Boreholes (Source: Aquatico, 2018)



- *Workshops and MCC1 PCD*: The groundwater down gradient from the MCC1 PCD (borehole NBSESM5) is affected by $NO_3$ pollution and remedial actions need to be considered to mitigate the impact. The $NO_3$ levels in this borehole decreased from 33 mg/l in February 2016 to 9 mg/l in February 2017. This decreasing trend forms part of a much longer trend that began shortly after the May 2012 sampling run and at a time when the groundwater $NO_3$ content was nearly 140 mg/l. It is assumed that this is as a direct result of mining activities which have ceased. These findings are in line with the hydrogeology report which indicated leachate of nitrates from TSF1 and the RWD. The groundwater Mg content in borehole NBSESM5 exceeded the WUL guideline concentration of 25 mg/l. Like $NO_3$, the Mg content in this borehole has been decreasing during the past five years or so. This also corresponds with the ceasing of mining activities. Management measures in the form of lining and the current upgrade of the storm water management system could alleviate the seepage issue and associated impacts on groundwater.

- *The MCC1 PCD* area is dominated by groundwater that is usually a mix of different types – either clean water that has undergone $SO_4$, but especially $NO_3$ mixing/contamination or old stagnant sodium Cl dominated water that has mixed with water richer in Mg. The groundwater is consequently dominated by Mg cations, while $NO_3$ dominates the anion content. This can be directly attributed to impacts associated with the past mining activities.

- *Regional Boreholes*: The water qualities of the regional boreholes serve as background / baseline water quality. The water quality in these boreholes shows no signs of impacts from mining or any other activities. The groundwater is dominated by Ca/Mg cations and bicarbonate alkalinity, which is typical of ambient water quality in this area.

<u>Booysendal North MR groundwater quality:</u>

The Phase 2 Project is located in an area which has not been subject to sources of contaminants and therefore presents a good indication of background water quality. Current operations at BN provide a good indication of potential expected impacts on groundwater quality. A summary of monitoring results is included in Table 5-16 and the location of the monitoring boreholes is included in Figure 5-24.

The site-specific groundwater monitoring results at BN indicate that groundwater quality within the immediate vicinity of the BN mining activities is chemically and physically considered to be of good quality according to SANS 241:2015. The WUL guideline concentrations were exceeded in most the monitoring boreholes. The long-term trends indicated no signs of any significant increase or decrease in concentrations. Long term increases in the Ca and/or Mg content of groundwater from monitoring boreholes NBGW09, NBGW10, NBGW12 and NBGW13 are, however, evident when considering the entire data record. The aquatic specialist believes these increase trends are not caused by any activities relating to the mine. The following presents a summary of the groundwater qualities at BN.

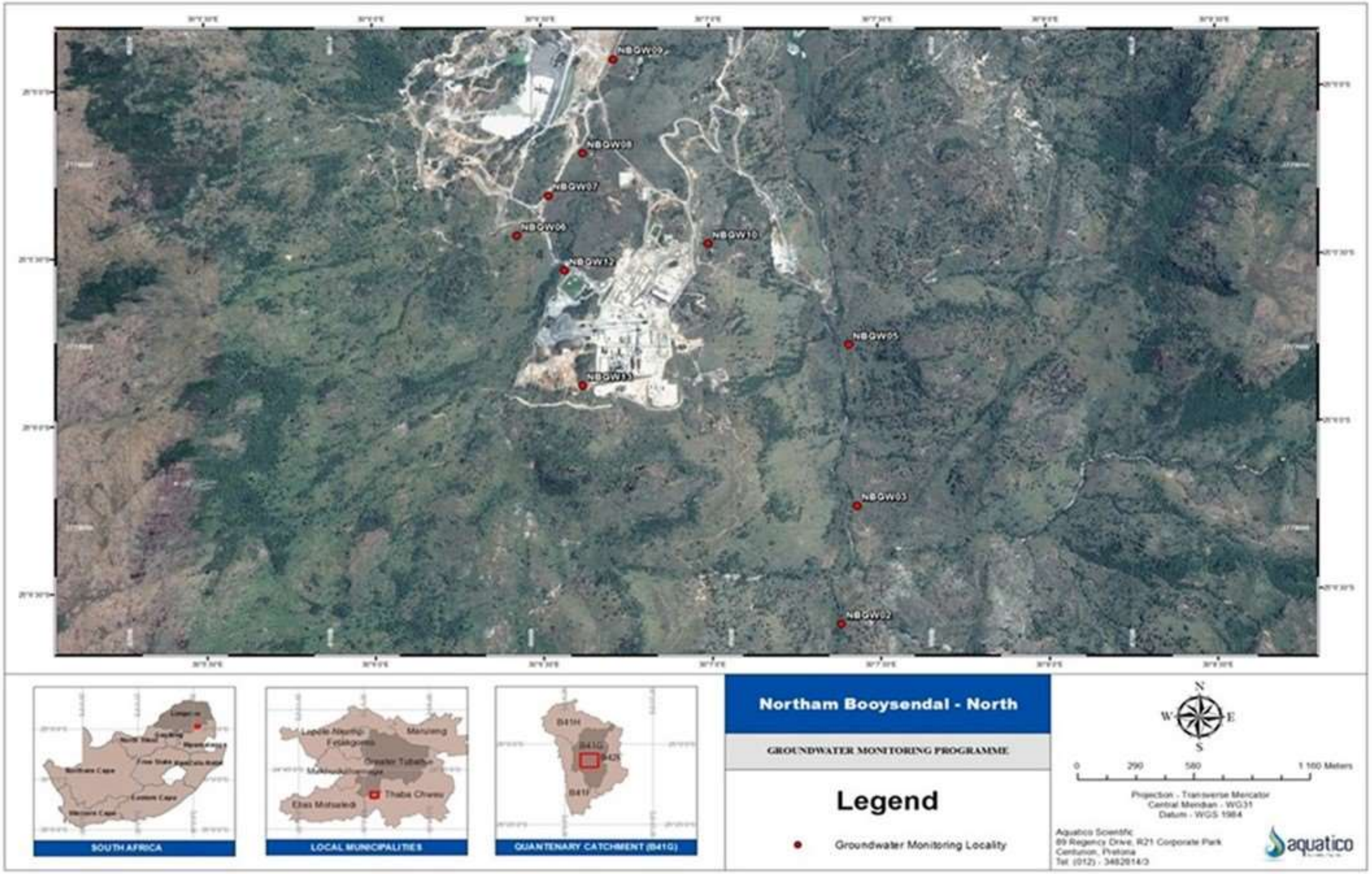
- Borehole NBGW09 is located directly down gradient from the TSF complex which, given its relatively large footprint area and “wet source” status, is considered to be one of the more significant sources of contamination in the mine lease area. Surface water sampled from the TSF sump is characterised by elevated concentrations of $SO_4$, K, $NO_3$ and Cl. None of these contaminants have yet been detected in monitoring borehole NBGW09.
- Borehole NBGW10 is located down gradient (north-east) from the Mine’s workshops and administration areas. At this point in time, no single source or specific activity can be linked to the increase in Ca observed in this borehole.
- Borehole NBGW12 is located directly down gradient from Tsunami PCD. Surface water sampled from the dam is characterised by exceptionally high levels of $NO_3$ pollution. Groundwater from NBGW12 has shown no signs of $NO_3$ pollution.
- Borehole NBGW13 is in the up-gradient groundwater flow direction and away from most of the obvious source areas. No reasonable explanation can therefore be provided for the increasing Ca and Mg trends observed in this borehole.
- The groundwater is dominated by Ca and Mg cations, while bicarbonate alkalinity dominates the anion content.

Table 5-16 Booysendal North Mining Right Groundwater Quality (Source: Future Flow, 2018)

| Borehole | pH | EC mS/m | TDS mg/l | Ca mg/l | Mg mg/l | Na mg/l | K mg/l | M-ALK CaCO3/L | Cl mg/l | SO4 mg/l | NO3-N mg/l | F mg/l | Al mg/l | Fe mg/l | Mn mg/l | N_Amonia mg/l | Total Hardness mg/l | NO2-N mg/l | PO4 mg/l | B mg/l | Cr mg/l | Cr6+ mg/l | Pb mg/l | Si mg/l | Zn mg/l | Turbidity NTU | Bicarb alkalinity CaCO3/L | Carb-alkalinity mg/l | Borehole Location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SANS241 Guideline | ≥5to≤9.7 | ≤170 | ≤1200 | N/S | N/S | ≤200 | N/S | N/S | ≤300 | ≤500 | ≤11 | ≤1.5 | ≤0.3 | ≤2 | ≤0.5 | ≤1.5 | N/S | ≤0.9 | N/S | N/S | ≤0.05 | N/S | ≤0.01 | N/S | ≤5 | ≤1 | N/S | N/S | |
| NBGW02 | 8.34 | 54.4 | 340 | 46.8 | 35.2 | 20.4 | 0.397 | 303 | 9.79 | -0.957 | 0.428 | -0.472 | -0.005 | -0.009 | -0.004 | 0.1 | 262 | 0.094 | -0.006 | 0.019 | -0.008 | -0.004 | -0.007 | 15 | -0.005 | 99[1] | 297 | 6.16 | 1.5 km southeast of BN |
| NBGW03 | 7.96 | 56.7 | 376 | 66.6 | 33.1 | 12.2 | 0.44 | 296 | 8.83 | 18.2 | 0.587 | -0.472 | -0.005 | -0.009 | -0.004 | 0.099 | 302 | 0.094 | -0.006 | 0.015 | -0.008 | -0.004 | -0.007 | 19.8 | -0.005 | 0.879 | 293 | 2.53 | 1.1 km southeast of BN |
| NBGW05 | 7.8 | 50.4 | 327 | 53.1 | 29.9 | 9.5 | 0.329 | 276 | 9.35 | 1.08 | 0.432 | -0.472 | -0.005 | 0.275 | 0.109 | 0.074 | 256 | 0.093 | -0.006 | 0.013 | -0.008 | -0.004 | -0.007 | 19.7 | -0.005 | 294 | 275 | 1.62 | 1km east of BN |
| NBGW06 | 7.8 | 30 | 250 | 34.7 | 17.9 | 7.05 | 0.359 | 176 | 4.58 | 1.82 | 0.705 | -0.472 | -0.005 | -0.009 | -0.004 | 0.072 | 161 | 0.097 | -0.006 | 0.012 | -0.008 | -0.004 | -0.007 | 26.9 | -0.005 | 0.799 | 175 | 1.04 | Upstream of BN |
| NBGW07 | 7.67 | 42.1 | 307 | 49.7 | 22.9 | 9.37 | 0.565 | 221 | 8.44 | 5.48 | 1.58 | -0.472 | -0.005 | -0.009 | -0.004 | 0.091 | 218 | 0.092 | -0.006 | 0.012 | -0.008 | -0.004 | -0.007 | 25.3 | -0.005 | 1.08 | 220 | 0.967 | Downstream of TSF |
| NBGW08 | 8 | 41.5 | 293 | 45.1 | 23.7 | 8.62 | 0.658 | 231 | 9.05 | -0.957 | 0.541 | -0.472 | -0.005 | -0.009 | -0.004 | 0.077 | 210 | 0.091 | -0.006 | 0.013 | -0.008 | -0.004 | -0.007 | 23 | -0.005 | 113 | 228 | 2.16 | Downstream of TSF |
| NBGW09 | 7.98 | 65.1 | 435 | 68.7 | 37.6 | 17.8 | 0.757 | 315 | 17.1 | 33.3 | 1.44 | -0.472 | -0.005 | -0.009 | -0.004 | 0.088 | 326 | 0.095 | -0.006 | 0.028 | -0.008 | -0.004 | -0.007 | 22.5 | -0.005 | 0.919 | 312 | 2.83 | Downstream of TSF |
| NBGW10 | 7.76 | 61.8 | 399 | 85.3 | 20.6 | 15.1 | 0.363 | 261 | 17.2 | 15.4 | 6.58 | -0.472 | -0.005 | -0.009 | -0.004 | 0.246 | 298 | 0.099 | -0.006 | 0.023 | -0.008 | -0.004 | -0.007 | 20.8 | -0.005 | 0.615 | 260 | 1.41 | Downstream of BN |
| NBGW12 | 7.76 | 78.1 | 492 | 86.3 | 45.1 | 14.8 | 0.394 | 437 | 15.3 | 10.1 | 0.426 | -0.472 | -0.005 | -0.009 | -0.004 | 0.067 | 401 | 0.086 | -0.006 | 0.02 | -0.008 | -0.004 | -0.007 | 18.8 | -0.005 | 0.677 | 435 | 2.35 | Downstream of PCD2 |
| NBGW13 | 8.1 | 66.1 | 439 | 58.3 | 46.7 | 13.5 | 0.588 | 356 | 9.59 | 15.9 | 0.622 | -0.472 | -0.005 | -0.009 | -0.004 | 0.068 | 338 | 0.087 | -0.006 | 0.02 | -0.008 | -0.004 | -0.007 | 27.4 | -0.005 | 1.09 | 351 | 4.16 | Upstream of BN |

[1] Grey blocks indicates water qualities exceeding SANS241 Guideline limits.

Figure 5-24 Booysendal North Mining Right Groundwater Monitoring Boreholes



- With regards to the organic and bacteriological content of the groundwater, SOG scans found organic compounds in all monitoring boreholes, while *E.coli* was found in boreholes NBGW06 and NBGW10. At this point in time no reasonable explanation can be provided for the occurrence of *E.coli* in the two abovementioned boreholes. Neither one of them are located near any form of a sewage treatment facility, which in a mining environment, is the main potential source of bacteria.
- The regional (baseline) groundwater monitoring boreholes are chemically and physically considered to be of good quality. The Ca, Mg and K content of groundwater from all three regional monitoring boreholes exceeded the WUL guideline concentrations. No significant change in concentration trends are evident.

Background groundwater quality for BS and BN cumulatively is indicated in Table 5-17.

Table 5-17 BS and BN Background Water Qualities

| Parameter | *Unit* | Booysendal North | Booysendal South |
|---|---|---|---|
| **Calcium** | mg/l | 60.0 | 150.0 |
| **Chloride** | mg/l | 100.0 | 50.0 |
| **Magnesium** | mg/l | 30.0 | 70.0 |
| **Nitrate** | mg/l | 3.0 | 3.0 |
| **pH** | pH | 5.9 – 8.7 | 7.0 – 8.7 |
| **Potassium** | mg/l | 10.0 | 10.0 |
| **Sodium** | mg/l | 90.0 | 30.3 |
| **Sulphate** | mg/l | 10.0 | 40.0 |
| **Total Dissolved Solids** | mg/l | 280.0 | 560.0 |
| **Faecal Indicator e.g E.coli** | CFU/100ml | 0 | 0 |
| **Total coliforms** | CFU/100ml | 10 | 10 |

### 5.9.4 Sensitivities

The Groot Dwars River drains towards the Olifants River which is considered one of the most polluted rivers in Southern Africa (Myburgh & Botha, 2009), it is therefore important to ensure that the upper catchment of this already stressed river system is monitored closely, and that impacts are mitigated and restricted. The Groot Dwars River is a FEPA system, which needs protection.

### 5.9.5 Ecosystem Services

Refer to Section 5.5.6 and Section 5.7.6.

## 5.10 Wetlands

The wetland assessment for the Phase 2 Project was undertaken by WCS, who also carried out the Phase 1 Project wetland assessment. The wetland assessment is included in Annexure I ("**WCS Wetland Assessment**").

### 5.10.1 Methodology

The WCS Wetland Assessment was carried out in the following phases:

#### 5.10.1.1 Information Collation

Baseline findings of the previous studies were collated. This provided an indication of gaps that had to be covered during the site visit. The National Freshwater Priority Areas dataset ("**NFEPA**") was again consulted to determine if there were any updates specifically applicable to the Phase 2 Project.

#### 5.10.1.2 Wetland Delineation

Wetlands within the Phase 2 Project Area were initially delineated using topographical maps, aerial imagery and orthophotos (1:10 000). The wetland boundaries were verified on site making use of indirect indicators of prolonged saturation, namely wetland plants and wetland soils. The wetlands were classified using a hydro-geomorphic classification, whereafter the present ecological state and ecological importance and sensitivity ("**EIS**") were determined based on wetland indicators.

#### 5.10.1.3 Reporting

The wetland reporting includes a description of the baseline conditions, an assessment of potential impacts, management and monitoring requirements. As with the other baselines studies, the WCS Wetland Assessment consolidated available wetland data for the Booysendal Operation to serve as a valuable planning tool going forward.

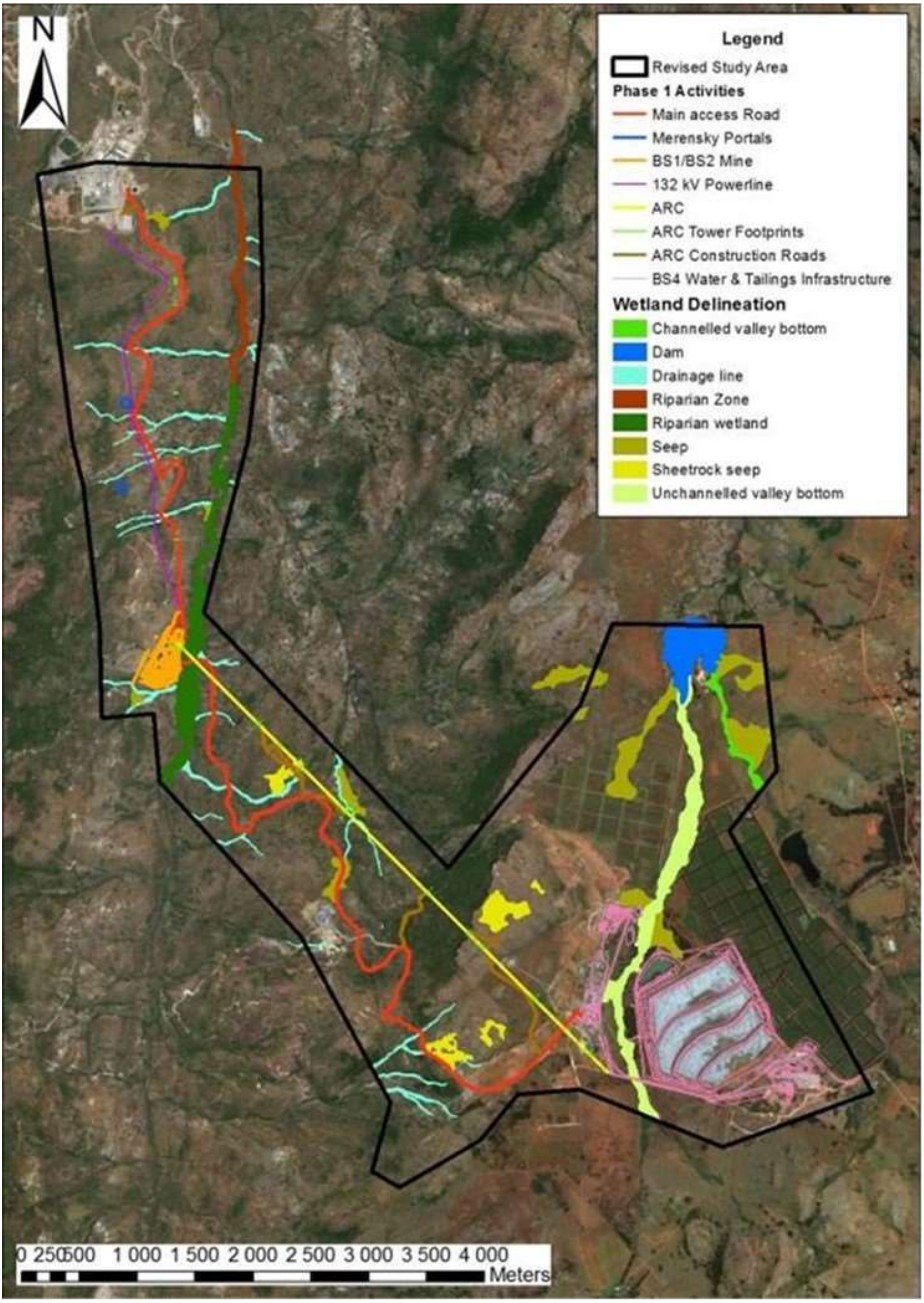
### 5.10.2 Wetland Baseline Findings

The wetlands within the Phase 2 Project Area falls in the Central Bushveld Group 1 (endangered) and the Mesic Highveld Group 7 (critically endangered) wetland vegetation types. In additional, all the wetlands are FEPA wetlands. WCS has identified 5 types of wetlands present in the Phase 2 Project Area. The distribution and percentage coverage of each of the wetland types are included in Table 5-18 and illustrated in Figure 5-25, Refer to Annexure I for detail around the various wetland types.

Table 5-18 Booysendal Operation Wetland Types (Source: WCS, 2018)

| **Wetland Type** | **Area_(ha)** | **% of wetland area** | **% of study area** |
|---|---|---|---|
| Channelled valley bottom | 4.69 | 3.24% | 0.25% |
| Un-channelled valley bottom | 32.31 | 22.35% | 1.73% |
| Riparian wetland | 24.36 | 16.85% | 1.31% |
| Riparian zone | 9.08 | 6.28% | 0.49% |
| Seep | 40.09 | 27.73% | 2.15% |
| Sheetrock seep | 10.84 | 7.50% | 0.58% |
| Drainage line | 23.30 | 16.12% | 1.25% |
| Total | 144.57 | 100.00% | 7.75% |

Figure 5-25 Booysendal Operation and Phase 2 Project Wetland Distribution (Source: WCS, 2018)



These wetlands can be described as an interconnected system of perennial and non-perennial drainage systems, perched sheetrock wetlands and valley bottom wetlands which are all connected to the larger Groot Dwars River. Most of the wetland areas and riparian systems are unmodified and in a natural condition providing habitat for a variety of protected and Red Data List (**"RDL"**) floral species such as *Eulophia ovalis*, *Catha transvaalensis* and *Merwilla plumbea*.

### 5.10.3 Wetland Present Ecological Status

Some of the smaller systems have been more heavily impacted where existing mining/construction activities has impacted on flow into wetlands.

Flow distribution and retention within some of the wetlands has also been impacted by linear infrastructure crossings, typically road crossings, which lead to flow concentration and accelerated erosion. Other impacts observed include alien vegetation, impoundments, increase in sedimentation and deterioration of water quality.

Notwithstanding the impacts, most of the wetlands, are largely natural to moderately modified with a PES category between B and C (refer to Table 5-19).

Table 5-19 Present Ecological Status of the Wetlands in the Phase 2 Project Area (WCS, 2018)

| Wetland Type | PES Category | | | | | TOTAL |
|---|---|---|---|---|---|---|
| | **B** | **B/C** | **C** | **C/D** | **D** | |
| Unchannelled valley bottom | | | 32.31 | | | 32.31 |
| Riparian wetland | 24.36 | | | | | 24.36 |
| Riparian Zone | 9.08 | | | | | 9.08 |
| Seep | 3.42 | | 2.52 | 12.91 | 8.32 | 27.17 |
| Sheetrock seep | 8.83 | | 2 | | | 10.83 |
| Drainage line | 11.36 | 5.01 | 6.31 | | 0.32 | 23 |
| TOTAL | 57.05 | 5.01 | 43.14 | 12.91 | 8.64 | 126.75 |
| Percentage | 45.01% | 3.95% | 34.04% | 10.19% | 6.82% | 100.00% |

### 5.10.4 Wetland Functionality and Ecosystem Services

The wetlands in the Booysendal Operation, including the Phase 2 Project Area plays an important role in:

- maintaining biodiversity;
- providing key habitats and contributing to the high biodiversity importance of the area;
- contributing run-off and water supply to the Groot Dwars River;
- maintaining water quality, sediment trapping and water purification function all contributing to improving or maintaining water quality; and
- flood control through wetlands retention capacity.

An assessment of the ecosystem services is included in Table 5-20.

Table 5-20 Wetland Functionality and Ecosystem Services

| ES Service | ES Category | Description | Additional Information (threats, availability) | Relevant Landscape | Importance of the ES | Replicability |
|---|---|---|---|---|---|---|
| Flood retention and sediment trapping | Regulating | Wetlands serve as flood attenuation and traps sediments | Wetland destruction leads to loss function | All wetlands | High | Medium |
| Biodiversity | Supporting | Wetlands provide assists in maintaining nutrient cycles and serve as important habitats | | All wetlands | High | Medium |
| Water supply | Provisional and Regulatory | Seepage from wetlands contributes to base flow maintenance | | All wetlands | High | Medium |

### 5.10.5 Ecological Importance and Sensitivity

The ecological importance **(**"**EI**") of wetlands are expressed as a function of its ability to maintain ecological diversity and functioning, while ecological sensitivity ("**ES**") is the ability of a wetland system to recover from disturbance. The EIS of the wetlands in the Booysendal Mine area in included in Table 5-21.

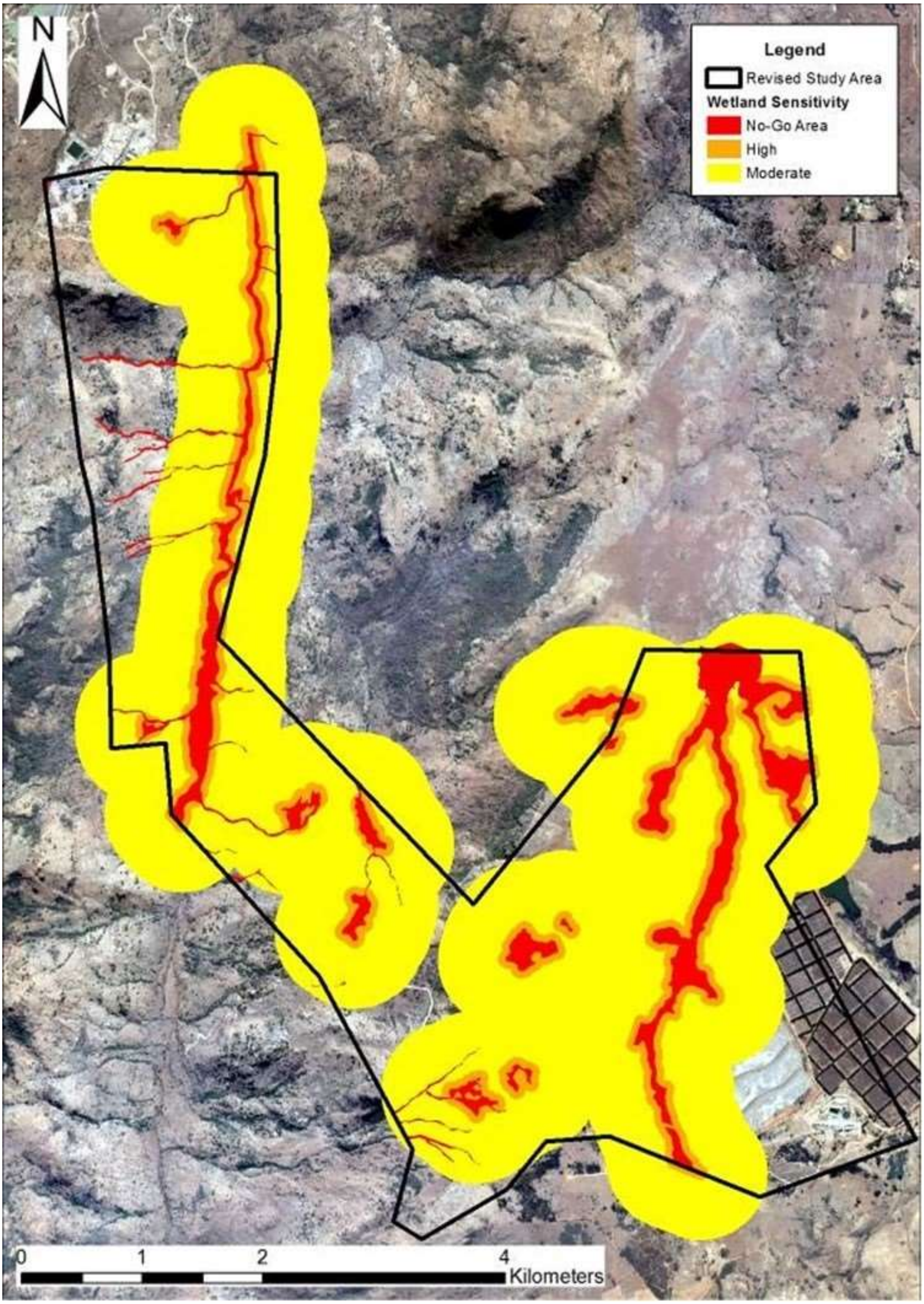
Table 5-21 Ecological Importance and Sensitivity of Wetlands in the Booysendal Mine Area (Source: WCS, 2018)

| Wetland Type | Importance & Sensitivity | | | Total |
|---|---|---|---|---|
| | High | Moderate | Low/Marginal | |
| Channelled valley bottom | 4.69 | | | 4.69 |
| Unchanneled valley bottom | 32.31 | | | 32.31 |
| Riparian wetland | 24.36 | | | 24.36 |
| Riparian zone | 9.08 | | | 9.09 |
| Seep | | 34.28 | 3.69 | 37.97 |
| Sheetrock seep | | 10.84 | | 10.84 |
| Drainage line | | 23.20 | | 20.90 |
| **TOTAL** | 61.36 | 66.02 | 3.69 | 142.45 |
| **Percentage** | 49.44% | 47.96% | 2.59% | 100.00% |

### 5.10.6 Wetland Sensitivities

The wetland habitat unit within the Phase 2 Project AoI falls in a FEPA system and is of high conservation importance, especially when the highly sensitive nature of the Groot Dwars River system and the high number of endemic species is taken into consideration. The sensitivity of the wetlands is indicated in Figure 5-26.

Figure 5-26 Wetlands Sensitivities



The buffer around wetlands according to GN 704 is 100m. However, for any activities taking place within 500m from a wetland a risk assessment must be undertaken to inform the need of a WUL. Because of the FEPA wetlands a WULA will be made to the DWS for all infrastructure components within 100m from wetlands. This application will form part of the IWULA.

## 5.11 Aquatic Ecology

Clean Stream undertook the initial Phase 1 Project aquatic biodiversity assessment ("**Clean Stream Aquatic Biodiversity Assessment**"). This Assessment was updated to include the Phase 2 Project activities.

### 5.11.1 Methodology

The methodology followed for the Clean Stream Aquatic Biodiversity Assessment included:

#### 5.11.1.1 Desktop Review

Previous aquatic biodiversity reports for the Booysendal Operation were reviewed to understand aquatic sensitivities, species abundance and diversity and existing impacts.

#### 5.11.1.2 Field Surveys

Three field surveys were carried out for the Booysendal South Expansion Project. The first two surveys were undertaken during the rainy season from 11 to 13 January 2016 and the second during the winter season 5 to 6 June 2017 as part of the Phase 1 Project. The aim of the latter study was to gain better insight into the distribution and presence of the IUCN Listed VU *Enteromius cf. motebensis* species. A follow-up Phase 2 Project survey was done in December 2017. The overall purpose of the study was to assess the PES, index of habitat integrity ("**IHI**"), macroinvertebrates, and fish species and fish response assessment index ("**FRAI**"). The surveys were carried out at potential receptor points in potentially affected rivers and streams and are representative of all development footprint areas. A description of the survey points and survey protocols undertaken at each point is included in Table 5-22. For a visual representation of the monitoring points, refer to Annexure J.

Table 5-22 Aquatic Biodiversity Field Survey Points

| Sub-reach | Sampling Site | Description | Coordinates | Sampling Protocols |
|---|---|---|---|---|
| **Sub-reach GD 1 (Upstream of BS1/2 and the bridge over the Groot Dwars River)** | US1 | Groot Dwars River upstream of BS3 | -25.165194° 30.116842° | Fish sampling |
| | US2 | | -25.160783° 30.116132° | |
| | Trib1 | Non-perennial tributary of the Groot-Dwars River overlying proposed mining at BS3 | -25.158520° 30.115486° | |
| | B0 | Groot Dwars River upstream of S24G activities and adjacent to proposed mining at BS3 | -25.155636° 30.116079° | SASS, fish, on-site water quality |
| | B0_A | Groot Dwars River upstream of S24G activities but downstream of proposed mining at BS3 | -25.152812° 30.117025° | Fish sampling |
| | B1A | | -25.150950° 30.116184° | SASS, fish, on-site water quality |
| | PS-US | | -25.139376° 30.117145° | SASS, fish, on-site water quality |
| | Bridge-US | | -25.136797° 30.118132° | Fish sampling |
| | GD-RC | | -25.129820° 30.119684° | SASS, fish, on-site water quality |
| | Trib2 | Near-perennial tributary of the Groot-Dwars River (may be affected by gravel roads to vent shafts at BS3) | -25.144808° 30.116973° | Fish sampling |

| | | | | |
|---|---|---|---|---|
| **Sub-reach GD 2 (Adjacent to and downstream of Phase 1 activities)** | Bridge DS | Immediately downstream of the bridge | -25.124790° 30.120071° | Fish sampling |
| | PS-DS | Downstream of the road crossing and the proposed mining at BS1/2 and the Southern Merensky Portal. This site is located adjacent to present activities at BS1/2. | -25.123105° 30.119828° | SASS, fish, on-site water quality |
| | PN-US | Downstream of the road crossing and proposed mining at BS1/2 and the Southern Merensky Portal and adjacent to a gravel road within the floodplain. This site is also located downstream of the Southern Tributary but upstream of the Waterfall Tributary and Everest tributary | -25.115644° 30.121357° | SASS, fish, on-site water quality |
| | GD2 | Downstream of most activities except for potential impacts from the northern portal (Waterfall Tributary) and the Tailings complex (via the Everest Tributary) | -25.108626° 30.122360° | SASS5, on-site water quality |
| **Sub-reach GD 3 (downstream of activities)** | B1 | Downstream of all activities, including potential impacts from the tailings complex, via the Everest Tributary. | -25.104202° 30.123396° | SASS, fish, on-site water quality |
| | B2 | The most downstream site in the study area, downstream of all activities, including potential impacts from the conveyor route to Booysendal North. | -25.095194° 30.122478° | SASS, fish, on-site water quality |
| **Everest Tributary E 1** | RC1 | Everest Tributary upstream of proposed activities associated with the tailings storage facility. | -25.161057° 30.172675° | SASS, fish, on-site water quality |
| | RC2 | Everest Tributary downstream of the haul road bridge | -25.157036° 30.173785° | SASS, fish, on-site water quality |
| | RC3 | Everest Tributary upstream of the TKO Dam | -25.134633° 30.161249° | SASS, fish, on-site water quality |
| | E1 | Everest Tributary downstream of the TKO dam. This site receives impacts from existing infrastructure associated with Everest Mine and is located downstream of the proposed new tailings storage facility at BS4. | -25.123718° 30.160772° | SASS, fish, on-site water quality |
| | E3 | Everest Tributary upstream of the confluence with Groot Dwars River. This site will be used as a biomonitoring site to assess the impact of this tributary on the Groot Dwars River. | -25.107026° 30.127369° | SASS, fish, on-site water quality |
| **Southern Tributary** | S-Trib | This non-perennial tributary may be impacted by road construction as well as the ARC connecting BS1/2 and BS4 | -25.116726° 30.124818° | On-site water quality |
| **Waterfall Tributary** | WF-US1 | Waterfall tributary 300m upstream of bridge crossing. | -25.107194° 30.111525° | Fish sampling |
| | WF-US2 | Waterfall tributary directly upstream of bridge crossing. | -25.107581° 30.114049° | |
| | WF-Trib | Lower reaches of Waterfall tributary (downstream of waterfalls) is impacted by construction of the main access road between BS1/2 and BN as well as by the proposed northern portal. The sampling site is located between Booysendal activities and the confluence with the Groot Dwars River | -25.107845° 30.119745° | SASS, fish, on-site water quality |
| **Central Trib** | C-Trib | Wetland draining immediately south of construction activities at BS1/2 | -25.130958° 30.118368° | water quality (Salinity and Turbidity) |

Methodology to Determine Ecostatus (PES and IHI): The ecostatus of the river system was determined by assessing the PES and IHI. The methodology used to determine the PES is the River Eco-Classification for Reserve Determination. The IHI for the various surveyed reaches considered water abstraction, flow modification, bed modification, channel modification, inundation, water quality, exotic macrophytes, solid waste, indigenous vegetation removal, exotic vegetation presence and bank erosion. The classification categories for PES and IHI is included in Table 5-23.

Water Quality: A probe was used to determine in-situ water quality for EC, pH, dissolved oxygen, oxygen saturation, and temperature to understand the baseline and potential ecological responses which may result from a change in the baseline.

Table 5-23 Present Ecological Status Classes (Clean Stream, 2018)

| CATEGORY | BIOTIC INTEGRITY | DESCRIPTION OF GENERALLY EXPECTED CONDITIONS |
|---|---|---|
| A | Excellent | Unmodified, or approximates natural conditions closely. The biotic assemblages compare to that expected under natural, unperturbed conditions. |
| B | Good | Largely natural with few modifications. A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modifications. Most aspects of the biotic assemblage as expected under rural unperturbed conditions. |
| C | Fair | Moderately modified. A lower than expected species richness and presence of most intolerant species. Most of the characteristics of the biotic assemblages have been moderately modified from its naturally expected condition. Some impairment of health may be evident at the lower end of this class. |
| D | Poor | Largely modified. A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderately intolerant species. Most characteristics of the biotic assemblages have been largely modified from its naturally expected condition. Impairment of health may become evident at the lower end of this class. |
| E | Very Poor | Seriously modified. A strikingly lower than expected species richness and general absence of intolerant and moderately tolerant species. Most of the characteristics of the biotic assemblages have been seriously modified from its naturally expected condition. Impairment of health may become very evident. |
| F | Critical | Critically modified. Extremely lowered species richness and an absence of intolerant and moderately tolerant species. Only intolerant species may be present with complete loss of species at the lower end of the class. Most of the characteristics of the biotic assemblages have been critically modified from its naturally expected conditions. Impairment of health generally very evident. |

Aquatic Macroinvertebrates: Aquatic Macroinvertebrates were assessed using the South African Scoring System ("**SASS5**") methodology to assess river health and water quality. The relative abundance and diversity of sensitive taxa provides an indication of a healthy system with good water quality.

Fish Assessment: The fish assessment considered the habitat composition and fish assemblage. Habitats were assessed according to different attributes to satisfy habitat requirements for various fish species based on the Habitat Cover Rating method. At each site electrofishing was done to determine the FRAI classes.

#### 5.11.1.3 Reporting

The Clean Stream Aquatic Biodiversity Assessment was developed as a consolidated baseline aquatic biodiversity report for the Booysendal Operation, also indicating the Phase 2 Project baseline and impacts.

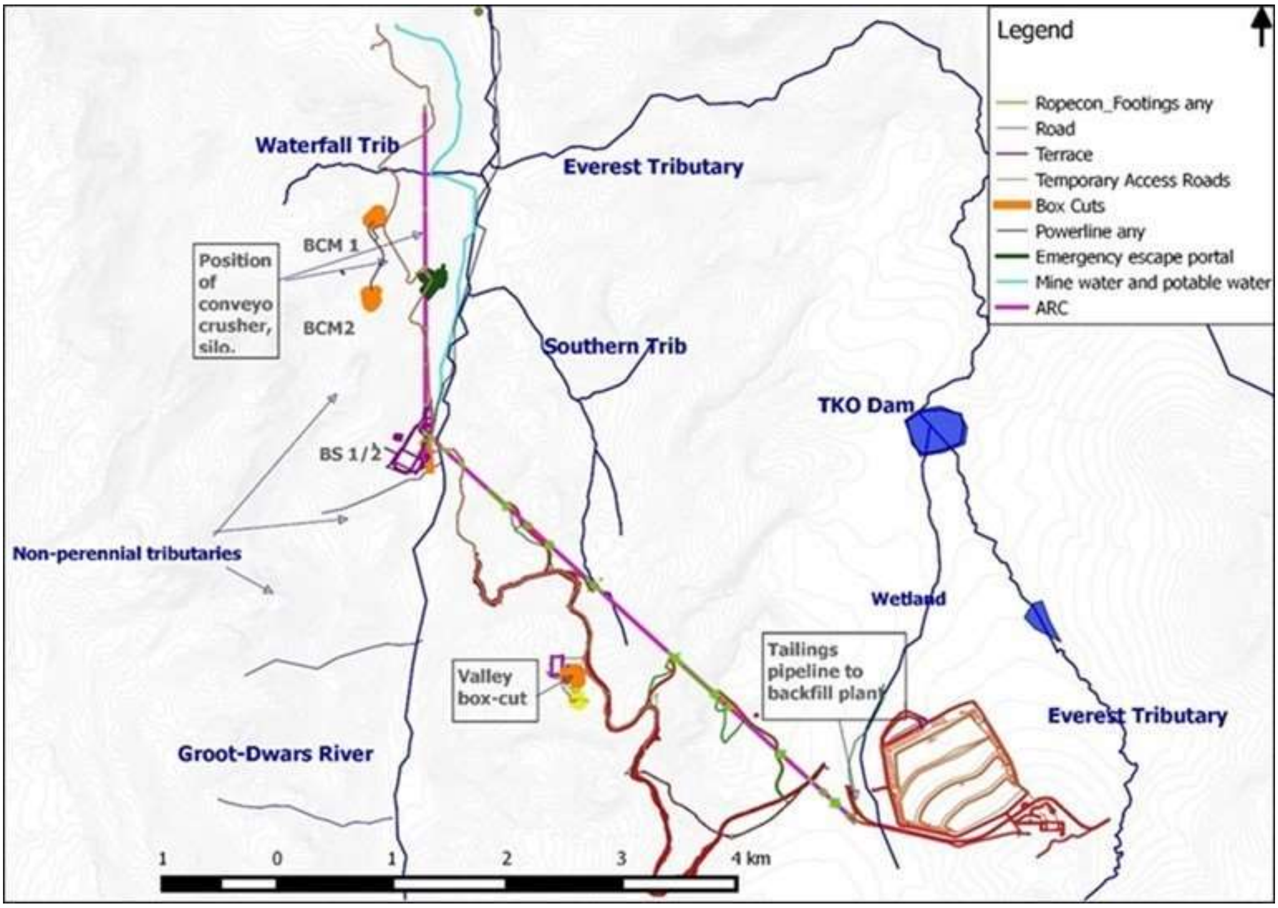
### 5.11.2 Aquatic Baseline

The Aquatic Biodiversity Study focussed on all potentially affected streams ant tributaries (refer to Figure 5-27).

#### 5.11.2.1 Ecological Importance and Sensitivity

The EI of the system to maintain biological diversity and ecological functioning was assessed to be HIGH. The ES (capacity of the system to resist disturbance and recover) was also assessed as being VERY HIGH.

Figure 5-27 Streams and Rivers within the Phase 2 Project Area of Influence (Source: Clean Stream, 2018)




### 5.11.3 Ecological Water Quality

Study findings indicates evaluated, indicated that there is a gradual increase in salinity downstream in the Groot Dwars River and Everest tributary. Turbidity was also visibly higher with a measured suspended solid spike from 11 to 210mg/l between August and December 2016 at BS1/2. Aluminium levels also at times exceeded the guideline limits for aquatic ecosystems in the Everest tributary. Salinity in the Waterfall tributary, where road construction is taking place, the tributary at BS1/2 where portal and terrace development is taking place and in the Everest tributary at BS4 were elevated.

### 5.11.4 Habitat Integrity

#### 5.11.4.1 Wider Area

The DWS (2014) desktop assessment considers the affected sub-quaternary reach ("**SQR**") in which the Booysendal Operation is located to be a Category C (Moderately Modified). However, the PES ranges from a PES A/B (Pristine to Largely Natural) in the upper reaches, upstream of mining activities, to a Category C (Moderately Modified), upstream of Der Brochen Dam but downstream of the de Kaffersspruit from BS4, to a

Category C-D (Moderately Modified to Largely Modified), downstream of Der Brochen Dam and various mining activities to the north.

The EI of the sub-quaternary catchment reach is rated as high (DWS, 2014). This is attributed to a variety of factors including:

- Very high invertebrate taxa rarity;
- Moderate fish species rarity;
- Very high habitat diversity; and
- Very high degree of natural riparian/ wetland vegetation.

The ES of the SQR was rated as very high. This was attributed to a variety of factors including the very high levels of sensitivity of the expected fish and aquatic macroinvertebrate communities to flow modifications and impacts on water quality.

#### 5.11.4.2 Phase 2 Project Area

The Clean Stream Aquatic Biodiversity Assessment found that the PES of the upper reaches of the Groot Dwars River was pristine to largely natural (Category A/B). The riparian habitat was also Largely Natural (Category B). The habitat integrity of the upper reach therefore has experienced limited impacts.

The integrity of the habitat in the middle reach of the Groot Dwars River (BS1/2) has been modified by the Section 24G EA activities and notably by the construction of the bridge and associated impacts on the wetland areas, resulting in a decrease of the habitat integrity and riparian habitat to Category C.

The habitat integrity downstream where the Waterfall and Everest tributary runs into the Groot Dwars River has also deteriorated because of the Phase 1 Project activities to a Category C (moderately modified). The habitat integrity of the Everest tributary has also deteriorated from Category B to Category C. The impact of the habitat integrity of the other streams surveyed were of lesser significance.

### 5.11.5 Aquatic Macroinvertebrates

The macroinvertebrate assemblage in the upper reaches of the Groot Dwars River, as well as the Everest tributary, include several taxa that are highly sensitive to changes in water quality, flow and habitat (e.g. *Psephenidae, Helodidae, Athericidae, Perlidae, Elmidae* and *Helodidae*) (Clean Stream, 2017). In general, the upper reach of the Groot Dwars River, upstream of the East Stream tributary, was considered to be more natural (Category B-C, Largely Natural to Moderately Modified), in terms of aquatic macroinvertebrates, than the lower reach, downstream of Der Brochen Dam and mining activities in the north, where the PES was, in general, classified as Category D (Largely Modified).

The baseline of Groot Dwars River indicates that Average Score Per Taxon ("**ASPT**") is 6.0 - 6.6 and the SASS score 114 to 149. The upper reaches of the Groot Dwars River, has been classified as pristine (ASPT 6.4 and SASS 180). A total of 28 taxa was recorded, many of which are sensitive to water quality change. The change in SASS scores over time for an upstream (B0) point to downstream (B1) of the Booysendal Operation is presented in Table 5-24.

Table 5-24 SASS Scores Trends (Clean Stream, 2017)

| | August 2015 | January 2016 | January 2017 |
|---|---|---|---|
| **SASS Score B0** | 185 | 150 | 151 |
| **SASS Score B1** | 152 | 123 | 99 |

The Everest tributary, which flows into the Groot Dwars River upstream of Der Brochen Dam, was sampled on the plateau upstream of the haul road to BS4. Here, there was a relatively high prevalence of sensitive taxa (such as stoneflies and more than two species of baetid mayfly), in response to good water quality. However, habitats have been compromised by a failed dam, upstream of the study area, resulting in a lower than expected diversity. Further downstream, downstream of BS4 activities as well as the TKO dam, the PES declined to a Category D-E (Largely to Seriously Modified), with a very low diversity of taxa recorded and an absence of sensitive taxa. It seems, therefore, that activities associated with BS4 tailings complex and associated infrastructure, have contributed to a decline in water quality within the Everest tributary. Based on past water quality monitoring data), the main contaminants are nutrients. The ASPT and SASS scores in the streams have deteriorated from upstream to downstream since 2016. The downstream site indicated an absence of sensitive species (*Heptageniidae* and *Athericidae*) which were found prior to 2016.

The Macro Invertebrate Response Index ("**MIRAI**"), which provides an indication of habitat modification and species diversity, confirms the good water quality and habitat suitability within the upstream reach, upstream of the road crossing of the Groot Dwars River. There was a gradual decline in the MIRAI score (see Table 5-25) in a downstream direction with the most downstream reach classified as Category C (Moderately Modified). Habitat and water quality were considered the most important drivers of macro-invertebrate assemblage patterns within these reaches.

Table 5-25 Macroinvertebrate Response Assessment Index

| | Groot Dwars River | | | |
|---|---|---|---|---|
| | **Upstream reach** | **Middle reach** | **Downstream reach** | **Everest Tributary** |
| **FLOW MODIFICATION** | 79.4 | 80.9 | 64.0 | 67.3 |
| **HABITAT** | 73.5 | 66.4 | 58.7 | 86.1 |
| **WATER QUALITY** | 80.2 | 80.2 | 63.7 | 71.4 |
| **INVERTEBRATE Ecological Category Score** | 78.7 | 77.8 | 63.9 | 73.8 |
| **INVERTEBRATE ECOLOGICAL CATEGORY** | **B/C** | **C** | **C** | **C** |

### 5.11.6 Fish

A significant amount of historical studies has been around Phase 2 Project Area since 2001. The results of the studies indicate that there are at least eleven indigenous species present in the various reaches on the study area and one alien species (*Cyprinus carpio*) (refer to Table 5-26).

Table 5-26 Fish Species in the Booysendal Mine Operational Area (Clean Stream, 2017)

| **Period** | 2001/02 | 2007 | 2008 | 2011/12 | 2012/13 | 2016 |
|---|---|---|---|---|---|---|
| **Source** | (RauEcon) | Nepid | CSBS | SAS | SAS | TBC |
| **Zone** | GD3 | Groot Dwars (BS4) | Groot Dwars downstream of study area. | E1 (RC1, TKO Dam) | GD1(B0, B1) | Upper reaches of Groot Dwars |
| *Amphilius uranoscopus* | X | X | | | | X |
| *Enteromius anoplus* | | ? | | | | |
| *Enteromius neefi* | X | X | X | | X | X |
| *Enteromius cf. motebensis* | | | | | | X |
| *Enteromius trimaculatus* | X | | X | | | |
| *Labeobarbus marequensis* | X | X | X | | X | |
| *Chiloglanis pretoriae* | X | X | X | | X | |
| *Clarias gariepinus* | X | | X | X | | |
| *Labeo cylindricus* | X | | X | | | |
| *Labeo molybdinus* | | | X | | | |
| *Oreochromis mossambicus* | X | | X | | | |
| *Tilapia sparrmanii* | X | | X | X | X | X |
| *Cyprinus carpio** | | | | X | | |
| **Total number of indigenous species** | 9 | 5 | 9 | 2 | 4 | 4 |
| **Total number of alien species** | | | | 1 | | |

Four species which are intolerant to change including: *E. cf. motebensis, E. neefi, L. cylindricus and L. molybdinus.*

The *Labeobarbus marequensis, Labeo* species and *Clarias gariepinus* are migratory species that require free movement to complete their life cycle.

The headwaters of the Groot Dwars River constitute critical habitat for the small minnow species *Barbus motebensis* (Marico barb) who prefers slow flowing pools. This species is currently listed as vulnerable (**"VU"**) on the IUCN Red List of Threatened Species. The international standard - IFC Performance Standard 6 - recognises areas associated with key evolutionary processes as critical habitat. Based on this definition, the upper reaches of the Groot Dwars River may therefore comprise critical habitat for a genetically distinct population of *B. motebensis*.

*Oreochromis mossambicus* (Mozambique tilapia), a fish species that is listed as near threatened (**"NT"**) on the IUCN Red List was recorded abundantly in the Groot Dwars River within the vicinity of BN. This species is likely to qualify for a threatened category within the near future (IUCN, 2016). The most serious threat facing *O. mossambicus* is hybridization with the rapidly spreading introduced species *Oreochromis niloticus* (Nile tilapia) (IUCN, 2016).

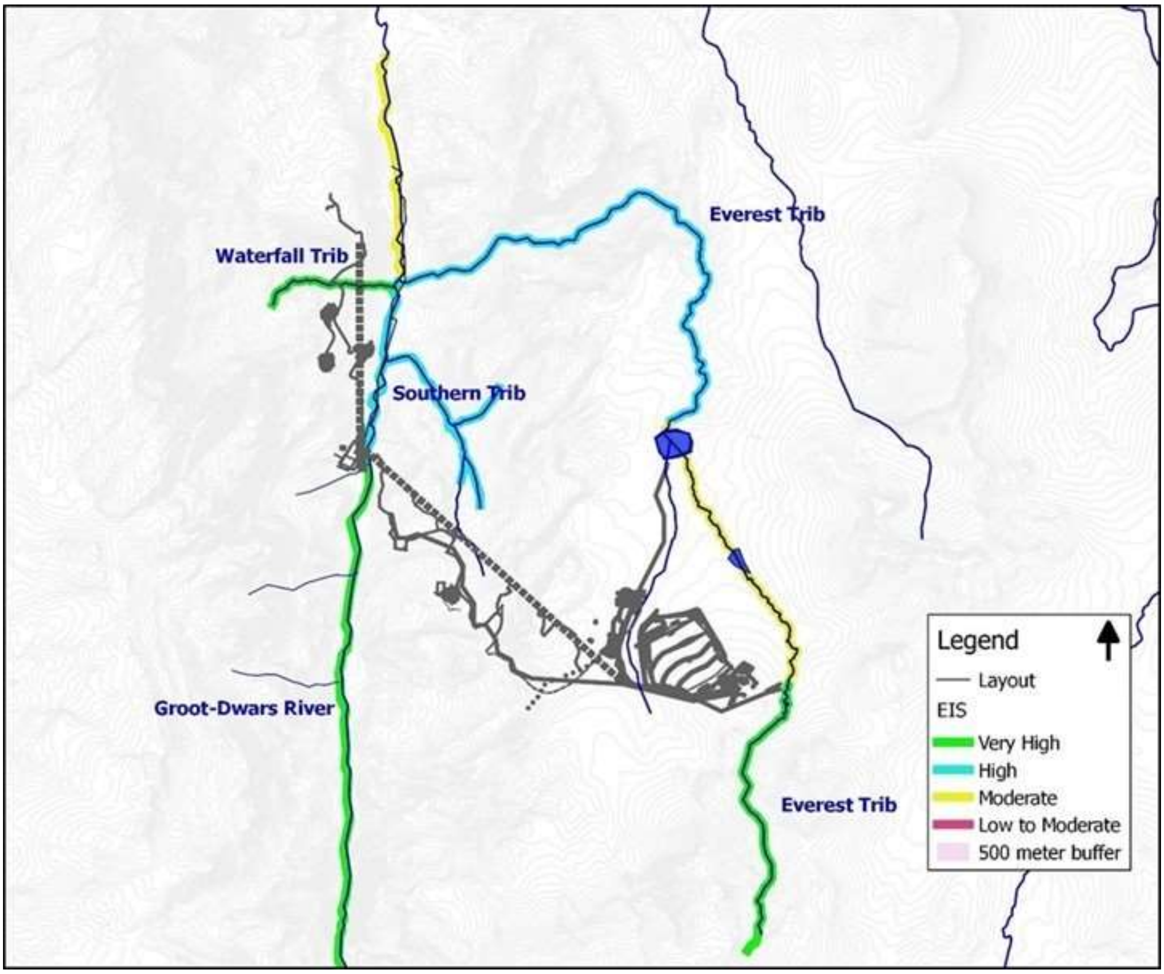
Two fish species that are highly sensitive to changes in flow, habitat (cobbled substrates) and water quality have been recorded within the Phase 2 Project Area (TBC 2016). The fish species, *Amphilius uranoscopus* and *Chiloglanis pretoriae*, are most at risk from construction and mining activities. As dust and eroded sediment are deposited within the Groot Dwars River, cobbled substrates will be altered and water quality will decline.

Very little fish data is available for the Everest tributary. It is expected that species moderately intolerant to changes in flow, habitats and water quality are likely to be present in the upper reaches of this stream (i.e. upstream of the TKO Dam). However, the alien invasive fish species, *Cyprinus carpio* (the common carp), has been recorded in the TKO Dam, downstream of BS4 (TBC, 2016). This species causes habitat destruction by means of its feeding behaviour in the bottom sediments, thereby also increasing turbidity levels.

### 5.11.7 Sensitivities

Clean Stream developed a sensitivity map based on the characteristics of the various reaches applicable to the Phase 2 Project (see Figure 5-28). Activities in the <u>Very High</u> sensitivity reaches must be avoided.

Figure 5-28 River and Stream Sensitivity Classification (Source: Clean Stream, 2018)




The upper reaches of the Groot Dwars River catchment which serves as habitat to the *Barbus motebensis* together with its associated slow flowing pool habitats are considered especially should not be disturbed.

The FEPA guideline recommend that a 1km buffer must be maintained around FEPA systems.

The presence of alien species within the system presents a threat to the sensitive system.

### 5.11.8 Ecosystem Services

Clean Stream identified the following ecosystem services:

- Provisioning: water mainly for drinking, harvesting of medicinal plants along the riparian zone and fishing; and
- Supporting services: especially where water supports sensitive aquatic species, aquatic life, wetlands, vegetation, fauna etc.

## 5.12 Terrestrial Ecology

The terrestrial ecology assessment for the Phase 2 Project was done by NSS ("**NSS Terrestrial Ecology Assessment**"), who was also responsible for sections of the Phase 1 Project. Annual follow-up studies on the *Pycna Sylvia* is undertaken by D.J. Stephens.

### 5.12.1 Flora Study Methodology

The purpose of the flora survey was to determine the structure, dominant species composition and condition of local floral communities situated within the Project Area. The assessment was conducted using the following methods:

#### 5.12.1.1 Desktop Assessment

The desktop assessment included an investigation into the regional vegetation and the conservation importance of the site. For this purpose, various national sources were consulted, including amongst others, the Mpumalanga Biodiversity Section Plan, 2013 ("**MBSP**"), species of Conservation Importance ("**CI**") from records sourced from the Plants of Southern Africa website, the online South African National Botanical Institute's ("**SANBI**") Threatened Species Programme list, species lists supplied from the Mpumalanga Parks and Tourism Agency for farms in the QDS 2530AA and the Botanical database of Southern Africa ("**BODATSA"**). Various specialist studies conducted over time for BS and BN were also consulted in support of the baseline assessment.

#### 5.12.1.2 Field Surveys

NSS performed field fauna and flora surveys for BS4 during the periods 9 to13 January 2017 and 23 to 26 January 2017, during 22 to 25 May (fauna) and 24 to 28 May 2017 (flora) for additional infrastructure associated and from 12 to 15 December 2017 for the Phase 2 Project. In addition to this, NSS also drew on previous field survey data undertaken by them for the BS4 Hoogland Project which was carried out during 23 to 25 April 2014, 25 to 27 August 2014 and 18 to 23 November 2014. The field survey information was further supplemented by the findings from the Ecofin study for which surveys were carried out from 8 to 11 February 2016 (flora), and 4 to 8 March 2016 (fauna).

The following methodologies were used in carrying out the flora field surveys as noted in the NSS Terrestrial Ecology Assessment report:

- Sampling of vegetation plots to determine the spatial extent, structure, condition and dominant species composition of different floral communities in the Phase 2 Project Area. Sampling plot size was standardised at 100m$^2$. Whilst a plot was sampled, a list of plant taxa was compiled and each taxon was assigned a cover-abundance estimate using the Braun-Blanquet approach" which also provided as output of common or dominant species;

- Walking random transects to detect localised and CI (i.e. Red Listed, endemic, Protected and medicinal) plant species;
- Recording any observed alien and invasive plant species on site for incorporation into a management plan; and
- Opportunistic counting, and GPS logging of *Vitex obovate wilmsii* which are associated with the endemic *Pycna Sylvia.*

The flora sampling plots are included in Figure 5-29.

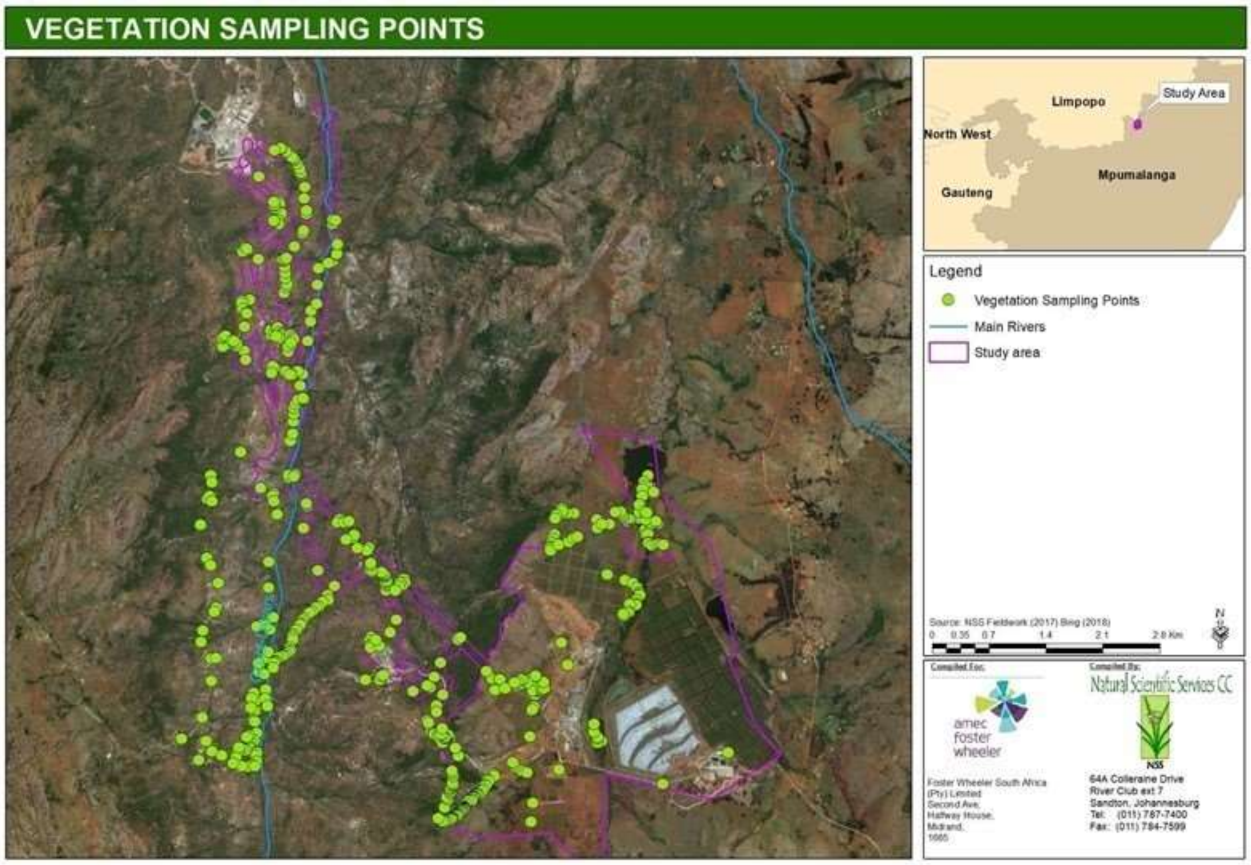
#### 5.12.1.3 Flora Data Analysis

For the analysis of flora survey data, the Juice software program was used to conduct a TWINSPAN detrended correspondence analysis and a Braun-Blanquet analysis to assess cover abundance and to determine the proximity of relationships between sample entities. For detail please refer to Annexure K1.

#### 5.12.1.4 Reporting

The reporting process included the regional and local floral communities, floral species, species of Conservation Importance, impacts on floral species and communities, management and monitoring requirements, and residual impacts.

Figure 5-29 Vegetation Sampling Plots (Source: NSS, 2018)



### 5.12.2 Fauna Study Methodology

#### 5.12.2.1 Desktop Assessment

The desktop assessment was carried out simultaneously with the flora assessment (see Section 5.12.1.1)

#### 5.12.2.2 Field Surveys

The faunal surveys were carried out during the same periods as the floral surveys. Survey techniques included:

- Identification of fauna based on visual observations of fauna, spoor, droppings, burrows and any other evidence. Birds were identified based on their calls, direct sightings and flight behaviour. Herpetofauna and scorpions were searched for by inspecting rock crevices and overturning or rocks and logs;
- Sweep-netting was carried out to catch butterflies, damselflies and dragonflies;
- Live trapping was done at four sites using array traps with pitfall traps at the centre, specifically aimed at reptiles, amphibians, and terrestrial macro-invertebrates. Fourteen metal mammal traps consisting of multi-entry and Sherman traps were also placed in the areas of the array traps aimed tat rodents;
- Grab samples;
- Camera-trapping through motion sensitive cameras installed at 13 locations at BS used to identify vertebrates and specifically nocturnal carnivores;
- Mist netting and acoustic bat trapping: Mist nets were erected at two areas for two survey days; and
- An ultra-sonic Echo Meter 3 detector was used to record caught bat’s echolocating calls. Calls were also recorded while driving at slow speed.

#### 5.12.2.3 Fauna Data Analysis

Bat calls were analysed through the conversion of the calls to wave and zero crossing files which then allowed for further examination of peak frequencies duration and band width to assist in the identification of bats.

The location of species encountered was analysed against he various databases and the location of proposed infrastructure.

#### 5.12.2.4 Reporting

The NSS Terrestrial Biodiversity Assessment report contains the findings of the fauna and flora assessments in the Phase 2 Project Area, including a description of sensitive species, assessment of potential impacts and recommendations on mitigation, management and monitoring. For details on methodology, refer to Annexure K1.

### 5.12.3 *Pycna sylvia* Methodology

The mine has appointed RD Stephens to undertake annual surveys and monitoring of the *Pycna sylvia* to gain a better understanding of this data deficient species. The field investigation was undertaken in November 2017 and a report produced providing a summary of previous years findings against the 2007 findings. The reason why the survey was undertaken in November is that it is the optimal time when the *Pycna sylcia* emerges annually. The 2017 *Pycna sylvia* report is included in Annexure K2.

### 5.12.4 Baseline General

The unique characteristics of vegetation in the Phase 2 Project Area is a direct result of specific environmental conditions. The variations in have contributed to specific micro-climatic conditions with greater moisture and higher temperatures in the valleys generally giving rise to bushveld vegetation and drier and cooler conditions on the plateaus with grassland vegetation. This in turn results in the development of habitats to which specific fauna species have adapted. The grassland ecosystem is associated with high biodiversity, of which a very small portion is currently formally protected. The underlying geology and associated soil layers originating from its geology, specifically the ultramafic rock, has contributed to the plant endemism.

### 5.12.5 Baseline Flora

#### 5.12.5.1 Regional Flora

The Phase 2 Project is set to occur in the SCPE. The Phase 2 Project activities associated with Booysendal North MR fall within the Sekhukhune Mountain Bushveld while the Booysendal South MR Phase 2 Project activities fall in the Sekhukhune Montane Grassland Biomes of the SCPE. Due to BS4's closeness to the Lydenburg Montane Grassland it has ecotone characteristics. The characteristics of the vegetation types and its conservation status are given in Table 5-27.

Table 5-27 Characteristics of the Vegetation Types applicable to the Phase 2 Project (Source: nss, 2018)

| Vegetation Type | Structure | Topography | Endemic Species | Status | Threats |
|---|---|---|---|---|---|
| **Sekhukhune Montane Grassland** | Dense grassland on rocky slopes and boulder fields, with scattered dense thickets on sheltered rocky outcrops | Steep hillsides and deep river valleys, with occasional level plains and plateaus (altitudinal range: 1,300 – 1,960 mabl | High proportion to the SCPE and four endemics to vegetation type. | Vulnerable and Endemic to Mpumalanga Conservation target of 24%. | Mining operations. |
| **Sekhukhune Mountain Bushveld** | Open to closed microphyllous and broad-leaved savanna, often with a well-developed herb layer. | Steep hillsides and mountain slopes, as well as gentle foot slopes. | High proportion to the SCPE and three endemics to vegetation type | Least Threatened | Increasing pressure from mining developments. |
| **Lydenburg Montane Grassland** | Dense grassland characterised by high species richness of forbs | High-altitude plateaus, undulating plains, mountain peaks and slopes, and deep valleys (altitude range up to 2,330 masl | High proportion to LCPE and 25 endemic to vegetation type | Vulnerable and Endemic to Mpumalanga | Commercial afforestation |

#### 5.12.5.2 Regional Flora Diversity

The SANBI PRECIS list indicates that there are 450 plant species in the quadrant where the Phase 2 Project is located. The dominant families include: *Asteraceae, Poaceae, Fabaceae* and various herb species. The vegetation is a result of the unique combination of topography, geology and resulting soil forms and climate. Refer to Annexure K for dominant plant family representation.

#### 5.12.5.3 Local Habitats and Floral Communities

The following five broad habitats were identified by NSS from at least 78 sampling points in the wider Booysendal South Expansion Project area:

- Bushveld Thicket;
- Riparian Wetland;
- Grassland;
- Rocky Outcrop and Boulders; and
- Transformed areas.

Within the habitats types, 16 floral communities were identified. A summary description of the habitat types and flora communities present in the wider Booysendal Mine area is summarised in Table 5-28. The distribution of the habitats can be seen in Figure 5-30.

Table 5-28 Booysendal Phase 1 and Phase 2 Habitat Types and Floral Communities (Source: NSS, 2017)

| Flora Community | National Importance | Species Diversity | Condition [2] |
|---|---|---|---|
| **Rocky Outcrop, Sheet Rock and Boulder Habitat Type** | | | |
| ***Aloe-Myrothamnus* Shrub Sheetrock Community**<br>**>90% Rock Cover**<br>**Six conservation important (CI) species or areas** | Mpumalanga -Critical Biodiversity Area<br>Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>North Eastern Escarpment Priority Area. | Diverse species composition.<br>Large succulent component<br>Irreplaceable. | No transformation was evident during the surveys.<br>Weedy species are rare.<br>The flora community is stable and has a strong association with Sheet Rock Seeps – resulting in a unique species assemblage. |
| ***Searsia- Diospyros - Rhoicssus***<br>**70 – 80% Rocky outcrops**<br>**Five CI or CI-areas** | Within De Berg Conservancy (DPNR) Buffer<br>Highest Biodiversity Importance (MBGs)<br>Sekhukhune Mountainlands Threatened Ecosystem<br>North Eastern Escarpment Priority Area. | Sensitive to change<br>High floral diversity<br>Irreplaceable. | Surrounding agricultural activities and grazing pressure.<br>Limited alien and invasive species present.<br>Relative intact community. |
| ***Brachiaria - Tristachya***<br>**70 – 80% Exposed Rock**<br>**Transition between Sekhukhune Montane** | Within De Berg Conservancy (DPNR) Buffer<br>Highest Biodiversity Importance (MBGs) | Proportionately high species diversity and irreplaceable community. | Transformation limited to road construction for the ARC. |

[2] Condition based on latest site survey information.

| Flora Community | National Importance | Species Diversity | Condition [2] |
|---|---|---|---|
| **Grassland and- Mountain Bushveld**<br>**Four CI or CI-areas** | Sekhukhune Mountainlands Threatened Ecosystem<br>North Eastern Escarpment Priority Area. | | Weedy species are scarce and community is considered stable.<br>Surrounding grazing pressures on these systems.<br>Limited Alien species present. |
| | **Woodland and Thicket Habitat Type**<br>**Located at the base of Cliff and Kloof valley** | | |
| ***Mashishingia - Vitex - Kirkia***<br>**Rocky Thicket Community**<br>**25-30% vegetation cover**<br>**Six CI or CI-areas** | Within De Berg Conservancy (DPNR) Buffer<br>Highest Biodiversity Importance (MBGs)<br>Mpumalanga - Critical Biodiversity Area<br>Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>North Eastern Escarpment Priority Area. | Moderate to high species diversity.<br>Sensitive to change<br>Difficult to rehabilitate, therefore deemed irreplaceable. | General fragmentation associated with valley activities.<br>Clearance for road network and tower/ pylon footprints was taking place<br>Dumping of topsoil on adjacent vegetation<br>Some weedy species<br>Non-impacted areas stable. |
| ***Acacia - Euclea- Hippobromus***<br>**Scolopia Thicket Community**<br>**30-40% land cover**<br>**Four CI or CI-areas** | Within De Berg Conservancy (DPNR) Buffer Highest Biodiversity Importance (MBGs)<br>Mpumalanga - Critical Biodiversity Area<br>Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>North Eastern Escarpment Priority Area. | Moderate species diversity<br>Still sensitive to change<br>Long term invested rehabilitation for damaged areas. | Limited transformation associated with clearance of access roads for the ARC.<br>Some weedy species are present.<br>Community considered stable. |
| ***Protea - Themeda***<br>**Slope Open Woodland**<br>**40-50% under canopy**<br>**Five CI or CI-areas** | Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>Highest Biodiversity Importance (MBGs)<br>Within De Berg Conservancy (DPNR) | Moderate to high species diversity<br>Sensitive to change<br>Long term invested rehabilitation for damaged areas. | Almost Intact, although road clearance and construction is planned.<br>Erosion because of prospecting roads – rehabilitation is required<br>Community still stable. |

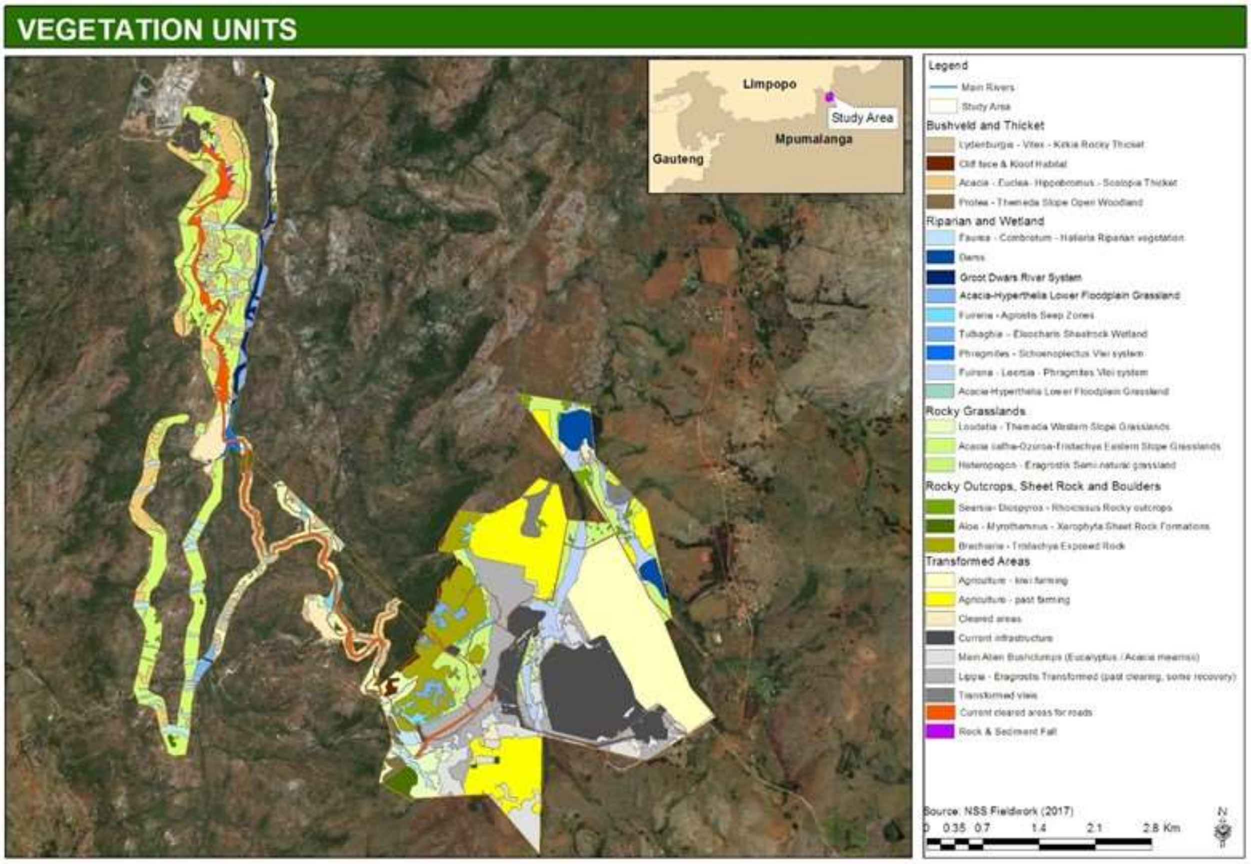
| Flora Community | National Importance | Species Diversity | Condition [2] |
|---|---|---|---|
| | Buffer North Eastern Escarpment Priority Area. | | |
| **Cliff Face and Kloof Habitat** | Could not be surveyed for safety reasons and poor accessibility. It is not expected that this habitat will be impacted | | |
| | **Rocky Grassland** | | |
| ***Loudetia - Themeda* and *Acacia caffra - Ozoroa - Tristachya*** <br> **Slope Grassland Communities** <br> **40-50% flora cover with rock** <br> **Four CI or CI-areas** | Sekhukhune Mountainlands Threatened Ecosystem <br> Mpumalanga Mesic Grasslands Focal Area <br> Highest Biodiversity Importance (MBGs) <br> Within De Berg Conservancy (DPNR) Buffer <br> North Eastern Escarpment Priority Area <br> Mpumalanga -Critical Biodiversity Area. | Moderate to high <br> Sensitive to change. <br> Difficult to rehabilitate due to soil, rock and slope. <br> Requires long term invested rehabilitation on damaged areas. | Fragmented in the valley due to road construction and past exploration roads <br> Erosion associated with the latter. <br> Community still stable. |
| ***Heteropogon - Eragrostis*** <br> **Semi-natural grassland** <br> **40-50% vegetation cover with exposed soil** <br> **Eight CI species** | Sekhukhune Mountainlands Threatened Ecosystem <br> Highest Biodiversity Importance (MBGs) <br> Within De Berg Conservancy (DPNR) Buffer <br> North Eastern Escarpment Priority Area. | Moderate to high diversity <br> Diversity of disturbed areas are lower than that of undisturbed areas. | Where historic grazing and farming took place, disturbance is evident. <br> Alien vegetation infestation apparent at BS4. |
| | **Riparian and Wetland** | | |
| ***Tulbaghia – Eleocharis*** <br> **Sheetrock Wetland** <br> **Mainly seep over rock – 10-15% cover** <br> **Three CI classifications** | FEPA River Catchment <br> Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7) <br> Nationally Protected (NWA) <br> Sekhukhune Mountainlands Threatened Ecosystem <br> Mpumalanga Mesic Grasslands Focal Area | Unique species assemblage due to the close association and links with the sheetrock community. | Structure intact little disturbance <br> Little to no weeds. |

| Flora Community | National Importance | Species Diversity | Condition [2] |
|---|---|---|---|
| | Highest Biodiversity Importance (MBGs)<br>Within De Berg Conservancy (DPNR) Buffer<br>North Eastern Escarpment Priority Area Mpumalanga -Critical Biodiversity Area. | | |
| ***Fuirena - Agrostis*** **Seep Zones**<br>**60-70% vegetation cover**<br>**Three CI classifications** | FEPA River Catchment Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7)<br>Nationally Protected (NWA); Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>Highest Biodiversity Importance (MBGs)<br>Within De Berg Conservancy (DPNR) Buffer<br>North Eastern Escarpment Priority Area<br>Mpumalanga -Critical Biodiversity Area. | Moderate diversity | Seep community at BS4 under pressure because of grazing<br>Valley seep community limited impact. |
| ***Phragmites - Schoenoplectus*** **and** ***Fuirena - Leersia - Phragmites*** **Vlei systems**<br>**80+% coverage**<br>**Three CI classifications** | FEPA River Catchment Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7)<br>Nationally Protected (NWA)<br>Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>Highest Biodiversity Importance (MBGs).<br>Within De Berg Conservancy (DPNR) Buffer. | Less diverse than the surrounding rocky grassland. | Disturbance due to the main access road and bridge construction. Agricultural disturbance and damming at BS4.<br>Due to the impacts the status of the community has been altered to monospecific cultures. |

| Flora Community | National Importance | Species Diversity | Condition [2] |
|---|---|---|---|
| | North Eastern Escarpment Priority Area Mpumalanga -Critical Biodiversity Area. | | |
| ***Faurea - Combretum - Halleria* Riparian vegetation**<br>**Mainly rock with scattered undergrowth**<br>**Three CI classifications** | FEPA River Catchment<br>Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7)<br>Nationally Protected (NWA); Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>Highest Biodiversity Importance (MBGs)<br>Within De Berg Conservancy (DPNR) Buffer<br>North Eastern Escarpment Priority Area<br>Mpumalanga -Critical Biodiversity Area. | Moderate to high species diversity. | Some road construction which lead to sedimentation of channels and displacement of boulders otherwise largely intact with limited alien species. |
| ***Acacia-Hyperthelia* Lower Floodplain Grassland**<br>**Approximately 80% coverage**<br>**One CI species** | FEPA River Catchment<br>Endangered Wetland Vegetation Group - Mesic Highveld Grassland Group 7 (MHGG7)<br>Nationally Protected (NWA)<br>Sekhukhune Mountainlands Threatened Ecosystem<br>Mpumalanga Mesic Grasslands Focal Area<br>Highest Biodiversity Importance (MBGs)<br>Within De Berg Conservancy (DPNR) Buffer<br>North Eastern Escarpment Priority Area,<br>Mpumalanga -Critical Biodiversity Area. | Moderate to low species diversity. | Historic activities in the valley and at BS4 contributed to some transformation of the community. |
| | **Transformed Areas** | | |

| Flora Community | National Importance | Species Diversity | Condition [2] |
|---|---|---|---|
| **Transformation of natural flora communities are associated with the Kiwi farms at BS4, current agricultural practices (grazing) at BS4, alien infestation at BS4 and along current disturbance footprints, and past agricultural practices along the Groot Dwars River. Some transformation of vlei areas at BS4 also occurred.** | | | |

Figure 5-30 Floral Community Distribution in the Booysendal South Expansion Project Area (Source: NSS, 2018)




### 5.12.5.4 Ferns

Several ferns species belonging to four geneses (*Pellea, Cheilianthus, Mohria* and *Ricca*) were found in site (Refer to Annexure K1). All these ferns have conservation significance

### 5.12.5.5 Fungi

Various fungi species were identified on site (refer to Annexure K1). The importance of these species is that they serve as major decomposers in the ecological system. Some of the fungi species are also used for medicinal purposes.

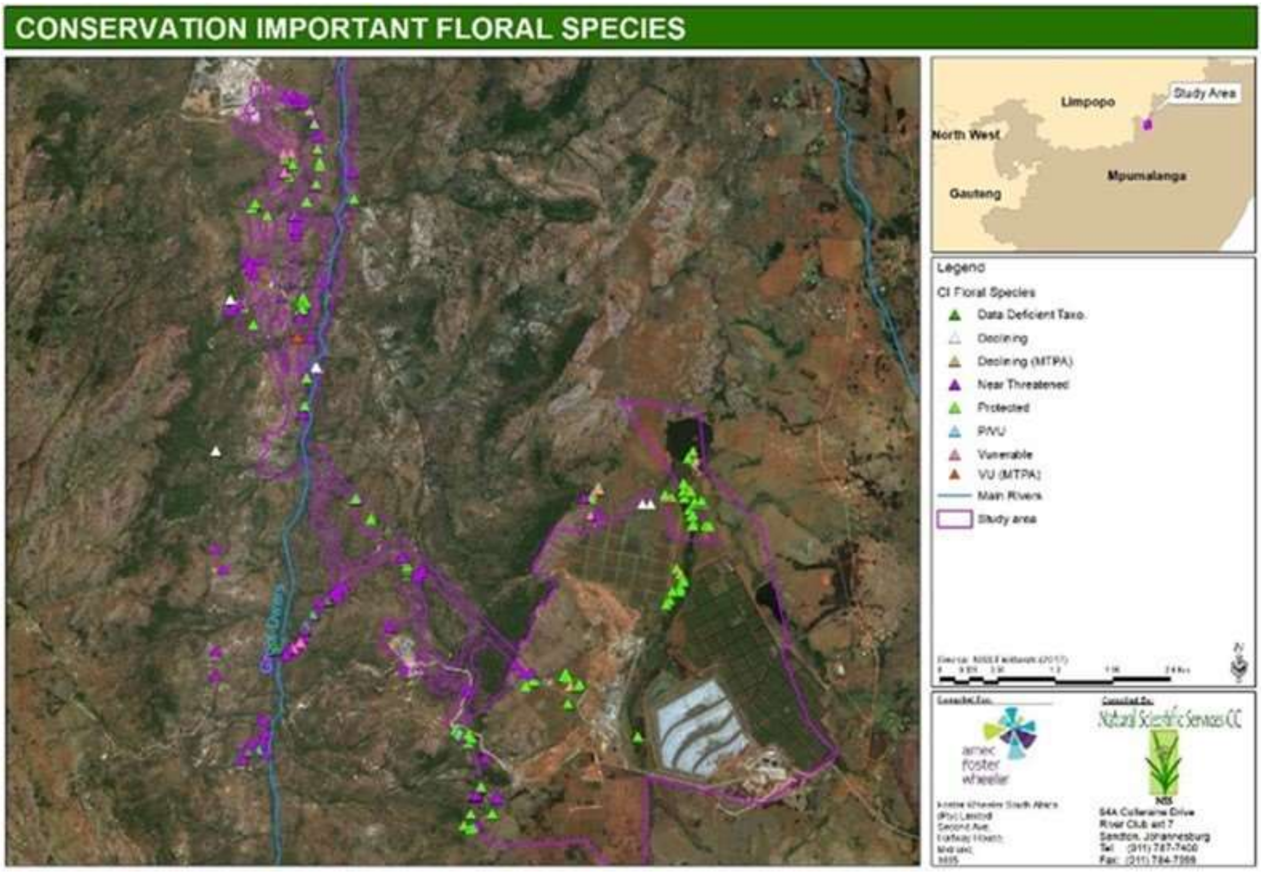
The location of all CI flora species identified on site is included in Figure 5-31. These areas are all sensitive.

### 5.12.5.6 Alien and Invasive Species

There are a limited amount of alien and invasive species associated with the Booysendal North MR Phase 2 Project Area, although some settlement has commenced in disturbed footprint areas. There are many alien and invasive species which have been identified within the Booysendal South MR Phase 2 Project Area. Category 1 species which require removal include:

- *Xanthium spinosum L;*
- *Opuntia ficus-indica (L.) Mill;*
- *Datura stramonium L; and*
- *Verbena brasiliensis and V bonariensis Vell*.

Figure 5-31 The Location of Conservation Important Flora Species (Source: NSS, 2018)




## 5.12.6 Baseline Fauna

This section provides a summary of the baseline fauna survey for Phase 2 Project. The detailed report and species lists are included in Annexure K1 and K2 (*Pycna sylvia*). The areas where pitfall traps, mist nets and cameras were placed are illustrated in Figure 5-32.

The overall findings from the study indicate that a large number (20) of CI species are associated with the wetland habitats. Approximately thirteen CI and geographically restricted species are associated with the rocky, grassy hillslopes and ridges. These habitats are, therefore, very sensitive. Additionally, the cliff face habitat to the west of BS4 is an important habitat for various CI bird species, including the NT Natal Long-fingered Bat, Geoffroy's Horseshoe Bat, the VU Cohen's Horseshoe, Vereaux's Eagle, the Southern Bald Ibis, Lanner Falcon and the EN Cape Vulture.

The sheet rock is critical habitat for the NT locally endemic Sekhukhune Flat Lizard, the NT FitzSimon's Flat Lizard, the VU Hadogenes polytrichobothrius scorpion and the PS Southern African Python.

The valley bushveld habitat has also been identified as important for the VU recorded Leopard, the NT Brown Hyena and locally endemic Pycna sylvia cicada. It is also anticipated that the VU Crowned Eagle and Wolkberg Dwarf Chameleon could also be found within this area. The location of the recorded CI species within the Phase 2 Project Area is included in Figure 5-33.

#### 5.12.6.1 Mammals

A total of 65 mammal species were recorded by NSS and other specialists (previous studies). Overall 90 mammal species are expected to occur within the study area. Species which commonly occur throughout the study area include in the Booysendal North and Booysendal South MR areas: The Black-backed Jackal, Bush Duiker, Four-striped Grass Mouse, Cape Porcupine, Scrub Hare, Slender Mongoose, South African Mole-rat, Four-striped Grass Mouse and Steenbok.

<u>Booysendal South MR:</u> A commonly occurring species associated with wetlands throughout BS4 is the Marsh/Water Mongoose. The TKO Dam provided sightings of the NT African/Clawless Otter and Serval species. The NT African Hedgehog is reported to also commonly occur within the area. Vervet Monkeys were also found within the alien vegetation areas at BS4. Cattle was recorded at and around BS4.

<u>Booysendal North MR</u>: Species recorded in the Groot Dwars River Valley included the Charcma Baboon, Eastern Rock Elephant Shrew, Namaqua Rock Mouse, Klipspringer, Red Rock Hares, the Marsh/Water Mongoose and Rock Hyrax. In the valley the Africa Civet, Caracal, VU Leopard, NT Brown Hyena, Kudu, Waterbuck, Bushbuck, Bushpig and Cane Rats were detected. Impala, Blue Wildebeest and Plains Zebra were seen closer to BN. Cattle was also recorded at in the valley between BS1/2.

<u>Bats in the Booysendal North and Booysendal South MR areas</u>:

Through the mist netting and acoustic recordings, the Cape Serotine, Dusky and Rusty pipistrelles, Egyptian Free-tailed and the Schlieffen's Twilight Bats were found in the riparian-woodland areas under the Booysendal South and Booysendal North MRs.

The NT cave-roosting Long Fingered Bat, NT Geoffroy Horseshoe Bat and the VU Cohen's Horseshoe Bat was found in the cave areas south of the Valley Boxcut.

At least 12 CI mammal species occur on site. CI species found and which could occur on site are included in Table 5-29. All species in green highlighted rows were found in the study area. The fauna assessment concluded that the fauna species located in the area are moving away from the operational and construction areas. A summary description of the CI species found on site and their preferred habitat below:

<u>Robust Golden Mole</u>: The Robust Golden Mole is listed as globally VU under the IUCN database. Tunnels and mounds of the is mole species were found in the wetland and grassland area between BS4 and the TKO dam.

<u>Lydenburg Golden Mole</u>: The Lydenburg Golden Mole is also an IUCN and MTPA listed VU species. The Lydenburg Golden Mole was found close to the northern most ARC tower access road at BN, along the proposed BS1/2 to BN pipeline route next to the Groot Dwars River and in the proposed area of the Emergency Escape Portal.

<u>Leopard</u>: The Leopard is IUCN and regionally VU and are known to inhabit the Groot Dwars River Valley. The spoor of two Leopard was found close to BS1/2. Development, especially roads and traffic increasingly cause disturbance in the migration patterns of these shy animals in the Groot Dwars River Valley.

<u>Cohen's Horseshoe Bat</u>: This bat species is globally and regionally VU. Evidence of this species was found on the Booysendal South and the Booysendal North MR areas. Caves are favoured it's as roosting place and should be avoided.

<u>Mountain Reebuck</u>: The Mountain Reebuck is classified as regionally EN. Preferred habitat includes grassland ridges and hillslopes typically at altitudes >1,500masl. The species can be expected to occur over the larger Booysendal Operation.

<u>Brown Hyana</u>: The Brown Hyana is endemic to southern Africa and IUCN listed as NT. NSS found evidence of the Brown Hyana in the Booysendal North MR area and south of the Valley Boxcut. Its preferred habitat is rocky, mountainous areas with bush cover.

<u>African Clawless Otter</u>: The African Clawless Otter is globally (IUCN)and regionally NT and was found in the north-eastern corner at BS4.

<u>Serval</u>: The Serval is regionally and provincially NT. It was found close to the Groot Dwars River in the Booysendal North MR area and prefers grassy dense habitat close to water.

<u>Geoffroy's Horseshoe Bat</u>: The Horseshoe bat was captured through mist netting at BS4 and within the wider BS area. It also roosts in caves.

<u>Natal Long-fingered Bat</u>: The Long-fingered Bat was recorded by NSS in the Phase 2 Project Area. It has a restricted habitat preference and roosts in large numbers.

<u>Aardvark</u>: The Aardvark is a nationally protected species. Evidence of Aardvark was found throughout the Dwars River Valley. The areas at the vent shafts, BS1/2 to BN pipeline route along the Groot Dwars River and the powerline corridor may pose a threat to the Aardvark.

Figure 5-32 Faunal Survey Mist Nests, Traps and Camera Trap Sites

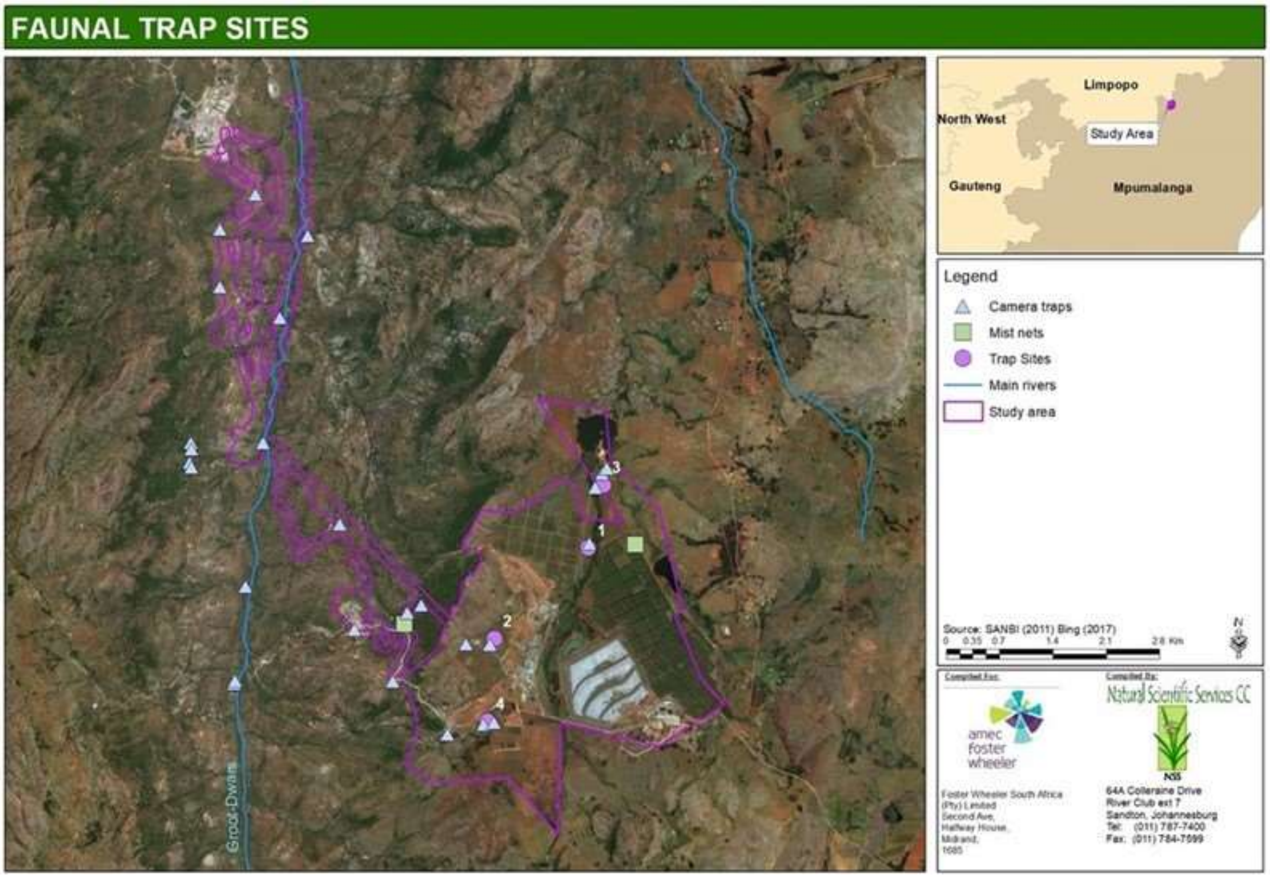


Figure 5-33 Conservation Important Fauna Species

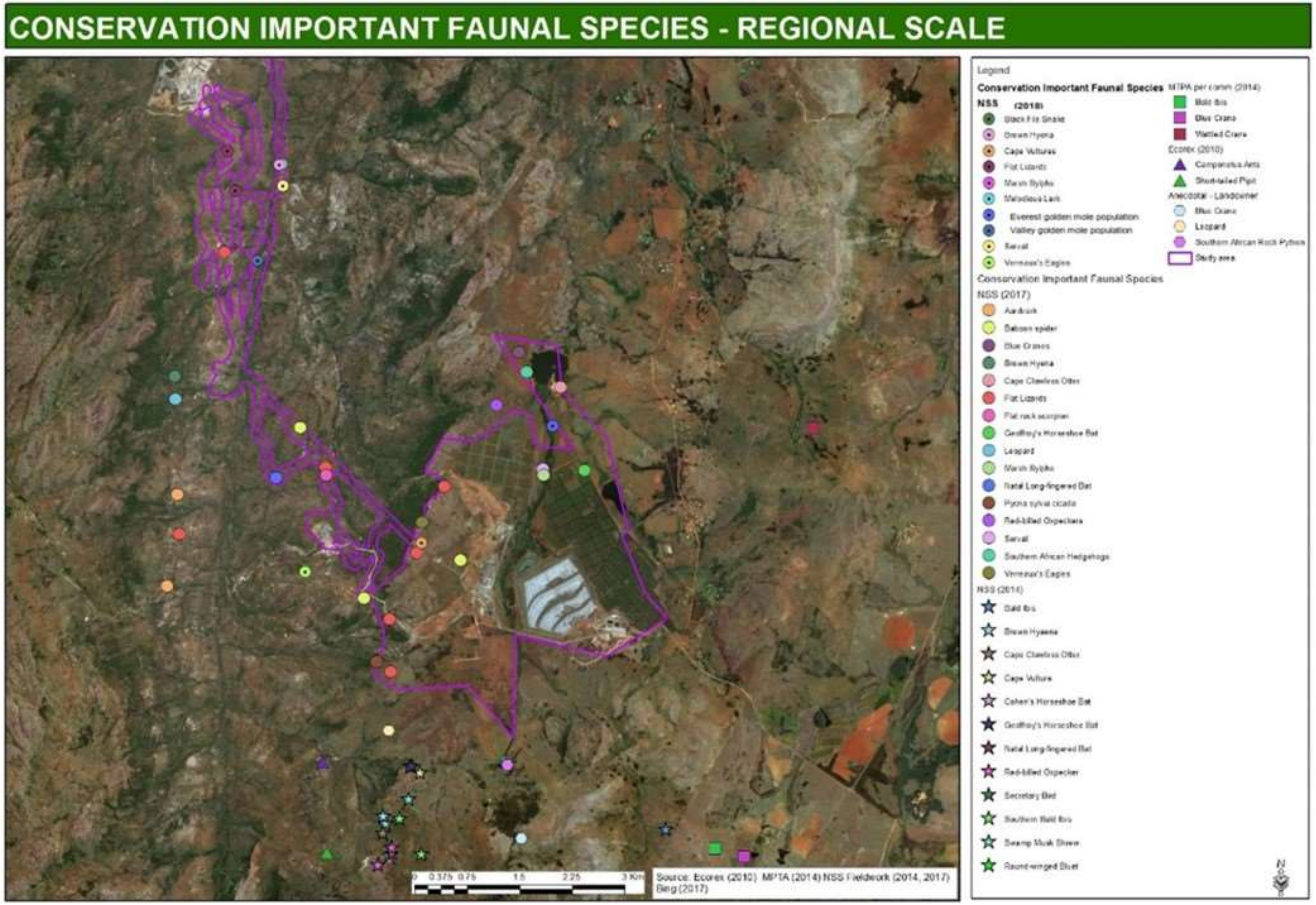


Table 5-29 Conservation Important Fauna Species (Source: NSS 2017, 2018)

**Threatened and/or Protected Fauna Taxa****

| **Scientific Name** | **Common Name** | **Conservation Status** |
|---|---|---|
| **Mammals** | | |
| *Aonyx capensis* | African / Cape Clawless Otter | NT |
| *Amblysomus robustus* | Robust Golden Mole | VU |
| *Atelerix frontalis (frontalis)* | Southern African Hedgehog | NT |
| *Crocidura mariquensis* | Swamp Musk Shrew | NT |
| *Dasymys robertsii* | Roberts' Marsh / Water Rat | VU |
| *Hyaena brunnea* | Brown Hyena | NT |
| *Hydrictis maculicollis* | Spotted-necked Otter | VU |
| *Leptailurus serval* | Serval | NT |
| *Miniopterus natalensis* | Natal Long-fingered Bat | NT |
| *Myosorex cafer* | Dark-footed Mouse / Forest Shrew | VU |
| *Orycteropus afer* | Aardvark | PS |
| *Panthera pardus* | Leopard | VU |
| *Pelea capreolus* | Vaal / Grey Rhebok | NT |
| *Poecilogale albinucha* | African Striped Weasel | NT |
| *Redunca fulvorufula* | Mountain Reedbuck | EN |
| *Rhinolophus clivosus* | Geoffroy's Horseshoe Bat | NT |
| *Rhinolophus cohenae* | Cohen's Horseshoe Bat | VU |
| To be scientifically named | Lydenburg Golden Mole | VU |
| **Birds** | | |
| *Anthropoides paradiseus* | Blue Crane | NT |
| *Alcedo semitorquata* | Half-collared Kingfisher | NT |
| *Anthus brachyurus* | Short-tailed Pipit | VU |
| *Aquila verreauxii* | Verreaux's Eagle | VU |
| *Balearica regulorum* | Grey Crowned Crane | EN |
| *Bugeranus carunculatus* | Wattled Crane | CR |
| *Buphagus erythrorhynchus* | Red-billed Oxpecker | NT |
| *Circus maurus* | Black Harrier | EN |
| *Circus ranivorus* | African Marsh Harrier | EN |
| *Eupodotis senegalensis* | White-bellied Korhaan | VU |
| *Falco biarmicus* | Lanner Falcon | VU |
| *Geronticus calvus* | Southern Bald Ibis | VU |
| *Gyps coprotheres* | Cape Vulture | EN |
| *Nettapus auritus* | African Pygmy Goose | VU |
| *Polemaetus bellicosus* | Martial Eagle | EN |
| *Sagittarius serpentarius* | Secretarybird | VU |
| *Stephanoaetus coronatus* | Crowned Eagle | VU |
| *Tyto capensis* | African Grass Owl | VU |
| **Reptiles** | | |
| *Acontias breviceps* | Short-headed Legless Skink | VU |
| *Chamaesaura aenea* | Coppery Grass Lizard | NT |
| *Homoroselaps dorsalis* | Striped Harlequin Snake | NT |

| | | |
|---|---|---|
| *Platysaurus orientalis fitzsimonsi* | FitzSimons' Flat Lizard | NT |
| *Platysaurus orientalis* | Sekhukhune Flat Lizard | NT |
| *Python natalensis* | Southern African Python | PS |
| *Tetradactylus breyeri* | Breyer's Long-tailed Seps | VU |
| **Frogs** | | |
| *Hadromophryne natalensis* | Natal Ghost Frog | VU |
| **Butterflies** | | |
| *Aloeides rossouwi* | Rossouw's Copper | EN |
| *Dingana fraternal* | Stoffberg Widow | CR |
| *Lepidochrysops rossouwi* | Rossouw's Blue | VU |
| *Metisella meninx* | Marsh Sylph | NT |
| *Platylesches dolomitica* | Hilltop Hopper | VU |
| **Dragonflies and damselflies** | | |
| *Aeshna ellioti* | Elliot's Hawker | VU |
| *Proischnura rotundipennis* | Round-winged Bluet | VU |
| *Pseudagrion celeste* | Catshead Sprite | VU |
| *Pseudagrion newtoni* | Harlequin Sprite | VU |
| **Scorpions** | | |
| *Hadogenes polytrichobothrius* | Flat Rock Scorpion | VU |
| ***Green rows - Species found in the study region during surveys*** | | |

#### 5.12.6.2 Birds

A total of 322 bird species could occur within the study area. Between the findings made by NSS and Ecofin respectively, a total of 230 species were recorded during the 2016 and 2017 surveys. 46 species which were not previously recorded have been observed, including the Ashy Flycatcher, Knysna Turaco, Lesser Spotted Eagle, Red-billed Oxpecker, Red-chested Flufftail and Scaly-throated Honeyguide.

The complete species list is included in Annexure K1. The list of species of conservation concern, including those found in the study area (blue rows), are included in Table 5-29. The habitat diversity supports a diverse bird assemblage ranging from water birds, typical Highveld grassland birds and Bushveld and Lowveld birds. The Phase 2 Project and particularly the development of the ARC poses a risk to various bird species in the area.

Species of specific concern are the EN Cape Vulture which habitat is found around the inaccessible cliffs in the Groot Dwars River Valley, the CI Blue Crane (in the area of the TKO dam), African March Harrier (along the BS4 wetland area and the Groot Dwars River), Verreaux's Eagle (cliffs west of the backfill plant), Melodious Lark (grassy slopes in the south-eastern grasslands of BN) and the Red-billed Oxpecker (north and south of BS4).

#### 5.12.6.3 Reptiles

A total of 82 reptile species are expected to occur in the Phase 2 Project Area (refer to Annexure G). Of these 82-reptile species, 24 species were confirmed to be present on site. Table 5-30 provides a list of the habitat types and the species in the various habitat types.

Table 5-30 Reptile Species Per Habitat Type

| Habitat | Species (Common Name) |
|---|---|
| **BS4 Rocky grassland** | Cape Skink, Montane Dwarf Burrowing Skink, Spotted Grass Snake, Holub's Sandveld Lizard and Wahlberg's Snake-eyed Skink |
| **Valley bushveld** | Common Flap-neck Chameleon, Black Mamba, Eastern Tiger Snake, Mozambique Spitting Cobra and Southern Tree Agama |
| **Wetland** | Brown Water Snake, Red-lipped Snake, South African Marsh Terrapin |
| **Boulders and sheet rock** | Common Crag Lizard, Rainbow Skink, Sekhukhune Flat Lizard (**NT**), Van Dam's Dragon Lizard and Van Son's Gecko |
| **Common to BS** | Common Dwarf Gecko, Southern Rock Agama, Variable Skink and Yellow-throated Plated Lizard |

The CI species which could occur in the study area and which have been spotted (indicated on blue) are included in Table 5-29.

#### 5.12.6.4 Frogs

The desktop study indicated that there are 14 frog species which could potentially occur within the Phase 2 Project Area.

At least 10 species were identified on site either through their calls or through sightings throughout BS, and BN including the Guttural Toads, Raucous Toads and Red Toads, often at a significant distance away from the nearest wetland.

The Mozambique Rain Frogs, Bubbling Kassinas and Boettger's Cacos were heard calling in the grassland areas in and around BS4.

BN: Juvenile and adult specimens of potentially the Bushveld Rain Frog were found on slopes and at the bottom of the valley. During the May 2017 site visit, Queckett's River Frogs were heard calling from the Groot-Dwars River. River frog tadpoles and adult frogs were also recorded in small, perennial, mountain streams that were feeding into the River. While evidence of Guttal and Raucous Toads, Bushveld Rain Frogs and Red Toads were also found throughout the Groot Dwars River Valley.

Only one CI could potentially occur in the Phase 2 Project Area, namely the VU Natal Cascade/ Ghost Frog. The Ghost Frog species are extremely vulnerable to destruction or degradation of habitats and especially sedimentation.

#### 5.12.6.5 Butterflies

The Phase 2 Project Area contains an especially rich diversity of butterflies. Between NSS (2017) and Ecofin (2015), a total of 74 butterfly species were recorded during the survey periods. This is approximately two and a half times more than the number of species which has been recorded in quadrant 2530AA to date. The rocky ridges and slopes supports several endemic and restricted range species, which means that these species habitats are limited

One CI species, the NT Marsh Sylph (*Metisella meninx*), was sighted in the wetland areas at BS4. Other CI species which could occur is included in Table 5-29.

The endemic and geographically restricted species identified on site, include the endemic:

- Long Tom Widow – generally found on steep, grassy south and east facing slopes at height between 1,200m and 2,000masl;

- Tite's Cooper - distribution is limited to high mountain peaks and ridges;
- Lydenburg Opal - distribution on high-lying rocky outcrops and hillsides; and
- Steelpoort Spotted-eyed Brown - limited to grassland and savanna rocky hillsides.

#### 5.12.6.6 Ordonata (Dragonflies and Damselflies)

70 dragon-and damselfly species could potentially occur within the Phase 2 Project Area of which 31 species were identified through sweep netting and observations by NSS (2017/2018). An additional 19 species are likely to occur in the wider Phase 2 Project Area. This once again confirms the high diversity of the Project area.

Although four CI species could potentially occur only one, the Round-winged Bluet (*Proischnura rotundipennis*) were identified to the south of BS4 but is also expected to occur elsewhere in the Phase 2 Project. Detailed findings on the Odonata is included in Annexure K1.

#### 5.12.6.7 Scorpions and Baboon Spiders

6 scorpions and 4 baboon spider species were identified in the Phase 1 and Phase 2 Project areas.

The 6-scorpion species include *Opistophthalmus glabrifrons, Opistacanthus validus* and *Uroplectes triangulifer* regularly found under rocks in BS. Ecofin (2015) also recorded *Chelectonus intermedius* and *Pseudolychas pegleri* in Phase 1 and Phase 2 Project areas.

There is a likelihood that 4 restricted range scorpion species may also be found in the Phase 2 Project Area, including the medically important *Parabuthus mossambicensis* and *Parabuthus transvaalicus*, the widespread bark scorpion *Uroplectes vittatus*, and the Pugnacious Burrowing Scorpion (*Opistophthalmus pugnax)*. None of the species are listed as CIs. One endemic species, the *Hadogenes polytrichobothrius* was only observed in sheet rock areas.

The 4 identified baboon spider species that have been identified in the area in: the Starbust Horned Baboon Spider (*Ceratogyrus bechuanicus*), the Transvaal Banded Baboon Spider (*Harpactira gigas*), the Malelane Golden-brown Baboon Spider (*Pterinochilus breyeri*), and the Transvaal Golden Baboon Spider (*Pterinochilus nigrofulvus*). None of these species are of CI. Baboon spiders are coming under increasing pressure due to their restricted range, poor resilience to disturbance and the slow maturation rate. Known areas of occurrences must be avoided.

#### *5.12.6.8 Pycna sylvia*

The *Pycna sylvia* a cicada species thought to be extinct, were rediscovered in 2004 in the Groot Dwars River valley.

Observations on the preferred habitat type and incidental observations of the *Pycna sylvia* formed part of the NSS specialist investigation (Annexure K1).

Data on the cicada is deficient but research indicates that there is a strong association of the cicada with the tree *Vitex obovate. wilmsii*. The tree is endemic to the south-eastern Limpopo, northern Mpumalanga, Gauteng and Swaziland.

Malherbe et.al (2004), sighted in the NSS report, indicated that the adult life stage is between 6 and 8 weeks during the period of mid-November to the end of December. The life cycle of the larva is not known but it can be anything from 1 to 7 years. During the field surveys, the *Pycna sylvia* was found around the ARC between BS4 and BS1/2, southerly and south-western slopes of the main access road, while its calls were heard throughout the Groot Dwars River valley.

NSS also did a density assessment to assist in determining offset measures for the *Pycna sylvia*. Their calculations indicate that the density of the Vitex was calculated as 326m$^2$ in the Groot Dwars River valley.

The habitat must be conserved and where disturbance occurs, offset. The *Pycna sylvia* has a restricted range. Continued species decline was observed in the areas where it is present.

RD Stephens is appointed on an annual basis to undertake monitoring of the *Pycna sylvia.* Since 2015 his monitoring was mainly concentrated in the Booysendal South Expansion Project area.

The known locations where the *Pycna sylvia* occurs are included in Figure 5-34.

Figure 5-34 Distribution of the *Pycna Sylvia* (Source: RD Stephans, 2015)

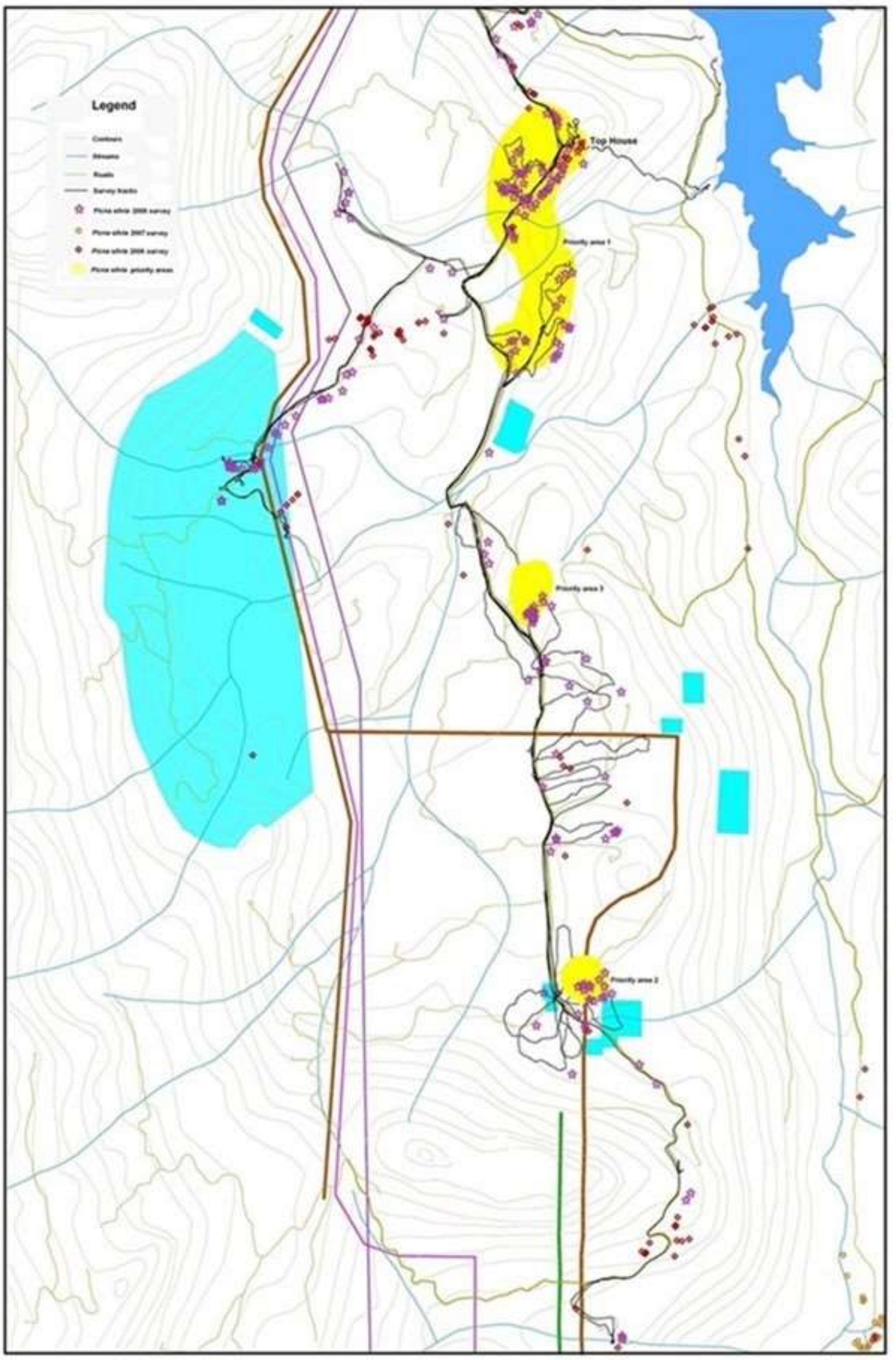


Table 5-31 Conservation Important Species Present at the Booysendal South Expansion Project Area

| Species | Family | Red Data | Endemic | Protected |
|---|---|---|---|---|
| *Asclepias schlechteri (WM754)* | Apocynaceae | EN | | |
| *Myrothamnus flabellifolius Welw.* | Myrothamnaceae | DDT | | |
| *Ledebouria (Resnova) megaphylla* | Hyacinthaceae | VU (Mp) | SCPE | |
| *Zantedeschia pentlandii* | Araceae | VU | SCPE (N) | MNCA |
| *Eucomis vandermerwei* | Hyacinthaceae | VU | LCPE /SCPE (N) | MNCA |
| *Watsonia occulta* | Iridaceae | Rare | LCPE | MNCA |
| *Curtisia dentata* | Cornaceae | NT | | NFA |
| *Habenaria barbertoni* | Orchidaceae | NT | | MNCA |
| *Merwilla plumbea (Lindl.) Speta* | Hyacinthaceae | NT | | MNCA |
| *Jamesbrittenia macrantha (Codd) Hilliard* | Scrophulariaceae | NT | | |
| *Callilepis leptophylla* | Asteraceae | Declining | | |
| *Aloe cooperi* | Asphodelaceae | Declining | | MNCA |
| *Eucomis autumnalis subsp. clavata* | Hyacinthaceae | Declining (MP) | | MNCA |
| *Eucomis montana* | Hyacinthaceae | Declining | | MNCA |
| *Ilex mitis* | Aquifoliaceae | Declining | | |
| *Aloe pretoriensis* | Asphodelaceae | | SCPE (N) | MNCA |
| *Huernia zebrina subsp. insigniflora (Sekhukhuneland form)* | Apocynaceae | | SCPE (N) | MNCA |
| *Cyphia transvaalensis* | Lobeliaceae | | SCPE (N) | |
| *Gnidia caffra (Meisn.) Gilg (Form)* | Thymelaeaceae | | SCPE | |
| *Kleinia longiflora DC. (Form)* | Asteraceae | | SCPE | |
| *Aloe barbara-jeppeae* | Asphodelaceae | NT | SCPE (N) | MNCA |
| *Vitex obovata E.Mey. subsp. wilmsii (Gurke) C.L.Bredenkamp & D.J.Botha* | Lamiaceae | | SCPE (N) | |
| *Berkheya insignis (Sekhukhune form)* | Asteraceae | | SCPE | |
| *Brachycorythis ovata Lindl. subsp. ovata* | Orchidaceae | | | MNCA |
| *Cyphostemma sp.nov.aff.humile* | Vitaceae | | SCPE | |
| *Gymnosporia species A* | Celastraceae | | SCPE | |
| *Ipomoea bathycolpos subsp. sinuatodentata* | Convolvulaceae | | SCPE | |
| *Melhania cf randii (form)* | Malvaceae | | SCPE | |
| *Agapanthus inapertus* | Agapanthaceae | | Mp | MNCA |
| *Streptocarpus dunnii Hook.f.* | Gesneriaceae | | Mp | |
| *Hermannia brachymalla* | Malvaceae | | LCPE | |
| *Searsia tumulicola var. meeuseana forma pumila* | Anacardiaceae | | LCPE | |
| *Searsia wilmsii (Diels) Moffett* | Anacardiaceae | | LCPE | |
| *Catha edulis* | Celastraceae | | | NFA |
| *Pittosporum viridiflorum* | Pittosporaceae | | | NFA |
| *Aloe arborescens* | Asphodelaceae | | | MNCA |
| *Aloe greatheadii var. davyana ("longibracteata" form)* | Asphodelaceae | | | MNCA |
| *Aloe modesta (possibly-unconfirmed)* | Asphodelaceae | VU | | MNCA |

| | | | |
|---|---|---|---|
| *Aloe minima (possibly-unconfirmed)* | Asphodelaceae | | MNCA |
| *Brachystelma coddii* | Apocynaceae | | MNCA |
| *Brunsvigia radulosa Herb.* | Amaranthaceae | | MNCA |
| *Corycium nigrescens* | Orchidaceae | | MNCA |
| *Dioscorea cotinifolia* | Dioscoreaceae | | MNCA |
| *Disa aconitoides* | Orchidaceae | | MNCA |
| *Disa cf. saxicola* | Orchidaceae | | MNCA |
| *Disa patula var. transvaalensis* | Orchidaceae | | MNCA |
| *Erica drakensbergensis Guthrie & Bolus* | Ericaceae | | MNCA |
| *Eulophia ovalis var bainesii* | Orchidaceae | | MNCA |
| *Eulophia ovalis var ovalis* | Orchidaceae | | MNCA |
| *Eulophia hians var nutans* | Orchidaceae | | MNCA |
| *Eulophia sp. (no flower)* | Orchidaceae | | MNCA |
| *Gladiolus papilio* | Iridaceae | | MNCA |
| *Gladiolus crassifolius* | Iridaceae | | MNCA |
| *Gladiolus densiflorus* | Iridaceae | | MNCA |
| *Gladiolus cf ecklonis* | Iridaceae | | MNCA |
| *Gladiolus woodii* | Iridaceae | | MNCA |
| *Habenaria caffra* | Orchidaceae | | MNCA |
| *Habenaria clavata* | Orchidaceae | | MNCA |
| *Habenaria pseudociliosa* | Orchidaceae | | MNCA |
| *Haemanthus humilis* | Amaranthaceae | | MNCA |
| *Kniphofia fluviatilis* | Asphodelaceae | | MNCA |
| *Kniphofia linearifolia* | Asphodelaceae | | MNCA |
| *Neobolusia tysonii* | Orchidaceae | | MNCA |
| *Olea capensis subsp. enervis* | Oleaceae | | MNCA |
| *Olea europaea subsp. africana* | Oleaceae | | MNCA |
| *Orthochilus foliosa (Lindl.) Bolus* | Orchidaceae | | MNCA |
| *Protea gaguedi* | Proteaceae | | MNCA |
| *Protea roupelliae Meisn. subsp. roupelliae* | Proteaceae | | MNCA |
| *Protea welwitschii* | Proteaceae | | MNCA |
| *Satyrium ocellatum subsp. hallackii* | Orchidaceae | | MNCA |
| *Satyrium cristatum var. longilabiatum* | Orchidaceae | | MNCA |
| *Satyrium parviflorum* | Orchidaceae | | MNCA |
| *Scadoxus multiflorus* | Amaranthaceae | | MNCA |
| *Scadoxus puniceus (L.) Friis & Nordal* | Amaranthaceae | | MNCA |
| *Schizocarphus nervosus* | Hyacinthaceae | | MNCA |
| *Triaspis glaucophylla Engl.* | Malpighiacaeae | SCPE (N) | |
| *Protea caffra Meisn. subsp. caffra* | Proteaceae | SCPE | MNCA |
| *Euclea crispa (Thunb.) Gurke subsp. Crispa (Sekhukhune)* | Ebenaceae | SCPE | |
| *Aloe spp* | Asphodelaceae | SCPE (N) | |
| *Aloe cryptopoda Baker* | Asphodelaceae | SCPE (N) | |

| | | | | | |
|---|---|---|---|---|---|
| *Aloe cf parvibracteata Schonland* | Asphodelaceae | | | | MNCA |
| *Brunsvigia radulosa Herb.* | Amaranthaceae | | | | MNCA |
| **Total** | | **82** | **17** | **27** | **59** |

LC = Least Concern; VU = Vulnerable; NT = Near Threatened; EN = Endangered; DDT: Data Deficient

MNCA: Mpumalanga Nature Conservation Act (No.10 of 1998); NFA: National Forest Act; SCPE: Sekhukhuneland Centre of Plant Endemism; LCPE: Mashishing Centre of Plant Endemism

### 5.12.7 Terrestrial Sensitivities

Ecological sensitivities of the Phase 2 Project Area include that the Sekhukhune Mountainlands, which is listed as an EN ecosystem under GN 1002 of 9 December 2011 and the TOPS List. The biome is also listed as a Priority Zone for conservation initiatives by the SANBI.

The Phase 2 Project is located approximately 4km north of the De Berg Conservancy (Davel Nature Reserve) and approximately 10km north from the Verloren Valei Nature Reserve. Increased pressure and impacts in the Phase 2 Project Area may also lead to increased pressures on the conservation areas. There are several threatened and protected and protected species declared in terms of section 56(1) of NEMBA. The Groot Dwars River system is classified as a FEPA. In terms of the FEPA, any mining activities should be restricted to 1km from of a wetland or any riverine habitats

In terms of the Mpumalanga Biodiversity Sector Plan, CBAs were identified where development should be restricted due to the sensitivity of the existing biodiversity. Similarly, a sector plan has been developed for the Limpopo Province.

NSS developed a sensitivity analysis of each habitat based on the conservation importance of species. Due to the extent of this analysis, the reader is referred to Annexure K1 Section E.

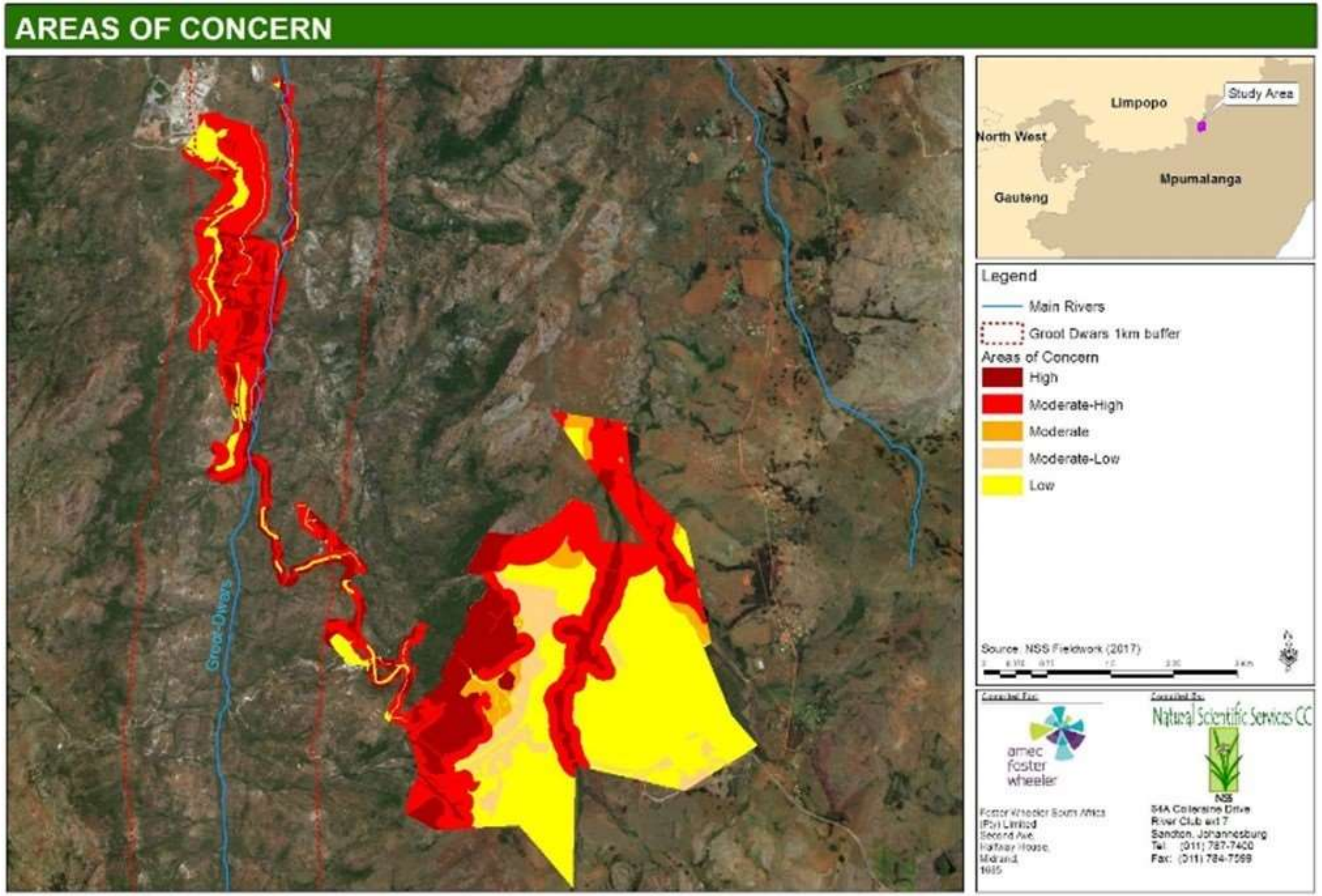
NSS developed a sensitivity rating for which culminated and sensitivity map with buffer zones. The analysis was based on the specialist findings, the CI of the various species found, applicable legislation, guidelines and plans (including those mentioned above). The sensitivity summary of the habitat units is included in Table 5-32and the CI and buffer zones illustrated in Figure 5-35. The methodology and detail on the sensitivity analysis is included in Section D of Annexure K1.

Table 5-32 Conservation Importance of the Booysendal South Expansion Project Habitats (Source: NSS, 2018)

| HABITAT & COMMUNITY | RATING |
|---|---|
| **Bushveld and Thicket** | |
| *Lydenburgia - Vitex - Kirkia* Rocky Thicket | High |
| Cliff face & Kloof Habitat | High |
| *Acacia - Euclea- Hippobromus - Scolopia* Thicket | Moderate-High |
| *Protea - Themeda* Slope Open Woodland | Moderate-High |
| **Riparian and Wetland** | |
| *Faurea - Combretum - Halleria* Riparian vegetation | High |
| Dams / Open Waterbodies | Moderate |
| *Fuirena - Agrostis* Seep Zones | High |
| *Tulbaghia – Eleocharis* Sheetrock Wetland | High |
| *Phragmites - Schoenoplectus* Vlei system | High |
| *Fuirena - Leersia - Phragmites* Vlei system | High |
| *Acacia-Hyperthelia* Lower Floodplain Grassland | Moderate-High |

| HABITAT & COMMUNITY | RATING |
|---|---|
| **Rocky Grasslands** | |
| *Loudetia - Themeda* Western Slope Grasslands | Moderate-High |
| *Acacia caffra - Ozoroa - Tristachya* Eastern Slope Grasslands | Moderate-High |
| *Heteropogon - Eragrostis* Semi-natural grassland | Moderate |
| **Rocky Outcrops, Sheet Rock and Boulders** | |
| *Searsia- Diospyros - Rhoicissus* Rocky outcrops | Moderate-High |
| *Aloe - Myrothamnus - Xerophyta* Sheet Rock Formations | High |
| *Brachiaria - Tristachya* Exposed Rock | High |
| **Transformed Areas** | |
| Agriculture - kiwi farming | Low |
| Agriculture - past farming | Low |
| Cleared Areas | Low |
| Current infrastructure | Low |
| Main Alien Bushclumps (*Eucalyptus / Acacia mearnsii*) | Low |
| *Lippia - Eragrostis* Transformed (past clearing, some recovery) | Moderate-Low |
| Transformed vleis | Moderate-Low |
| **BUFFER** | **RATING** |
| 1km buffer around Groot-Dwars River FEPA | Moderate-High |
| **Fauna** | |
| 500m no-go buffer around each golden mole population | Moderate-High |
| 100m buffer around all wetlands | Moderate-High |
| 30m buffer on Cliff face and all Sheet Rock | Moderate-High |
| **Flora** | |
| 500-600m around all VU *Zantedeschia pentlandii* | Moderate-High |

Figure 5-35 Sensitivities and Buffer Zones (Source: NSS, 2018)



## 5.12.8 Ecology Ecosystem Services

| Service | Service Category | Threats/ Availability | Relevant Environment of ES | Importance of ES | Replicability |
|---|---|---|---|---|---|
| Production of $O_2$ | Supporting | Clearing of vegetation, disturbance of wetlands and dust outfall on vegetation. | All areas containing vegetation. | High CI - Fundamental ecosystem process. | Moderate |
| Provision of habitats for fauna | Supporting | Will be impacted throughout the BS footprint and beyond, wherever terrestrial and wetland habitats are cleared or degraded by dust, erosion, sedimentation, contamination, in-vasive alien flora, noise, light, etc. | All vegetated areas. | High CI - Unique local floral communities provide critical habitat for local endemic fauna. | Irreplaceable |
| Sense of Place and eco-tourism | Cultural | The potential impacts from BS such as dust, noise, light and invasive alien flora, on the nearby Davel Private Nature Reserve and the Verloren Valei Nature Reserve and Ramsar Wetland are of significant concern. | Groot Dwars River Valley. | High CI - The aesthetic value of the region is important for regional ecotourism and protected areas. | Irreplaceable |
| Flora with medicinal and other cultural uses | Cultural | E.g. Catha edulis is harvested in the BS area by people who reportedly travel long distances to obtain and harvest the plant matter. | Mainly in the Groot Dwars River Valley. | High CI - Harvested products can have high economic value. | Low |
| Research opportunity and scientific knowledge | Cultural | Several recently discovered and un-described or recently described, and many data deficient floral and faunal taxa occur in the region. | Especially in undisturbed areas. | High CI - Locally endemic species are highly threatened by expanding mining activities. | Low |
| Vegetation bind soil and assist in controlling erosion | Regulating | Removal of vegetation for construction and settlement of alien and invasive species. | All areas where vegetation growth is taking place. | High CI - Vegetation is critical in controlling erosion due to the local soil's high susceptibility to erosion and the steep slopes, and heavy regional thundershowers which | Low |

| Service | Service Category | Threats/ Availability | Relevant Environment of ES | Importance of ES | Replicability |
|---|---|---|---|---|---|
| | | | | contribute to and advance erosion. | |
| Pollination of CI and other native flora | Regulating | Removal of habitat and mining activities could impact on pollinators and plant production. | All except for build-up areas | High CI - Pollination is critical for the Sekhukhuneland Centre of Plant Endemism. | Irreplaceable |
| Run-off regulation including flood control, retention and dissipation | Regulating | Run-off velocities will increase over areas where vegetation has been removed or where areas are compacted and provided with hardened surfaces. | All areas containing vegetation | High CI - Water regulation is essential for people and biodiversity. | Low |
| Water purification | Regulating | Will impact on wetlands, in particular the Groot Dwars River and main BS4 wetland, are subject to significant disturbance. | Especially wetland areas with *Phragmites* | High CI - Clean water regulation is essential for people and biodiversity. | Low |
| Carbon sequestration | | Will be impacted to some degree wherever terrestrial and wetland vegetation is cleared or plant photosynthesis is compromised by dust. | Vegetated areas | High CI - Fundamental eco-system process. | Moderate |

# 5.13 Socio-economic Environment

## 5.13.1 Methodology

### 5.13.1.1 Desktop Review

The purpose of the desktop review was to gather secondary data for the Phase 2 Project Area. Sources consulted included:

- Documents derived from the information request to the Client (Booysendal) (i.e. SLP 2015 to 2019, Stakeholder Engagement Policy);
- Socio-economic and demographic statistics (sourced from Statistics South Africa's 2011 Census data);
- IDPs, LEDs and SDFs of the EDM and SDM, as well as the TCLM and GTLM; and
- Available maps and imagery.

### 5.13.1.2 Social Surveys and Primary Data Collection

Using a variety of research tools, including questionnaires, primary data were collected for the socio-economic baseline study between 16 to 20 January 2017. These research tools included community information sheets, focus group meetings, and key informant interviews. A total of eight focus group meetings were held in four communities to gather socio-economic primary data. To ensure participation of all groups, including vulnerable groups (woman, children and aged population) the meetings were separated.

Social surveys were held in the Shaga, Choma, Phetla and Makhuwa communities. Meetings were separated between men and woman except in the Makhuwa community where one meeting was held. These meetings covered the communities directly affected by the Booysendal Operations conducted under the Booysendal North MR and Booysendal South MR.

Key informant interviews were held with the Ward Councillor of Ward 5, the Chairman of the Emerging Contractors Forum and Principals at Shaga Primary School and Tonteldoos Secondary School. The interviews sought to verify and expand on data gathered during the focus group meetings. Detail around the primary data and attendance registers of the social surveys is included in Annexure L.

### 5.13.1.3 Data Analysis and Reporting

In each of the communities, comparable qualitative social data was collected. Primary data gathered from the focus group discussions and key informants, as well as, observations made by the study team on livelihood strategies, infrastructure, services and amenities were transcribed. To strengthen and increase the levels of confidence in the qualitative findings of the social study, primary data was triangulated with secondary data from the IDPs, LEDs, SDFs and StatsSA. The outcome resulted in the development of a Social Baseline Report, a SIA and a social management plan (**"SMP"**).

## 5.13.2 Socio-economic Baseline for Booysendal North MR

The detailed baseline findings are included in Annexure L.

### 5.13.2.1 Municipality

The Booysendal North MR Phase 2 Project Area falls in the SDM. The bulk of the Phase 2 Project development falls within the SDM. According to the 2016/17 IDP, the municipality has a population of

1,076,840 inhabitants, of which 99% are Africans, and the remainder 1% comprise Whites, Indians and Coloureds. The IDP further states that the three main contributors to Gross Geographic Product ("**GGP**") in the SDM economy are community services (3.62%), mining (2.38%) and trade (2.66%).

The area under Booysendal North MR falls in Ward 31 of the GTLM of the SDM. GTLM is characterized by a weak economic base, inadequate infrastructure, major service backlogs, dispersed human settlements and high poverty levels.

#### 5.13.2.2 Greater Tubatse Local Municipality Social Contents

Demographics:

According to the GTLM IDP (2016/17 – 2020/21), there are 335,767 people (83,199 households) in the GTLM of which 160,398 are male and 175,278 are woman. The age structure indicates that a total of 133,459 people are below the age of 15 and 24,160 older than 60. The municipality has a large dependency ratio of 46.94%.

Economy: The economy in the GTLM remains predominantly rural. According to the GTM IDP (2016/17 – 2020/21), the area is economically the most marginalised region in the Limpopo Province. Although the GTM IDP (2016/17 – 2020/21) indicates that the main economic drivers in GTM are agriculture, services and construction, it also stated that the area is solely dependent on government handouts and remittances from migrant labour.

Employment: The unemployment rate for the GTLM is 41%, and according to the GTM IDP (2016/17 – 2020/21) the unemployment rate is projected to increase to 47% by 2020.

Household Income: In GTLM, a great proportion of the population, 48.25%, do not earn an income, while 2.65% of the population earn between R1 –to R400 per month, followed by 2.58% who earn between R401 and R800 per month, and 12.89% earn between R801 and R1600 per month.

Education: In the GTLM, an estimate 20% of the population have no schooling, and only 16% of the population achieved a Grade 12 pass in 2011.

Heath Care: There is a total of 26 medical facilities in GTLM, which mainly constitute regional clinics that provide localised inputs to the community.

Services – Water, Sanitation and Refuge Removal: In GTLM most the population use unventilated pit latrines, and almost 5.5 % of the households use ventilated improved toilets ("**VIP**") toilets. Most villages in GTLM do not have access to refuse removal and, dumping and burning of waste is the more common way of disposing waste.

Housing: The GTLM IDP (2016/17 – 2020/21) describes 83.91% of the housing types in the GTLM as formal housing types, 7.31% as informal housing types, and 7.83% as traditional housing types, and the total number of people on the RDP housing waiting list stands at 2,749.

Electricity: According to the GTLM IDP (2016/17 – 2020/21) a total number of 144 villages are electrified, and 56 villages are still without electricity supply.

Transportation: In GTLM, buses and taxis are the main mode of public transport, and although the GTLM IDP (2016/17 – 2020/21) recorded 405 taxi vehicles, 18 public buses, and a number of private bus companies operating in the area, the IDP also stated that there is lack of public transport facilities and that an overwhelming majority of the taxi facilities are informal.

### 5.13.3 Socio-economic Baseline for Booysendal South

#### 5.13.3.1 Municipality

The Booysendal South MR Phase 2 Project Area falls in the EDM. According to the 2016/17 IDP for the EDM 94% of the population is Black while the rest comprises of Whites, Colored, Indians and Other racial groups. The IDP further states that in 2011 the unemployment rate for people between the ages of 15 and 65 was 32.32%, and majority of the population in EDM are dependent on social grants.

BS falls within Ward 5 of the TCLM which has a population of 98,387 with a total of 34,521,75 households. Poor and inadequate basic services have also contributed to the scattered nature of settlements in the rural areas of the TCLM, which makes infrastructure development challenging and costly (TCLM IDP, 2017/22).

#### 5.13.3.2 Thaba Chweu Local Municipality Social Contents

Demographics: Although EDM has the highest population density in Mpumalanga, of the four local municipalities TCLM has the lowest population density, and accommodates 7% of the population of the EDM. (TCLM IDP, 2017/22). The demographic structure of the TCLM indicates that approximately 25.17% of the population is under the age of 14 years, 4.92% are aged 65+ and 69.91% is between 15 and 65. Approximately a third of this population by demographic structure is economically inactive consequently contributing to a large dependency ratio. The gender ratio is fairly even with 51% of the population being female and 49% being male. The most commonly spoken language is Sepedi (94%), followed by iSiZulu (1.2%), English and Afrikaans (0.5% each).

Economy: The economy of the TCLM is mainly characterised by a dependency on agriculture (33%) followed by manufacturing (22%), community services (16%) and trade and catering (11%), which contribute to 19% of the district municipality GGP. The main economic activities in the TCLM is forestry, mining (32%) and tourism.

Employment: Given that the economic characterisations in TCLM are mainly driven by mining, tourism, agriculture and forestry sectors, many employment opportunities come from the mining sector (23.9%) followed by trade (18.1%), community services (14.7%) and agriculture (14%). The key informant interviews indicated that in Mashishing 80 small businesses are registered with the Emerging Contractors Forum in the sectors of construction, catering, engineering and maintenance, which are supported by the local municipality with training and skills development.

Whilst the Phase 2 Project Area is located in a region endowed with tourist attractions, agricultural and mining land, a large proportion of the population in TCLM remains unemployed, unskilled and impoverished. Per the TCLM IDP (2016 – 2017 and 2020/21), the unemployment rate in 1996 was 18.64% whereas in 2001 it was at its highest at 25.12%, which dropped to 20,49% in the year 2011. People with disabilities, women and youth are vulnerable to unemployment in the TCLM. In 2011, 28.04% of women and 26.56% of youth were unemployed.

Household Income: According to TCLM IDP (2016/17) about 7,500 households have an annual income of between R19,000.00 and R38 000.00, while about 10,000 households have an average annual income of between R1.00 and R4 800.00. At least 32,000 households have an annual average income of between R76,400.00 and R153,000.00, and a minority group of about 77 households have an annual income of above R1 million.

Education: Per the Census 2011, only 21% of the population in TCLM achieved a matric qualification, most the population (28%) have some form of secondary schooling, while 20% have some primary schooling and only 5% have completed primary school, illustrating a significant need for schools and the associated facilities in the municipality.

Health Care: Currently Sabie, Mashishing and Matibidi each have three public hospitals and three public clinics, and although mobile clinics operate in farm and rural areas, these clinics do not adequately meet community healthcare needs and are often an unreliable service. Due to the high levels of poverty in some of the areas of the local municipality, people cannot afford to pay for transport to public healthcare facilities, and are in serious need of mobile clinics. The main causes for deaths in the TCLM are included in Table 5-33.

Table 5-33 Main Causes of Deaths in the TCLM

| Number (ranking) | Causes | Number of deaths in 2011 |
|---|---|---|
| **1** | Tuberculosis | 188 |
| **2** | Influenza and pneumonia | 140 |
| **3** | Intestinal infectious diseases | 99 |
| **4** | Other external causes of accidental injury | 98 |
| **5** | Other forms of heart disease | 59 |
| **6** | Diabetes | 55 |
| **7** | Cerebrovascular diseases | 54 |
| **8** | Hypertensive diseases | 47 |
| **9** | Certain disorders involving the immune mechanism | 35 |
| **10** | Heart diseases | 25 |

Although HIV/AIDS is not listed as a primary cause of the death in the area, according to the TCLM IDP (2016/17 – 2020-21) the rate of HIV infection is increasing in the area. In 2009, HIV prevalence stood at 30.20%, while in 2010 it stood at 39.70%. (TCLM IDP, 2016/17 – 2010/21).

Services – Water, Sanitation and Refuse Removal: In rural communities, most households do not have regular adequate water supply, and most households rely on water sourced from nearby rivers and springs (Key informant interview, 2017). In communities with drilled boreholes, no maintenance plans are in place, thus, many borehole equipment are broken, non-functional and in need of repair. In 2011 a total of 1072 households in TCLM did not have access to basic water facilities (TCLM IDP, 2016/17 – 2010-21), and 21% of households used unventilated pit latrines (Mphahlele Wessels & Associates, 2016. The two water treatment plants in Mashishing are in dire need of refurbishment.

Without bulk water supply, the Municipality is also unable to provide communities with bulk sanitation, where approximately 1,619 households in farm areas are without access to basic sanitation. As an interim solution, the Municipality is rolling out VIPs until the problem of bulk supply of water is addressed and resolved, which will ultimately solve the sewerage network and reticulation backlogs. (TCLM IDP, 2016/17 – 2020/21).

A process of developing water and sanitation master plans to deal with problem is underway. A Water Service Development Plan ("**WSDP**") is in place, which depicts the current status quo and requirements for bulk water and sanitation service delivery. (TCLM IDP, 2016/17 – 2020/21). In the Local Municipality, it is estimated that 84% of the population does not have access to refuse removal services.

Housing: Data from the 2011 Census (Statistics SA, 2011) describe 45% of households in the municipality as formal housing types,36% as informal housing and 3,95% as traditional housing types. Per the IDP, 58,82% of housing types in Ward 5 are formal housing types, 22.77% are informal housing, and 12.66% as traditional housing types.

Electricity: TCLM provides electricity to the urban areas, businesses and industrial sites, while electricity in the rural areas is provided by Eskom. Although there has been a steady growth in electricity supply since 1996, approximately 4,314 rural households in TCLM do not have access to electricity, which amounts to about 16% of all the households in TCLM (TCLM IDP, 2016/17 – 2020/21).

Transportation: In general, the main roads between Lydenburg, Sabie, Graskop, and Pilgrim's Rest are indicated in the TCLM IDP (2016/17 – 2020/21) to be in relatively good condition. The TCLM IDP (2016/17 – 2020/21) acknowledges that the roads within the towns and villages (including the paved and unpaved roads) are not being maintained. Buses and minibus taxis are presently the two major modes of transport.

Development Challenges: The TCLM IDP (2016/17 – 2020/21) identifies the following key challenges to development in the area:

- Inadequate institutional capacity of the TCLM;
- Inadequate budgeting for operations and maintenance;
- Low education and skills base;
- Human settlements development and population growth; and
- Prevalence of TB and HIV/AIDS.

The baseline conditions present an ideal opportunity for Booysendal to expand their current SLP commitments with the new expansion to the benefit of the communities.

### 5.13.4 Booysendal Communities Baseline

Insight into the communities surrounding the Booysendal Expansion Project (Phase 1 and 2) was mainly obtained through key focus group meetings. The data gathered during these meetings provided a baseline for the Booysendal Expansion Project.

#### 5.13.4.1 Focus Group Meetings

The following key focus group meetings were held:

| Date | Time | Focus Group Meetings |
|---|---|---|
| **16th January 2017** | 11:00 | Key informant interview with representatives of the Thaba Chweu Municipality |
| | 14:00 | Key informant interview with Emerging Contractor, Mashishing and Letageng |
| | 15:00 | Key informant interview with Protea Farms, Mashishing |
| **17th January 2017** | 8:00 – 17:00 | Shaga Community:<br>Key informant interview with traditional authorities<br>Key informant interview with representatives of the Shaga CPA<br>Focus group meetings with men, women and youth |
| **18th January 2017** | 8:00 – 17:00 | Phakaneng Choma Community:<br>Key informant interview with traditional authorities<br>Key informant interview with representatives of the CPA<br>Focus group meetings with men, women and youth |
| **19th January 2017** | 8:00 – 17:00 | Phetla Community:<br>Key informant interview with traditional authorities<br>Key informant interview with representatives of the CPA<br>Key informant interviews with Community Development Forum<br>Focus group meetings with men, women and youth |
| **20th January 2017** | 8:00 – 17:00 | Makua Community:<br>Key informant interview with traditional authorities<br>Key informant interview with representatives of the Stageng CPA<br>Focus group meetings with men, women and youth |

#### 5.13.4.2 Local Governance Structures

- Ward Committees – elected community members who work closely with the Ward Councillor, and are responsible for service delivery in the communities located in the Project Area;
- Community Development Forums – elected community members responsible for identifying and communicating community development needs to the Ward Committees;
- CPAs – landowners in the Project Area governed by the Communal Property Associations Act, No 28 of 1996 ("**CPA Act**"); and
- Traditional Councils – elected traditional leaders governed by the Traditional Leadership and Governance Framework Act, No 41 of 2003 ("**Framework Act**") who are responsible for preserving cultural heritage resources, managing land and natural resources, supporting local development, and maintaining peace and communal justice systems.

In the study area, relationships between the governance structures and amongst community members vary from community to community. For example, in the Phetla community the primary governance structure is the CPA, which comprises an elected CPA Executive made up of land claimants and Traditional Council representatives from the Limpopo Province. The Choma CPA Executive does not recognise or engage with the newly established Community Development Forum, which is primarily made up of labour tenants who resided in the area prior to the land claims. The CPA Executive perceives the Community Development Forum as competing for authority and jostling for political power within the community (Key informant interview, 2017).

In general, community governance in the Project Area is complex and overshadowed by conflict over land claims and mistrust of community leaders who are perceived as not being representative of the broader community, corrupt and restricting access to natural resources and employment opportunities with mines in the area. Engagement by Booysendal with only CPA Executive structures and community leaders is likely to be ineffective and to further contribute to existing views of mistrust between community members and community leaders.

As an alternative to solely communicating to neighbouring communities through existing governance structures and/or relying on CPAs to communicate key project messages to constituencies, Booysendal is advised to consider sharing project information during community meetings that are representative of the local communities impacted by the project. This may potentially improve trust between the mines and the neighbouring communities, and assist Booysendal with gaining the support of the local communities for the Booysendal South Expansion Project and related mining activities.

#### 5.13.4.3 Demographics

The population comprises both land claimants and labour tenants, with most land claimants moving to the areas surrounding the Project Area in 2012. Accurate population figures are not available for Communities in the Project Area, however, estimates were collected in consultation with Community representatives and verified by community members in focus group meetings. The figures are included in Table 5-34.

Table 5-34 Project Area Population Figures (Source: SES Community Information Sheets, 2017)

| Community | Estimate Households | Estimate Population |
|---|---|---|
| **Phetla** | 50 | 450 |
| **Choma** | 53 | 477 |
| **Shaga** | 700 | 7000 |
| **Stageng** | 800 | 8000 |
| **Total** | **1 603** | **15 927** |

The average household size is 9.94 people with a complex extended family composition.

#### 5.13.4.4 Age and Gender

Between 57% and 60% of the population was younger than 18 years. A small number of people were over the age of 60. There is therefore a high dependency ratio and a low life expectancy. According to the communities, this can be attributed to poor healthcare facilities and the spread of communicable diseases such as tuberculosis and HIV/AIDS.

The information indicates that females (62% to 55%) outnumber the number of males (38% to 45%).

#### 5.13.4.5 Ethnicity and Religion

The majority of the population is Sepedi (90%), followed by 10% Ndebele. The main religion is Christianity while 50% also practice various traditional religions.

#### 5.13.4.6 Land Use and Access to Land

Many communities moved back into the area after successful land claims. Community members can acquire one-hectare of land through the traditional council and CPAs. At present, the influx into the area is characterised by illegal squatting, and this was most evident in the Choma and Phetla communities.

#### 5.13.4.7 Land Ownership

The main landowners in the Project Area are CPAs and Booysendal. According to community members in Shaga, a private farmer recently acquired a farm in the study area close proximity, which is not under a land claim, and employs seasonal labourers to work on the blueberry farm.

#### 5.13.4.8 Education

There are 3 primary schools and 1 secondary school located close to the study area. Two of the three primary schools in the Project Area are used by the Shaga Community. These include Shaga Primary School and Boschfontein Primary School. The third primary school, Kiwi Primary School, is used by the Phetla Community, and the secondary school, Tonteldoos Secondary School, by the in Stageng Community. Pupils from the Stageng Community do not attend primary schools in the study area, and the majority of these students are enrolled at Sisabonga Primary School in Roossenekal, Limpopo. The schools, location, number of pupils and teachers are included in Table 5-35. School attendance at the schools consulted as part of the assessment report was high. Bussing children to school has contributed to these high attendance figures. The conversion to Grade 12 is however significantly low as pupils often leave school at various stages for diverse reasons.

Table 5-35 Primary and Secondary Schools in the Project Area

| School Name | Location | No. of teachers | No. of pupils | Fees (per annum) |
|---|---|---|---|---|
| Shaga Primary School | Shaga | 3 | 60 | R0.00 |
| Boschfontein Primary School | Shaga | 11 | 304 | R0.00 |
| Kiwi Primary School | Phetla | 4 | 62 | R0.00 |
| Sisabonga Primary School | Roossenekal | 11 | 667 | R0.00 |
| Tonteldoos Secondary school | Stageng | 13 | 297 | R0.00 |
| Skhila Secondary School | Mashishing | 29 | 761 | R350.00 |
| Mashishing Secondary School | Mashishing | 1554 | 52 | R450.00 |

Challenges experienced in the area include lack of secondary schools, lack of transport, shortage in textbooks, increased number of orphans, no library / computer / laboratory facilities, limited extramural facilities, no flushing toilets and no administrative buildings for teachers.

#### 5.13.4.9 Healthcare

A mobile clinic is supposed to provide healthcare services to the Communities, but this service is unreliable. The closest healthcare services are the Hospital and Clinic in Mashishing, and a Clinic in Mashishing Township. Cost of transport, treatment and demand for healthcare at these facilities makes it inaccessible for the Communities. Traditional healers are expensive and therefore not accessible from a financial point. Many self-medicate using traditional herbs collected in the nearby forest.

The most commonly reported ailments and diseases included high blood pressure, diabetes, tuberculosis, diarrhoea, and colds and flu.

#### 5.13.4.10 Housing

Most houses are built with cement and brick and corrugated roofing with one or more outbuildings. There are very few traditional houses and some shanty houses are present. Some houses have pit latrines.

#### 5.13.4.11 Energy

Although there is electricity, financial conditions restrict the use thereof, therefore many households use wood for cooking and candles for light.

#### 5.13.4.12 Water Supply, Sanitation and Waste Removal

The Protea Farms Community Forum was the only Community having gravity fed communal pipes providing water to household stands. Other Communities collect water from springs and streams, mainly tributaries of the Groot Dwars River. Water security in winter months can be a problem and the water quality was reported to be poor reportedly leading to high number of cases of diarrhoea. Although Government has supplied boreholes, lack of maintenance makes the boreholes ineffective for water supply.

Some members have pit latrines while a large number make use of the bush.

There are no waste services and refuse is disposed of in public places, in the open or burnt.

#### 5.13.4.13 Roads and Transport

There are no taxis of public transport in the area. People walk to the R577 where taxis are found. The cost varies between R120 and R160 return to Mashishing or Roossenekal.

#### 5.13.4.14 Livelihood

Although mines employ people, lack of transport make it difficult for employees to effectively remain employed. Seasonal labour on farms have declined due to the land claims. All the households are dependent on subsistence farming including livestock rearing (chickens, cattle, sheep and goats) and planting of maize, sorghum, beans, potatoes and some fruit trees. There are no informal businesses in the area from which income can be generated.

Medicinal plants (i.e. African potato, lengana and aloe) are harvested and used for household consumption. It was reported that some people sell traditional herbs, and that Luang Plant was commonly sold to Somalis.

It was reported that a number of Community members are artisans with varying skills. These skills include welding, driving, operating heavy machinery, construction, bricklaying, baking, catering, and sewing but many Community members don't hold formal qualifications required by the mines. Therefore, skills training and development was identified, as a priority community need.

#### 5.13.4.15 Income and Expenditure

Dependence on social grants are very high due to unemployment which is the main source of income. The main household expenditure is on transport, food, energy, airtime and clothes.

Sensitivities

There is a clear majority of the population within the study area who can be regarded as vulnerable due to high levels of unemployment and poverty. The most vulnerable is the 60% youth population followed by the old-aged and female population.

### 5.13.5 Ecosystem Services

The following ecosystem services were identified during the focus group surveys:

- Provisional: Grazing livestock, subsistence farming, collecting wood for heat and building material, collecting clay for pottery, harvesting honey and collecting grass for thatching and brooms. It is not foreseen that the mine will impact on these activities;
- Graves and cultural heritage sites: some of the sites are on the properties comprising the Booysendal Mine area. Access for communities is provided for and undertaken in terms of the Booysendal Mine's existing visitor access procedure; and
- Plants for medicinal use: as the Booysendal Mine is fenced it is assumed that these are mainly collected in the Project Area and therefore it is not foreseen that the project will impact on availability.

## 5.14 Cultural Heritage and Palaeontology

The cultural heritage phase 1 assessment was done by HCAC who was also responsible for sections of the Phase 1 assessment. The palaeontological assessment was carried out by Prof Bruce Rubidge. Refer to Annexure M1 and M2 respectively. The purpose of the cultural heritage assessment was to identify and assess cultural heritage resources in the Phase 2 Project footprint areas and secondly to consolidate the records of cultural heritage resources found during various studies over time for the wider Booysendal Operation. This is once again important to inform the overall cultural heritage management at the Booysendal Mine and any future planning and activities.

### 5.14.1 Methodology

#### 5.14.1.1 Desktop Review

The specialist undertook a detailed literature review as part of the Phase 1 Project heritage impact assessment ("**HIA**"), including extensive reviews of previous studies done in the area, maintained databases from Provincial Heritage Resources Authorities **(**"**PHRA**"), the Archaeological Data Recording Centre at the National Flagship Institute (Museum Africa) in Pretoria and SAHRA's national archive ("**SAHRIS**").

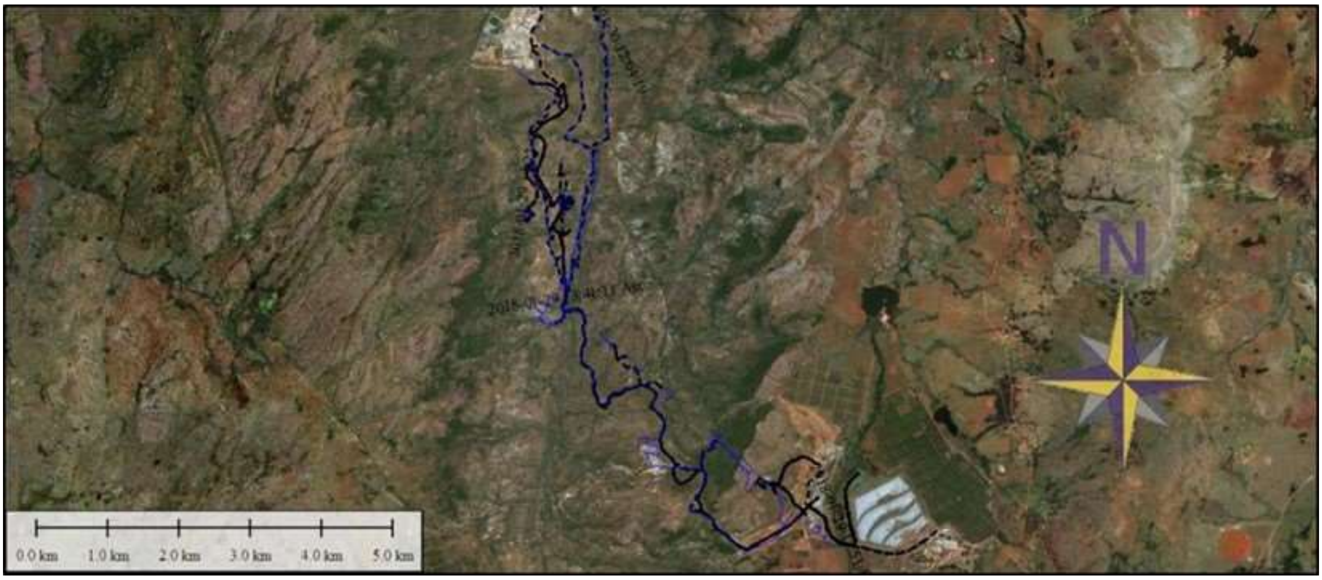
The initial background data was updated through a brief survey of existing documents, aerial imagery, unpublished and published reports and the SAHRA website.

#### 5.14.1.2 Field Surveys

Various field surveys were undertaken as part of the Booysendal South Expansion Project from 2 to 5 February 2016, 8 to 12 February 2016, 22 March 2016, 1 and 2 of November 2016 and again on 17

November 2016. For each of the surveys, GPS tracks were taken for the foot surveys, although the signal at times got lost. Additional surveys on smaller gravel tracks were also undertaken by 4x4 vehicles. Field surveys for the Phase 2 Project was undertaken from 29 – 31 January 2018. The tracks for the second survey are included in Figure 5-36.

Figure 5-36 Cultural Heritage Track Log for the Phase 2 Project Survey (Source: NSS, 2018)




#### 5.14.1.3 Impact Assessment and Reporting

NHRA has prescribed a methodology according to which the significance of impacts on heritage sites need to be undertaken. This rating is based on the use of 2 rating (grading) schemes, namely:

- A scheme of criteria which outline places and objects as part of the national estate as they have cultural-historical significance or other special value; including amongst others:
  - Its importance in / to the community, or patterns of South African history;
  - Its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
  - Its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
  - Its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects; and
  - Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.
- A field rating scheme according to which heritage resources are graded in three tiers (levels) of significance based on the regional occurrence of heritage. The field rating is based on amongst others:
  - The unique nature of the site;
  - The integrity of the archaeological/cultural heritage deposits;
  - The wider historic, archaeological and geographic context of the site;
  - The location of the site in relation to other similar sites or features;

- The depth of the archaeological deposit (when it can be determined/is known);
- The preservation condition of the sites; and
- Potential to answer present research questions.

The rating scale is included in Table 5-36. This rating scale is based on the NHRA requirements and the prescribed criteria from SAHRA.

Table 5-36 Cultural Heritage Field Rating Scale

| ***FIELD RATING*** | ***GRADE*** | ***SIGNIFICANCE*** | ***RECOMMENDED MITIGATION*** |
|---|---|---|---|
| National Significance (NS) | Grade 1 | - | Conservation; national site nomination |
| Provincial Significance (PS) | Grade 2 | - | Conservation; provincial site nomination |
| Local Significance (LS) | Grade 3A | High significance | Conservation; mitigation not advised |
| Local Significance (LS) | Grade 3B | High significance | Mitigation (part of site should be retained) |
| Generally Protected A (GP.A) | - | High/medium significance | Mitigation before destruction |
| Generally Protected B (GP.B) | - | Medium significance | Recording before destruction |
| Generally Protected C (GP.C) | - | Low significance | Destruction |

## 5.14.2 Cultural Heritage Baseline

### 5.14.2.1 Type of Heritage Resources

The following heritage resource types are present in the study area (i.e. the larger Booysendal Operation):

- Early Stone Age, dating back from 2.5 million to 250 000 years ago;
- Middle Stone Age, dating back 250 000 to 22 000 years ago. A limed number of these artefacts are present on site;
- Late Stone Age, dating back around 20 000 years ago. Some rock graving dating back to this period were found on the eastern slopes of the Groot Dwars River; and
- Late Iron Age, stretching from AD1600 into the nineteenth century. Especially stone walled settlements along the eastern edge of the Groot Dwars River Valley associated with the Choma and Phetla tribes which dates to this era (the historical period in this area is associated with the Ndzundaza-Ndebele and Voortrekkers settling in the area).

### 5.14.2.2 Heritage Resources in the Study Area

The consolidated list of heritage sites within the larger Booysendal Operation, the location, a description and the significance of the sites are included in Table 5-37. The distribution of the sites are included in Figure 5-38. Sites to be impacted by the Phase 2 Project according to current layouts are highlighted in yellow. These impacts are discussed in Section 10.13.

## 5.14.3 Cultural Baseline

The cultural value of the area is low due to the extensive mining in the wider area. No indication of intangible of living heritage were identified on site during the various surveys.

### 5.14.4 Palaeontology Baseline

An independent study was conducted by Rubidge (2017) and concluded that most of the area is underlain by Precambrian igneous rocks of the Rustenberg Layered Suite of the Bushveld Igneous Complex. This is an intrusive igneous body comprising a series of ultramafic-mafic layers and a suite of associated granitoid rocks. A very minor part of the TSF1 development will extend onto the arenaceous Steenkampsberg Formation of the Transvaal Supergroup. The geological map indicates that parts of the TSF1 development will be on unconsolidated Quaternary alluvial deposits

As the Precambrian Bushveld Igneous Complex is of igneous origin and the Precambrian arenaceous Steenkampsberg Formation of the Transvaal Supergoup is not known to host fossils it is highly unlikely that palaeontological heritage will be affected by the proposed Phase 2 Project. The Quaternary alluvial sediments which are covered by vegetation in the study area are the only sedimentary deposits in the area which could host fossils of Quaternary-aged animals and plants. As these deposits are not consolidated it is very unlikely that any fossils will be present (Rubidge 2017).

### 5.14.5 Sensitivities

Cultural Heritage sites within or in close to mining infrastructure footprints or activities are at risk of being impacted and are for the purposes of this study considered sensitivities.

## Table 5-37 Heritage Sites within the Booysendal Operation

| Site Number | Field Number | Type Site | Type Site-Description | Longitude | Latitude | Source | Description | Significance Rating | Mitigation | Cause of Impact |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 344 | Historical | Historical Ruin | 30° 06' 55.5553" E | 25° 05' 53.9016" S | Van der Walt 2016 | Site is fenced in by green palisade fence (fenced by mine). The site consists of several circular enclosures and least two rectangular enclosures. | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | No impact |
| **2** | 345 | Historical | Historical Ruin | 30° 07' 01.9849" E | 25° 06' 50.1949" S | Van der Walt 2016 | Consists of the foundations of a mud dwelling (circular enclosure) as well as a rectangular foundation of a house with at least three rooms. Additional stone circle built up against natural rocks. Cultural material consists of cans and undecorated pottery, lower grinders and a possible deflated midden. | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | Inside development footprint |
| **3** | 346 | Historical | Historical Ruin | 30° 07' 05.0483" E | 25° 06' 51.8832" S | Van der Walt 2016 | Consists of mud and stone foundations of the ruins of several large rectangular features. Lower grinders and undecorated pottery together with the ruins of approximately 6 houses. Burnt daga fragments. | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | Inside development footprint |
| **4** | 347 | Burial Site | Cemetery | 30° 07' 04.3609" E | 25° 06' 54.3563" S | Van der Walt 2016 | Three graves with headstones. Oldest visible date is 1962. | High Significance | Graves are already fenced and should be preserved in situ. | Inside development footprint |
| **5** | 350 | Iron Age | Iron Age | 30° 07' 07.7520" E | 25° 06' 57.3659" S | Van der Walt 2016 | Possible deflated midden. A little bit of slag and undecorated ceramics. One decorated piece was found with a cross hatching motif as decoration. | Low to Medium Significance | Test excavation | Inside development footprint |

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|---|---|---|---|---|---|---|---|---|---|---|
| **6** | 351 | Stone Cairn | Stone Cairn | 30° 07' 09.8977" E | 25° 06' 57.6288" S | Van der Walt 2016 | Rectangular stone dressing orientated north to south. Purpose is unknown but could be a possible grave. | If confirmed as a grave it is of high social significance. | Preservation in situ. | Inside development footprint |
| **7** | 352 | Iron Age | Communal Grinding Area | 30° 07' 09.7031" E | 25° 06' 58.3201" S | Van der Walt 2016 | Large communal grinding area on exposed bedrock with 7 grinding hollows. Possibly associated with the Iron age. | Low to Medium Significance | Surrounding communal grinding area could contain the subsurface remains of an Iron Age site. Mapping and test excavations are recommended. | Inside development footprint |
| **8** | 353 | Historical | Historical Ruin | 30° 07' 13.6201" E | 25° 06' 40.8419" S | Van der Walt 2016 | Rectangular stone wall structure incorporated into natural rock. Entrance is orientated to the North. Possible filled in entrance to the South. Several ephemeral terraces surround the feature. Cultural material consists of undecorated ceramics. Linear walls are located to the East and West of this feature. | Low to Medium Significance | Test excavation, Mapping, Monitoring | No impact |
| **9** | 354 | Historical | Historical Ruin | 30° 07' 03.7236" E | 25° 07' 37.1279" S | Van der Walt 2016 | Rectangular stone walled structure measuring 5 x 4 meters. | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | Inside development footprint |
| **10** | 355 | Historical | Historical Ruin | 30° 07' 04.7927" E | 25° 07' 38.4493" S | Van der Walt 2016 | Linear stone wall, most likely associated with Feature 354. Cultural material consists of fragments of an iron 3-legged cooking pot. | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | BS1/2 Infrastructure (Phase 1 / S24G) |
| **11** | 356 | Historical | Historical Ruin | 30° 07' 04.1771" E | 25° 07' 40.1231" S | Van der Walt 2016 | Rectangular stone walled ruin. Entrance orientated east. Could be a goat kraal. Cultural material consists of an old plough. | Low significance | Community Liaison, Test excavation, Mapping, Monitoring | BS1/2 Infrastructure (Phase 1 / S24G) |
| **12** | 357 | Historical | Historical Ruin | 30° 07' 20.0280" E | 25° 07' 56.5068" S | Van der Walt 2016 | Stone walls that form a funnel towards a rectangular stone walled structure (8 x 8 meters). Fragments of undecorated pottery | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | Inside development footprint |

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| | | | | | | | noted. The possibility exists that more structures might be present as the area is highly overgrown. | | | |
| **13** | 358 | Iron Age | Terracing | 30° 07' 43.1401" E | 25° 08' 13.0885" S | Van der Walt 2016 | Possible terrace wall measuring approximately 12 meters in length. Various other ephemeral walls are visible between rock outcrops. The site is overgrown and visibility is poor due to the vegetation. | Low significance | Monitoring if the site will be impacted on. | Inside development footprint |
| **14** | 359 | Stone Cairn | Stone Cairn | 30° 07' 45.6851" E | 25° 08' 14.9603" S | Van der Walt 2016 | Two stone cairns of unknown purpose. One is rectangular in shape and the other circular. Measuring 1.2 meters in diameter. | If confirmed as graves it is of high social significance. | Preservation in situ. | Inside development footprint |
| **15** | 360 | Iron Age | Terracing | 30° 07' 44.4757" E | 25° 08' 16.7065" S | Van der Walt 2016 | Ephemeral terrace walls, surrounding a koppie with undecorated ceramics present on site. | Low to Medium Significance | Test excavation | Inside development footprint |
| **16** | 362 | Historical | Historical Ruin | 30° 07' 10.3331" E | 25° 08' 18.5640" S | Van der Walt 2016 | Consists of the mud foundations of a possible residential dwelling. The ruin measures 12 by 8 meters. | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | Inside development footprint |
| **17** | 363 | Burial Site | Possible Graves | 30° 07' 10.3835" E | 25° 08' 18.1609" S | Van der Walt 2016 | Stone standing upright, possibly a grave marker. Cultural material consists of a 20-c piece dating to 1989. Glass and metal fragments. Several lower grinders. | If confirmed as a grave it is of high social significance. | Preservation in situ. | Inside development footprint |
| **18** | 365 | Stone Cairn | Stone Cairn | 30° 07' 43.4497" E | 25° 08' 41.3449" S | Van der Walt 2016 | 4 Stone cairns of unknown purpose. Could be linked with initiation. Although unlikely, it could also be possible graves. Measure between 0.5 to 1.5 / 2 meters. Cultural material includes broken | If confirmed as graves it is of high social significance. | Test excavation | Inside development footprint |

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| | | | | | | | lower and upper grinders, pottery - decoration indicate possible Marateng pottery (Pedi). Possible Iron Age site with terracing. | | | |
| **19** | 366 | Iron Age | Terracing | 30° 07' 48.1513" E | 25° 08' 44.3364" S | Van der Walt 2016 | Ephemeral terrace walls. Fragments of daga with pole impressions and undecorated ceramic scatter occur on site. | Low to Medium Significance | Monitoring if the site will be impacted on. | Inside development footprint |
| **20** | 367 | Iron Age | Terracing | 30° 08' 05.8560" E | 25° 09' 00.1260" S | Van der Walt 2016 | Ephemeral terrace walls with undecorated ceramics. Sheet erosion is washing ceramics downhill. | Low significance | No mitigation required. | Inside development footprint |
| **21** | 368 | Iron Age | Terracing | 30° 08' 04.3404" E | 25° 09' 00.7093" S | Van der Walt 2016 | Ephemeral terrace walls with undecorated ceramics. Sheet erosion is washing ceramics downhill. | Low significance | No mitigation required. | Inside development footprint |
| **22** | 369 | Iron Age | Rock Engraving | 30° 07' 19.4088" E | 25° 05' 31.7004" S | Van der Walt 2016 | Rock engravings. Circular motifs. Possibly resembling later Iron Age lay outs. | Medium significance | Preservation in situ. | No impact |
| **23** | 370 | Iron Age | Iron Age | 30° 08' 46.8169" E | 25° 09' 17.9029" S | Van der Walt 2016 | Disturbed area due to bulldozing activities. Several undecorated ceramics scattered over the area. The site is extensively disturbed. | Low significance | No mitigation required. | Inside Development footprint |
| **24** | 372 | Historical | Linear Stone Wall | 30° 08' 50.9171" E | 25° 08' 43.1629" S | Van der Walt 2016 | Linear stone wall, probably associated with the exploration road and is approximately 5 meters wide. | Low significance | No mitigation required. | Inside Development footprint |
| **25** | 373 | Historical | Historical Ruin | 30° 08' 51.9901" E | 25° 08' 44.2607" S | Van der Walt 2016 | Rectangular structure with a North facing entrance. Walls are well preserved. Structure measures 18 x 15 meters. Several other foundations of mud dwellings are also visible. Cultural material consists of modern iron and glass artefacts | Low to Medium Significance | Community Liaison, Test excavation, Mapping, Monitoring | Inside Development footprint |

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| | | | | | | | together with undecorated ceramics. the site also includes the remains of two rectangular stone packed kraals measuring 12 x 18 meters (approximately). | | | |
| **26** | 374 | Burial Site | Cemetery | 30° 08' 19.0859" E | 25° 09' 42.5808" S | Van der Walt 2016 | Site is highly overgrown and the number of graves could not be determined. The graves are located within a kraal wall and belongs to the Mokala family. | High Significance | Preservation in situ. | Inside development footprint |
| **27** | 375 | Stone Cairn | Stone Cairn | 30° 08' 13.5241" E | 25° 09' 44.8777" S | Van der Walt 2016 | Orientated north to south and measures 2.5 x 1.5 m. The cairn is of unknown purpose but could represent a grave. | If confirmed as a grave it is of high social significance. | Preservation in situ. | Inside development footprint |
| **28** | 376 | Historical | Linear Stone Wall | 30° 08' 19.9969" E | 25° 09' 44.1683" S | Van der Walt 2016 | Long stone packed wall close to exploration road. Measures 12 meters in length. The wall is of unknown purpose and no cultural material is present. | Low significance | No mitigation required. | Inside development footprint |
| **29** | 378 | Iron Age | Terracing | 30° 06' 39.4199" E | 25° 05' 59.6185" S | Van der Walt 2016 | Terrace walls located at the foot of the mountain. Undecorated ceramics are present on site. Possible agricultural terraces leading up to Iron Age site higher up on the mountain. | Low to Medium Significance | If the site is impacted on it is recommended that the site should be mapped and monitored. | Ropecon / Aerial rope way |
| **30** | 379 | Iron Age | Iron Age | 30° 6'39.87"E | 25° 6'8.13"S | Van der Walt 2016 | Extensive Iron Age stone walled settlement in the saddle on top of a hill. Various enclosures with middens and archaeological deposit present. High frequency of undecorated ceramics. | Medium to high significance | It is preferable to preserve the site in situ if this is not possible and if the site is impacted on it is recommended that the site should be excavated, mapped and monitored. | |
| **31** | 600 | Iron Age | Terracing | 30° 07' 10.7868" E | 25° 06' 56.5956" S | Van der Walt 2016 | Various stone packed terrace walls. | Low significance | No mitigation required. | Inside development footprint |

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|---|---|---|---|---|---|---|---|---|---|---|
| **32** | 601 | Iron Age | Terracing | 30° 07' 11.9820" E | 25° 06' 46.8144" S | Van der Walt 2016 | Terrace wall next to erosion gulley or drainage line. Measure 7 meters in a North South direction and is about half a meter high. | Low significance | Community Liaison , Test excavation, Mapping, Monitoring | Inside development footprint |
| **33** | 602 | Burial Site | Grave | 30° 08' 47.2000" E | 25° 09' 01.0000" S | Huffman and Schoeman 2002A | African grave with headstone. Located next to stone foundations of a rectangular house. | High Significance | Preservation in situ. | No impact |
| **34** | 603 | Iron Age | Historic Pedi Complex | 30° 08' 45.0000" E | 25° 09' 01.0000" S | Huffman and Schoeman 2002A | Substantial Pedi Complex centres around a rock dome. The site is characterised by low stone lapa walls and burnt daga. | Low to Medium Significance | If the site is impacted on it is recommended that the site should be mapped and monitored. | No impact |
| **35** | 604 | Stone Age | MSA | 30° 08' 45.0000" E | 25° 09' 02.8000" S | Huffman and Schoeman 2002 | Middle stone Age scatter. | Low significance | No mitigation required. | No impact |
| **36** | 605 | Historical | Stone Kraal 2 | 30° 08' 31.4000" E | 25° 09' 28.2000" S | Huffman and Schoeman 2002 | Historic stone kraal. | Low significance | Monitoring if the site will be impacted on. | Inside development footprint |
| **37** | 606 | Historical | Stone Kraal | 30° 08' 34.8000" E | 25° 09' 26.0000" S | Huffman and Schoeman 2002 | Historic stone kraal. | Low significance | Monitoring if the site will be impacted on. | Inside development footprint |
| **38** | 607 | Burial Site | Graves | 30° 08' 41" E | 25° 09' 30" S | Huffman and Schoeman 2001 | Graveyard Complex inside an old homestead | High Significance | Preservation in situ | Inside development footprint |
| **39** | 608 | Iron Age | Iron Age | 30° 07' 26.2000" E | 25° 06' 59.3001" S | Huffman and Schoeman 2002 B | Middle Iron age Eiland villages with burnt daga | Medium significance | | No impact |
| **40** | 609 | Iron Age | Iron Age | 30° 07' 18.6001" E | 25° 07' 12.9000" S | Huffman and Schoeman 2002B | Middle Iron age Eiland villages with burnt daga | Medium significance | | No impact |
| **41** | 610 | Iron Age | Iron Age | 30° 07' 56.3401" E | 25° 08' 53.6399" S | Pistorius 2007 | Rudimentary Terrace walls against slope of low protrusion. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | BS1/2 Infrastructure (Phase 1 / S24G) |

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|---|---|---|---|---|---|---|---|---|---|---|
| **42** | 611 | Iron Age | Iron Age | 30° 07' 45.9600" E | 25° 08' 52.6800" S | Pistorius 2007 | Interrupted circular stone wall on low protrusion. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | Cleared Area (Phase 1 / S24G) |
| **43** | 612a | Iron Age | Iron Age | 30° 07' 55.2601" E | 25° 08' 53.2799" S | Pistorius 2007 | Rudimentary Terrace walls against slope of low protrusion. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | BS1/2 Infrastructure (Phase 1 / S24G) |
| **44** | 612b | Iron Age | Iron Age | 30° 07' 54.9599" E | 25° 08' 52.9199" S | Pistorius 2007 | Rudimentary Terrace walls against slope of low protrusion. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | BS1/2 Infrastructure (Phase 1 / S24) |
| **45** | 613 | Iron Age | Iron Age | 30° 07' 50.3401" E | 25° 08' 52.1399" S | Pistorius 2007 | Rudimentary Terrace walls against slope of low protrusion. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | No Impact |

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|---|---|---|---|---|---|---|---|---|---|---|
| **46** | 614 | Iron Age | Iron Age | 30° 07' 45.3601" E | 25° 08' 49.4999" S | Pistorius 2007 | Stacks of stone on flat surface. Possible boundary walls for homestead. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | Cleared Area (Phase 1 / S24G) |
| **47** | 615 | Iron Age | Iron Age | 30° 07' 44.7599" E | 25° 08' 48.4200" S | Pistorius 2007 | Stacks of stone on flat surface. Possible boundary walls for homestead. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | Cleared Area (Phase 1 / S24G) |
| **48** | 618 | Iron Age | Iron Age | 30° 07' 43.4401" E | 25° 08' 47.8801" S | Pistorius 2007 | Clay with pole impression marking. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | Cleared Area (Phase 1 / S24G) |
| **49** | 617 | Iron Age | Iron Age | 30° 07' 42.4799" E | 25° 08' 50.3400" S | Pistorius 2007 | Interrupted circular stone wall on low protrusion. | Medium significance | Sites should be mapped, test excavated and the results recorded. It is also recommended that the presence of unmarked graves should be confirmed through community liaison. . | Cleared Area (Phase 1 / S24G) |

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|---|---|---|---|---|---|---|---|---|---|
| **50** | H01 | Historical | Historical Village | 30° 08' 30.6601" E | 25° 10' 40.0201" S | Pistorius 2017 | Historical House Coetzee family | Medium to high significance | As per Pistorius 2017 |
| **51** | H02 | Historical | Historical Village | 30° 07' 07.4399" E | 25° 09' 31.0199" S | Pistorius 2017 | 1st Hamlet in Groot Dwars River Valley | Medium to high significance | As per Pistorius 2017 |
| **52** | H03 | Historical | Historical Village | 30° 07' 04.0199" E | 25° 09' 36.6001" S | Pistorius 2017 | 2nd Hamlet in Groot Dwars River Valley | Medium to high significance | As per Pistorius 2017 |
| **53** | V01 | Historical | Historical Village | 30° 07' 52.2599" E | 25° 11' 05.9400" S | Pistorius 2017 | Village against the slope of a hill | Medium to high significance | As per Pistorius 2017 |
| **54** | V02 | Historical | Historical Village | 30° 08' 46.9201" E | 25° 09' 13.4400" S | Pistorius 2017 | Village situated between and next to boulders | Medium to high significance | As per Pistorius 2017 |
| **55** | V03 | Historical | Historical Village | 30° 08' 39.7201" E | 25° 09' 12.9600" S | Pistorius 2017 | Close to GY05 dates from more recent past | Medium to high significance | As per Pistorius 2017 |
| **56** | GY01 | Burial Site | Cemetery | 30° 07' 07.4399" E | 25° 09' 31.0199" S | Pistorius 2017 | Three graves on bottom of Groot Dwars River Valley | High Significance | As per Pistorius 2017 |
| **57** | GY02 | Burial Site | Cemetery | 30° 08' 30.0002" E | 25° 10' 45.3001" S | Pistorius 2017 | Graves of Coetzee family associated with HH01 | High Significance | As per Pistorius 2017 |
| **58** | GY03 | Burial Site | Cemetery | 30° 08' 43.9201" E | 25° 10' 49.5599" S | Pistorius 2017 | Graveyard of the Phetla community with 13 graves | High Significance | As per Pistorius 2017 |
| **59** | GY04 | Burial Site | Cemetery | 30° 08' 49.6799" E | 25° 10' 32.2800" S | Pistorius 2017 | Holds approximately 15 graves | High Significance | As per Pistorius 2017 |
| **60** | GY05 | Burial Site | Cemetery | 30° 08' 37.1401" E | 25° 09' 14.6401" S | Pistorius 2017 | Holds nine graves | High Significance | As per Pistorius 2017 |
| **61** | G01 | Burial Site | Grave | 30° 08' 22.0201" E | 25° 10' 52.6199" S | Pistorius 2017 | Single grave in iron frame | High Significance | As per Pistorius 2017 |
| **62** | G02 | Burial Site | Grave | 30° 08' 58.0800" E | 25° 11' 00.7201" S | Pistorius 2017 | Single grave with upright stone acting as headstone | High Significance | As per Pistorius 2017 |
| **63** | 4 | Burial Site | GY01 | 30° 07' 17.5799" E | 25° 07' 58.0799" S | Additional Sites recorded S24 G Pistorius 2017 | GY01 | High Significance | As per Pistorius 2017 |
| **64** | 5 | Historical | HH01 | 30° 07' 18.2401" E | 25° 07' 58.7401" S | Additional Sites recorded S24 G Pistorius 2017 | HH01 | Low to Medium Significance | As per Pistorius 2017 |
| **65** | 6 | Historical | HH02 | 30° 07' 18.7800" E | 25° 07' 58.1399" S | Additional Sites recorded S24 G Pistorius 2017 | HH02 | Low to Medium Significance | As per Pistorius 2017 |

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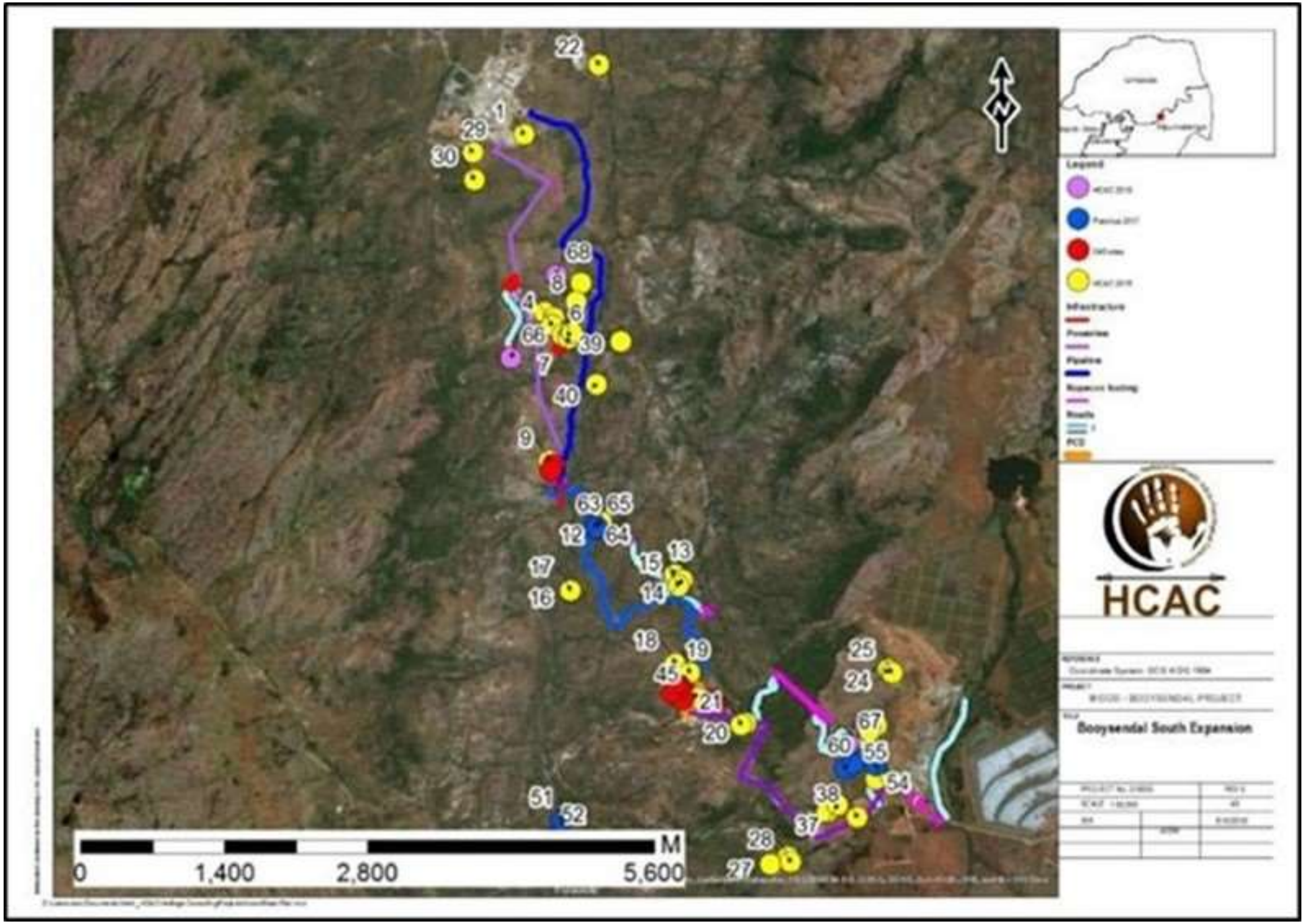
|---|---|---|---|---|---|---|---|---|---|---|
| **66** | BD1 | Iron Age | Ephemeral Stone Walling | 30° 06' 51.5915" E | 25° 07' 04.5192" S | Van der Walt 2018 | Ephemeral Stone Walling | Low to Medium Significance | Mapping after which a destruction permit can be applied for. Monitoring during construction. | Inside development footprint |
| **67** | BD2 | Historical | Rectangular cattle kraal | 30° 08' 38.1121" E | 25° 09' 06.9156" S | Van der Walt 2018 | Rectangular cattle kraal | Low significance | Sufficiently recorded. | |
| **68** | | Historical | Ruin | 30°07'05.85"S | 25°06'38.32" | Van der Walt 2018 | Historical Homestead | Low to Medium Significance | Moved Tower 2 (100 m south). No further impact. | Secondary impact |

Figure 5-37 Distribution of Heritage Sites within the Booysendal Operation



### 5.14.6 Ecosystem Services

There are ecosystem services applicable to Cultural services. Through the cultural heritage finds and identifications on site, this service is applicable in two ways:

- spiritual and historical sites which are related to religious or heritage value; and
- science and education – the loss of cultural heritage sites and the loss of intrinsic knowledge.

The value and potential impacts on ecosystem services associated with cultural resources are included in Table 5-38. Damage to some of the sites of low-medium significance on the footprint areas of the Phase 1 Project already occurred, including sites 9, 10, 54 (historical ruins), 41 to 44 and 46 to 49 (Iron Age).

Table 5-38 Cultural Heritage Resources Ecosystem Services

| Service | Description | Relevant Areas | Importance | Replicability |
|---|---|---|---|---|
| Graves and gravesites | Loss of self and possibly ancestral linkages | Various around the corridors of development | High | Irreplaceable if damaged<br><br>Replaceable if relocated |
| Heritage sites | Damage or destruction of cultural-heritage sites | Loss of our historic knowledge and places of cultural and religious importance | Depending of the site, importance can differ from low too high in this area | Irreplaceable if destructed without mitigation |

## 5.15 Noise and Vibration

The noise and vibration assessment of the Booysendal South Expansion Project: Phase 1 and Phase 2 was done by dBAcoustics.

### 5.15.1 Methodology

#### 5.15.1.1 Desktop Review

The desktop review undertaken during the Phase 1 Project was updated to determine if there are any additional noise information available.

#### 5.15.1.2 Noise Survey

The noise and vibration study was carried out during three periods during the Phase 1 Project, namely summer (15 to 16 February 2016), winter time (19 July 2016) and spring (10 October 2016). An additional noise survey was done on 11 December 2017 for the Phase 2 Project. The different periods were required due to the difference between the prevailing ambient noise levels during summer when the insect activities increased whereas there are no insect activities during the winter, resulting in lower prevailing ambient noise levels. The coordinates of the noise monitoring points are included in Annexure N and C and therefore not repeated here. The different field surveys were furthermore required due to the expansion of the Phase 2 Project definition. The noise measurements were preceded by an identification of points where noise measurements were required (refer to Annexure N). Daytime (6:00 – 22:00) and night time (22:00 – 6:00) noise measurements were taken with the following instruments:

- Larsen Davis Integrated Sound Level Meter Type 1 – Serial no. S/N 0001072;
- Larsen Davis Pre-amplifier – Serial no. PRM831 0206;

- Larsen Davis ½" free field microphone – Serial no. 377 B02 SN 102184; and
- Larsen Davis Calibrator 200 – Serial no.9855.

The LAeq was measured over a representative sampling period exceeding 10 minutes at each measuring point. The instruments were calibrated before and after each reading and the calibration certificates for the instruments are also included on the noise report.

#### 5.15.1.3 Reporting

The assessment of noise levels is described using statistical noise calculations based on an average of the projected noise levels of the project. This is compared to the ambient noise level. The outcome of the comparison provides an intrusion level which can vary in dBA. Anything over the allowed threshold level of 7dBA is considered a noise disturbance. The measurement of noise levels is based on a Leq value, which is the constant sound level that would contain the same acoustic energy as the varying sound level during a period.

Noise calculations were done using the equation:

Lp = Lw – 20log R – 5dB

Where:

- Lp is the sound level at a distance from the source in dBA;
- Lw the sound level at source in dBA; and
- R the distance to the source.

The noise level inputs used for the various noise sources are included in Section 6.3 of the Noise Impact Assessment Report (Annexure N), and includes noise sources from BN, BS1/2, linear infrastructure components, mechanical equipment and vehicle fleet, BCM1, BCM2, BS4 and the Valley Boxcut.

Blasting during the construction phase can cause ground vibration and over-air pressure. The formula used to calculate vibration is: $V = k.\left(\frac{R}{\sqrt{W}}\right)^b$ where V is the peak particle velocity in mm/s; R is the distance from the blast to the monitoring point in m; W is the explosive charge weight per delay in kg; k and b are standard weighting factors.

Air overpressure is generally more apparent than ground vibration and can cause for instance windows to rattle. The formula used to calculate air overpressure is: $P[dBZ]5\% = 165.3 - 24\log 10\left(\frac{D}{\sqrt[3]{W}}\right)$ where P is the 95th percentile of the peak pressure on dBZ; D is the distance to the blast in and W is the charge per mass delay in kg. Generally, concerns of public are more related to air overpressure which is generally mistaken for ground vibration.

During the Phase 2 Project, blasting will be mainly done to establish the BCM1 and BCM2 adits and terraces. It is not foreseen that any fly rock which could impact on communities will result from this.

### 5.15.2 Noise and Vibration Baseline

The baseline noise measurements were done at 24 monitoring points across the Phase 2 Project AoI (refer to Figure 6-4). The Phase 2 Project is located in a rural area, therefore SANS 10103:2008 rural noise limits are applicable to the wider AoI. The acceptable noise levels for various receptor are included in Table 5-39.

Table 5-39 SANS 10103:2008 Sound Level Limits (Source: dBAcoustics, 2018)

| Type of District | Equivalent Continuous Rating ($L_{Req.T}$) for ambient noise - dBA | | | | | |
|---|---|---|---|---|---|---|
| | Outdoors | | | Indoors, with Open Windows | | |
| | Day-Night $L_{Rdn}$ | Day $L_{Reqd}$ | Night $L_{Reqn}$ | Day-Night $L_{R.dn}$ | Day $L_{Req.d}$ | Night $L_{Req.n}$ |
| **Rural Districts** | 45 | 45 | 35 | 35 | 35 | 25 |
| **Suburban with little road traffic** | 50 | 50 | 40 | 40 | 40 | 30 |
| **Urban Districts** | 55 | 55 | 45 | 45 | 45 | 35 |
| **Urban with some workshops, business premises and main roads** | 60 | 60 | 50 | 50 | 50 | 40 |
| **Central Business District** | 65 | 65 | 55 | 55 | 55 | 45 |
| **Industrial District** | 70 | 70 | 60 | 60 | 60 | 50 |

Existing noise sources in the study area include: the processing plant at BN (which can be heard near the communities at BS4), heavy duty vehicle noise, distant traffic from the feeder roads, Phase 1 Project construction activities, sounds associated with farming activities, birds and insects. As noise monitoring must be done at the border of the mining property and at sensitive locations outside of the mining boundary, the noise levels measured will depict that noise levels from all noise sources. It is therefore not possible to distinguish between noise levels at BN and BS as in each case the current noise levels of the one will influence the noise levels of the other. All the baseline points will also have been applicable to either BN or BS in any case. The results of the baseline noise monitoring for the Phase 2 Project is included in Table 5-40, which also provides a description of the noise sources at the specific point.

Table 5-40 Phase 2 Project Baseline Noise Levels (Source: dBAcoustics, 2018)

| Position | Day time | | | | Night time | | | |
|---|---|---|---|---|---|---|---|---|
| | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks |
| 1 | **64.3** | 76.8 | 58.3 | Concentrator plant noise. | **58.6** | 62.1 | 57.0 | Concentrator plant noise. |
| 1a | **60.5** | 65.8 | 57.0 | Flotation noise. | **60.4** | 64.1 | 58.4 | Flotation noise. |
| 1b | **66.2** | 76.2 | 62.4 | Spiral plant and other plant noise. | **63.1** | 66.1 | 62.0 | Spiral plant and other plant noise. |
| 1c | **68.7** | 71.2 | 66.9 | DMS on western side. | **68.4** | 69.9 | 67.3 | DMS on western side. |
| 1d | **84.2** | 87.1 | 81.9 | At footprint boundary fence - 40m from secondary crusher. Crushing noise. | **74.2** | 75.8 | 73.2 | Secondary crusher noise. |
| 1e | **68.2** | 77.7 | 64.5 | Primary crusher noise. | **68.2** | 77.7 | 64.5 | Primary crusher noise. |
| 1f | **40.8** | 65.4 | 30.2 | Distant plant noise. | **44.7** | 49.7 | 42.9 | Distant plant noise. |
| 1g | **79.8** | 90.4 | 61.2 | Frag ventilation opening – ventilation noise. | **79.8** | 90.4 | 61.2 | Frag ventilation opening – ventilation noise. |

| Position | Day time | | | | Night time | | | |
|---|---|---|---|---|---|---|---|---|
| | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks |
| 1h | **57.5** | 64.1 | 54.8 | Distant plant noise as perceived from the Meg 10 water reservoir | **58.6** | 67.7 | 56.7 | Distant plant noise as perceived from the Meg 10 water reservoir. |
| 1i | **54.3** | 74.3 | 30.9 | Along feeder road – traffic noise. | **52.2** | 68.8 | 45.5 | Along feeder road – traffic noise. |
| 2 | **34.0** | 64.7 | 20.6 | Natural noises. | **32.0** | 50.5 | 24.4 | Distant insects. |
| 3 | **41.4** | 67.5 | 25.5 | Distant excavator activities at 300m from site. | **30.0** | 58.2 | 21.7 | Distant insects. |
| 4 | **35.4** | 63.6 | 23.8 | Far distant excavations. | **28.8** | 48.4 | 24.7 | Distant insects. |
| 5 | **32.3** | 49.5 | 20.0 | Distant traffic from the R577 & domestic | **29.8** | 49.1 | 19.4 | Distant insect noise. |
| 6 | **34.4** | 60.0 | 22.1 | Distant traffic from the R577 & domestic | **28.2** | 44.8 | 22.2 | Distant insect noise. |
| 7 | **36.0** | 49.5 | 18.4 | Distant traffic from the R577 & domestic | **31.2** | 48.1 | 19.1 | Distant insect noise. |
| 8 | **33.7** | 47.2 | 19.9 | Farm animals. 50.3dBA when aircraft flew over property. | **36.5** | 47.5 | 33.3 | Distant insect noise. |
| 9 | **27.4** | 45.6 | 18.0 | Distant animal noises. | **36.0** | 57.7 | 32.0 | Distant insect noise. |
| 10 | **35.1** | 60.7 | 20.8 | No mine activities. | **34.8** | 54.3 | 28.9 | Distant insect noise. |
| 11 | **30.7** | 45.2 | 21.1 | Distant security point noise. | **37.8** | 53.6 | 34.6 | Distant insect noise. |
| 12 | **38.6** | 56.6 | 20.9 | Distant domestic noise. | **38.4** | 52.9 | 31.2 | Distant insect noise. |
| 13 | **34.6** | 65.4 | 22.5 | Distant domestic noise. | **37.4** | 60.7 | 35.0 | Distant insect noise. |
| 14 | **37.9** | 61.0 | 25.1 | Distant domestic noise. | **33.6** | 63.7 | 29.6 | Distant insect noise. |
| 15 | **42.7** | 58.5 | 26.5 | Domestic noise. | **33.7** | 57.9 | 28.9 | Distant insect noise. |
| 16 | **50.1** | 76.9 | 23.1 | Distant traffic noise from R 577 and the access road to mine intermittent traffic. | **34.5** | 60.7 | 35.0 | No traffic noise and only distant insect noise. |
| 17 | **39.8** | 55.7 | 23.8 | Distant traffic noise from R577 and domestic noise. | **28.6** | 47.8 | 17.0 | Distant insect noise. |
| 18 | **54.7** | 79.8 | 24.7 | Traffic noise from R577. | **53.0** | 60.4 | 42.7 | Fewer vehicles along this road at night. |

| Position | Day time | | | | Night time | | | |
|---|---|---|---|---|---|---|---|---|
| | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks | Leq - dBA | Lmax (Fast) - dBA | Lmin (Fast) - dBA | Remarks |
| 19 | **36.4** | 61.1 | 21.2 | Distant traffic noise from R577. | **32.7** | 52.8 | 19.8 | Distant insect noise. |
| 20 | **39.1** | 56.8 | 21.3 | Farm activities. | **32.1** | 49.6 | 19.2 | Distant insect noise. |
| 21 | **52.5** | 71.8 | 27.8 | Traffic noise. | **50.2** | 68.2 | 40.1 | Traffic noise. |
| 22 | **27.0** | 45.1 | 16.9 | Natural noise. No mine activities | **25.3** | 59.8 | 15.4 | Natural noise. No mine activities. |
| 23 | **26.9** | 47.5 | 17.2 | Natural noise. No mine activities | **24.0** | 41.4 | 15.2 | Natural noise. No mine activities. |
| 24 | **28.5** | 62.8 | 16.5 | Natural noise. No mine activities | **26.7** | 58.6 | 15.3 | Natural noise. No mine activities. |

### 5.15.3 Vibration and Air Overpressure

The effect of blasting can be twofold and can cause ground vibration which could result in greater of lesser impacts on building structures and air overpressure. During none of the monitoring campaigns were there any blasting therefore no vibration of air overpressure results area available.

### 5.15.4 Sensitivities

Human sensitive receptors are all the people who might be affected by an increase in noise levels more than 7dBA. The location of potential sensitive receptors is included in Figure 6-4 and highlighted in Table 5-40.

Fauna are known to be impacted by human activities and noise, especially noise frequencies influencing breading patterns, migration routes and habitat preference. Fauna within close to the proposed Phase 2 Project are therefore regarded as sensitive receptors especially as a result of various noise frequencies which will result from the Phase 2 Project.

### 5.15.5 Ecosystem Services

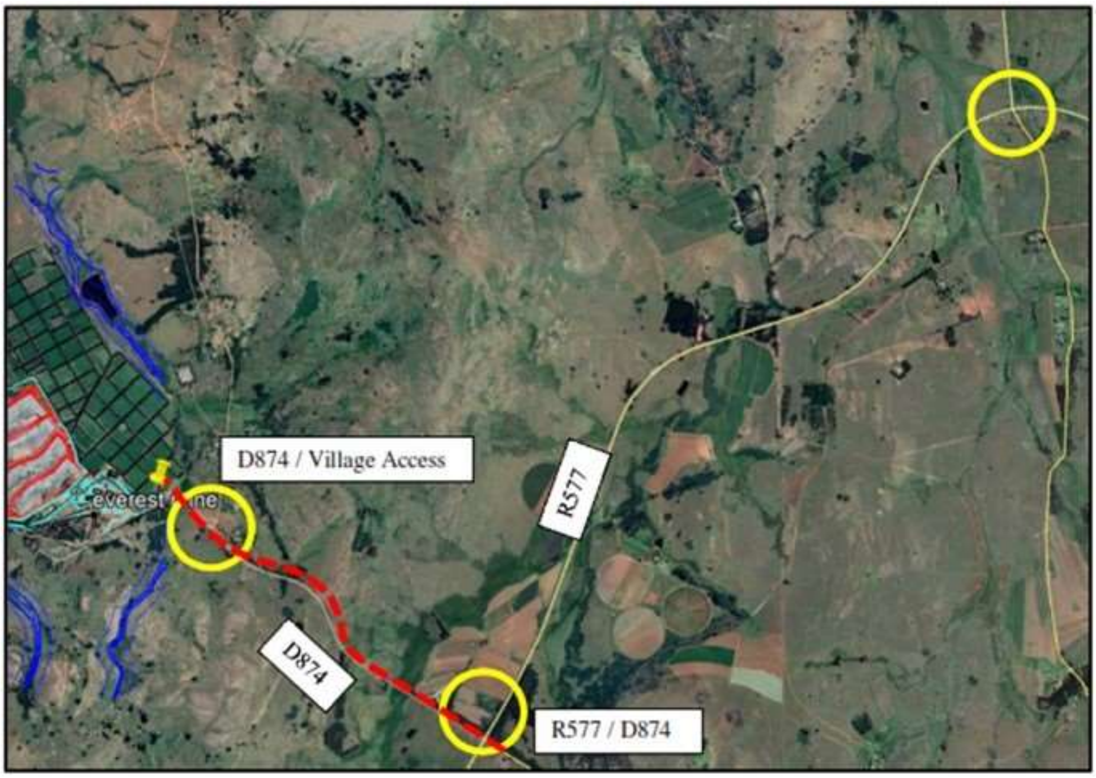
No ecosystem services were highlighted by the noise specialist.

## 5.16 Traffic

The traffic impact assessment ("**TIA**") was undertaken by Hamatino Consulting Engineers. The purpose of the TIA is to determine current traffic volumes and safety on the potentially affected roads and to determine the cumulative increase in traffic, to assess if access would be appropriate in terms of safety standards, to assess if the increased traffic, which will result from the Booysendal South Expansion Project, can be accommodated safely especially at the various intersections and to provide management recommendations.

The TIA is applicable to the access road from BS4 where it ties into the D874 and into the R577 Roossenekal – Mashishing Road. It also considers the intersection between the R577 and the D212, Sekhukhune turn-off. The road configuration is included in Figure 5-38. The TIA is included in Annexure O.

Figure 5-38 Traffic Impact Assessment Roads and Intersections (Source: Hamatino, 2018)




### 5.16.1 Methodology

The first step in the traffic study was to carry out traffic counts at the intersections indicated in Figure 5-38 to obtain background traffic volumes. The traffic count of the D874/Village access road and D874/R577 intersections was carried out on Tuesday 7 February 2017 from 18:00pm to Wednesday 8 February 18:00pm and the traffic count for the D577/D212 intersection in March 2018 just after the school holiday ended.

The traffic count was followed by a trip generation where the increase in traffic has been calculated and analysed in terms of type of vehicles, trips, peak flows. The data was them included into the aaSidra & Traffix for Windows computer software design packages to determine if the road intersections will be able to handle the additional traffic volumes. The reporting also included recommendations to deal with the increase in traffic volumes.

### 5.16.2 Traffic Baseline

The main roads applicable to the Booysendal South Expansion Project, including the Phase 2 Project, are the:

- D874 which runs from the BS4 security gate to the intersection with the D577. This road is mainly used by farmers in the area and BS4 mine personnel and the communities which live to the east of BS4;
- The Village road (D874) which ties into the D874 close to the BS4 entrance. This road is used by the village communities to the east of BS4; and
- The intersection between the Sekhukhune (D212) and Roossenkal/Mashishing road. This intersection carries mainly farm and town traffic on the R577 and mine traffic on the D212.

The results of the traffic count and average daily traffic ("**ADT**") volumes is included in Table 5-41. Traffic flows are currently very low.

Table 5-41 Traffic Volumes on the Roads associated with Booysendal South Expansion Project: 2017 and 2018 Count (Source: Hamatino Consulting Engineers, 2018)

| Intersection | Count | Peak Hour | Peak Hour Factor |
|---|---|---|---|
| **Average Daily Traffic Volumes** | | | |
| **R577 / D874** | 401 vehicles through intersection (sum of all directions) | | |
| **D874 / Village Intersection** | 137 vehicles through intersection (sum of all directions) | | |
| **AM Peak Hour Traffic** | | | |
| **R577 / D874** | 40 | 06:00-07:00am | 0.61 |
| **D874 / Village Intersection** | 18 | 06:15-07:15am | 0.61 |
| **R577 / D212 Intersection** | 646 | 05:45-06:45am | 0.82 |
| **PM Peak Hour Traffic** | | | |
| **R577 / D874** | 46 | 15:30-16:30pm | 0.68 |
| **D874 / Village Intersection** | 21 | 16:00-17:00pm | 0.75 |
| **R577 / D212 Intersection** | 526 | 15:45-16:45 | 0.81 |

The direction of traffic at the various intersections are included in Annexure A of the TIA (Annexure O).

The aaSidra & Traffix for Windows computer software design packages was used to analysed current level of service ("**LOS**") at the various intersections. As part of the analysis, an intersection delay is provided. The current LOS exclude any operational increase in traffic expected from the Booysendal South Expansion Project's operational phase. The LOS is defined according to the Highway Capacity Manual criteria included in Table 5-42. The LOS findings are included in Table 5-43.

Table 5-42 Level of Service Criteria (Source: Hamatino Consulting Engineers, 2018)

LEVEL-OF-SERVICE CRITERIA FOR PRIORITY INTERSECTIONS & ROUNDABOUTS

| Level of Service | Average Control Delay (S/veh) |
|---|---|
| A | 0-10 |
| B | >10-15 |
| C | >15-25 |
| D | >25-35 |
| E | >35-50 |
| F | >50 |

LOS CRITERIA FOR SIGNALIZED INTERSECTIONS

| LOS | Control Delay per Vehicle (s/veh) |
|---|---|
| A | 0-10 |
| B | >10-20 |
| C | >20-35 |
| D | >35-55 |
| E | >55-80 |
| F | >80 |

LOS A: free flowing traffic with a volume to ratio between 0 to 0.1
LOS B: low stable flow with a volume to ratio between 0.1 to 0.3
LOS C: high stable flow with a volume to ratio between 0.3 to 0.7
LOS D: approaching unstable flow with a volume to ratio capacity between 0.7 to 1.0
LOS E: unstable flow with a volume to capacity ration of 1.)
LOS F: forced flow
Intersections with LOS E or F should be upgraded.

Table 5-43 Current Level of Service of Potentially Affected Intersections

| Intersection | Level of Service and Delays | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Northbound | | Southbound | | Eastbound | | Westbound | | Intersection | |
| | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| **Weekday AM** | | | | | | | | | | |
| **R577 / D874** | A | 9.2 | A | 9.1 | A | 7.5 | A | 7.5 | A | 9.2 |
| **D874 / Village Intersection** | A | 7.5 | A | 0 | n/a | n/a | A | 9.0 | A | 9.0 |
| **R577 / D212** | D | 25.8 | C | 19.9 | A | 7.5 | A | 8.7 | D | 25.8 |
| **Weekday PM** | | | | | | | | | | |
| **R577 / D874** | A | 9.5 | A | 8.8 | A | 0 | A | 7.5 | A | 9.5 |
| **D874 / Village Intersection** | A | 7.5 | A | 0 | n/a | n/a | A | 8.7 | A | 8.7 |
| **R577 / D212** | B | 14.1 | B | 12 | A | 0 | A | 7.5 | B | 14.1 |

The R577 / D874 and the D874 / Village Intersection currently operates ad acceptable LOS during peak hours. Although the R577 / D212 is currently operating at an acceptable LOS it is expected to reach full capacity soon.

### 5.16.3 Sensitivities

Sensitive receptors are the road users that makes use of the roads under normal circumstances, including the inhabitants of famers, communities, villagers and towns along the roads.

### 5.16.4 Ecosystem Services

There are no ecosystem services provided by the roads, but the roads could have impacts on the ecosystem services through emissions affecting flora or road kills of fauna.

## 5.17 Visual

The Visual Impact Assessment ("**VIA**") for the Phase 2 Project was carried out by GISM who also did the Phase 1 Project and the original BN VIA. In rural areas especially, development has the potential to intrude visually through the structures and through lights at night on the baseline visual components. The existing visual baseline conditions of the Phase 2 Project Area is mainly rural in nature. Some intrusion from high structures at BS4 is visible to surrounding communities, while night glare at night could result in some intrusion to communities directly surrounding the site. The area to the south has a very strong rural sense of place.

### 5.17.1 VIA Methodology

#### 5.17.1.1 Desktop Review

Spatial digital terrain model data was analysed and manipulated in ArcGIS. This data provides 2m-contour data, which in ArcGIS portrays the topography of the Phase 2 Project Area. The Project data was also manipulated in ArcGIS to give a three-dimensional representation of Phase 2 Project infrastructure.

#### 5.17.1.2 Field Survey

A field survey was undertaken as part of the Phase 1 Project to identify representative viewpoints, gain a better understanding of the sense of place and the character of the landscape to accommodate and absorb change; and to understand the receptors that may be affected by the Booysendal South Expansion Project (Phase 1 and 2).

#### 5.17.1.3 Data Analysis and Reporting

ArcGIS was used to determine the zone of influence ("**ZVI**") through terrain, topographical and land cover modelling of the various infrastructure components. Additional modelling was done to determine the visual impact index ("**VII**"), therefore the magnitude and extent of the various infrastructure components and the potential combined visibility thereof on the various receptors. Finally, representative views as experienced of local residents were used for the photographic simulations. The photographic simulation shows the proposed activity superimposed onto the existing landscape scene.

### 5.17.2 Visual Baseline

Visual impact is influenced by topographical character (refer to Section 5.3) which determines the visual extent activities will be seen, the landscapes' absorption capacity which is directly linked to the type and density of vegetation (refer to Section 5.12) and the nature of the receiving environment as it is perceived by the occupiers, the land use (refer to Section 5.8) and the character of the land which influence the sense of place. The character of the land include:

<u>Topography</u>: The steep sided valley in which the Booysendal North MR Activities are located will assist to screen infrastructure components, while the more exposed BS4 will receive less screening.

<u>Vegetation</u>: Although the vegetation in this environment ranges in height from 2.5 to 5m, it could contribute to screen some of the lower infrastructure components.

<u>Road Networks</u>: The Phase 2 Project is located in a remote part of the Mpumalanga and Limpopo provinces and is relatively inaccessible via road. The current transport network within the immediate area mainly comprises of a network of informal dirt tracks and pathways, the D874 and the R577 which forms part of the Steenkampsberg Pass. The ZVI analysis indicates that the proposed infrastructure will not be visible from the R577 main road but may be visible from the Village road.

<u>Land Use</u>: is limited to wilderness areas to the south and the western escarpment, some farming to the east the western side or the Steenkamps Berg and nearby south-eastern areas.

<u>Sense of Place</u>: Central to the concept of sense of place is that the landscape requires uniqueness and distinctiveness as perceived by its inhabitants. The sense of place in the various areas can be described as follow:

- North - The visual character of the northern section is dominated by conventional mining activities (BN, Anglo Platinum-Glencore Mototolo JV, Glencore's Helena Mine followed by Glencore's Magareng and Thorncliffe Mines and further north the Assmang Dwarsriver Mine, Anglo Platinum's Twickenham Mine and to the west the African Rainbow Minerals' Two Rivers Mine, and associated infrastructure. Operational and security lighting from the various mines generate direct light and a general glow within this section at night. Mining and associated activities provide the northern section with a distinct sense of place associated with commercial mining and exploration activities.
- South and West - The area is located in a natural, elevated 'vessel' that opens to the north and which is contained by the dramatic Steenkamps Berg on three sides. From higher vantage points the rural nature and rugged character of the scene is evident. These factors combine to create the perception that the place has a rather unique natural and biodiversity quality and character. However, there is a sense that the beauty and 'wildness' of the area is being compromised to the north with the presence of the existing mining operation and its necessary support infrastructure. The southern section of the Groot Dwars River valley is not inhabited and not easily accessible, this is combined with the visual splendour of the landscape adds to the uniqueness of this section. These characteristics as mentioned before, provide this section with a distinct aesthetic and natural sense of place.
- East - The eastern section has a rural character and is more accessible and populated than the southern section. Limited agriculture and some existing mining activities are located at BS4. Operational and security lighting from existing BS4 operations generates direct light and a general glow at night. The landscape is impacted by the existing mining operation and invasive plant species,

some settlements and limited farm homesteads. However, the sense of place of the study area is established with the combination of natural valleys and the surrounding mountains. The typical aesthetic character is that of a rural area within a natural landscape.

The extent to which the Phase 2 Project will change the above will be one of the factors determining the significance of the visual impact

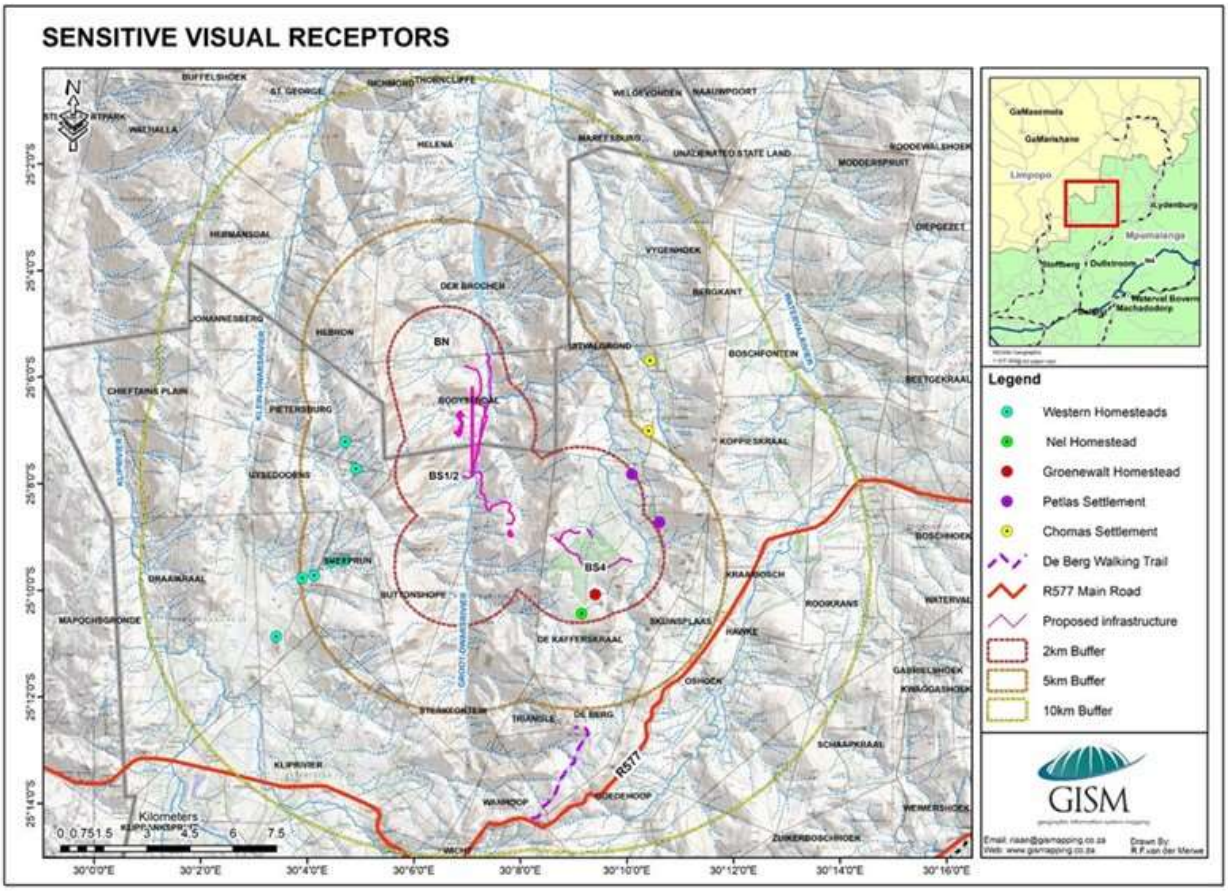
Visual Quality and Character: The once spectacular and 'wild', rural landscape, especially to the south, is increasingly compromised by the presence of 'foreign', seemingly 'out of place' activities of the existing mining operations, prospecting sites, Eskom power lines and the encroachment of alien vegetation – mainly in the northern and eastern sectors. For this reason and when considered together, the whole study area's aesthetic value is reduced to moderate, although high to the south.

### 5.17.3 Sensitivities

Sensitive human receptors may experience a visual intrusion as a result of the Phase 2 Project cumulatively with other influences. The location of sensitive receptors is included in Figure 5-39. It also indicates the 10km buffer from where light and the activities should no longer be visible.

Natural sensitive receptors include mainly fauna species which could be influenced mainly by the unnatural light, especially nocturnal fauna species.

Figure 5-39 Zone of Visual Influence and Sensitive Receptors (Source: GISM, 2018)




### 5.17.4 Ecosystem Services

Visual ecosystem services are included in Table 5-44.

Table 5-44 Visual Ecosystem Service

| Service | ES Category | Description | Additional information (including threats and alternative ES) | Relevant Habitats | Importance to Beneficiaries | Replaceability |
|---|---|---|---|---|---|---|
| Recreation and aesthetic enjoyment | Cultural Services | It is assumed that scenic wilderness areas form the core recreation amenity in this area due to the high positive aesthetic appeal. | Removal of scenic wilderness areas to install mine infrastructure will reduce the scenic quality of the immediate area and therefore the recreation and aesthetic value of the surrounding environment. | Pristine/ Natural habitats. | **Low**<br>Localised visual perceptions of the economically marginalised communities of the population may be influenced by the short term economic and job opportunities that will exist rather than the direct visual perception of the Project.<br>**Moderate** Other residents Geographic proximity estimated at <10km. | **Low** Spatial alternatives are dependent upon type of sensitive receptor. For residents, the views are irreplaceable as the views are static, whereas local motorist the views are dynamic. |

# 6. Project Area of Influence

In terms of the IFC Performance Standards, 2012, (IFC-PS1) the Phase 2 Project AoI is defined as:

"*The area likely to be affected by:*

- *the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project;*
- *impacts from unplanned but predictable developments caused by the project that may occur later or at a different location;*
- *indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent;*
- *associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable; and*
- *cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted*."
- and refers to areas outside the 10-km zone of the direct impact.

Table 6-1 provides the AoI identified by each of the specialist fields for the Phase 2 Project. These are further spatially indicated in figures where it aided an understanding of the area to be affected.

Table 6-1 Phase 2 Project AoI of the Different Environmental Components

| Environmental Component | Area of Influence (AoI) |
|---|---|
| **Terrestrial Flora and Fauna** | *Direct* (e.g. loss of flora and fauna with clearing of vegetation): The Phase 2 Project footprint and 100m buffer around the Phase 2 Project footprint.<br>*Indirect* (e.g. habitat degradation and faunal disturbance from dust, light and noise): The Phase 2 Project footprint and all adjoining areas contained within the highest surrounding topographic contours. |
| **Aquatic Flora and Fauna** | *Direct:* The Phase 2 Project footprint and 100m buffer around the footprint, as well as from the upper reaches of the Groot Dwars River, north to Der Brochen Dam and associated tributaries in the Phase 2 Project Area (see Figure 6-3).<br>*Indirect*: Groot Dwars River downstream of Der Brochen Dam up to the confluence with the Steelpoort River. |
| ***Pycna Sylvia*** | *Direct and Indirect*: From the upper reaches of the Groot Dwars River valley to BN. |
| **Water Quality** | *Direct:* The Phase 2 Project footprint and 100m buffer around the footprint, as well as from the upper reaches of the Groot Dwars River, north to Der Brochen Dam and associated tributaries in the Phase 2 Project Area.<br>*Indirect*: Groot Dwars River downstream of Der Brochen Dam up to the confluence with the Steelpoort River. |
| **Wetlands** | *Direct*: The Phase 2 Project footprint and 500m buffer around the Phase 2 Project footprint, as well as from the upper reaches of the Groot Dwars River south of BS1/2 and north to directly downstream of the Phase 2 Project Area.<br>*Indirect*: Groot Dwars River downstream of the Phase 2 Project Area to the BS4 fence line.<br>*Cumulative:* FEPA wetland ecosystem of the Groot Dwars River. |
| **Hydrology** | *Direct:* The site delineated catchment areas i.e. the Groot Dwars River upstream of De Brochen Dam (Tier 3); and affected surface water resources (Tier 4), including 27 sub-catchments.<br>*Indirect:* The Olifants River WMA (Tier 1); and DWS Quaternary Catchment Area (B41G) (Tier 2). |

| | |
|---|---|
| **Hydrogeology** | *Direct:* The areas affected by potential dewatering and dewatering cone. Areas which may by the formation of a pollution plume.<br>*Indirect:* Should decant become applicable the indirect AoI will be the same as that of the Hydrology (refer to Figure 6-1). |
| **Soil, Land Use and Land Capability** | *Direct:* Phase 2 Project footprint and an approximately 100m buffer around the footprint.<br>*Indirect:* Groot Dwars River valley and 500m around BS4.<br>*Cumulative*: Total Booysendal South Expansion Project Footprint. The spatial extent of the AoI is included in Figure 6-2 |
| **Air Quality** | *Direct*: 1km from unpaved roads; 2km from crusher; and 4km from tailings dam and any cleared area.<br>*Cumulative:* 15.3km (north-south) by 14.4km (east-west) |
| **Greenhouse Gas Emissions** | *Direct, Indirect and Cumulative:* Global impact as climate change is a phenomenon which impacts on everybody and all ecosystems |
| **Noise** | *Direct*: Residential properties within a radius of 8km from centre of each Phase 2 Project Area (see Figure 6-4). |
| **Traffic** | *Direct*: Road users which could be directly affected by an increase in traffic. This includes people making use of the Village access road and the D874.<br>*Indirect:* Road users of the D577 Roossenekal-Lydenburg Road and the D577 Steelpoort-Lydenburg Road. |
| **Visual** | *Direct*: Views from next to the project development to a 10km radius around the project. Refer to Figure 5-39.<br>*Indirect:* The same as direct. |
| **Social** | *Direct*: Booysendal (most farms owned by Booysendal); the settlement to the north of BS4, the Phetla community; and people residing within the municipal wards and communities near the mining operation - Ward 5 of the TCLM and Ward 31 of GTLM (see Figure 6-5).<br>*Indirect*: The regional target population encompassing the Ehlanzeni and Sekhukhune District Municipalities, mainly within a 10km radius around the site (see Figure 6-5). |
| **Cultural Heritage** | *Direct:* Phase 2 Project footprint and an approximately 100m buffer around the footprint.<br>*Indirect*: Groot Dwars River valley and 500m around BS4. |

Figure 6-1 Groundwater AoI (Source: Future Flow, 2018)

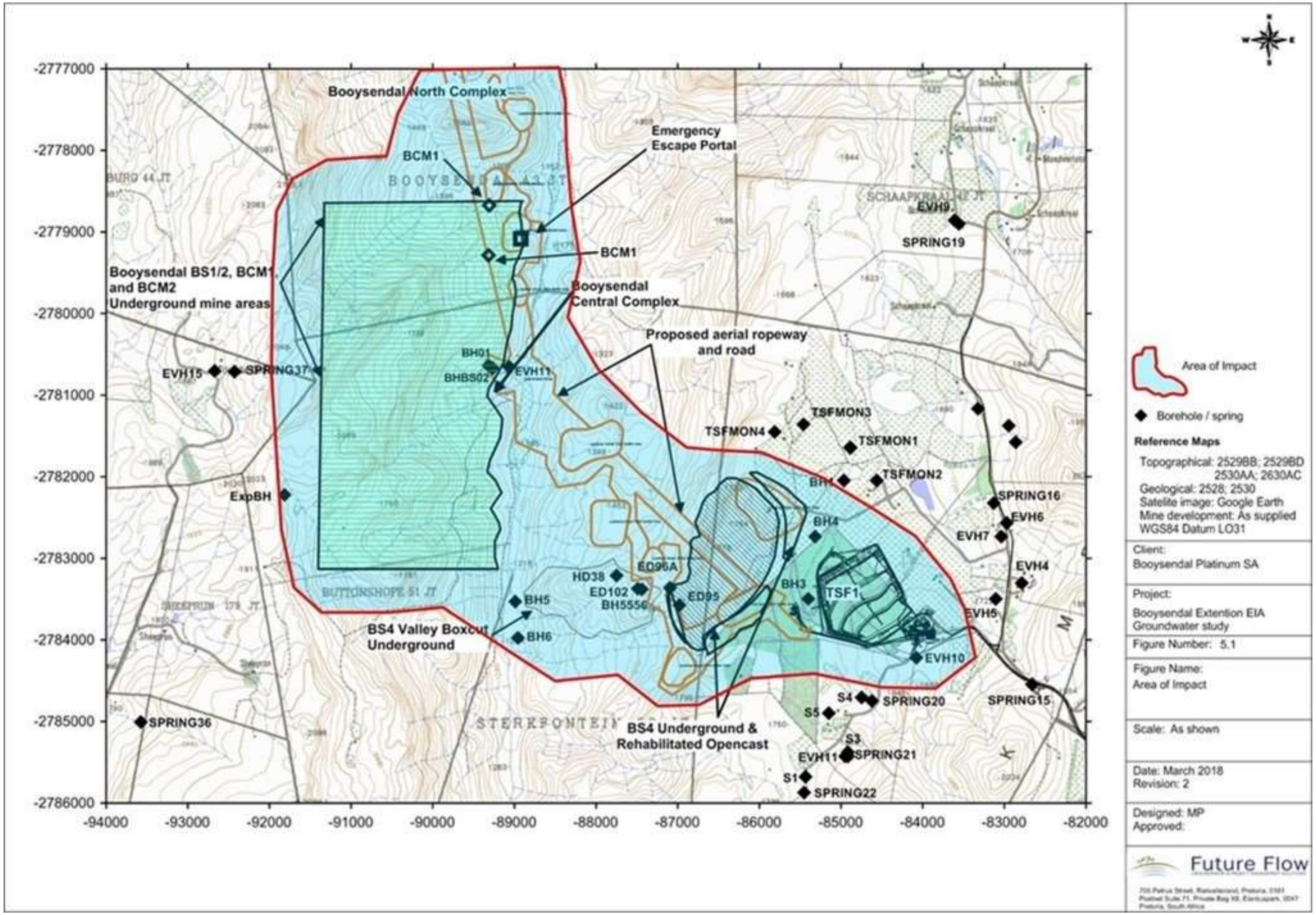


Figure 6-2 Area of Influence of Potential Impacts on Soils, Land Use and Land Capability (Source: Terra-Africa, 2018)

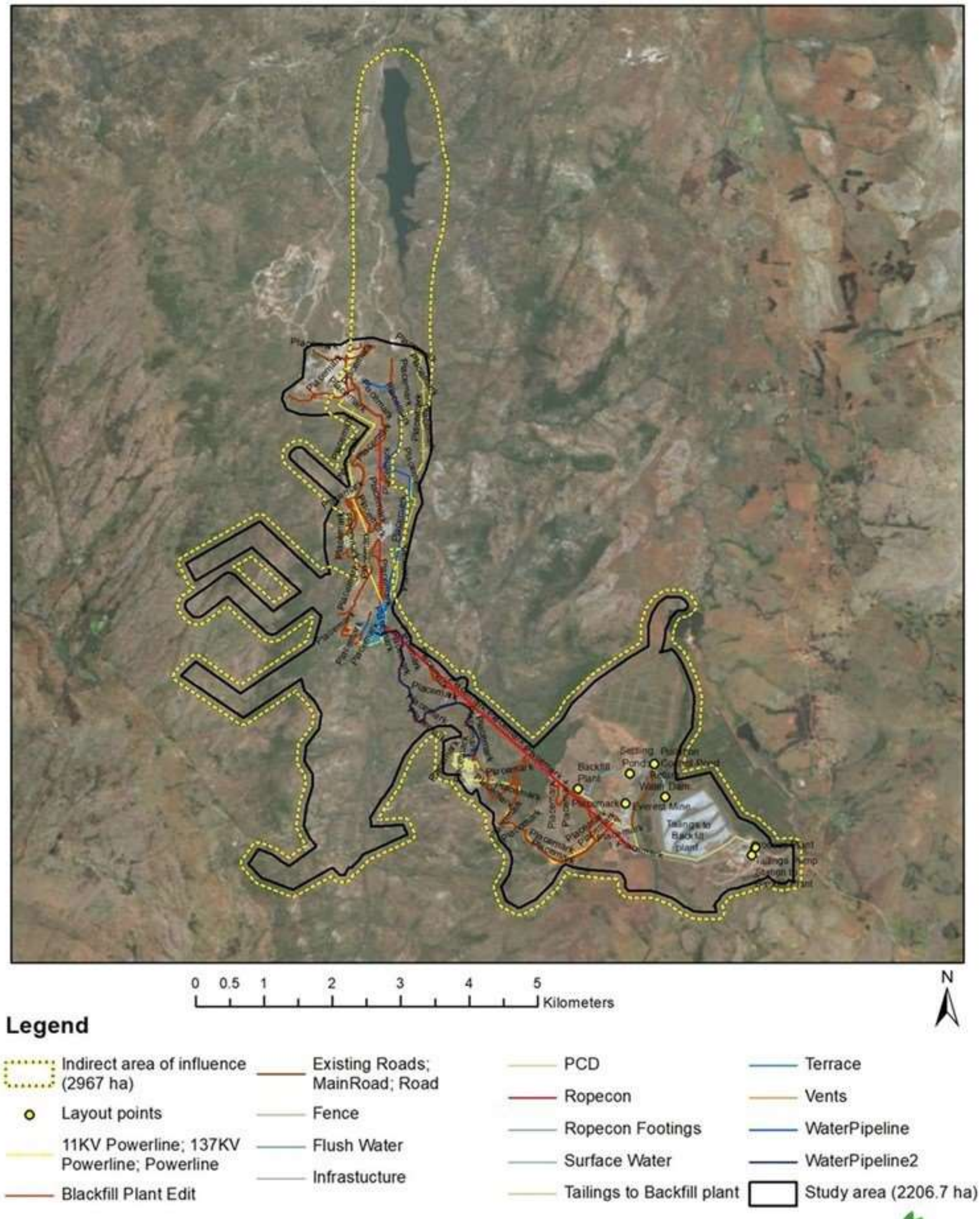


Figure 6-3 Aquatic Biodiversity Area of Influence (Source: Clean Stream, 2018)

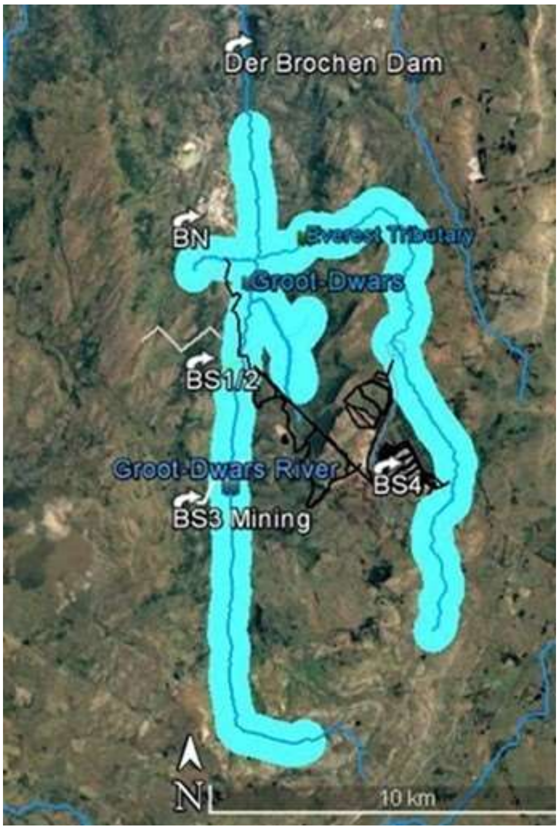



Figure 6-4 Noise Sensitive Receptors and AoI (Source: dBAcoustics, 2018)

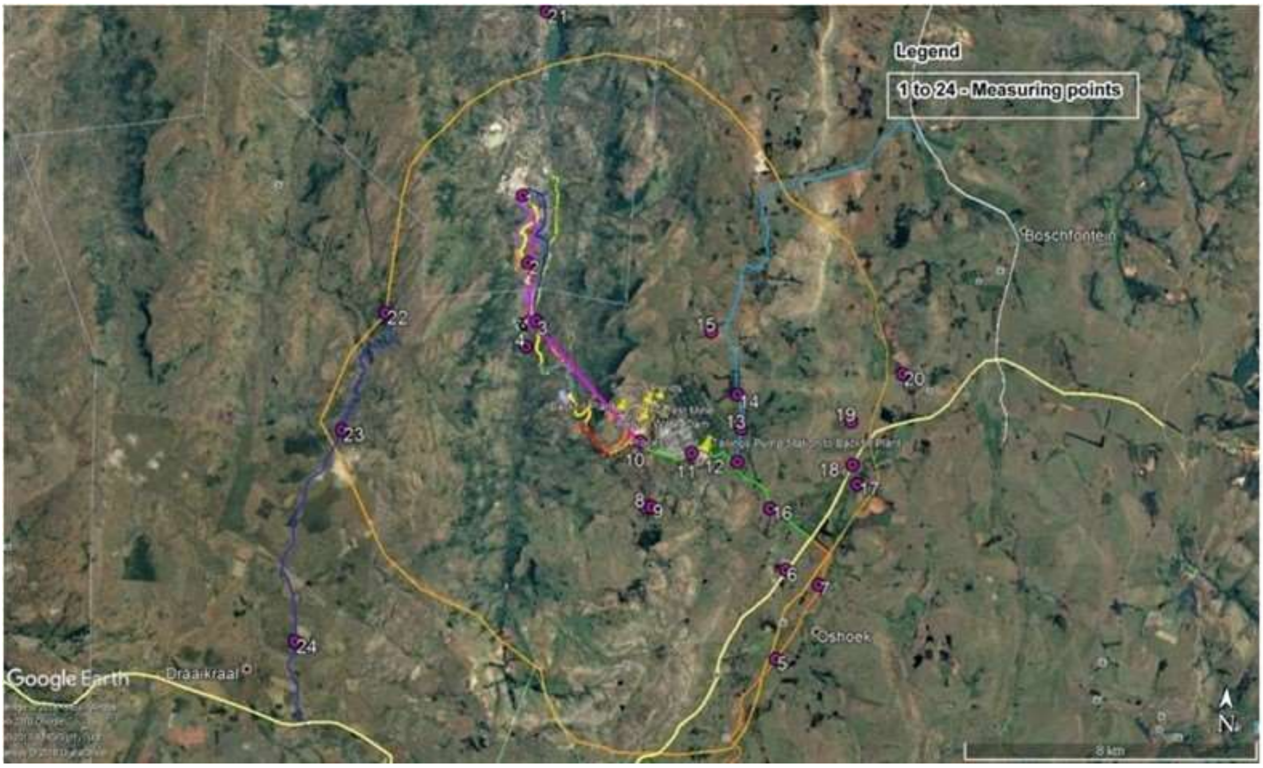
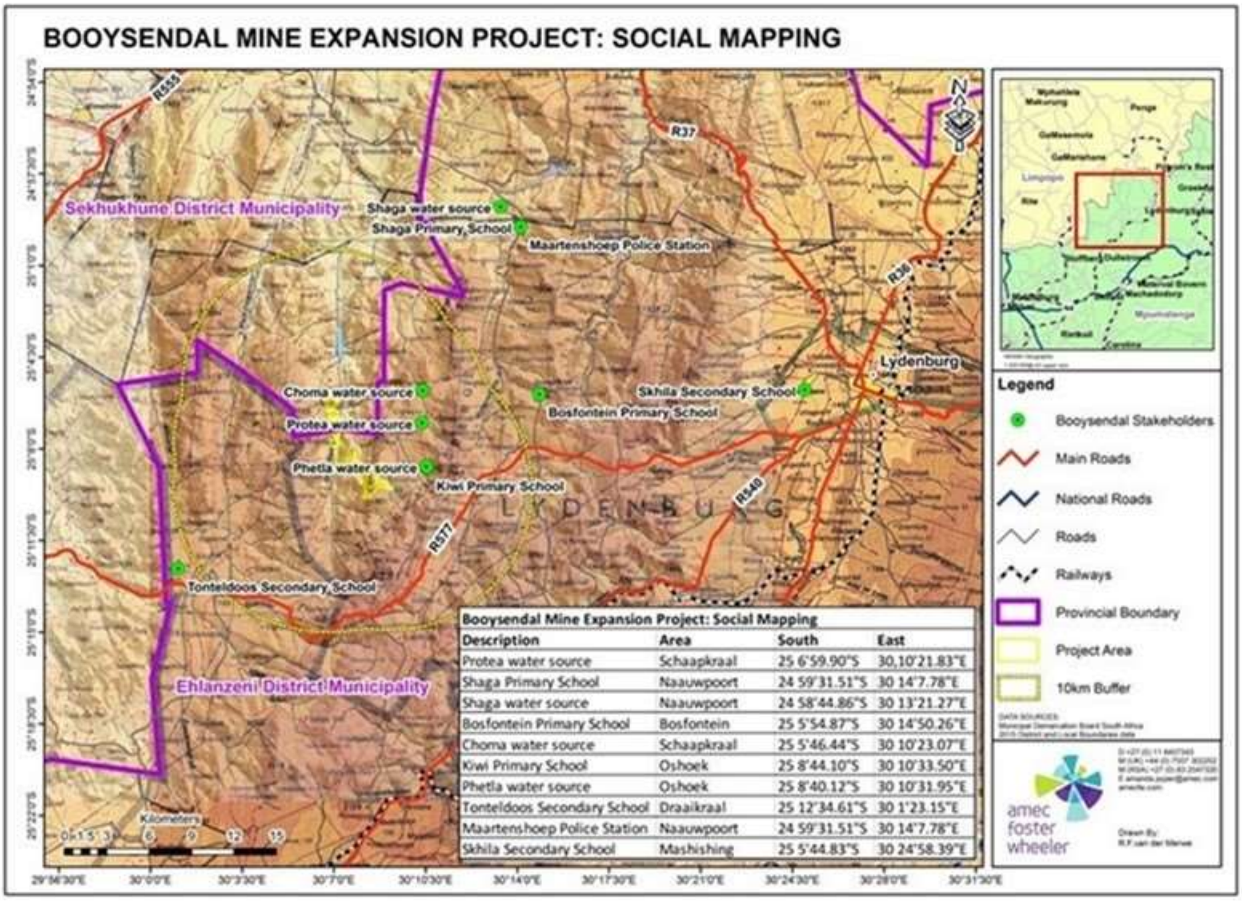


Figure 6-5 Social Area of Influence, Directly-and Indirectly Affected Communities




| Booysendal Mine Expansion Project: Social Mapping | | | |
|---|---|---|---|
| Description | Area | South | East |
| Protea water source | Schaapkraal | 25 6'59.90"S | 30,10'21.83"E |
| Shaga Primary School | Naauwpoort | 24 59'31.51"S | 30 14'7.78"E |
| Shaga water source | Naauwpoort | 24 58'44.86"S | 30 13'21.27"E |
| Bosfontein Primary School | Bosfontein | 25 5'54.87"S | 30 14'50.26"E |
| Choma water source | Schaapkraal | 25 5'46.44"S | 30 10'23.07"E |
| Kiwi Primary School | Oshoek | 25 8'44.10"S | 30 10'33.50"E |
| Phetla water source | Oshoek | 25 8'40.12"S | 30 10'31.95"E |
| Tonteldoos Secondary School | Draaikraal | 25 12'34.61"S | 30 1'23.15"E |
| Maartenshoep Police Station | Naauwpoort | 24 59'31.51"S | 30 14'7.78"E |
| Skhila Secondary School | Mashishing | 25 5'44.83"S | 30 24'58.39"E |

# 7. Public Participation Process

As part of the Environmental Consents application process, public participation or stakeholder engagement must be conducted. The NWA, MPRDA, NEMA and Waste Act specifically require that public participation be conducted to allow I&APs the opportunity to participate in the process by providing their comments and concerns during the application process. An integrated public participation process ("**PPP**") is followed, for the Phase 2 Project combining the public participation requirements of the different applications under NEMA, Waste Act and the NWA to ensure efficiency in terms of time and costs and to ensure that a holistic view of the Booysendal South Expansion Project: Phase 2 is provided to I&APs. The proposed process has been agreed to with CAs.

A SEP has been compiled to steer and guide the required PPP in compliance with the regulatory requirements. The SEP will remain in draft as regular updates will be made as the PPP unfolds. The SER containing the results of the consultation process thus far is included in Annexure B. The SER will be updated throughout the process and submitted with the draft and final reports.

## 7.1 Objectives of Public Participation

The objective of public participation is to provide sufficient and accessible information to I&APs in an objective manner to assist them to:

- raise issues of concern and suggestions for enhanced benefits and commenting on reasonable alternatives;
- verify that their issues have been recorded (CRR) and considered in investigations; and
- contribute relevant local information and traditional knowledge to the process.

## 7.2 Written Consent

The farm portions on which the Phase 2 Project is planned, are owned or leased by Booysendal (Table 1-2 and Table 1-3), in accordance with regulation 39(1) of Chapter 6 of the 2014 Regulations.

## 7.3 Interested and Affected Parties

For this Phase 2 Project, I&APs typically include the following:

- the owners or persons in control of the land where the proposed activities are to be undertaken – only the Bakoni CPA, as Booysendal owns the other properties in the Project Area;
- the occupiers of the property where the activities are to be undertaken – not applicable as the Bakoni CPA does not occupy any properties in the Project Area that they own. These properties are leased by the Bakoni CPA to Booysendal;
- the owners and occupiers of land adjacent to the Project Area – this includes all adjacent landowners and occupiers in the areas - specifically central and south;
- provincial (Mpumalanga and Limpopo) and local government (EDM (Mpumalanga), TCLM (Mpumalanga), GSDM (Limpopo) and GTLM (Limpopo));
- state organs, other than the authorising authorities, such as the DAFF, DWS, etc., having jurisdiction in respect of any aspect of the proposed activities;

- relevant residents' associations, agricultural unions, Tribal Authorities, CPAs, ratepayers' organisations, community based organisations, water user associations, and any catchment management authority and Non-Governmental Organisation ("**NGOs**");
- media (local and regional – e.g. Steelburger / Lydenburg News);
- environmental and water bodies, forums, groups and associations; and
- private sector (business, industries) in the vicinity.

The existing register of I&APs will be updated throughout the process.

## 7.4 Integrated Public Participation Process for the Booysendal South Expansion Project: Phase 2

The PPP is linked to the progress made with the technical work of the EIA and IWULA, which dictate the timeline of the study, per regulated timeframes. It is estimated that the PPP will still continue for a period of six months.

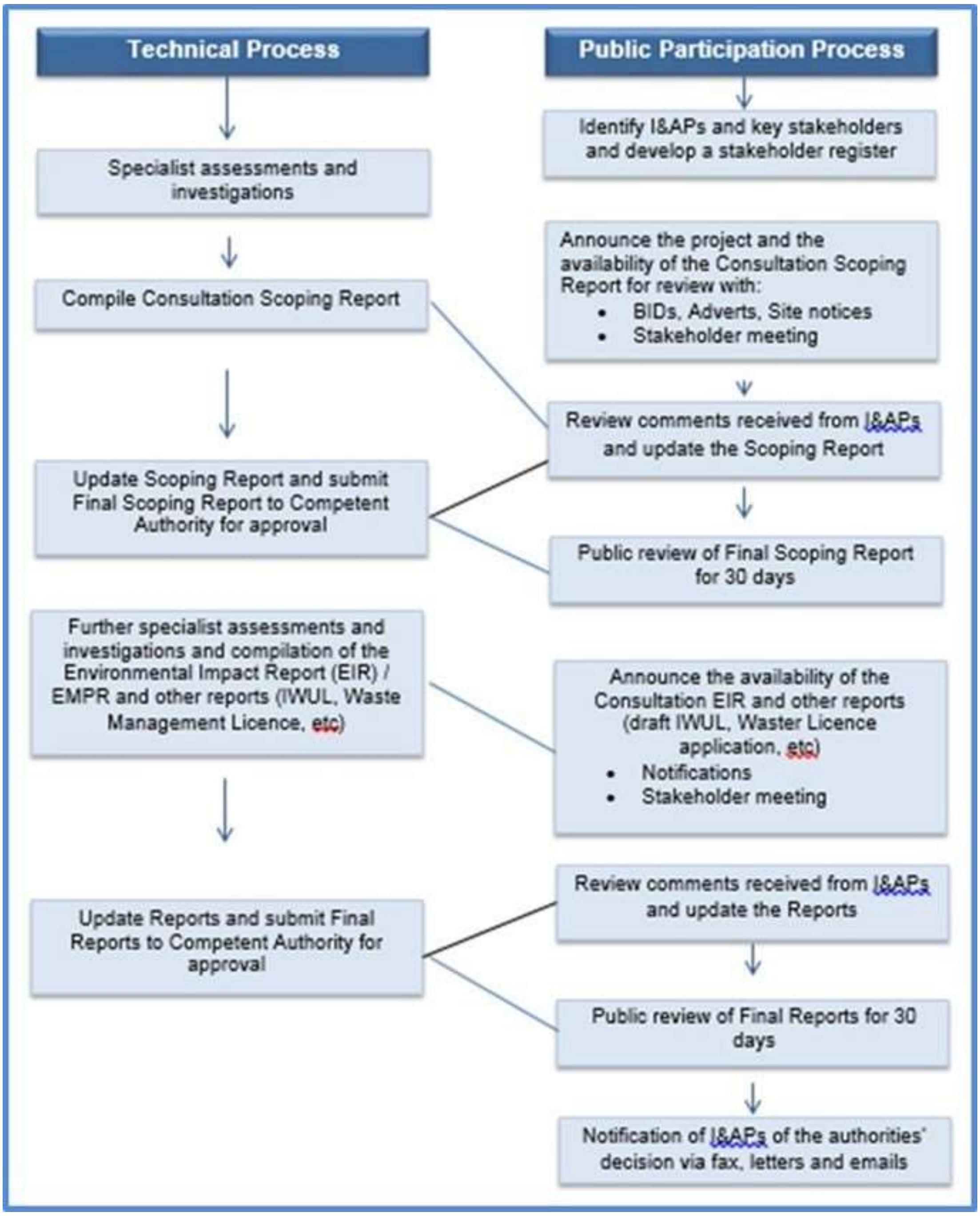
Figure 7-1 provides a flow between the technical work of the EIA and IWULA and the public participation activities. This figure also shows the deliverables that have and will be prepared as part of the output from the PPP.

<u>Deliverables from the Public Participation Process</u>

The PPP, which are followed, will have the following main deliverables:

- letters / emails or telephonic communication to I&APs (e.g. announcement of the projects and notification that consultation and reports are available for review);
- background information document ("**BID**") in English, Afrikaans and Sepedi;
- site notice boards in English, Afrikaans and Sepedi;
- advertisements in the Steelburger (approximately two rounds, depending on some variables) in English;
- stakeholder database;
- CRR (versions 1 to 3);
- proof of delivery of all reports to public places and authorities;
- minutes from the stakeholder meetings (x2) and associated documents such as attendance registers, presentations and agendas; and
- notifications of authority decisions to I&APs.

Figure 7-1 Flow between Environmental Processes and Public Participation Process




## 7.5 Integrated Participation Process Thus Far

### 7.5.1 Introduction of the Project

The Phase 2 Project, the integrated application process and the availability of the Consultation Scoping Report was announced to the I&APs by means of the following:

- Advertisements in the local Steelburger / Lydenburg newspaper (distributed in the areas surrounding the Phase 2 Project Area and in both Limpopo and Mpumalanga provinces). An advertisement was published on Friday, 23 February 2018. Appendix B to this report records proof of the advertisement published.
- A BID was compiled, translated (in English, Afrikaans and Sepedi) and distributed as follows:
  - to all I&APs on the stakeholder database via email notifications on 16 February 2018;
  - per hand to those who were visited while the site notices were placed on 15 February 2018; and
  - at meetings held during the review of the Consultation Scoping Report;
- Site notices were placed on 15 February 2018 all around the Booysendal Mine on main roads and at public places. Appendix D to this report provides a description of where 20 site notices were placed as well as a photo of each site notice placement;
- Telephonic notification to key I&APs and landowners.
- Placement of a notices and the BIDs on the Amec website (www.amecfw.com/booysendal).

### 7.5.2 Consultation Meetings

Stakeholder meetings were held just before the review period of the Consultation Scoping Report. A record of the deliberations at the meetings will be included as part of the CRR – Version 1 which will be made available with this Final Scoping Report.

Meetings were held as follows:

| Date | Time | Meeting |
|---|---|---|
| 22 February 2018 | 10:00 | Meeting with Thaba Chweu Municipality, provincial and national authorities; |
| 22 February 2018 | 14:00 | Meeting with adjacent commercial farmers and mines |
| 23 February 2018 | 10:00 | Meeting with the Main Community Forum |

The purpose of the meetings was to announce the integrated application process for the Phase 2 Project Applications, to present to stakeholders a summary of the Consultation Scoping Reports, and to obtain their views and comments on the information available as was presented to them during the meetings. All attendees were reminded of the process being followed and that there will be another opportunity for them to comment on the Final Scoping Report as well as on the reports to be compiled as part of the EIA phase (e.g. Consultation and EIR for the Phase 2 NEMA and Waste Act Applications and IWULA Report).

The presentations delivered at the meetings as well as the attendance registers of each meeting are included on Annexure B.

### 7.5.3 Announcement of Consultation Scoping Report

The announcement of the integrated application process also introduced the availability of the Consultation Scoping Report for public review and comment. The Consultation Scoping Report was available for public comment for a period of 30 days from 28 February to 30 March 2018. The Report was available as follows:

| **Printed Copies** |
|---|
| Lydenburg Public Library, 41 Viljoen Street, Lydenburg (Tel: 013 235 3700) |
| Maartenshoop Police Station, Naauwpoort Farm (Tel: 013 235 4041) |
| Thusong Centre, Mashishing<br>*(Please note, this public place was included for the review of the Final Scoping Reports after a request from stakeholders at a meeting held in February 2018)* |
| **Electronic Copies** |

| | |
|---|---|
| **Website download** | www.amecfw.com/booysendal |
| **CD copy** | On request to the public participation office |
| **Hard copies and / or CDs** | To all commenting authorities |

The availability of the Consultation Scoping Report was announced via the publishing of advertisements, in the BIDs and on-site notices (refer to Annexure B). E-mails were sent to all I&APs registered on the stakeholder database, providing the direct link to an electronic version of the Consultation Scoping Report and its appendices. At all stakeholder meetings held the availability of the reports and how stakeholders may access copies of the reports were communicated. Comments received during the comment period were included in the CRR (refer to Section 7.5.5).

### 7.5.4 Final Scoping Report

The Consultation Scoping Report and CRR were updated after the comment period and the Final Scoping Report submitted to both DMR Limpopo and Mpumalanga Regional Offices on 13 April 2013.

The Final Scoping Report was made available to I&APs for their final comments to the CAs from 14 April to 18 May 2018. Copies of the reports were made available at the same venues and through the same platforms as the Consultation Scoping Report. Stakeholders were requested to provide their comments on the final reports directly to the DMR Limpopo and Mpumalanga Regional Offices respectively. Stakeholders were requested to copy their comments to Amanda Pyper, the appointed EAP, and the public participation officer (Anelle Lotter).

The availability of the Final Scoping Report and where copies of the Final Scoping Report could be obtained were announced to registered I&APs via email. CDs containing the Final Scoping Report was submitted to commenting authorities. A list if the commenting authorities is included in Annexure B which also contains the stakeholder database.

### 7.5.5 Comments and Response Report

All comments which have been and will be received during the integrated application process will be captured in a CRR. The CRR will be updated on a continuous basis and will be presented to the authorities and other I&APs together with the consultation and final reports as a full record of issues raised, including responses on how the issues were considered during the integrated application process. The following versions of the CRR will be available:

- CRR Version 1: Submitted with the Final Scoping Report. This version of the report captured comments and issues raised from the beginning of the announcement until 30 March 2018. Comments received after this date will be captured in version 2 of the CRR;
- CRR Version 2: This version is included in this Consultation EIR/EMP and Draft IWULA and include all comments received up to end of the Final Scoping Report commenting period on 18 May 2018; and
- CRR Version 3: Will be submitted with the Final EIR/EMP and Final IWULA.

### 7.5.6 Pre-consultation Meetings

Pre-consultation meetings were held with and correspondence sent to authorities as follow:

#### 7.5.6.1 DMR Limpopo Regional Office

Booysendal North MR: The Booysendal South Expansion Project was discussed with the DMR Limpopo Officials on 23 April 2017, 3 August 2017 and 7 August 2017. It was indicated that the DMR Limpopo is the CA for only the Booysendal North MR.

#### 7.5.6.2 DMR Mpumalanga Regional Office

A letter was submitted to the DMR to request guidance on the way forward. This was followed with a telephonic conversation. The outcome of the communication was that the Scoping Report and Application form for the Booysendal South MR could be submitted simultaneously. It was also confirmed that the DMR Mpumalanga Regional Office is the CA for the Booysendal South MR.

#### 7.5.6.3 Department of Water and Sanitation

A pre-consultation meeting was held with the DWS on 26 March 2017. DWS advised that one integrated IWULA covering all the Booysendal South Expansion Project: Phase 1 and Phase 2, as well as historic water uses associated with BS4, should be submitted.

## 7.6 Comments

A summary of the main comments and concerns which were raised during the PPP thus far, including during the focus group meetings and the comment period on the Consultation Scoping Report include:

### 7.6.1 Comments from Authorities

#### 7.6.1.1 DWS

- the need for a water use license to make provision for the Phase 1 and Phase 2 activities was raised;
- concerned about potential mining at BS3 and potential future opencast mining;
- the following requirements amongst others must be addressed in the IWULA: assessment of alternatives based on the hierarchy of impacts; storm water management plan based on the separation of clean and dirty water; modelling of the pollution plume and cone of depression; assessment of water losses, discharge into the natural system and the impacts on the PES and the EI and EIS; rehabilitation and plant species plan; and a plant and animal search and rescue plan; and
- the Environmental Management Framework for the Olifants CMA, the Limpopo Conservation Plan 2, the Mining & Biodiversity Guidelines and the Limpopo SDF need to be considered in the EIA and IWULA phases.
- The IWULA must include the following:
  - Alternatives with the hierarchy of impacts investigated. One alternative will always be exclusion of watercourses;
  - Master Plan showing and naming all infrastructure, watercourses, scientific buffers, riparian habitat, sensitive areas like for cicadas;
  - Storm Water Management Plan showing separation of clean and polluted water, and PCDs;
  - Cone of depression impacts;
  - Pollution plume map;
  - Water losses to the natural system and what the Mine is prepared to treat and discharge back to the natural system and how this will affect the PES and EIS;
  - Designs to investigated hydrological and ecological connectivity;
  - Rehabilitation Plan and Plant Species Plan by landscape architect or botanist;

- Plant and Animal Search and Rescue Plan;
- EIA / EMP; and
- Waste Management Plan; and Monitoring and Auditing Plan.

#### 7.6.1.2 MPTA

The MPTA provided amongst others the following comments:

- The would have no objection to the Booysendal South Expansion Project: Phase 2;
- Concern about potential development at BS3 and potential opencast mining;
- Queried whether authorisation for the proposed Backfill Plant has already been granted;
- Asked who administers the authorisation of the tailings facility;
- Enquired about the route of the proposed ARC;
- Indicated that the sensitivity of the farms (mentioned as part of the application – i.e. the Phase 2 Project Area) was assessed under to the Mpumalanga Biodiversity Sector Plan (MBSP: MTPA, 2014) in terms of a terrestrial and freshwater assessment. According to the terrestrial assessment, the proposed Phase 2 Project activities will be placed on CBA Irreplaceable areas. It is recommended that the clearing of such sensitive areas be kept at a minimal as far as possible to reduce the loss of ecosystems, functionality and species;
- In terms of the freshwater assessment, there are FEPA Wetlands on the proposed Project Area. Mining is a land use that would compromise the biodiversity objective of maintaining the wetland in a natural state with no loss of ecosystems, functionality or species. Care should be taken to adhere to the prescribed wetland buffers;
- All the negative environmental impacts that could arise as a result of this mining operation should be avoided, minimised, mitigated or rehabilitated to its pre-mining land use or to the standards agreed to with the land owner. It is thus imperative to have photographs taken before any work commences on the land or on the existing routes; and
- The MTPA is in agreement with the proposed specialist assessments that will be conducted as part of the EIA process. The MTPA is interested in the cumulative impact that the Booysendal South Expansion Project will have on both the terrestrial and freshwater environments.

#### 7.6.1.3 LEDET

- LEDET recommended:
  - Involvement of competent authorities for WMLs and WULs to help map the “One Environmental System” route in dealing with the application; and
  - Utilisation of the following tools to ensure an informed decision is undertaken – a) Environmental Management Framework for the Olifants and Letaba River Catchments Area; b) Limpopo Conservation Plan, Version 2; and c) Mining and Biodiversity Guidelines, d) Limpopo Spatial Development Framework.

### 7.6.2 Comments from I&APs

Comments and concerns raised during the Scoping Phase meetings and consultation period include amongst others:

- potential release of process water / effluent into the Groot Dwars River and impacts on water quality;

- rectification of water uses and storm water management at BS4;
- the Phase 2 Project needs to benefit the local communities in terms of employment and business opportunities, services, infrastructure and empowerment;
- the need for fire breaks;
- concerns about mine employees travelling on local roads at high speeds and the increases in traffic in general;
- noise associated with the ventilation shafts;
- access to cultural heritage sites need to be secured to community members;
- placement of public review documents at the Thusong Centre and other venues closer to the communities who may be impacted;
- how will the local communities and the royal families benefit from the Phase 2 Project;
- enquired about activities at BS4;
- request for community meetings as held previously during the Section 24G EA process;
- request to inform communities of the activities of the mine, including application processes via community radio; and
- indicated that educational support and health care to communities is required.

The complete CRR is included in Annexure B.

## 7.7 Next Steps in the Public Consultation Process

All registered I&APs will be notified of the progress of the Phase 2 Project Applications, which includes notification of the availability of the Consultation EIR/EMP (30 days) and IWULA (60 days) for comment and of any future public meetings that may be held. The public participation activities during the EIA and IWULA phase of the integrated application process will include:

- Email notifications to stakeholders to inform them of the opportunity to review the Consultation EIRs/EMP from 6 June 2018 to 6 July 2018 and subsequently the draft IWULA Report for a review period of 60 days;
- The Consultation EIR/EMP will be made available for review for a period of 30 days and the and draft IWULA Report for a period of 60 days (the NWA requires a review period of 60 days for the IWULA Report). The same public places are used to make the reports available as per the Scoping Phase (see section 4.4);
- Advertisements to notify stakeholders of the availability of the Consultation EIR/EMP Report and draft IWULA Report were published in the Steelburger / Lydenburg Newspaper on Friday, 1 June 2018 (see Appendix B);
- Meetings with stakeholders will be held during the review period of the draft IWULA Report to provide them with the contents of the report for their comments and views.
- The final versions of the EIR/EMP and IWULA will also be made available to stakeholders once submitted to the different competent authorities; and
- The CRR will be kept updated with stakeholder comments and issues and responses will be included with the updated versions which will be made available with the relevant reports.

The SER will be updated with a record of the PPP as it unfolds during the EIA and IWULA phase.

# 8. Project Motivation: Need and Desirability

Northam is a mid-tier, integrated PGM producer, with two flagship, mining operations - Zondereinde and Booysendal - and its own metallurgical facilities (base metals plant and smelter) based at Zondereinde with a planned smelter expansion. The company has a strong balance sheet and an aggressive growth plan, illustrated by the acquisition of BS4, amongst others.

Paul Dunne, Chief Executive Officer of Northam, in his presentation of the company results on 26th August 2016 (reported in Mining Weekly, 26th and 29th August 2016) believes that there is a steady PGM demand. He predicts a lower primary mine supply than predicted due to the underinvestment in replacement and new platinum mining capacity; the challenging orebodies left behind and the reduction of the higher quality Merensky reef, which has generally been mined out. This situation provides an opportunity for significant organic and greenfields growth opportunities, with an advantage if construction effort is started now and not on the day the market turns. The Northam Board has therefore approved a capital expenditure of R5.5Billion on four growth projects, with the biggest being the R4.2Billion, six years, 240 000 oz/y Booysendal South Expansion Project.

With the Booysendal South Expansion Project, Northam will be able to expand organically by targeting the mining area in the BS orebody, which contains some 60Moz of PGMs. With fully funded growth projects, Northam intend to be "first to market" when the platinum supply-demand changes (Northam Platinum Limited – Strategic Update: Strengthening the NHM Investment Case. Paul Dunne, CEO, Northam Investor Day, 30 June 2016).

Booysendal indicated that at least 2,132 direct and contract employment opportunities will be created through the Booysendal South Expansion Project; with a further 13,750 indirect employment opportunities. With the high dependency ratio in the area, it is expected that a total of 49,476 people will benefit from the Project. Currently 60% of the workforce employed at Booysendal comes from local communities. This means that a significant amount of the current annual wages of R505,372,151 filters through to the local communities.

In addition, preferential procurement from HDSAs at Booysendal is currently 87.18%. The Booysendal South Expansion Project will increase the demand for further procurement and will enhance benefits and business development in communities. In addition to the local economy, Booysendal also contributes R86,639,513 to government revenues in the form of taxes.

LED spent by the mine since 2014 is R8,926,913. Booysendal indicates that the expansion of the Mine will assist in continuous development spend, including investment into schools and development centres.

At the peak of construction, a labour force of up to 3,200 will be required. The Booysendal South Expansion Project has an estimated capital spend of R4,199,800,000 over 5 years. The projected turnover (2016 values) is R2.7 billion of which some 8-10% (about R250 million) will represent ongoing capital investment for the projected LoM.

The Project has economic benefits for South Africa due to increased platinum production and local socio-economic benefits because of job creation, capital expenditure on contractors, materials and equipment, and ensuring an extension of the LoM in the long term, which will prevent retrenchments and early mine closure.

The local Government Handbook (Source: http://www.localgovernment.co.za/locals/view/145/Thaba-Chweu-Local-Municipality#demographic) indicates that the dependency ratio for the TCLM is in the order of 43%. In addition, the official unemployment is 20.5% and the youth unemployment is 27.10%. The trickle-down effect, being an additional approximately 6,000 jobs will have in the area, will be significant.

In addition to this, Booysendal also undertakes the following as part of their approved 2016 – 2020 SLP for the Booysendal North MR:

- technical skills training which will lead to further empowerment of the employees;
- the adult based education and training ("**ABET**") programme will be expanded into the community;
- offering learnerships as part of the skills development strategy;
- portable skills training which can be applied outside of the mining industry, including amongst others basic training in: welding; electricity; plumbing; finance; leadership; and entrepreneurship;
- career progression plans to develop the skills of individuals;
- employee mentorship programmes to fast track on the job training and skills development;
- skills and qualification enhancement through internships and bursary plan; and
- implementation of an employee equity programme.

The value of these training programmes in the rural communities will further contribute to employment and marketability.

# 9. Alternatives and Alternative Assessment

## 9.1 Booysendal Mining Right Alternatives

For the Booysendal South Expansion Project: Phase 2, the following alternatives were considered in relation to the Booysendal North MR:

- process and potable water pipeline alternative route; and
- alternative technologies for the transport of ore.

To avoid duplication this section will refer the reader back to the relevant Figures earlier on in the EIR.

### 9.1.1 BS1/2 to BN Pipeline

Two alternative routes were considered for the process and potable water line between BS1/2 and BN (refer to Figure 2-8).

- Alternative 1: Pipelines to run along the existing gravel access road next to the Groot Dwars River;
- Alternative 2: Pipelines to run along the main access road; and
- No-go option: Existing polyvinyl chloride water supply line along the Groot Dwars River remains with no changes.

The purpose of the process water line is to pump excess water from the PCD at BS1/2 during high rainfall events to BN, thereby avoiding overtopping and spillage into the Groot Dwars River.

Potential impacts which could emanate from the pipelines are related to soil, vegetation and drainage lines. In assessing the preferred alternatives, these three aspects are of specific importance due to the sensitives of these components. An assessment of the alternatives is included in Table 9-1.

Table 9-1 Potable and Process Water Pipeline Route Alternatives

| **Alternative 1 – Along the Groot Dwars River** | **Alternative 2 – Along the Main Access Road** | **No-Go Option** |
|---|---|---|
| Additional clearance of CBA vegetation in relative undisturbed area. | Areas along the road have already been disturbed therefore disturbance to soil, vegetation and potential impacts on the watercourses should be less significant. | No additional disturbance. |
| Disturbance of soil could lead to additional siltation of the sensitive Groot Dwars River system. | Storm water and erosion control management measure are installed along the road. | No additional disturbance to soil. |
| Corridors along the route serves as habitat for the IUCN listed VU, the Lydenburg Golden Mole habitat. | Disturbance of habitat in the road corridor has already taken place. | Optimisation of process water and use of current pipeline water for potable use. |
| Pipeline crosses the Groot Dwars River, and 4 drainage lines which could lead to additional impacts. | Crossings and culverts are already in place. | Limited current disturbance. |

| | | |
|---|---|---|
| Risk of spillage of process water into the Groot Dwars River will be reduced. | Risk of spillage of process water into the Groot Dwars River will be reduced. | A water treatment plant will have to be installed downstream of the BS1/2 PCD to ensure that any overflow is treated.<br>Potential overflow of the PCD could contribute to contamination of the Groot Dwars River should there be no means to transfer the water to BN. |
| Disturbance of hydromorphic soil along the Groot Dwars River. | No additional impacts on soil due to existing disturbance as part of the main access road development. | No additional disturbance. |

From the specialist findings and observations of the EAP, it is concluded that the environmental impact of Alternative 2 will be less significant than Alternative 1 within the contents of the Phase 2 Project. Alternative 2 should be further investigated by the engineering team as it is the preferred alternative for the B1/2 to BN pipeline.

### 9.1.2 Transport of Ore

Visual, fauna, flora, noise and air quality are the most significant aspects which could be negatively impacted by the transportation of ore. Three alternatives have been considered for the transportation of ore from BCM1 and BCM2 to the Process Plant at BS4:

- Alternative 1: Transport of ore via the proposed road between BCM1/BCM2 and BN;
- Alternative 2: Transport of ore via an ARC;
- Alternative 3: Transport of ore via overland conveyor; and
- No-go option: No transportation of ore.

The preliminary assessment of the three alternative technologies are included in Table 9-2.

Table 9-2 Ore Transportation Alternatives

| **Alternative 1 – Road** | **Alternative 2 – ARC** | **Alternative 2 – Overland Conveyor** | **No-Go Option** |
|---|---|---|---|
| Increase in traffic on the main access road between BN and BS4 could pose a risk to accidents. Road killings of animals may increase | Golden-mole population at the start of a proposed access road for the ARCs at the north starting point is a protected species | Higher noise level than the ARC (continuous noise level)<br>Crossing of various watercourses. | No additional disturbance to soil, air, fauna and flora or visual. |
| Existing road for which no additional clearance will be required. | Additional clearance of CBA vegetation for the ARC towers and access roads | Clearance of large sections of CBA. | Protection of CBA. |
| Limited visual impact | The ARC could remain aesthetically incompatible with surrounding landscape | The overland conveyor may create a visual disturbance, though less significant than the ARC. | No visual impact. |
| Increase in noise levels from large trucks. | Lower noise levels compared to overland conveyor or road traffic. | Higher noise level than ARC and continuous noise level. | No impact. |
| Culverts and water crossing measures already in place | Three towers fall within watercourses. | New impedance in watercourses. | No impact. |

| | | | |
|---|---|---|---|
| The increase in $CO_2$ air pollutants should not be significant. | Eskom power with indirect increase in carbon emissions. | Eskom power with indirect increase in carbon emissions. | No impact. |
| Transport and processing of ore which will lead to revenue. | Transport and processing of ore which will lead to revenue. | Transport and processing of ore which will lead to revenue. | No job creation<br>Loss of revenue<br>Loss of local and national taxes. |
| Preferred alternative from a VIA perspective as the road will be constructed in any event. | Largest visual impact and component with least visual absorption capacity. | May result in a permanent change in the visual quality but less visible than the ARC. | No visual intrusion. |
| Potential increase in road kills of fauna. | Disturbance of avifauna | Migration barrier to smaller fauna species | No impact |
| Potential spillages from trucks could lead to contamination of surface resources | ARC designed to avoid any spillages of ore | Definite risk off spillages off a conventional conveyor system | No impact |

Alternative 1 is the preferred option, with the least significant environmental and social impacts. It is, however, recommended that an Environmental Impact Identification (**"ENVID"**) be carried out, with the input of reputable terrestrial ecologists who has in depth knowledge of the SCPE who to optimise the design of the ARC should this be approved.

## 9.2 Booysendal South Mining Right Alternatives

For the Booysendal South MR, two alternative technologies for the tailings backfill material were considered.

### 9.2.1 Tailings Backfill Material

Two technologies were considered for the backfill material:

- Alternative 1: Cemented tailings;
- Alternative 2: Floatation cyclone tailings; and
- No-go option: TSF1 remains and no backfilling.

For the purpose of cemented tailings, a thickener will firstly to be added to the floatation tailings after which approximately 4% of cement will have to be added to the tailings as part of the backfill stream. No additional additives are required for the flotation cyclone tailings. A comparison of the two alternatives is included in Table 9-3.

Table 9-3 Backfill Material Alternatives

| **Alternative 1 – Cemented Tailings** | **Alternative 2 – Floatation Tailings** | **No-Go Option** |
|---|---|---|
| Negligible volumes of drainage water resulting from material in the backfilled underground workings. | High volumes of drainage water from tailings. Underground dewatering system required to pump water to surface. | Existing TSF1 management to continue |
| Limited seepage of nitrates or chromium as water source which can transport chemicals is reduced. | Potential seepage of nitrates and chromium into groundwater with potential decanting at the Valley Boxcut should underground pumping not be sufficient. | Management of current TSF1. |

| | | |
|---|---|---|
| Lower wear rate in pipeline system. | More corrosive action and higher wear rate which will require more pipe maintenance | No additional pumping of tailings. |

Reworking of the existing TSF1 will assist in creating additional capacity thereby reducing the immediate need for an additional TSF1. With the correct management measures in place either Alternative 1 or 2 seems feasible.

### 9.2.2 MCC1 PCD to RWD Pipeline Alternative Routes

During the impact assessment, it came to light that the initial alignment of the MCC1 PCD to RWD pipeline route could have significant negative impacts. As such an alternative route was proposed by WCS (refer to Figure 2-10. An assessment of the alternatives is included in Table 9-4.

Table 9-4 MCC1 PCD to RWD Pipeline Route Alternatives

| **Alternative 1 – Shortest Route to the RWD** | **Alternative 2 – Longer Alternative** | **No-Go Option** |
|---|---|---|
| Extent of impact on the unchanneled valley wetland will be reduced. | Larger extent of the unchanneled valley wetland will be impacted. | Existing pipeline will have to be used. |
| Magnitude of potential siltation and erosion will be less and could be more readily controlled. | Larger disturbance could lead to more siltation and erosion. | Existing pipeline will have to be utilized. |
| Smaller area of sensitive hydromorphic soils will be impacted . | Larger area of sensitive hydromorphic soils will be impacted. | Impacts already in place. |

It is recommended that Booysendal investigate the option to use the existing pipeline from the MCC1 PCD to the RWD to transfer water between the two structures. In the event that this can't be done, Alternative 1 will be more feasible.

# 10. Impact Assessment

## 10.1 Impact Assessment Methodology

The aim of the impact assessment was to identify the impacts related to the Phase 2 Project during the life of the Phase 2 Project, including the construction phase, mining and associated activities during the operational phase and potential impacts related to closure and decommissioning within the AoI.

As a quantitative assessment methodology alone can be very subjective, Amec Foster Wheeler opted for a combined qualitative and quantitative evaluations system. The impact assessment methodology includes a description of the impact and an assessment of the significance of the impact. It furthermore considered direct, indirect and cumulative impacts as further described herein:

- Direct impacts – are caused by the action and which occur at the same time and place;
- Indirect impacts – are caused by the action and are later in time or further removed in distance, but are still reasonably foreseeable; and
- Cumulative impacts – are impacts which result from the incremental impacts of the action when added to other past, present and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions.

### 10.1.1 Description of Impacts

Each potential impact is described separately to gain a clear understanding of the nature thereof in relation to the Phase 2 Project activities. The description includes:

- Activities responsible for the impact;
- Risk or impact caused by the activity;
- The phase in the Phase 2 Project life cycle when the activity could be expected. The following abbreviations are applicable to the phases: Construction phase = "**CP**"; Operational phase = "**OP**"; and Closure and post-closure phase = "**CL**";
- Indication if the nature of the impact – negative or positive impact;
- Classification of impact as direct, indirect or cumulative;
- Assessment of the significance of the impact before and after mitigation; and
- Required mitigating and management measures.

### 10.1.2 Impact Significance

The significance of an impact is a combination of the consequence of the impact and the probability of the impact occurring. A description and a rating was assigned to each component to, as far as possible, avoid subjectivity. The significance was assessed without mitigating measures and reassessed should the recommended mitigating measures be implemented. For each impact the following was considered:

- Likelihood: The likelihood or probability of the impact occurring (see Table 10-1) contains the rating scale for likelihood);
- Duration: It is important to note that the anticipated LoM is more than 50 years; therefore four time periods were considered (refer to Table 10-2);
- Extent: provides a description of the area which will or is affected by the impact. The weighting of the extent is provided in Table 10-3;
- Receptor Sensitivity: describes and weighs the sensitivity of areas, recipients or species (see Table 10-4), and
- Magnitude: provides an indication of the area or type of loss that is occurring or which is anticipated to occur (refer to Table 10-5).

The significance of the impact was determined using the sum of the likelihood + duration + extent on the x-axis and the intersection of the magnitude score on the y-axis. The significance rating by colour identification as low to high is indicated in Table 10-6.

Impacts which cannot be mitigated to an acceptable significance level of lower than high are classified as residual impacts. Off-set recommendations for these impacts have been included.

Table 10-1 Description and Rating of Likelihood

| **1 = Unlikely** | **2 = Possible** | **3 = Likely** | **4 = Definite** |
|---|---|---|---|
| Low to no probability of occurrence with the implementation of management measures | Possible that impact may occur from time to time | Distinct / realistic possibility that impacts will occur if not managed and monitored | Impacts will occur even with the implementation of management measures |

Table 10-2 Quantitative and Qualitative Assessment of Duration

| **1 = Temporary** | **2 = Short Term** | **3 = Long Term** | **4 = Permanent** |
|---|---|---|---|
| Possible to mitigate / immediate or quick progress with management implementation <3 yr. | Impacts reversible within a short period +3 to 5 yrs. | Impacts will only cease after the operational life +/- 50 yrs. | Long term, beyond mine closure or irreplaceable |

Table 10-3 Quantitative and Qualitative Assessment of Extent

| **1 = Localised** | **2 = Site** | **3 = Area of Influence** | **4 = Regional/ Provincial/ National** |
|---|---|---|---|
| Localised to specific area of activities / footprints | Confined to the site | The extent of the impacts will affect the wider area of Influence | Importance of the impact is of regional provincial or national importance |

Table 10-4 Quantitative and Qualitative Assessment of Sensitivity

| 1 = Low | 2 = Moderate Low | 3 = Moderate | 4 = High |
|---|---|---|---|
| Areas already subjected to significant degradation<br><br>Non-designated or locally designated sites / habitats<br><br>Non-sensitive receptor with regards to the impact type (e.g. noise receptors)<br><br>No vulnerable communities | Partially degraded area<br><br>Sensitive receptors present<br><br>Small number of vulnerable communities present | Regionally designated sites / habitats<br><br>Regionally rare or endangered species<br><br>Moderately sensitive receptor regarding the impact type<br><br>Some vulnerable communities present | Nationally or internationally designated sites/habitats<br><br>Species protected under national or international laws / conventions<br><br>High sensitivity regarding the impact type<br><br>High number of vulnerable communities present<br><br>High dependency |

Table 10-5 Quantitative and Qualitative Assessment of Magnitude

| Negative Impacts | | | |
|---|---|---|---|
| **-1 = Low** | **-2 = Minor** | **-3 = Moderate** | **-4 = High** |
| Deterioration of baseline conditions or functions are negligible<br>Nuisance<br>Will not cause any material change to the value or function of the receptor/s of<br>Emissions will comply with legal limits<br>Emissions contained within footprint within limits | Moderate deterioration, partial loss of habitat / biodiversity / social functions or resources,<br>Emissions at times exceed legal limits<br>Emissions reach outside project footprint | Reversible although substantial illness, injury, loss of habitat, loss of resources<br>Notable deterioration of functions<br>Impact on biodiversity<br>Causes a change in the value or function of receptor but does not fundamentally affect its overall viability<br>Emissions regularly exceed legal limits<br>Emissions will affect the wider region<br>Livelihood of sensitive receptors are impacted | Mainly irreversible<br>Causes a significant change in the environment affecting the viability, value and function of the receptors<br>Substantial impact and loss of biodiversity<br>Death/ loss of receptors<br>Loss of livelihood<br>Emissions do not comply with regulations<br>Impact on listed species |
| **Positive Impacts** | | | |
| **+1 = Low** | **+2 = Minor** | **+3 = Moderate** | **+4 = High** |

| | | | |
|---|---|---|---|
| Slight enhancement of baseline conditions or functions<br>Potential pollution sources are removed Slight positive change to the value or function of the receptor/s<br>Project controls assists in Emissions will comply with legal limits<br>Emissions contained within footprint within limits | Minor enhancement, of habitat / biodiversity / social functions or resources<br>Better control of emissions<br>Project assist in management and control of emissions | Substantial improvement in human health habitat, and ecosystem services<br>Notable improvement of functions<br>Moderate improvement of biodiversity<br>Causes a change in the value or function of receptor and improves overall viability<br>Emissions regularly improves<br>Livelihood of sensitive receptors are improved | Significant positive change in the environment viability, value and function Substantial impact and improvement of biodiversity<br>Better protection of receptors<br>Development of livelihood<br>Emissions improve to comply with regulations<br>Protection of listed species |

Table 10-6 Significance Rating of Impacts

| | | Likelihood + duration + extent + sensitivity | | | |
|---|---|---|---|---|---|
| | | Low (+ / -) ≤4 | Minor (+/ -) 5 - 8 | Moderate (+ / -) 9 - 12 | High (+ / -) 13 - 16 |
| Magnitude | Low (1) | Not significant | Not significant | Minor | Moderate |
| | Minor (2) | Not significant | Minor | Minor | Moderate |
| | Moderate (3) | Minor | Moderate | Moderate | High |
| | High (4) | Moderate | High | High | High |

The activities; impacts; phase of the development when impacts and potential impacts are expected; the impact significance prior to mitigation; the required mitigating measures; significance after mitigation; and impact statement for each identified activity was included in an impact table. It is important to note that these tables make provision for identification of impacts for all phases of the LoM.

The following abbreviations are applicable in the impact tables for the various phases in the Phase 2 Project lifecycle when the impacts occur or are likely to occur:

- CO = construction;
- OP = operational; and
- CL = Closure and post-closure.

The table and assessment also clearly states when **cumulative impacts** are applicable. This impact assessment section is structured per study field. Under each study field impact are assessed, management/mitigating measures provided and a gap included as applicable.

### 10.1.3 Management and Monitoring

Management and monitoring requirements for each impact was identified by the specialists. These requirements and recommendations are also included in the impact tables and the EMP (Annexure C).

It is important to note that the impact assessment presented in the following sub-sections highlights the potential most significant impacts and required management and monitoring requirements as identified by the specialists. Minor impacts have not been included, therefore the Consultation EIR must be read in conjunction with the specialist reports. The management requirements have been included in the EMP.

## 10.2 Air Quality

Airshed identified potential impacts on air quality during the various phases on the LoM.

### 10.2.1 Impact Assessment

#### 10.2.1.1 Construction Phase

It is anticipated that the main impacts during the construction phase will be nuisance caused by fugitive dust and dust-outfall. This will be caused due to site clearance, topsoil removal, stockpiling, grading, infilling, excavations etc. Due to the temporary nature of construction phase and the limited footprint areas the potential impacts were considered to have a low significance. Implementation of the dust suppression control measures included in Section 10.2.2. should ensure that the impacts are negligible.

It is anticipated that the additional construction vehicles will contribute to an increase in gaseous emissions. The construction phase impacts are assessed in Table 10-7.

Table 10-7 Air Quality Impact Assessment - Construction Phase (Source: Airshed, 2018)

| Impact Component | Impact 1 | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Transport and general construction activities | | |
| Risk/ Impact | Gaseous and particulate emissions; fugitive dust | | |
| Project Phase (during which impact will be applicable) CO = construction, OP = operational, CL = Closure and post-closure<br>Nature of Impact | CO<br>Negative | | |
| Type of Impact | Deterioration of ambient air quality and an increase in dust outfall | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Sort-term<br>Impacts during construction | 2 | 2 |
| Extent | Site, including linear | 2 | 2 |

| | | | | |
|---|---|---|---|---|
| | | infrastructure components | | |
| Receptor Sensitivity | | Moderate | 3 | 3 |
| Magnitude | | Moderate | 3 | 2 |
| Impact Significance | Moderate significance as National Ambient Air Quality Standards ("**NAAQS**") may be exceeded off site without mitigation in place | Moderate<br>10<br>3 | | Minor<br>10<br>2 |
| Mitigating and Monitoring Requirements | | | | |
| Required Management Measures | • Maintenance of vehicles and wet suppression or chemical treatment on unpaved road surfaces.<br>• Wet suppression where feasible.<br>• Minimise extent of disturbed areas.<br>• Reduction of frequency of disturbance.<br>• Early re-vegetation.<br>• Stabilisation (chemical, rock cladding or vegetative) of disturbed soil.<br>• Avoid dust outfall on vegetation. | | | |
| Required Monitoring (if any) | Dustfall network as recommended in EMP (Annexure C) | | | |
| Responsibility for implementation | Environmental Officer | | | |
| Impact Finding | | | | |
| Impact Finding | Impact can be managed through dust management plan. | | | |

#### 10.2.1.2 Operational Phase and Cumulative Impact Assessment

Airshed developed an air emissions inventory based on emissions factors from potential sources of emission during the operational phase that may result from processes and environmental disturbances. It was assessed that particulate matter associated with the Phase 2 Project and specifically related to crushing, materials transport, storage and tipping, windblown dust from the TSF1 and stockpiles and vehicle movement over unpaved areas present the most significant aspects of concern together with particulate emissions from equipment and vehicles. The emissions inventory furthermore took consideration of emissions resulting from l Booysendal Mine areas which do not form part of the Phase 2 Project. This assisted in giving an overall understanding of the cumulative impact of the Booysendal Operation on air quality. The air emissions inventory is included in Annexure D.

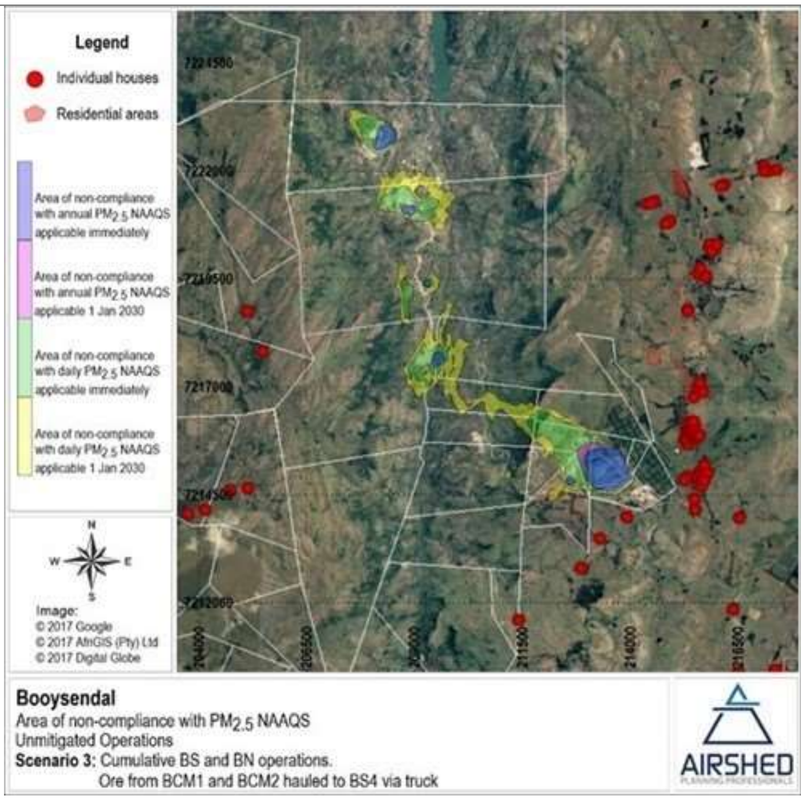
The following scenarios were modelled to determine potential air quality impacts:

- Scenario 1: Current BN TSF and the TSF1 at BS4 assuming no cover and 100% exposure to wind;
- Scenario 2: Emissions and dust outfall from BN, BS1/2, BCM1, BCM2 and BS4 (including the Valley Boxcut), including transportation of ore from BCM1 and BCM2 to BN by truck via road;
- Scenario 3: Emissions and dust outfall from BN, BS1/2, BCM1, BCM2 and BS4 (including the Valley Boxcut), including transportation of ore from BCM1 and BCM2 to BS4 by truck via road;
- Scenario 4: Emissions and dust outfall from BN, BS1/2, BCM1, BCM2 and BS4 (including the Valley Boxcut), including transportation of ore from BCM1 and BCM2 to be transported via ARC to BN; and
- Scenario 5: Emissions and dust outfall from BN, BS1/2, BCM1, BCM2 and BS4 (including the Valley Boxcut), including transportation of ore from BCM1 and BCM2 to be transported via ARC to BS4.

The AIRMOD software was used to model the potential air quality impacts for $PM_{10}$ and $PM_{2.5}$ and total suspended particles ("**TSP**")**.** The findings from all unmitigated scenarios for all particulates indicated that under none of the scenarios will none of the national air quality standards for $PM_{10}$ or $PM_{2.5}$ or the NDCR for dust outfall reach any of the sensitive receptors. Figure 10-1 indicates the worst-case scenario for $PM_{10}$ and

$PM_{2.5}$ and Figure 10-2 for dust outfall related to TSP. Potential cumulative impacts during the operational phase are assessed in Table 10-8.

Figure 10-1 AIRMOD Modelled Unmitigated Air Emissions Results for $PM_{2.5}$ and $PM_{10}$



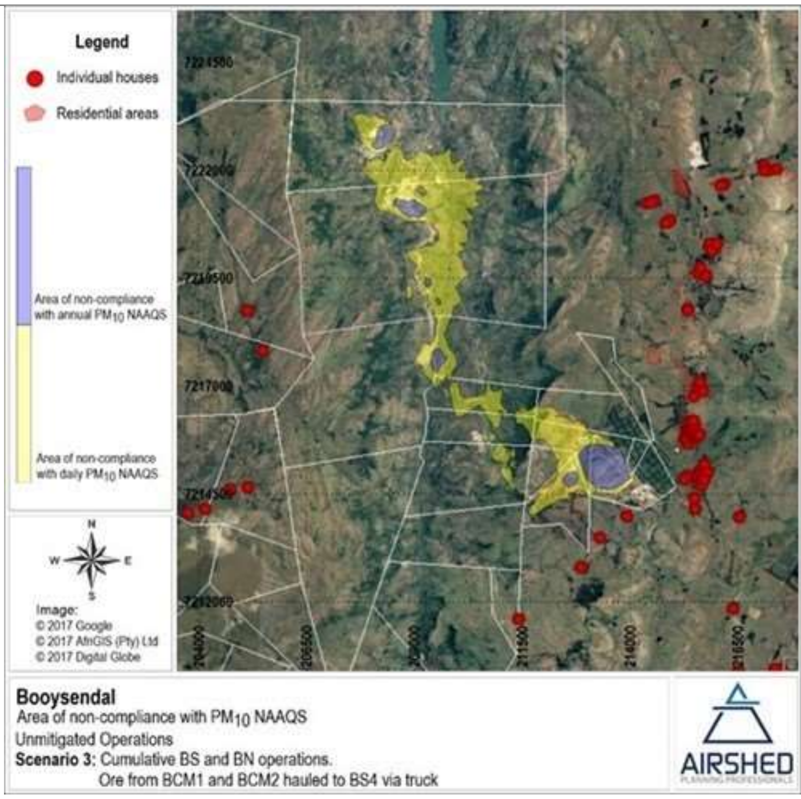
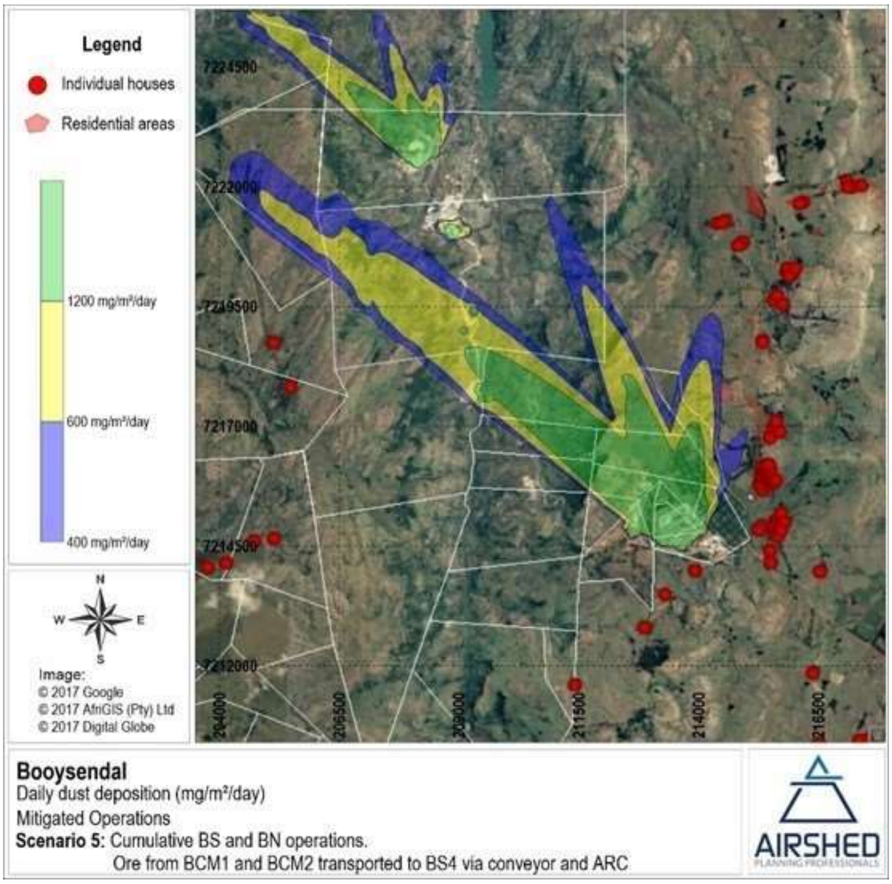



Figure 10-2 AIRMOD Modelled Unmitigated Dust Outfall




Operational phase impacts are assessed to be low should the recommended mitigation measures be implemented. At present, there are no regulated dust outfall limits for fauna and flora. Due to the ecological sensitivity of the area, it is however important to minimize dust outfall on surrounding areas. The impact of dust outfall is discussed in more detail under the terrestrial ecology section .

Table 10-8 Air Quality Impact Assessment - Operational Phase

| Impact Component | Impact 1 | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Materials handling operations<br>Crushing activities<br>Wind erosion<br>Vehicle entrainment | | |
| Risk/ Impact | Gaseous and particulate emissions; fugitive dust | | |
| Project Phase: CO, OP, CL | OP | | |
| Nature of Impact | Negative | | |
| Type of Impact | Deterioration of ambient air quality and increase in dust outfall | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Long-term<br>Impacts during operation | 3 | 3 |

| | | | |
|---|---|---|---|
| Extent | Area of influence | 3 | 2 |
| Receptor Sensitivity | Moderate | 3 | 3 |
| Magnitude | Moderate | 3 | 2 |
| Impact Significance | Moderate significance as NAAQS may be exceeded off site without mitigation in place | Moderate<br>12<br>3 | Minor<br>11<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Wet suppression where feasible on materials handling activities and reducing drop height. Enclosure or wet suppression on crushing activities. | | |
| Required Monitoring (if any) | Dustfall network as recommended in the EMP (Annexure C) and the Dust Management Plan included in Section 6 of Annexure D | | |
| Responsibility for implementation | Environmental Officer | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through dust management plan | | |

#### 10.2.1.3 Closure Phase

Potential activities which could result in dust or emissions during closure include:

- Dust from open surfaces being rehabilitated;
- Demolition of structures and infrastructure; and
- Emissions from vehicles used.

As during the construction phase, it is anticipated that the main impact will be nuisance caused by fugitive dust and dust-outfall as a result of the above. It is foreseen that the closure phase will be relatively short, restricted to disturbed areas and the significance of the impacts therefore low (refer to Table 10-9).

Table 10-9 Air Quality Impact Assessment - Closure Phase

| Impact Component | Impact 1 | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Dust generated during rehabilitation activities<br>Demolition of the structure<br>Tailpipe emissions from vehicles utilised during the closure phase | | |
| Risk/ Impact | Gaseous and particulate emissions; fugitive dust | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CL<br><br>Negative | | |
| Type of Impact | Deterioration of ambient air quality | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Sort-term<br>Impacts during construction | 2 | 2 |
| Extent | Site | 2 | 2 |
| Receptor Sensitivity | Moderate | 3 | 3 |

| | | | |
|---|---|---|---|
| Magnitude | Moderate | 3 | 2 |
| Impact Significance | Moderate significance as NAAQS may be exceeded off site without mitigation in place | Moderate<br>10<br>3 | Minor<br>10<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Maintenance of vehicles and wet suppression or chemical treatment on unpaved road surfaces<br>• Wet suppression where feasible | | |
| Required Monitoring (if any) | Dustfall network as recommended in the EMP (Annexure C) | | |
| Responsibility for implementation | Environmental Officer | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through dust management plan. | | |

### 10.2.2 Air Quality Recommendations, Mitigating, Management and Monitoring Requirements

#### 10.2.2.1 Construction Phase

During construction phase fugitive dust control measures included in Table 10-10 should be implemented.

Table 10-10 Construction Phase Air Quality Control Measures

| Construction Activity | Recommended Control and Mitigating Measures |
|---|---|
| Materials storage, handling and transfer | Wet dust suppression on exposed surfaces, stockpiles and materials handling areas |
| Vehicle entrainment | Speed limit of 40km/h<br>Restrict vehicle movement to designated construction areas<br>Apply wet dust suppression to unpaved road surfaces |
| Exposed areas (windblown dust) | Restrict clearance areas<br>Reduce double handling and frequency of disturbance<br>Phase construction activities<br>Concurrent rehabilitation and revegetation<br>Stabilisation of disturbed soil and exposed areas |

#### 10.2.2.2 Operational Phase

Table 10-11 contains the recommended mitigating and management measures during the operational phase as proposed by Airshed.

Table 10-11 Operational Phase Air Quality Control Measures

| Operational Activity | Recommended Control and Mitigating Measures |
|---|---|
| Materials storage, handling and transfer | Wet dust suppression on exposed surfaces, stockpiles and materials handling areas<br>Water spraying system at the conveyors and ARC |
| Vehicle entrainment | Speed limit of 60km/h<br>Restrict vehicle movement to designated construction areas<br>Apply wet dust suppression to unpaved road surfaces |
| Exposed areas (windblown dust) | Reduce double handling of material<br>Concurrent rehabilitation and revegetation |

| | |
|---|---|
| Crusher Plant | Enclose crusher (scrubbers and screens)<br>Telescopic chute with water spray<br>Regular equipment inspection and maintenance |
| TSF | Rock cladding or concurrent revegetation<br>Keep at least 40% of the top surface wet<br>Water spray on the outer surface when windspeed exceed 4m/s |

#### 10.2.2.3 Closure Phase

Mitigating and management measures required during the closure and rehabilitation phases are included in Table 10-12.

Table 10-12 Closure Phase Air Quality Control Measures

| **Closure Activity** | **Recommended Control and Mitigating Measures** |
|---|---|
| Materials storage, handling and transfer | Dust control measures: chemical suppressants, wind breaks, revegetation<br>Wet dust suppression on exposed surfaces, stockpiles and materials handling areas |
| Vehicle entrainment | Speed limit of 40km/h<br>Restrict vehicle movement to designated rehabilitation areas<br>Apply wet dust suppression to unpaved road surfaces |
| Exposed areas (windblown dust) | Restrict the vehicle movement to rehabilitation footprints<br>Reduce double handling and frequency of disturbance<br>Commence with concurrent rehabilitation during the operational phase<br>Stabilisation of disturbed soil and exposed areas |

#### 10.2.2.4 Monitoring

A full description of the monitoring requirements is included in the EMP (Annexure C) and the AQIA Report (Annexure D). Expansion of the existing dust monitoring network will be required to ensure the adequate monitoring of dust outfall. $PM_{10}$ sampling will also be required once a month.

### 10.2.3 Limitations and Gap Analysis

The main gaps and limitations identified in the AQIA Report are (refer to Annexure D for complete list):

- The quantification of emission sources was restricted to the Booysendal Operation only. Other background emission sources were identified, though not quantified.
- Vent shaft parameters were not available at the time the study was carried out and was therefore, based on similar operations.
- No $PM_{2.5}$ or $PM_{10}$ measurements available thereby limiting the cumulative emissions impact assessment.

It is not foreseen that the gaps and limitations would have a significantly different outcome to the findings should it have been available. Therefore, the level of confidence in the study remains high.

### 10.2.4 Impact Statement

Airshed is of the opinion that with the implementation of the recommendations and conditions for authorisation included on Section 11 of the Consultation EIR, the Phase 2 Project can proceed.

# 10.3 Greenhouse Gas Emissions

## 10.3.1 Impact Assessment

Actual diesel and oil consumption figures and forecast diesel and oil consumption figures for Booysendal Mine were used to assess the GHG emissions. The results of the assessment indicated that the Booysendal Mine will likely be responsible for emissions of Scope 1 carbon equivalents of not more than approximately 19,500 tons per year. At the current assumed carbon tax rate of R120 per ton, this may result in a tax liability of not more than R2 340 000 per year.

However, with offsets and other rebates, this amount per ton should be drastically reduced to between R6 and R40 per ton, or a potential liability of between R43 000 and R286 720. No final decision has been made on carbon taxation yet and these figures are simply to serve as indicators. The significance of the impacts of the Booysendal South Expansion Project (Phase 1 and Phase 2) on GHG are included in Table 10-13.

Table 10-13 Greenhouse Gas Emission Impact Assessment during the LoM (Source: Kirjani Green, 2017)

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Increase in fossil fuel usage because of an increase vehicle and machinery usage | | |
| Risk/ Impact | Increase in GHG emissions and contribution to global warming | | |
| Project Phase: | CP and OP | | |
| Nature of Impact | Negative | | |
| Type of Impact | **Cumulative Impact**: any increase in GHG emissions could cumulatively increase global warming | | |
| Likelihood/ probability | Definite. With the implementation of energy conservation methods, the likelihood can be decreased | 4 | 3 |
| Duration | Long term<br><br>GHGs emitted by the operation will persist for the LoM. Some gasses may persist in the atmosphere for some time after closure | 4 | 4 |
| Extent | Global warming has a global extent | 4 | 4 |
| Magnitude | Minor. The contribution to the region's carbon budget will be minor | -1 | -1 |
| Receptor Sensitivity | Low. The global warming impact on the local receiving environment is may be extensive in time. However, the proportion of that for which the mine is responsible is negligible | 1 | 1 |
| Impact Significance | Low significance due to the low global contribution to the impact with opportunity for mitigation | 13/1 | 12/1 |
| Required Management Measures | • Implement energy efficient technologies<br>• Ensure that vehicles and machinery are maintained<br>• Investigate and implement more environmental friendly technologies | | |
| Required Monitoring | Annual carbon reporting | | |
| Responsibility for implementation | Mine manager<br><br>Environmental Officer | | |
| Impact Finding | The significance of the impact is not of such a nature that it presents a flaw to the project | | |

### 10.3.2 Recommendations, Mitigating, Management and Monitoring Requirements

Kirjani Green recommended that the dust monitoring programme continue. Additional management requirements are included in Section 10.2.

#### 10.3.2.1 Monitoring

Refer to AQIA Section 10.2.2.4.

### 10.3.3 Gap Analysis

Various limitations, restrictions and gaps were noted and identified in the GHG assessment. During the GHG assessment, no data pertaining to the potential release of hydro fluorocarbons associated with the refrigeration systems within the Booysendal operations was available. It was advised that it was not expected that emissions would make a material difference to the overall carbon equivalent profile of the Booysendal Mine.

The project definition has changed since the GHG assessment was conducted and may therefore require an update once the project definition has been finalised should this entail any significant changes from the original mechanical equipment lists and predicted hydro-carbon consumption. No data on electricity use and forecast use was available at the time that the assessment was conducted. The GHG emission calculations may therefore be underestimated and should be revised and updated once the project definition has been finalised. Nevertheless, the level of confidence in the findings of the GHG assessment remains high.

### 10.3.4 Impact Statement and Reasoned Opinion

The specialist is of the opinion that the Booysendal South Expansion Project should not materially alter the existing emissions profile of the current operation and there is therefore no reason why the Phase 2 Project should not be authorised. The GHG Report is included in Annexure D.

## 10.4 Hydrogeology

The two main impacts which the Phase 2 Project could have on the groundwater environment are:

- Reduction in groundwater levels due to dewatering at BCM1 and BCM2, which, in turn, could lead to an increase in overall dewatering and reduction in baseflow of the Groot Dwars River; and
- Seepage of contaminants into groundwater resources (e.g. from the PCDs, along the slurry line at BS4 etc), with potential transportation of contaminants in the groundwater regime and/or decanting into surface water resources.

It is important that the potential impacts be assessed on a cumulative basis taking consideration of all potential sources of contamination and dewatering associated with the Booysendal Operation due to the interconnectivity of the aquifer. The assessment is therefore applicable to the Booysendal North and the Booysendal South MR Activities.

### 10.4.1 Impact Assessment

#### 10.4.1.1 Aquifer Dewatering

Hydraulic connection between aquifers tend to be absent at depths >60mbgl, thereby reducing inflow rates. As most of the mining will take place at depths >100mbgl it will contribute to reduced inflow. Total inflows over time for the various Booysendal South Expansion Project areas are included in Annexure E.

BCM1 and BCM2: From the current mine scheduling for the Booysendal North MR Activities, it has been calculated that groundwater inflow into the underground workings will reach a peak of approximately 970 $m^3$/day around 2038, after which mining at BS1/2 will slow down, thereby decreasing the inflows at BCM1 and BCM2 to approximately 950 $m^3$/day up to the end of LoM in 2052.

Future Flow modelled the potential drawdown cone. Phase 2 Project activities will not have any significant impacts on groundwater levels or dewatering (refer to Figure 10-3). The findings indicate that drawdown will potentially occur up to a depth of 80mbs, but that the drawdown will extend around 100m from the underground workings in the direction of the Groot Dwars River. This will result in water from the Groot Dwars River being drawn to the underground workings at a rate of between 110 to 120 $m^3$/day.

According to the Letsolo Hydrological Assessment, low flows in the Groot Dwars River ranges between 1 000 to 2 000 $m^3$/day. The modelled drawdown could therefore lead to between a 6 to 12% reduction in baseflow during the dry season. Although the drawdown will not have any impact on surrounding water users, the impact of the drawdown on this sensitive aquatic system could be significant. Water levels will only start recovering after mine closure which, at this stage, is foreseen to be around 2052.

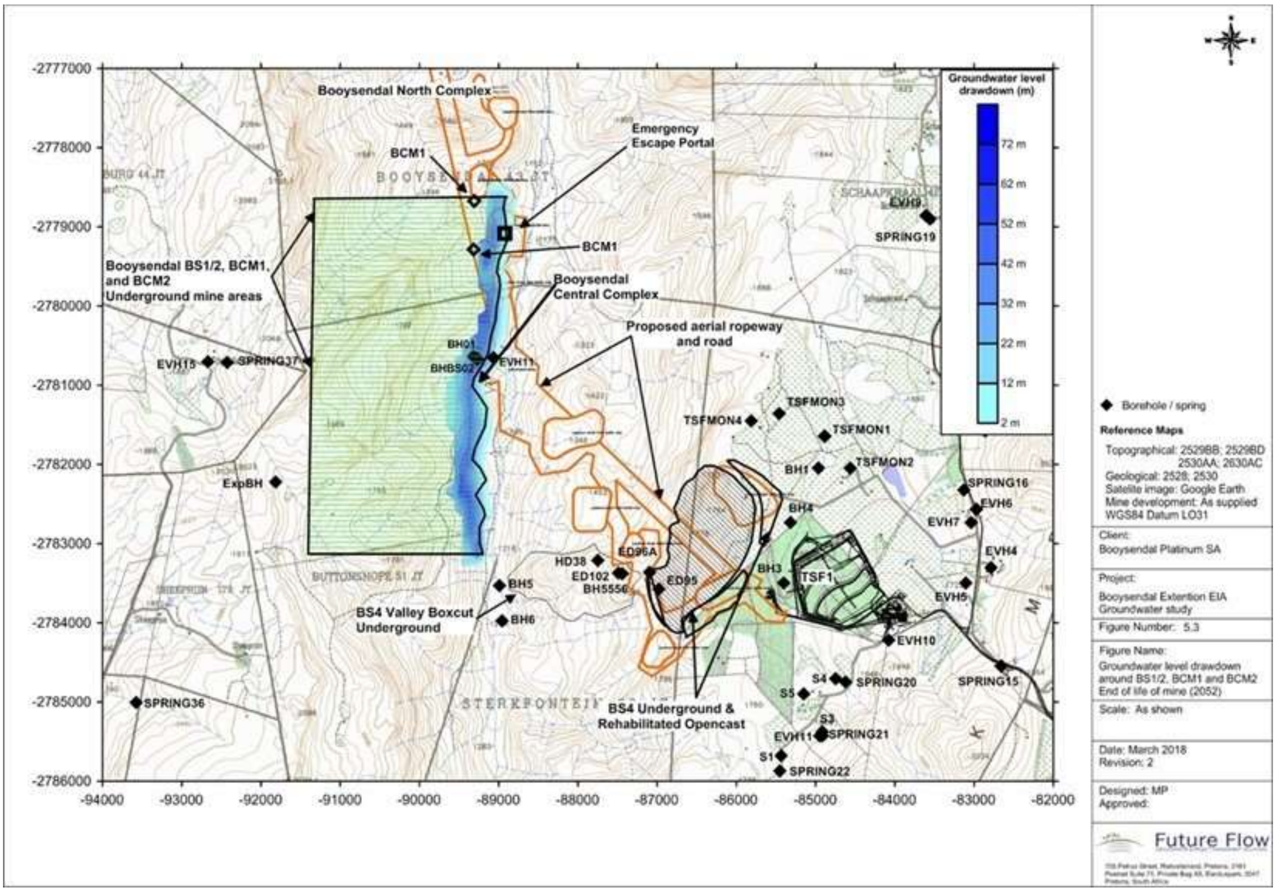
It is not foreseen that undermining of the Waterfall tributary will affect flows in this stream due to the depth of mining. Due to the depth of mining it is also not foreseen that mining at BCM1 and BCM2 will impact on any of the western catchments.

Phase 2 Project activities will not have any significant impacts on groundwater levels or dewatering but will impact on surface water flow of the Groot Dwars River during the LoM .

BS4: Inflows into the underground workings of between 850 and 900 $m^3$/day are expected into the underground workings. However, due to the short nature of the backfill activities, the groundwater model indicated that potential drawdown impacts will be negligible. Impacts are not expected further than 100m from the backfill operations, thereby limiting potential inflows from the Everest and De Kafferspruit. The potential impacts will seize after two years after which groundwater levels will recover.

Phase 2 Project activities will not have any significant impacts on groundwater levels or dewatering.

Figure 10-3 Booysendal South Expansion Project Drawdown Cone (Source: Future Flow, 2018)




10.4.1.2 Groundwater Contamination and Pollution Plume

BCM1 and BCM2: During the **operational phase,** pollutants will flow in the direction of the underground mining. Underground dewatering during the operational phase will capture any polluted water in the various PCDs.

The largest risk for groundwater plume formation is associated with the **post-closure phase** once groundwater inflows into the underground workings will commence at a rate of between 800 and 900 m$^3$/day. It is expected that decanting will start 72 years after mine closure. It is also at this point when contamination migration away from the Mine will commence. It is expected that the pollution plume will reach baseflow seepage within a distance of 4 100m of the Groot Dwars River at a concertation of 8 mg/L. It is also expected that this will increase the current average Groot Dwars River nitrate baseline levels from 0.5 mg/L to 0.65 mg/L under normal flow and to between 1.5 and 2.5 mg/L during low flows. It can also lead to an increase of chromium levels from the current 0.0007 mg/L to 0.1mg/L (an increase of 0.0035 mg/L).

Activities associated with the Phase 2 Project specifically e.g. the ARC, BCM1 and BCM2 surface infrastructure, Emergency Escape Portal, process and potable water pipelines and 11kVA powerline were deemed to have an insignificant contamination risk to the groundwater regime.

BS4: During the **operational phase** is expected that after backfilling seizes groundwater will flow into the underground workings leading the workings to be submerged within 6 years. Decanting and contamination migration from these areas can start around year 9 of the Phase 2 Project LoM. Due to the connectivity between BS4 and the Valley Boxcut, contamination migration will be in the direction of the Groot Dwars River up to around 100m from the Valley Boxcut. This decant can be contained during the operational phase through collection and recycling. However, at the end of LoM it is expected that water will decant from BS4 at the Valley Boxcut at a rate of between 375 and 3 275 m$^3$/day. It is expected that nitrate levels will exceed drinking water qualities and the special limits currently included in the BN IWUL. During the operational phase, backfilled areas will be dewatered, thereby reducing the possibility for any pollution migration.

Any discharge which will lead to a change in water quality could have significant impacts on the aquatic environment. Therefore, discharge during the operational phase of the LoM into the environment must be avoided.

Other sources of potential groundwater contamination include vertical seepage from the TSF1 and RWD. Leachate elements of concern which exceed drinking water qualities are nitrates and chromium. Leachate will be away from the TSF1 in a downstream northerly direction. It is expected that during the operational phase any decant of chromium into the natural environment will reach the streams at 0.07 mg/L concentrations due to dilution. The SANS 241:2015 limit for chromium is 0.05mg/l. Dilution of nitrates will also result in surface concentrations of 3 mg/L where the drinking water limit is 11 mg/L, however, the discharge concentration exceed the BN IWUL special limits.

**Post-closure** concentrations are expected to be the same with the migration plume expected to continue to migrate away from the TSF1 but not further than 100m from the TSF1. Seepage is foreseen to be at the same concentrations as during the operational phase.

It is important to note that potential groundwater contamination specifically associated with the Phase 2 Project with the Booysendal South MR Activities, including the Backfill Plant, the emergency backfill ponds and the slurry and process water pipelines, were deemed insignificant.

Decant from the Valley Boxcut is also expected to exceed drinking water and special limits for nitrates and drinking limits for chromium. However, because of the Valley Boxcut area, which will also decant, it is not possible at this point in time to calculate post-closure decant water qualities. It is therefore important that monitoring continues post-closure and that appropriate management measures are put in place during such time.

Figure 10-4 indicates the pollution plume 100 years after mine closure the Booysendal South Expansion Project for the Booysendal North and Booysendal South MR.

The significance of potential dewatering, contamination transport for the Phase 2 Project underground workings and the BS4 TSF1 is included in Table 10-14 and Table 10-15 respectively.

Figure 10-4 Pollution Plume 100 years after Mine Closure

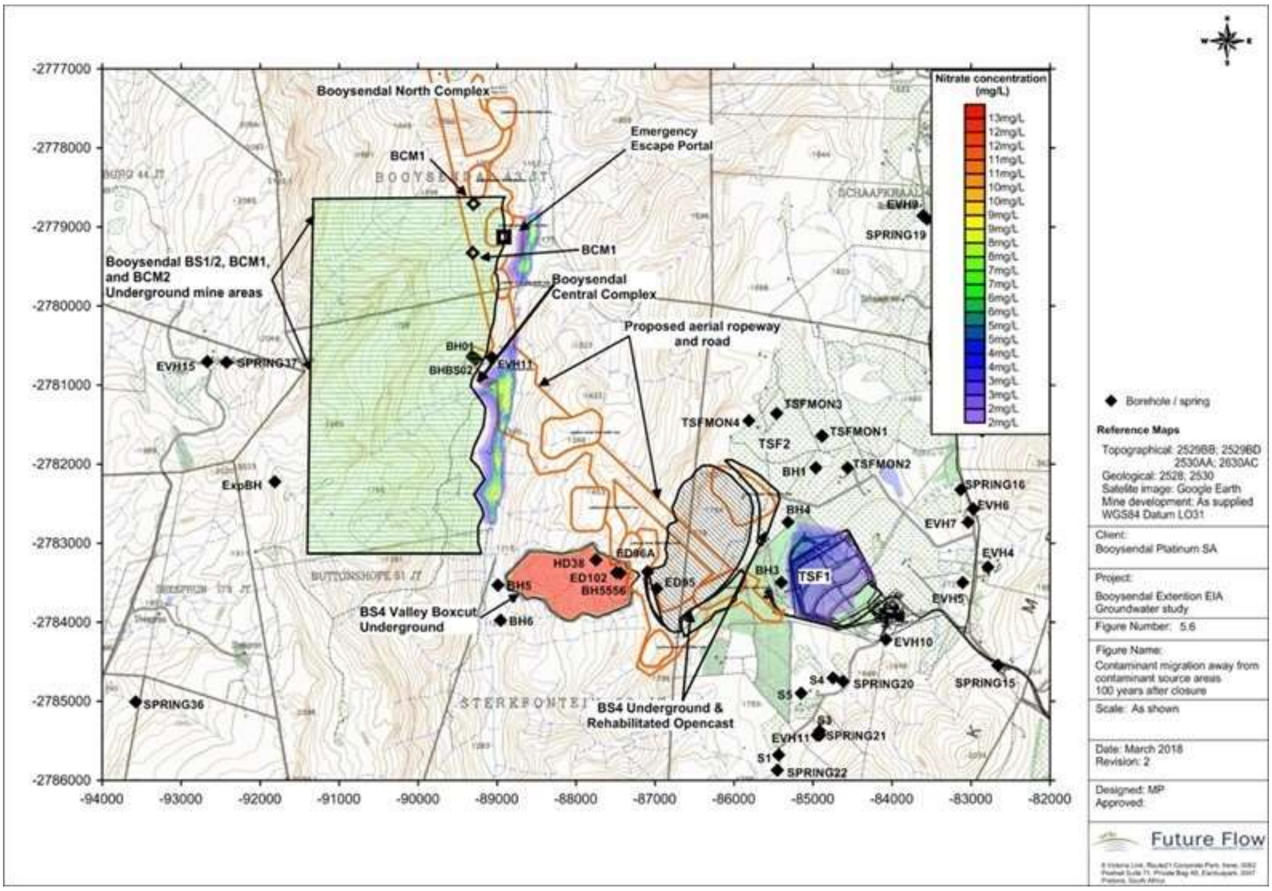



Table 10-14 Significance of Aquifer Dewatering (Source: Future Flow, 2018)

| Impact Component | Impact 1 | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Dewatering of the aquifers as part of the underground mining activities | | |
| Risk/ Impact | The aquifers will be dewatered due to dewatering of the active mining areas (declines, stopes, etc.) | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Direct: dewatering of the underground excavations will have a direct impact on the groundwater levels in the surrounding aquifers<br>Indirect: Water will be drawn from the Groot Dwars River at a rate of 110 to 120 m$^3$/day (<1 % of the average stream flow volume and 6 – 12 % of the low flow volumes)<br>Recovering of groundwater post-closure<br>Cumulative: Could have an impact on groundwater supply or stream ecological reserve. Will contribute to existing dewatering in the vicinity of the existing BS4 underground mine | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Definite | 4 | 4 |
| Duration | Permanent<br>When mining stops the mine dewatering will stop. This will allow the groundwater levels to recover to (near) pre-mining levels. It is calculated that it will take around 72 years for the | 4 | 4 |

| | | | |
|---|---|---|---|
| | water levels to recover at BCM1 and BCM2, while it will take at least 62 years for the water level at BS1/2 to recover. The water level in the BS4 Valley Boxcut underground will take 6 years to recover. | | |
| Extent | Site<br>The zone of impact of the groundwater level drawdown is calculated to be around 100m from the underground mining areas. This relatively small zone of influence is due to the low aquifer activity at the mining depths where the majority of the mining takes place (150 to 950m below surface) | 2 | 1 |
| Receptor Sensitivity | Moderate-Low | 2 | 2 |
| Magnitude | Minor<br>The zone of impact is relatively small and there are no groundwater users that will be impacted. The stream flow volumes in the Groot Dwars River will on average be impacted by less than 1%. During the dry season it can be up to 12%. | 2 | 1 |
| Impact Significance | Minor significance: There are no groundwater users that will be impacted and the impacts on the Dwars River will on average be small. | Minor<br>12<br>2 | Minor<br>11<br>1 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Sealing off of any major inflow areas in the underground workings, especially during the early years when mining takes place closest to the Groot Dwars River | | |
| Required Monitoring (if any) | Long-term monitoring of groundwater levels | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | There are few feasible management options, other than sealing off of high inflow zones. The impact is expected to have a moderate significance<br>With mitigation, water levels will rise post-closure to natural levels. | | |

### Table 10-15 Significance of the Phase 2 Project Underground Workings Pollution Plume (Source: Future Flow, 2018)

| **Impact Component** | **Impact 1** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Contamination of the aquifers due to the underground mining activities and TSF1 at BS4 | | |
| Risk/ Impact | The aquifers will be contaminated due to increased nitrate concentrations from blasting and tailings deposition. Total chromium concentrations can increase due to leaching from the walls and vertical leachate from the TSF1. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Direct: Contamination of water in the underground excavations will have a direct impact on the groundwater qualities in the surrounding aquifers<br>Indirect: Contaminated groundwater seeping into streams could impact on the stream water quality and downstream water users<br>Cumulative: Add to contamination of the groundwater reserve in the vicinity of the existing BS4 underground mining area and the TSF1. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Definite | 4 | 4 |
| Duration | Permanent<br>Increased nitrate concentrations will be present from when the first blasting takes place. Decant from the BCM1 and BCM2 area starts around 72 years after closure. Decant from the | 4 | 4 |

| | | | |
|---|---|---|---|
| | BS1/2 area could start from 62 years after closure while decant from the BS4 area starts around 6 years after mine dewatering stopped. The nitrate concentration in both areas will decrease over time as the mine area is flushed. | | |
| Extent | Site<br>The zone of impact of the groundwater contamination will be restricted to the underground mine, the area between the mine and the Groot Dwars River and a radius of 100m around the TSF1 at BS4 | 2 | 2 |
| Receptor Sensitivity | Moderate-Low<br>It is not expected that the aquatic biodiversity of the Groot Dwars River will be impacted | 2 | 2 |
| Magnitude | Minor<br>The zone of impact from the BS1/2, BCM1 and BCM2 mining area and the TSF1 at BS4 is relatively small and there are no groundwater users that will be impacted. The water qualities in the Groot Dwars River will not be impacted to exceed drinking water guidelines. It is calculated that on average the nitrate concentration can be expected to increase by 0.15 mg/L from 0.5 mg/L to 0.65 mg/L. during low flow periods the nitrate concentration is expected to increase by 1 to 2 mg/L to between 1.5 and 2.5 mg/L | 2 | 2 |
| Impact Significance | Minor significance as there are no groundwater users that will be impacted and the impacts on the Dwars River will be negligible | Minor<br>12<br>2 | Minor<br>12<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | None required (the impacts are minor) | | |
| Required Monitoring<br>(if any) | Long-term monitoring of groundwater quality | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | The impact rating is high, but there are no groundwater users that will be impacted and the impact on the Groot Dwars River water quality will also be negligible | | |

### 10.4.2 Hydrogeology Recommendations, Mitigating, Management and Monitoring Requirements

Management, mitigating and monitoring requirements other than those included in Table 10-14 and Table 10-15 have been detailed in the EMP (Annexure C).

### 10.4.3 Limitations and Gap Analysis

The following gaps and limitations area central to the hydrogeological assessment:

- Underground mining at BCM1 and BCM2 will take place at depths of between 200 and 900 mbgl. Aquifer and packer testing are seldom done for depths >100 mbgl. Little information on aquifer characteristics at depths below 100 mbgl is available.
- Several major fault lines and dykes intersect the area that would have disturbed the host geology to a great depth during their formation and intrusion of the dyke material, thereby creating groundwater flow pathways. However, it would be expected that at that depth the vast majority of fractures are closed by the weight of the overlying rock mass. It does not rule out the possibility that high-yielding fractures could be intersected.

- There was no information available on the Merensky Reef floor contours. For the purpose of the assessment a constant 75m separation between the Merensky and UG2 Reef was assumed. Re-watering rates could be influenced should this assumption change.

The limitations and gaps do not change the overall impact statement.

### 10.4.4 Impact Statement

The hydrogeologist recommended that the Phase 2 Project be authorised, based on the following:

- Impacts on groundwater levels and quality are expected to be minor;
- Flow impacts on the Groot Dwars River are expected to be minor;
- There are no significant impacts expected to result from the Phase 2 Project; and
- It is possible to manage impacts effectively.

## 10.5 Geochemistry

A geochemistry assessment for reworking of tailings, disposal of reworked tailings on the TSF1 at BS4 and backfilling of a section of the underground workings at BS4 was done as part of the Phase 1 Project and was approved as part of the Section 24G EA. No additional activities which could result in leachate or ABA is applicable to the Phase 2 Project.

## 10.6 Hydrology

As purpose of the hydrological assessment was to determine design requirements based on the catchment delineation and flood calculations for each catchment; to delineate 1:100-year floodlines or 100m buffer areas; determine the potential impact on surface water quality in the event of spillages in the AoI; and to determine management requirements.

### 10.6.1 Impact Assessment

#### 10.6.1.1 Booysendal North MR Activities Hydrology Impacts

Contamination of Surface Water Resources: Potential impacts identified include spillages from dirty water containment infrastructure and run-off from dirty water areas. The potential significance of spillage and dirty water run-off impacts is included in Table 10-16.

Table 10-16 Spillages from Dirty Water Infrastructure and Dirty Water Areas

| Impact Component | Impact 1 | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Construction of surface infrastructure associated with BCM1 and BCM2, including conveyor systems, workshops, offices, a PCD each, clean and process water storage facilities, ore stockpiles, discharge from STPs and potential oil and diesel storage bays | | |
| Risk/ Impact | Spillages from dirty water infrastructure | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP<br><br>Negative | | |
| Type of Impact | Direct: Pollution of water resources<br>Cumulative: increase in Groot Dwars River contamination as a result of upstream pollution | | |

| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Likelihood/ probability | Likely | 3 | 2 |
| Duration | Long-term<br>The management of dirty water infrastructure is required from the construction to post closure phase | 3 | 2 |
| Extent | AoI<br>The Groot Dwars River is a significant stream in the catchment. In the event of pollution, pollutants will be easily washed further downstream. | 3 | 2 |
| Receptor Sensitivity | Moderate | 4 | 3 |
| Magnitude | Moderate<br>The extent of the pollution will determine the magnitude. | 3 | 2 |
| Impact Significance | Moderate significance | Moderate<br>13<br>3 | Minor<br>9<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • The PCD must be designed, constructed, maintained and operated in such a way that it is not likely to spill into any clean water system more than once in 50 years.<br>• Storm water management infrastructure must be constructed around all dirty water areas<br>• The pollution control dam must have a minimum freeboard of 0.8m above full supply level.<br>• All dirty water infrastructure need regular maintenance.<br>• Oil separators and dirty water trenches have to be cleaned regularly.<br>• A Storm Water Management Plan ("**SWMP**") must be compiled and adhered to.<br>• Water and salt balance must be updated annually to track trends and pollutants.<br>• STPs need to be designed and operated to treat effluent to the special limits.<br>• All dirty water and storm water infrastructure and chemical containment infrastructure must be lined. | | |
| Required Monitoring (if any) | Monthly surface water quality monitoring must be conducted on the proposed monitoring points. | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through proper Storm Water Management Measures. | | |

Erosion and Siltation: Site clearance or channelling of surface water resulting from Phase 2 Project infrastructure could lead to erosion and consequently to siltation. In addition, access roads between BCM1 and BCM2 will lead to several drainage line crossings, impacting on 4 non-perennial drainage lines. The steep slopes against which BCM1, BCM2 and the Emergency Escape Portal are located could lead to erosion affecting the drainage lines. The assessment of the impact is included in Table 10-17.

Table 10-17 Erosion at Booysendal North Mining Right Phase 2 Area

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Site preparation and vegetation clearance<br>Storm water run-off during the operational phase<br>Site rehabilitation at the end of the LoM | | |
| Risk/ Impact | Vegetation clearance for mine infrastructure can directly impact on sediment transport. Loose particles are erodible.<br><br>Exposed areas during operation and at closure and final rehabilitation can contribute to erosion | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CP<br><br>Negative | | |
| Type of Impact | Direct: clearance will directly lead to impact | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Possible | 2 | 1 |
| Duration | Short Term | 2 | 1 |
| Extent | Site | 2 | 1 |
| Receptor Sensitivity | Moderate | 3 | 2 |
| Magnitude | Moderate | 3 | 2 |
| Impact Significance | Moderate | Moderate<br>9<br>3 | Minor<br>7<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Vegetation stripping must be limited to the minimum width required.<br>• The topography of all disturbed areas must be rehabilitated, in such a manner that it blends with the surrounding natural area. This will reduce soil erosion and improve natural re-vegetation.<br>• The necessary flood attenuation and erosion control structures have to be put in place. | | |
| Required Monitoring (if any) | A maintenance schedule for the removal of silt in water management infrastructure must be established | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through Erosion Control Measure programs | | |

Change in Catchment Characteristics: The infrastructure components, diversion of clean water, artificial surfaces and storm water management infrastructure components has the potential to change the natural flow regime and catchment characteristics. The significance of the impact is included in Table 10-18.

Table 10-18 Change in Flow Regime and Catchment Characteristics

| **Impact Component** | **Impact 1** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Site establishment and construction of required infrastructure, roads, culverts, storm water drains, diversion channels. | | |
| Risk/ Impact | • Change in flow regime<br>• Increase in hydrological yield<br>• Decrease in hydrological yield | | |

| | | | |
|---|---|---|---|
| | • Change in catchment characteristics | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Direct: artificial infrastructure like channels and berms, may have a significant impact on the flow regime due to the change in flow direction and velocity | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 2 | 2 |
| Duration | Long-term<br>As part of clean and dirty water separation, water management infrastructure will be required for the LoM | 4 | 4 |
| Extent | Area of influence | 2 | 1 |
| Receptor Sensitivity | Moderate | 4 | 2 |
| Magnitude | Moderate | 3 | 2 |
| Impact Significance | Moderate significance | Moderate<br>12<br>3 | Minor<br>9<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • The proposed infrastructure may not impede or divert the flow, unless authorised by the DWS.<br>• The location of mining infrastructure must be outside the 1:100-years floodlines or, where the 1:100-year floodlines are not known, outside of the 100m buffers.<br>• Efforts should be made to minimize the dirty water catchment.<br>• Dirty water channel should be designed and constructed to collect contaminated water and to dispose of it into the PCD.<br>• Post-closure reinstatement of drainage lines, flow patterns and the run-off regime. | | |
| Required Monitoring (if any) | Water and salt balance must be amended annually. The outcomes of the study must be used as a management tool as well as a means of investigating the latest technologies for water management. | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through management programs | | |

#### 10.6.1.2 Booysendal South MR Phase 2 Project Hydrology Impacts

Contamination of surface water resources: Potential spillages from the Backfill Plant and process water and slurry pipelines could lead to contamination of surface water resources. The significance of the potential impacts is included in Table 10-19.

Table 10-19 Surface Water Impacts at Booysendal South Mining Right Phase 2 Area

| **Impact Component** | **Impact 1** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Backfill plant<br>Slurry pipelines from the process plant to the Backfill Plant and the underground workings<br>Three emergency ponds along the slurry line<br>Process water lines between the Backfill and Process Plants and the RWD | | |
| Risk/ Impact | Deterioration of water quality.<br>Cumulative Impact: Increase in salt loads, sediments and pollutants in the catchment | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |

| | | | |
|---|---|---|---|
| Type of Impact | • Potential negative impact on quality of local surface water receptors<br>• Potential alteration of flow regime within local watercourses or drainage pathways<br>• Potential negligible impact in quality of downstream surface water receptors<br>• Potential change in flow regime<br>• Potential erosion risk<br>• Spillage of dirty water from dirty water storage facilities during design exceedance or pump failure event<br>• Pipeline failure may cause an uncontrolled discharge of dirty water to a surface water environment causing a pollution, short term increase in flows and potential erosion risks near the failure point | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 4 | 2 |
| Duration | Long-term | 3 | 2 |
| Extent | Area of influence | 3 | 1 |
| Receptor Sensitivity | Moderate | 3 | 2 |
| Magnitude | Moderate | 3 | 2 |
| Impact Signific;ance | Moderate | Moderate<br>13<br>3 | Minor<br>7<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Some of the potential impacts and risks posed by mining remain long after mining operations cease. In particular, tailings may pose physical and chemical risks in perpetuity.<br>• The integrity of the surface run off control systems must be maintained for the effective separation of clean and dirty water systems.<br>• Leak detection measures must be in place. Automatic emergency stop must be put in place in the event of spillage or leakage.<br>• Water from the dirty water catchment must be managed as dirty water in line with the Best Practice Guideline.<br>• Dirty water and process water must be recycled as far as practically possible..<br>• Pumping equipment should be adequately maintained.<br>• All process and slurry lines must be provided with flow meters. | | |
| Required Monitoring (if any) | Monthly surface water quality monitoring must be conducted on the proposed monitoring points | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through proper design and maintenance of hydraulic structures and through management measures | | |

### 10.6.2 Hydrology Recommendations, Mitigating, Management and Monitoring Requirements

<u>Booysendal North MR Activities:</u>

Flood volumes for different durations take account different return periods using the Smithers and Schulze method, based on data taken from the six nearest rain stations which have similar mean annual precipitation and altitudes. The flood calculations for the return periods are included in Table 10-20. Especially during rain events spillages from dirty water containment areas or run-off from dirty water areas can lead to surface water contamination. It is therefore essential that the storm water infrastructure components be designed taking account of the peak flows.

Table 10-20 Booysendal North Mining Right Activities Flood Calculations (Source: Letsolo 2018)

| Recurrence interval | Area ($m^2$) | Ave slope (m/m) | Tc (hrs) | C - runoff coef. | Peak flow ($m^3/s$) |
|---|---|---|---|---|---|
| **2** | 14,000 | 0.17333 | 0.022 | 0.58 | **0.09** |
| **5** | 14,000 | 0.173333 | 0.022 | 0.58 | **0.13** |
| **10** | 14,000 | 0.173333 | 0.022 | 0.58 | **0.18** |
| **20** | 14,000 | 0.173333 | 0.022 | 0.58 | **0.24** |
| **50** | 14,000 | 0.173333 | 0.022 | 0.58 | **0.39** |
| **100** | 14,000 | 0.173333 | 0.022 | 0.58 | **0.58** |

The probability of the flood events for the various return periods were then determined of which the results are as follows:

- a 1:50-year storm event has an 80% probability of occurrence during the LoM (40 years);
- a 1:100-year storm event has a 40% probability of occurrence during the LoM; and
- a 1:200-year storm event has a 20% probability of occurrence during the LoM.

It is important that: storm water infrastructure be designed to accommodate at a minimum a 1:50-year storm event; all dirty water infrastructure be operated at all times to maintain the GN 704 of 4 June 1999 requirements; and excess storm water be pumped to BN to avoid spillages during a 1:100 and 1:200-year storm event.

Booysendal South MR Activities: The depth-duration-frequency rainfall estimates were calculated for the Project Fairway EMP (SLR, 2011) and is still applicable to the Phase 2 Project design parameters. The calculated rainfall estimates are included in Table 10-21. Detail for specific catchments are included in Annexure F.

Table 10-21 Depth Duration Frequency Estimate for Booysendal South Mining Right Activities (Source: SLR, 2017)

| Duration (hours) | Rainfall Depth (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1:2yr** | **1:5yr** | **1:10yr** | **1:20yr** | **1:50yr** | **1:100yr** | **1:200yr** |
| 0.08 | 8.4 | 11.1 | 13.1 | 15 | 17.7 | 19.8 | 22.1 |
| 0.167 | 12.2 | 16.2 | 19.1 | 21.9 | 25.8 | 28.9 | 32.2 |
| 0.25 | 15.3 | 20.3 | 23.8 | 27.3 | 32.2 | 36.1 | 40.2 |
| 0.5 | 19.4 | 25.7 | 30.2 | 34.7 | 40.9 | 45.9 | 51 |
| 0.75 | 22.3 | 29.6 | 34.7 | 39.9 | 47.1 | 52.7 | 58.7 |
| 1 | 24.6 | 32.7 | 38.3 | 44.1 | 52 | 58.2 | 64.8 |
| 1.5 | 28.3 | 37.5 | 44.1 | 50.7 | 59.8 | 67 | 74.5 |
| 2 | 31.3 | 41.5 | 48.7 | 56 | 66 | 73.9 | 82.2 |
| 4 | 36.6 | 48.6 | 57 | 65.6 | 77.3 | 86.6 | 96.3 |
| 6 | 40.2 | 53.3 | 62.5 | 71.9 | 84.8 | 95 | 105.6 |

| Duration (hours) | Rainfall Depth (mm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1:2yr | 1:5yr | 1:10yr | 1:20yr | 1:50yr | 1:100yr | 1:200yr |
| 8 | 42.9 | 56.9 | 66.8 | 76.8 | 90.5 | 101.4 | 112.8 |
| 10 | 45.1 | 59.8 | 70.3 | 80.8 | 95.2 | 106.7 | 118.7 |
| 12 | 47 | 62.4 | 73.2 | 84.2 | 99.3 | 111.2 | 123.7 |
| 16 | 50.2 | 66.6 | 78.2 | 89.9 | 106 | 118.8 | 132.1 |
| 20 | 52.8 | 70.1 | 82.3 | 94.6 | 111.5 | 125 | 139 |
| 24 | 55.1 | 73 | 85.8 | 98.6 | 116.3 | 130.3 | 144.9 |

As in the case of the Booysendal North MR Activities, the probability of the flood events for the various return periods were then determined as follows:

- a 1:50-year storm event has an 80% probability of occurrence during the LoM (40 years);
- a 1:100-year storm event has a 40% probability of occurrence during the LoM; and
- a 1:200-year storm event has a 20% probability of occurrence during the LoM.

In the case of Phase 2 Project infrastructure pertaining to the Booysendal South MR Activities, it is important that: storm water infrastructure be designed to accommodate at a minimum a 1:50-year storm event; all dirty water infrastructure be operated as empty; and excess storm water be pumped to BN to avoid spillages during a 1:00 and 1:200-year storm event.

<u>General Management and Mitigating Requirements for the Phase 2 Project</u>

- Dirty water containment infrastructure should be sized and constructed to hold at least a 1:50-year storm event;
- PCDs and process water lines must be HDPE lined;
- Containment infrastructure, e.g. oil and diesel storage areas must be sized to accommodated 110% of the storage volume, must be bunded and provided with an impervious base. The infrastructure must be maintained and inspected regularly;
- All dirty water infrastructure must be operated as empty;
- No release of dirty water into the natural environmental should be done;
- Pumps must be put in place to pump excess water during a 1:00 and 1:200-year storm event to BN;
- The requirements included in the SWMP and EMP (Annexures F and C respectively) need to be implemented; and
- Designs should be done to ensure that any discharge will comply with the special standards for the Groot Dwars River catchment is not exceeded.
- A water and salt balance was developed for the IWULA, which includes the Phase 1 and 2 Projects. The current model indicates that there is a deterioration in water quality downstream in the system. This is a sensitive system, therefore, management measures must be put in place to ensure that water quality does not deteriorate. The water and salt balance must be used as a management tool and updated annually. The monitoring points which were used to develop the model are included in
- Figure 10-5, the water qualities for BN in Table 10-22 and for BS in Table 10-23.

Figure 10-5 Water and Salt Balance Monitoring Points

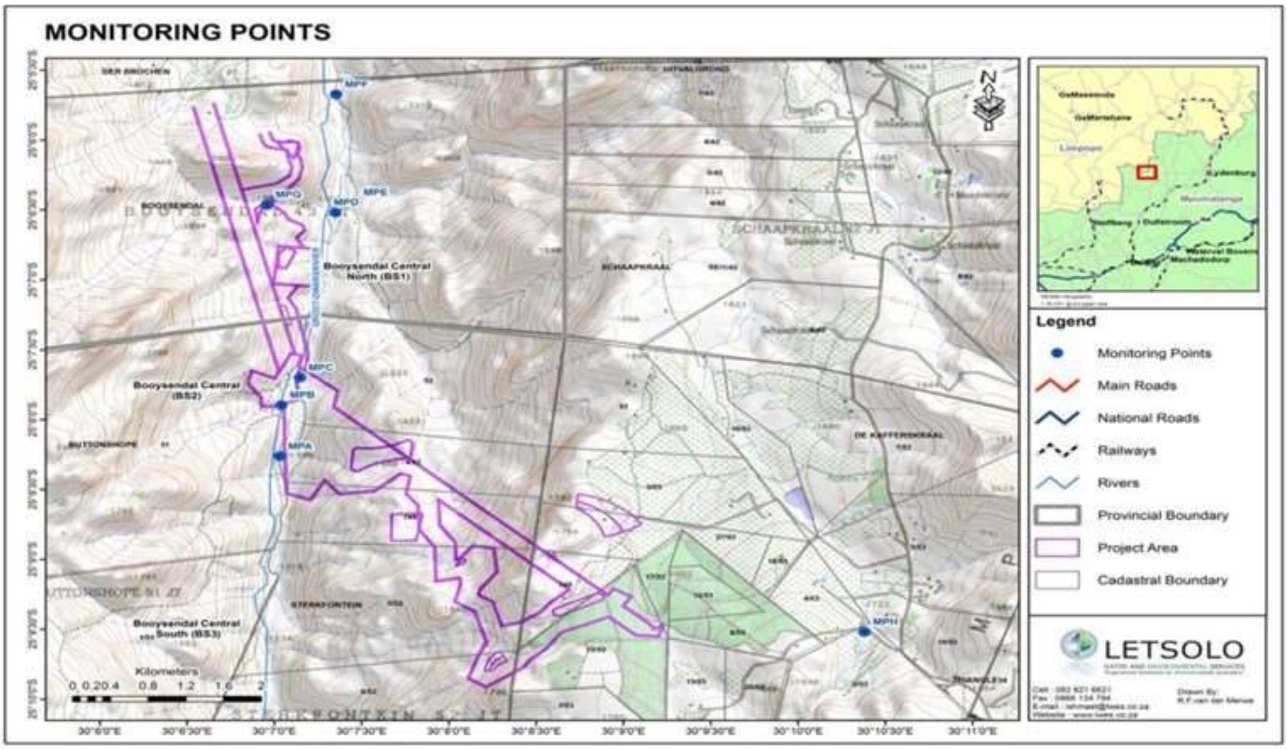



Table 10-22 Water and Salt Balance for the Groot Dwars River

| Monitoring Points | Area (km$^2$) | Flow Vol (m$^3$/a) | TDS (Salt load kg) | Na (Salt load-kg) | SO4 (Salt load-kg) | Cl (Salt load-kg) | Total loads |
|---|---|---|---|---|---|---|---|
| **MPA** | 60.767 | 4004545 | 400455 | 19358 | 7685 | 6171 | 433668 |
| **MPB** | 60.767 | 4004545 | 784891 | 34687 | 3031 | 6435 | 829045 |
| **MPC** | 60.767 | 4004545 | 416473 | 19294 | 7613 | 6311 | 449690 |
| **MPD** | 141.767 | 9342445 | 896875 | 46320 | 18255 | 13986 | 975435 |
| **MPF** | 142.847 | 9413617 | 884880 | 38831 | 14751 | 15862 | 954324 |
| **MPG** | 7.39 | 487001 | 74998 | 2354 | 1185 | 413 | 78950 |
| **MPE** | 38.2 | 2517380 | 186286 | 12169 | 3172 | 4448 | 206075 |
| **MPH** | 2.28 | 150252 | 4508 | 1301 | 71 | 143 | 6023 |
| Total concentration | **514.785** | **33924332** | **3649365** | **174315** | **55763** | **53769** | **3933212** |

Table 10-23 Water and Salt Balance for the BS4 Streams

| | | Salt Loads Calculations | | | | | |
|---|---|---|---|---|---|---|---|
| **System** | **Monitoring Point** | **Sodium Concentrations (mg/l)** | **Sodium Salt loads (kg/a)** | **Sulphates Concentrations (mg/l)** | **Sulphates Salt loads (kg/a)** | **TDS Concentrations (mg/l)** | **TDS Salt loads (kg/a)** |
| **Everest stream** | MP H | 1.322 | 667 | 0.472 | 1227 | 30 | 15127 |
| | MP E | 3.6 | 9076 | 1.26 | 3177 | 74 | 186569 |

### 10.6.3 Limitations and Gap Analysis

Deterioration of water quality increases downstream in the Groot Dwars River. This deterioration indicates cumulative contaminant loads attributed to the various mines along the river. The significance of the deterioration is a gap in this study as it is doubtful that the overall impact of mining on the Groot Dwars River was modelled. Some discrepancies exist between the Aquatico coordinates and locations for surface water quality monitoring points.

This needs to be resolved as it complicates data analysis.

No trend analysis on water quality results have been done since monitoring commenced in 2009. This is limiting the interpretation of water quality results.

### 10.6.4 Impact Statement

Underground mining activities have lesser impacts on surface water resources when compared to opencast activities. However, due to the need of support services on the surface, it is necessary to ensure that reasonable mitigation measures are put in place and that these measures are maintained and reassessed through water quality trend analysis and an annual update of the water and salt balance. Should the required management measures be put in place, then the Phase 2 Project is recommended.

## 10.7 Soil

### 10.7.1 Impact Assessment

The most significant impacts which may result from the Phase 2 Project include:

- Loss of soil capability, change in land use, chemical properties and supporting ES due to stripping of soil in footprint areas, topsoil stockpiling and mine infrastructure;
- Soil erosion due to exposure of soils; and
- Chemical soil contamination from hydrocarbon and ore spillages.

An assessment of the most significant impacts is included in the following tables. For more detail refer to the Soil Report is included in Annexure G. Impacts included in the tables in sections 10.7.1.1,10.7.1.2, 10.7.1.3, 10.7.1.4 and 10.7.1.5 relate to the Booysendal North MR and the Booysendal South MR Activities as they will involve vegetation clearance, construction activities, topsoil stripping and mining related activities.

### 10.7.1.1 Impact on Soil Properties

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Earthworks will include clearing of vegetation from the surface, drilling and blasting for the initial BCM1 and BCM2 box cuts, stripping and stockpiling of topsoil for mine infrastructure and the construction of access roads | | |
| Risk/ Impact | These activities are the most disruptive to natural soil horizon distribution and cause soil mixing and layer inversion. It will impact on the current soil hydrological properties and functionality of the soil and may also result in a loss of topsoil | | |
| Project Phase: CO, OP, CL | CO, OP | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct: earthworks will directly lead to impact | | |
| Likelihood/ probability | Definite | 4 | 4 |
| Duration | Permanent<br><br>The impact is considered to be permanent since it is impossible to re-create original soil profile distribution. However, carefully conducting topsoil stripping, the impact may only last as long as the operational phase continues (project life) | 4 | 3 |
| Extent | Localised<br>The impact will be localised within the site boundary | 1 | 1 |
| Magnitude | High<br>The impact on soil functionality is mainly irreversible. With the minimisation of the project footprint and protection of topsoil stockpiles, the magnitude can be reduced to moderate. | 4 | 3 |
| Receptor Sensitivity | Soils have a high sensitivity to earthworks. By minimising the footprint of the surface disturbance, sensitivity can be reduced to moderate. | 4 | 3 |
| Impact Significance | The impact is considered to have high significance without mitigation measures. Implementing mitigation measures in Section 10.7.2 will reduce the impact after mitigation to moderate. | $\frac{13}{4}$ | $\frac{11}{3}$ |
| Required Management Measures | Minimise project footprint as far as possible. Manage location of stockpiles, topsoil stripping and stockpiling, demarcation of topsoil stockpiles and prevention of stockpile erosion and contamination. | | |
| Required Monitoring (if any) | Monitoring the revegetation of topsoil stockpiles and the prevention of contamination and erosion thereof. | | |
| Responsibility for implementation | Mine management | | |
| Impact Finding | Impact can be managed through protection of topsoil stockpiles to keep it viable for rehabilitation purposes | | |

### 10.7.1.2 Soil erosion

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Soil erosion is anticipated due to steep slopes and vegetation clearance | | |
| Risk/ Impact | Reduction in soil quality which results from loss of the nutrient-rich upper layers of the soil and the reduced water-holding capacity of severely eroded soils. Soil erosion also causes the disruption of riparian ecosystems and sedimentation. | | |

| | | | |
|---|---|---|---|
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Direct: erosion by wind and water leads to loss of soil.<br>Indirect: off-site indirect impacts of soil erosion include riparian ecosystem disruption and sedimentation.<br>Cumulative: loss of soils can impact on the sensitive Sekhukhune Centre of Plant Endemism vegetation | | |
| Likelihood/ probability | Likely and with erosion prevention measures, still possible | 3 | 2 |
| Duration | Without proper mitigation measures, soil erosion will be a permanent impact. Implementing proper erosion control measures will reduce the duration of the risk to the end of LoM (until all operations have ceased). | 4 | 3 |
| Extent | Localised<br>Although there are off-site indirect impacts associated with erosion, the impact is mainly considered to be local. | 1 | 1 |
| Magnitude | High<br>The impact on soil functionality is mainly irreversible. With proper erosion control on stockpiles and minimising bare soil surfaces stability, the magnitude can be reduced to moderate. | 4 | 3 |
| Receptor Sensitivity | Soils have a high sensitivity to erosion. With the implementation of embedded controls (geotextiles for erosion control) it can be reduced to moderate. | 4 | 3 |
| Impact Significance | Without any mitigation, soil erosion will have high significance, especially since the site is highly sensitive to erosion impacts. With proper mitigation measures, the significance can be reduced to moderate. | $\frac{12}{4}$ | $\frac{9}{3}$ |
| Required Management Measures | Stripping of topsoil should not be done earlier than required; reduce slope gradients as far as possible along road cuts using drainage control measures and culverts to manage surface runoff; and revegetate topsoil stockpiles as soon as possible. | | |
| Required Monitoring (if any) | Monitoring the revegetation of topsoil stockpiles and the functioning of drains and the maintenance of roads. | | |
| Responsibility for implementation | Mine management | | |
| Impact Finding | Impact can be managed through revegetation of topsoil stockpiles and the management of surface runoff. | | |

### 10.7.1.3 Impact on Land Use

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Mining activities | | |
| Risk/ Impact | Change of land use from wilderness with habitat to game and other animals, to that of mining and supporting infrastructure. | | |
| Project Phase: CO, OP, CL | CO, OP | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct and cumulative | | |
| Likelihood/ probability | Definite | 4 | 4 |

| | | | |
|---|---|---|---|
| Duration | Without mitigation, the impacts will subsist even after the mining has ceased. With mitigation (proper land rehabilitation), the impact will prevail until the end of LoM (long term) | 4 | 3 |
| Extent | Without erosion and pollution control, the mining operations may have land use impacts outside the site boundary. With mitigation, the impact will be localised within the site boundary. | 3 | 2 |
| Magnitude | The impact is considered to be high without mitigation because there is a complete change of land use within the footprint area. With mitigation, the impact can be reduced to moderate. | 4 | 3 |
| Receptor Sensitivity | Moderate Sensitivity: the change in land use is regional | 3 | 3 |
| Impact Significance | Without any mitigation measures, the impact on land use will be highly significant. With proper land rehabilitation techniques and minimising the planned footprint of the operations, the impact on land use can be reduced to moderate significance. | 14<br>4 | 12<br>3 |
| Required Management Measures | Minimise project footprint as far as possible. | | |
| Required Monitoring (if any) | Monitor the mining activities to ensure that mining operations will be restricted to the clearly defined limits of the project footprint. | | |
| Responsibility for implementation | Mine management | | |
| Impact Finding | Impact can be managed through limitation of the project footprint. | | |

### 10.7.1.4 Impact on Land Capability

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Mining activities | | |
| Risk/ Impact | Through the mining activities, the land capability will change from arable, grazing, wetland and wilderness to industrial. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP<br><br>Negative | | |
| Type of Impact | Direct<br>Cumulative | | |
| Likelihood/ probability | Definite | 4 | 4 |
| Duration | Without mitigation, the impacts will be permanent. With rehabilitation and proper mitigation measures, the impacts will last until the end of the project life. | 4 | 3 |
| Extent | Without mitigation, the impact on land capability can extend outside the site boundaries.<br><br>With strictly following mitigation measures, the impact can be confined to only site-specific localities. | 3 | 1 |
| Magnitude | The impact prior mitigation is considered to be high because there is a complete change of land capability within the footprint area. With proper land rehabilitation techniques, it can be reduced to moderate. | 4 | 3 |
| Receptor Sensitivity | Moderate Sensitivity: the change in land capability is in previously undegraded portions of land. | 3 | 3 |

| | | | |
|---|---|---|---|
| Impact Significance | Without mitigation measures, the impact will have high significance. When the change in land capability is mitigated through a reduced project footprint and thorough rehabilitation, the significance of the change in land capability will be moderate. | 14<br>4 | 11<br>3 |
| Required Management Measures | Minimise project footprint as far as possible. | | |
| Required Monitoring (if any) | Monitor the mining activities to ensure that mining operations will be restricted to the clearly defined limits of the project footprint. | | |
| Responsibility for implementation | Mine management | | |
| Impact Finding | Impact can be managed through limitation of the project footprint. | | |

#### 10.7.1.5 Cumulative Impacts on Soil

Large sections of natural soil properties have been altered as a result of mining development at BS1/2, Valley Boxcut and BS4. The Phase 2 Project will lead to additional changes in soil properties extending the area of impact. The SCPE is dependent of the specific soil properties of the areas. Extended impacts on soil will also lead to an extension of impacts on the terrestrial ecology.

Dry crop and grazing agricultural land of the wider area is cumulatively being transformed due to mining. This also leads to a change in the land capability as a result of increased disturbance.

### 10.7.2 Recommendations, Soil Mitigating, Management and Monitoring Requirements

The following recommendations are important to ensure soil conservation and to avoid significant cumulative impacts.

- Sensitive soils and no-go areas must be avoided;
- A proper soil quality audit should be conducted every second year that will measure the soil quality parameters;
- Audits need to be undertaken by an independent Environmental Control Officer ("**ECO**") to determine status of land degradation, including visual evidence whether soil erosion has increased and if proper erosion management techniques are in place. Additional management measures must be proposed if deemed required;
- All bare soil surfaces must be covered by either vegetation or geotextiles to prevent future soil erosion;
- Disturbance outside planned infrastructure footprints will lead to increased compaction and soil layer inversion and must be avoided;
- Soil chemical sampling of topsoil stockpiles as well as surrounding undisturbed areas must be undertaken to determine the soil fertility levels of the stockpiles for rehabilitation purposes; and
- The soil management plan prepared as part of the soil study must be adhered to.

### 10.7.3 Limitations and Gap Analysis

There were no soil quality monitoring reports available for review. Therefore, potential soil contamination could not be assessed.

Soil characteristics were assessed using a 1.5m hand-held soil auger. Properties of soil deeper than 1.5m have not been included in the study. The inaccessible terrain affected the sampling plan which had to be adapted as access allowed.

### 10.7.4 Impact Statement

The Phase 2 Project Area has a high sensitivity to water erosion and sedimentation of wetlands should water erosion occur. The Phase 2 Project will result in additional impacts on the soil and land capability properties of the Booysendal Operation. Potential impacts on soil include erosion, chemical soil pollution, soil compaction and inversion of current soil form horizons. The increase in surface footprints will also lead to cumulative impacts on the soils.

These impacts can be reduced by keeping the footprint minimised where possible and strictly following soil management measures pertaining to topsoil stripping, stockpiling and conservation of the soil quality of topsoil stockpiles. Surface infrastructure development should aim to avoid high sensitivity soils. It is also of the utmost importance that the best soil management practices be applied within the Project Area. The Phase 2 Project can be authorised should these recommendations be strictly implemented and monitored.

## 10.8 Water Quality

The surface-and groundwater impact assessment also has a bearing on the wetland, aquatic ecosystem, hydrology and hydrogeological regimes.

### 10.8.1 Impact Assessment

Groundwater and surface water impacts have been addressed in Section 10.4 and Section 10.6 respectively. Additional impacts are included in this section.

### 10.8.2 Recommendations on Water Quality

Additional recommendations made by the water quality specialist include:

- Waste needs to be separated and stored in specially prepared bunded areas;
- All spills need to be cleaned up immediately;
- Dirty water footprint areas must be minimised and all dirty water contained. The capacity of cut-off trenches, oil separators, wash bay cut-off trenches must not be compromised;
- No process water or effluent must be discharged into the Groot Dwars River system;
- The surface-and groundwater monitoring programme included in the EMP (Annexure C) must be followed; and
- Additional source monitoring boreholes must be drilled and the surface water monitoring network expanded. Potential locations are included in the EMP (Annexure C).

### 10.8.3 Limitations and Gap Analysis

Some of the boreholes have collapsed. Because of the collapse, the monitoring and assessment of some of the boreholes over time was not possible. The collapsed boreholes need to be fixed or, alternatively, new boreholes need to be drilled. During the rainy season, some boreholes become inaccessible, restricting and limiting data collection. It is not anticipated that the gaps in information will materially change the findings made in this Consultation EIR regarding water quality.

### 10.8.4 Impact Statement

The Olifants River is an already stressed system. It is therefore important that the upper reaches of the system, including the Groot Dwars River be protected and impacts restricted. Process water and treated effluent must be recycled in the process and not discharged into the Groot Dwars River system. The existing surface-and groundwater monitoring programme needs to be expanded to ensure that any pollution sources or impacts are identified timeously and to ensure that the necessary management and mitigating measures are put in place. Should these recommendations be implemented, then the Phase 2 Project can be authorised.

## 10.9 Wetland

### 10.9.1 Wetland Impact Assessment

Booysendal North MR Activities: The findings from the wetland assessment indicated that there will be no direct impact on wetlands as a result of the BCM1, BCM2 or the Emergency Escape Portal. However, as the infrastructure will be within 500m of wetlands, indirect impacts are likely to occur. The 11kVA powerline crosses the Groot Dwars River and various drainage lines, none of which are directly in wetlands or drainage lines, thereby limiting any long-term impact on the riparian habitat.

Although the BS1/2 to BN pipelines crosses approximately 5 drainage lines, it does not cross any wetlands. The pipeline will however be within 500m of wetlands, which could result in indirect impacts.

The wetland assessment found that the ARC towers will indirectly impact on wetlands.

No direct impacts on wetlands are therefore foreseen as a result of the Booysendal North MR Activities. However, indirect impacts can result from erosion, siltation and activities within drainage lines. Table 10-24 to Table 10-28 contain the assessment of potentially significant impacts of the Phase 2 Projects on wetlands during the LoM. Table 10-29 also includes an assessment of potential cumulative impacts.

Booysendal South MR Activities: According to current designs, the Backfill Plant, process water line from the Backfill Plant to the settlers and MCC1 and emergency backfill ponds are located away form any delineated wetlands and will therefore have no impact on wetlands.

The slurry pipeline between the Process and Backfill Plants will cross an unchanneled valley bottom wetland. Although this crossing will be on the existing access road bridge, spillages during the operational phase could impact on the wetland. Similarly, the process water pipeline from the MCC1 PCD to the RWD will also cross the unchanneled valley bottom wetland further downstream. This pipeline could lead to disturbance of the wetland during various phases of the Phase 2 Project. Due to the short life of the Backfill Plant, these impacts should be short term.

Table 10-24 Wetland Impacts due to Site Clearance and Linear Infrastructure Construction

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Vegetation clearance and earth-moving activities within wetland and riparian areas. Construction of linear infrastructure crossing rivers and wetlands. | | |
| Risk/ Impact | Loss and disturbance of wetland habitat. All wetland habitat falling directly within the development footprints and construction servitudes will be lost. Construction activities, if not strictly controlled, will also result in disturbances to the wetland vegetation and habitat adjacent to the development footprints through, for example, uncontrolled driving in the wetland area, fire, construction of associated infrastructure, or temporary stockpiling of material in the wetland area. Such disturbances can lead to increased erosion in the wetlands (e.g. preferential flow paths created by vehicle tracks), displacement of wetland fauna, changes in wetland vegetation and invasion by alien vegetation. Blasting activities are also likely to result in disturbance and possibly displacement to wetland fauna. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Direct: clearance will lead directly to impact | | |

| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Likelihood/ probability | Likely | 4 | 4 |
| Duration | Permanent<br>Loss of wetland habitat will be permanent | 4 | 2 |
| Extent | Site<br>Direct impact will be limited to development footprint | 2 | 2 |
| Receptor Sensitivity | High<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | 4 | 4 |
| Magnitude | High<br>Loss of wetland habitat will be permanent and irreversible | 4 | 2 |
| Impact Significance | High significance<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | High<br>14<br>4 | Moderate<br>12<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Wetlands should be excluded from the proposed development footprints as far as possible. The Groot Dwars River riparian wetland and Everest tributary valley bottom wetland should be considered no-go areas. Wetland areas that have already been disturbed outside the direct construction footprint should be rehabilitated through landscaping back to the original profile, alleviation of soil compaction, and revegetation with locally indigenous species common to the area.<br><br>The following further mitigation measures are recommended:<br>• All construction areas should be fenced off/clearly demarcated prior to commencement of vegetation clearing activities on site so as to prevent access to adjacent wetlands and their associated buffer zones by construction machinery and personnel. In addition, all wetland areas should be clearly marked and demarcated as such to alert construction staff on site. All construction staff should also be educated on the importance and sensitivity of the wetland systems on site. This should form part of the induction process.<br>• Develop and implement a construction storm water management plan prior to the commencement of site clearing activities.<br>• No stockpiling of material may take place within the wetland areas and temporary construction camps and infrastructure should also be located away from these areas, with a minimum buffer of 30m maintained from delineated wetland boundaries.<br>• Rehabilitate and re-vegetate all disturbed areas as soon as possible following disturbance.<br>• An alien vegetation management plan should be drawn up by the Environmental Manager and implemented. Regular removal of invasive alien species should be undertaken. This should extend right through to the decommissioning and closure phase of the project.<br>• Detailed method statements should be developed for all wetland crossings in consultation with a wetland/aquatic specialist.<br>• Linear infrastructures should follow existing disturbances or roads as far as possible. | | |
| Required Monitoring | Long-term monitoring of wetland integrity using WET-Health or other suitable tools | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Some wetland loss likely to be unavoidable unless layout plans altered. Wetland disturbance can be mitigated to short-term nuisance impacts if activities strictly controlled and mitigation measures fully implemented. | | |

Table 10-25 Increased Sedimentation and Turbidity during the Construction Phase

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Vegetation clearance and earth-moving activities within wetland and riparian areas. Construction of linear infrastructure crossings of rivers and wetlands. | | |
| Risk/ Impact | • Increased sedimentation and turbidity.<br>• Stripping of vegetation will increase volumes and velocities of surface runoff generated from the affected areas, increasing erosion risk within downslope receiving wetlands. Soil compaction due to movement of machinery during construction will further increase runoff, while vehicle ruts and tracks resulting from construction activity could provide preferential flow paths that lead to flow concentration, again increasing erosion risk.<br>• Increased sediment loads transported into adjacent wetlands from the sediment rich runoff generated on site will be deposited within the wetlands as flows slow down. Deposited sediments are likely to be colonised by pioneer and ruderal species, leading to deterioration of habitat quality. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, CL<br><br>Negative | | |
| Type of Impact | Direct: clearance will lead directly to impact | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 4 | 3 |
| Duration | Short-term | 2 | 1 |
| Extent | Wider are of influence<br>Impacts will be transferred to downstream reaches | 3 | 3 |
| Receptor Sensitivity | High | 4 | 4 |
| Magnitude | Moderate<br>Reversible although habitat loss is likely, followed by a decline or loss of sensitive species and a decline in overall biodiversity and ecological integrity | 3 | 2 |
| Impact Significance | High significance<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | High<br>13<br>3 | Minor<br>11<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • A construction SWMP should ideally be developed and implemented prior to the commencement of large scale vegetation clearing activities or construction activities and be maintained until the end of the construction phase. Where construction activity has already commenced, a construction SWMP must be implemented at the latest before the onset of the coming rainy season. Such a plan should aim to minimise the transport of sediment off site as well as prevent the discharge of high velocity flows into downslope wetlands. Sediment traps and sediment barriers should be installed where necessary, and discharge points should be protected against erosion and incorporate energy dissipaters.<br>• Vegetation clearing, soil stripping and major earthmoving activities should be phased to minimise the extent of bare soils surfaces exposed at any one time. Vegetation clearing and soil stripping should also only be undertaken immediately preceding the onset of construction activities on site, i.e. ideally not more than 7 days before the onset of construction activities. A scenario of cleared areas lying bare and unused for weeks on end must be avoided. | | |

| | |
|---|---|
| | • To minimise the impact of increased runoff and sediment transport into adjacent wetlands, vegetation clearing and soil stripping should be concentrated in the dry season. Given the duration of construction activities as well as uncertainties around the commencement date, limiting all construction activities to the dry season is however likely to be impossible.<br>• Erosion within the construction site must be minimised through the following:<br>o Limiting the area of disturbance and vegetation clearing to as small an area as possible;<br>o Where possible, undertaking construction during the dry season;<br>o Phasing vegetation clearing activities and limiting the time that any one area of bare soil is exposed to erosion;<br>o Control of storm water flowing onto and through the site. Where required, storm water from upslope should be diverted around the construction site;<br>o Prompt stabilisation and re-vegetation of soils after disturbance and construction activities in an area are complete; and<br>o Protection of slopes. Where steeper slopes occur, these should be stabilised using geotextiles or any other suitable product designed for the purpose.<br>• Sediment transport off the site must be minimised through the following:<br>o Establishing perimeter sediment controls. This can be achieved through the installation of sediment fences along downslope verges of the construction site. Where channelled or concentrated flow occurs, reinforced sediment fences or other sediment barriers such as sediment basins should be used (refer to US EPA guidelines on Storm Water Pollution Prevention);<br>o Discharge of storm water from the construction site into adjacent grassland rather than directly into wetland habitat. Discharged flows must be slow and diffuse; and<br>o Regular inspection and maintenance of sediment controls |
| Required Monitoring | Long-term monitoring of wetland integrity using WET-Health or other suitable tool |
| Responsibility for implementation | Environmental Manager and Mine Manager |
| Impact Finding | |
| Impact Finding | Impact can be minimised by mitigation measures but a decline in habitat integrity is likely |

During the operational phase the most significant impact anticipated as a result of the Phase 2 Project is related to spillages and materials handling (Table 10-26 and Table 10-27).

### Table 10-26 Water Quality Deterioration due to Materials Handling

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Handling of waste and potential contaminants on site | | |
| Risk/ Impact | • As part of supporting activities for the mining activities, numerous hazardous and potentially polluting substances will be utilised and possibly temporarily stored on site, including, for example, diesel and oil. Spillages and leaks of these hydrocarbons could result in the deterioration of water quality should they enter the adjacent wetland areas via surface runoff.<br>• Stockpiling of any waste material could also result in contaminated runoff and/or seepage entering adjacent wetlands.<br>• Water leaking or overflowing from any dirty water retention dams or PCDs on site could also lead to water quality deterioration. | | |
| Project Phase: CO, OP, CL | OP, CL | | |

| | | | |
|---|---|---|---|
| Nature of Impact | Negative | | |
| Type of Impact | Direct: Spills and leaks will directly impact on water quality | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Short-term (possibly long-term in the case of severe spills) | 2 | 2 |
| Extent | Wider are of influence<br>Impacts will be transferred to downstream reaches | 3 | 3 |
| Receptor Sensitivity | High<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | 4 | 4 |
| Magnitude | Moderate to High<br>A decline in water quality will result in the loss of sensitive species. | 3 | 2 |
| Impact Significance | High significance<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | High<br>12<br>3-4 | Moderate<br>12<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • All hazardous substances should be stored on impervious surfaces, outside any wetland areas, that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the Environmental Manager. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site.<br>• Any waste material stored on site must be located within a dirty water area isolated from the surrounding catchment and all runoff and seepage from the waste contained. No discharge of such dirty water may take place on site.<br>• All PCDs should be suitably lined and designed as per the required specifications and legislation to ensure that no overflow occurs at least up to the 1:50 year return event. Management of water levels within the PCD should be carefully controlled to ensure that the required storage capacity is always available. Water quality and biomonitoring plans should be implemented to monitor for water quality deterioration downslope of any dirty water areas, carbonaceous stockpiles, PCDs or any other potentially polluting activity. | | |
| Required Monitoring | Long-term monitoring of water quality and aquatic fauna (biomonitoring) | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be mostly mitigated, though some decline in water quality is likely. | | |

## Table 10-27 Water Quality Deterioration affecting Wetlands during the Operational Phase

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Water quality deterioration due to leaking pipes | | |
| Risk/ Impact | Numerous pipelines are required as part of the proposed project, a number of which will convey dirty water or slurry. Spills or leaks from these pipelines could lead to water quality deterioration in receiving watercourses. | | |

| | | | |
|---|---|---|---|
| Project Phase: CO, OP, CL<br><br>Nature of Impact | OP, CL<br><br>Negative | | |
| Type of Impact | Direct: Spills and leaks will directly impact on water quality | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Short-term (possibly long-term in the case of severe spills) | 2 | 2 |
| Extent | Wider are of influence<br>Impacts will be transferred to downstream reaches | 3 | 3 |
| Receptor Sensitivity | High<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | 4 | 4 |
| Magnitude | Moderate to High<br>A decline in water quality will result in the loss of sensitive species. | 3 | 2 |
| Impact Significance | High significance<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | High<br>12<br>3-4 | Moderate<br>12<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Pipelines must be regularly inspected and maintained to ensure that any leaks that do occur are quickly fixed. A detailed log book of all inspections should be kept.<br>• Leak detection systems should be installed on dirty water pipelines crossing wetland systems. | | |
| Required Monitoring | Long-term monitoring of water quality and aquatic fauna (biomonitoring) | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be mostly mitigated, though some decline in water quality is likely. | | |

The most significant impacts on wetlands expected during the decommissioning phase relate to decanting and the impact of contaminated water on wetlands. The assessment of the significance of the impacts is included on Table 10-28.

### Table 10-28 Decommissioning Phase Impacts on Wetlands

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Underground mining | | |
| Risk/ Impact | Post- closure, the mined-out voids will begin to fill with water and could eventually start decanting into adjacent watercourses, specifically the Groot Dwars River. This will likely lead to deterioration in water quality, particularly in terms of metals and salts, followed by a loss of aquatic fauna. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CL<br><br>Negative | | |
| Type of Impact | Direct: decant will lead directly to impact | | |

| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Long-term | 4 | 4 |
| Extent | The impact will be transferred to downstream reaches of watercourses and rivers | 3 | 3 |
| Receptor Sensitivity | High<br>Catchment is classified as a NFEPA. | 4 | 4 |
| Magnitude | High<br>This impact is irreversible. The magnitude depends on the quality and amount of water decanting, as well as the proximity of decant points to the watercourse. | 4 | 3 |
| Impact Significance | High significance, taking into account the good water quality within receiving watercourses and the prevalence of sensitive species. | High<br>14<br>4 | Moderate<br>14<br>3 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Identify the location, timing, volume and expected quality of decant prior to the commencement of mining.<br>• Apply mining methods that will limit the amount of water entering mined out areas.<br>• Avoiding under-mining wetlands.<br>• Provision should be made for the management and/or treatment of decanting water well beyond closure.<br>• ABA techniques and evaluation should be applied to determine the expected quality of the water that will decant. | | |
| Required Monitoring<br><br>(if any) | • Long-term monitoring of wetland integrity using WET-Health or other suitable tool.<br>• Biomonitoring and water quality monitoring.<br>• Flow monitoring in the Groot Dwars. | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | The degree to which this impact can be mitigated is uncertain. The magnitude depends on the quality and volume of water decanting, as well as the proximity of decant points to the watercourse. | | |

Extensive wetland habitat transformation has occurred in the Groot Dwars River wetland system due to anthropological impacts. The Phase 2 Project can contribute to further wetland degradation. An assessment of the potential cumulative impacts on wetlands is included in Table 10-29.

Table 10-29 Phase 2 Project Cumulative Wetland Impacts

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Mining and all associated activities and infrastructure within the Groot Dwars River Valley. | | |
| Risk/ Impact | Increased degradation and transformation of wetland habitat as adjacent land use is changed, as well as a deterioration in water quality and reduction in water quantity within the larger systems of the area, i.e. the Groot Dwars riparian wetland and the wetlands associated with the Everest tributary. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Direct and Indirect | | |

| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Likelihood/ probability | Likely | 4 | 4 |
| Duration | Permanent<br>Loss of wetland habitat will be permanent | 4 | 2 |
| Extent | Regional<br>Direct impact will be limited to development footprint but indirect impacts will extend downstream. | 4 | 2 |
| Receptor Sensitivity | High<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | 4 | 4 |
| Magnitude | Moderate<br>Habitat loss is likely, followed by a decline or loss of sensitive species and a decline in overall biodiversity and ecological integrity | 3 | 3 |
| Impact Significance | High significance<br>Wetlands of good condition and moderate to high EIS. Wetland vegetation types CR and EN. | High<br>16<br>3 | Moderate<br>12<br>3 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Cumulative impacts are difficult to mitigate as many factors contributing to these impacts are beyond the control of Booysendal. However, the following is proposed:<br>• Consideration should be given to the removal/closure of the road through the Groot Dwars valley following completion of construction and after mining activities.<br>• The upper reaches of the Groot Dwars River valley must be conserved and protected to mitigate and offset the impacts of the Booysendal South Expansion Project on the river system.<br>• If found to be practically implementable, the upper Groot Dwars Valley should be formally protected. | | |
| Required Monitoring | Long-term monitoring of wetland integrity using WET-Health or other suitable tool | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Some wetland degradation will be unavoidable if proposed mining activities proceed. Wetland impacts must be limited to as small an area as possible, with activities within close proximity to wetlands or within the regulated area (500m buffer) strictly controlled and mitigation measures fully implemented. | | |

### 10.9.2 Recommendations on Wetland Management

Ensure that all ARC towers are located outside of delineated wetlands. Avoid delineated wetlands and demarcate footprints in close proximity of wetlands.

Refer to impact tables (Table 10-24 to Table 10-29) for additional recommendations. Management and monitoring requirements are included in the EMP in Annexure C.

### 10.9.3 Limitations and Gap Analysis

Due the to the constant changes in the Booysendal South Expansion Project, it was not at all time clear which activities are to be included and which excluded. Therefore, only activities included in Annexure I have been assessed as per the specialist's understanding of the Phase 2 Project. It might be possible that some smaller wetlands might have been missed in the field due to the nature of the terrain. The delineated wetland boundaries have an accuracy of between 10 to 20m on the ground. No hydro-pedological modeling of wetlands was done, nevertheless, the level of confidence in the findings of the wetland assessment is high.

### 10.9.4 Impact Statement

The wetland specialist is of the opinion that approval of the Phase 2 Project could be granted under the conditions included in Section 11.

## 10.10 Aquatic Biodiversity

### 10.10.1 Aquatic Biodiversity Impact Assessment

An assessment of the most significant Phase 2 Project aquatic impacts identified is included in this section. Detail around impacts with a low significance is included in Annexure J, while some of the impacts in water have been addressed under the hydrology, hydrogeology, soil and wetland sections.

### 10.10.2 Booysendal North Mining Right Activities Aquatic Impact Assessment

#### 10.10.2.1 Construction Phase

The main anticipated impacts during the construction phase include a loss of *Enteromius cf. motebensis*, direct impacts on streams and rivers, erosion and siltation and deterioration of water quality, all of which have the potential to impact sensitive species. The assessment of the impacts and required management and monitoring requirements are included in Table 10-30 and Table 10-31.

Table 10-30 Increase in Turbidity and Sedimentation

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Vegetation removal and earth-moving activities during construction of ARC towers and laying of pipeline in riparian and wetland areas. | | |
| Risk/ Impact | The main impact during the construction phase will be the erosion of sediments and their deposition in receiving watercourses, especially where construction takes place within the 1:100 year floodline of a river or watercourse or less than 100m away from the channel. This applies in particular to the pipeline route and the location of the ARC towers. The Groot Dwars River will be most affected between the bridge and the confluence with the Everest tributary (Middle Reach). The pipeline and ARC route will run alongside the Groot Dwars River (within its 100-m buffer zone) for the entire length of this river reach. Two ARC towers will be constructed within the 100m buffer. Tower 3 falls within the 100m buffer of a non-perennial drainage line. The Waterfall tributary will be impacted by the pipeline crossing. The Everest tributary is affected by the 11kVA powerline crossing.<br><br>Runoff from infrastructure that is not located within the floodplain of the river but affects non-perennial drainage lines (i.e. BCM2, the Emergency Escape Portal and associated access roads) may also have additional impacts, with eroded sediments being transported via non-perennial drainage lines which feed into the river. This is exacerbated by the steep terrain.<br><br>Sediments that are washed from construction activities into the river will result in a higher turbidity (affecting aquatic species with a high requirement for good water quality) and sedimentation of the riverbed (negatively affecting aquatic species that require clear, cobbled substrates and favouring more common, widespread species, such as *Clarias gariepinus*). Considering the prevalence of sensitive species, particularly fish species, within this reach of the Groot Dwars River, this impact is considered significant and could result in a decline in overall integrity and aquatic biodiversity. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, CL<br><br>Negative | | |
| Type of Impact | Direct: clearance and construction activities will lead to direct, indirect and cumulative impacts will apply due to all construction activities in the sub-catchment. | | |

| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
|---|---|---|---|
| Likelihood/ probability | Definite | 4 | 4 |
| Duration | Short-term | 2 | 2 |
| Extent | Wider area of influence | 3 | 3 |
| Receptor Sensitivity | High<br>NFEPA catchment | 4 | 4 |
| Magnitude | Moderate.<br>Reversible but potentially substantial erosion | 3 | 2 |
| Impact Significance | Moderate significance to aquatic ecosystems. | High<br>13<br>3 | Moderate<br>13<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Tower 7, 6 and 3 must be moved out outside of the 100m buffer zone or as approved by DWS.<br>• Ideally the pipeline route should follow the main access road to reduce the risk to watercourses and wetlands. At the very least the pipeline should be moved so that it is more than 30m from the riparian wetland and its buffer zone. Plinths constructed for the pipelines need to be located outside of drainage lines and delineated wetlands.<br>• The disturbance footprint should be kept to a minimum. Wetland and riparian areas should be cordoned off and considered no-go areas to vehicles. Access to wetlands by construction vehicles should be avoided or minimised as far as possible.<br>• Construction during winter (dry season only) is recommended.<br>• Sediments should be trapped (sediment traps should be installed) and prevented from entering receiving watercourses.<br>• Responsible storm water management measures should be implemented at all construction areas (including BCM1, BCM2 and the Emergency Escape Portal and associated access roads).<br>• Soil stockpiles and cement batching areas should be located outside of wetland areas and their buffers (>30 metres from the watercourse).<br>• Any damage to riparian or wetland areas should be rehabilitated (reshaped and revegetated) after construction to prevent subsequent erosion. | | |
| Required Monitoring (if any) | Long-term monitoring of water quality (including turbidity and Suspended Solids ("**SS**")), wetland integrity and aquatic fauna (biomonitoring). | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be minimised by mitigation measures | | |

## Table 10-31 Loss of Habitat, Biodiversity and a Decline in Ecological Integrity

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | All construction activities | | |
| Risk/ Impact | Loss of habitats, sensitive species and a decline in ecological integrity and biodiversity due to a decline in water quality and loss of habitat. The risk of this impact is considered high due to the good water quality and pristine to largely natural conditions within the watercourses, together with the catchment's status as a NFEPA and the presence of the endangered *E. cf. motebensis*.<br><br>During the construction phase, there is likely to be a decline in diversity and ecological integrity within the Groot Dwars River downstream of the bridge at BS1/2 (middle and downstream reaches). | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, CL<br><br>Negative | | |
| Type of Impact | Indirect and Cumulative: This impact is considered to be associated with a range of activities that impact on habitats and water quality, with each activity adding to the magnitude of the impact. | | |

| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
|---|---|---|---|
| Likelihood/ probability | Definite | 4 | 4 |
| Duration | Long-term to permanent | 3 | 2 |
| Extent | Wider area of influence<br>Impacts will be transferred to downstream reaches | 3 | 3 |
| Receptor Sensitivity | High<br>NFEPA catchment and the presence of a Red Listed (VU) fish species | 4 | 4 |
| Magnitude | Moderate<br>Substantial harm to aquatic biota during the construction phase. However, some degree of recovery possible. | 2 | 2 |
| Impact Significance | High significance due to the presence of sensitive and threatened species. | Moderate<br>14<br>2 | Moderate<br>13<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | All the mitigation measures to address impacts to water quality and habitat should be implemented. In addition, a Biodiversity Management Plan should be compiled for aquatic biota and implemented as part of a Biodiversity Action Plan for the Mine as a whole.<br>A rehabilitation plan must be compiled for each phase of mining. | | |
| Required Monitoring (if any) | Long-term monitoring of water quality and aquatic fauna (fish, macroinvertebrates, riparian vegetation) and instream and riparian habitat integrity. | | |
| Responsibility for implementation | Environmental Manager and Mine Manager. Aquatic specialist appointed by mine. | | |
| Impact Finding | | | |
| Impact Finding | Impact can be reduced by mitigation measures but an overall decline in ecological integrity is already evident. Aquatic species that are sensitive to changes in water quality, habitat and flow are likely to be lost from the affected reach. | | |

#### 10.10.2.2 Operational Phase

The main impacts anticipated during the operational phase is impacts on water quality as a result of spillages from ore, dust, PCDs and hazardous material storage areas, which could impact on the aquatic biodiversity. An assessment of the impacts, required management and monitoring is included in Table 10-32 and Table 10-33.

Table 10-32 Decline in Water Quality from Transportation and Ore Crushing

| **Impact Component** | **Impact 1** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Transport (by overland conveyor and ARC), crushing of ore (crusher) and storage of ore (silo). | | |
| Risk/ Impact | Decline in water quality as a result of dust generated during the crushing and transport of ore. Ore will be transferred from underground to the crusher via overland conveyor. From the crusher, ore will be transported to the silo and from there to the ARC via a chute. During each of these stages, dust will be generated and spills are likely. The dust and spills will be blown or washed into receiving watercourses, including the Groot Dwars River, resulting in a significant decline in water quality and a loss of sensitive aquatic species. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | OP<br><br>Negative | | |
| Type of Impact | Direct: Spills will lead to impact<br>Cumulative. This will exacerbate existing and future impacts to water quality attributed to the Booysendal South Expansion Project. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |

| | | | |
|---|---|---|---|
| Likelihood/ probability | Definite | 4 | 4 |
| Duration | Long-term | 3 | 3 |
| Extent | Wider area of influence<br>Impacts will be transferred to downstream reaches. | 3 | 3 |
| Receptor Sensitivity | High<br>NFEPA catchment. | 4 | 4 |
| Magnitude | Moderate<br>Reversible although there may be considerable water quality and habitat impacts, which may cause the loss of sensitive biota. | 3 | 2 |
| Impact Significance | Moderate significance as a few sensitive and threatened species occurring in the area may be impacted. | High<br>14<br>3 | Moderate<br>13<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Dust suppression during all stages of crushing and transport of ore is considered critical.<br>• It is recommended that road transport of ore between BCM1 and 2 and BN be considered, rather than transfer via a chute to the ARC.<br>• Crushing of ore should also be limited to already-disturbed areas at BN. The rationale for this recommendation is that ore handling should be minimised in the Groot Dwars Valley so as to minimise potential impacts to water quality.<br>• All design specifications to reduce spills and dust from the ARC must be implemented (DRA 2015). As specified, this must include covered feed conveyors and chutes, vibrating feeders, spillage conveyors, multiple break system, fail-safe breaks, covers, skirts, cleats, out-of-balance force, etc.<br>• It is recommended that the ARC (as well as overland conveyors) be enclosed (covered) where it crosses wetlands and drainage lines.<br>• No conveyor transfers should be located within 100m of a watercourse.<br>• Conveyors must be operated according to load specifications and effectively maintained. Regular inspections should be conducted to detect potential malfunctions. | | |
| Required Monitoring (if any) | Long-term monitoring of water quality (including turbidity and SS) and aquatic fauna (biomonitoring). See EMP (Annexure C) | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | With mitigation, the likelihood and magnitude may be reduced. However, effective mitigation can only be assured if crushing and transfer is done in accordance with the management and mitigating measures proposed above | | |

Although there is concern around potential spillages from the ARC, it was indicated that the design of the ARC is as such that it captures potential spills.

### Table 10-33 Loss of Habitat, Biodiversity and Decline in Ecological Integrity

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | All activities | | |
| Risk/ Impact | Loss of habitats, sensitive species and a decline in ecological integrity and biodiversity due to a decline in water quality, altered flows and decline in habitat integrity. The risk of this impact is considered high due to the good water quality, presence of sensitive and threatened species and FEPA status of the catchment. There is a high risk that the Vulnerable fish species, *Enteromius cf. motebensis* will be lost from the middle reach of the Groot Dwars River downstream of the road crossing. The genetic uniqueness, population size and distribution of this species is uncertain and it is likely that critical habitat for its future survival will be compromised. It is not known whether the remaining undisturbed habitat within the upper reach of the Groot Dwars River, will be sufficient to sustain the population. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |

| Type of Impact | Indirect and Cumulative: This impact is considered to be associated with a range of activities that impact on flow, habitats and water quality, with each activity adding to the magnitude of the impact. | | |
|---|---|---|---|
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Long term | 3 | 3 |
| Extent | National implications as NFEPA status may be lost | 3 | 2 |
| Receptor Sensitivity | High<br>NFEPA catchment | 4 | 4 |
| Magnitude | High<br>Irreversible | 4 | 3 |
| Impact Significance | High on account of the sensitivity of the area and the potential presence of threatened species. The cumulative impact is likely to be high. | High<br>13<br>4 | Moderate<br>13<br>3 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Apply all management and mitigation measures for flow, habitat and water quality.<br>• The habitat within the upper Groot Dwars River and upper Everest tributary should be protected. No developments should take place within the sub-catchments containing critical habitat of this species.<br>• An offset strategy should be implemented and should include aquatic biodiversity considerations, incorporating cumulative impacts from all present and proposed Phase 2 Project activities.<br>• It is strongly recommended that sub-catchments be identified along the Groot Dwars River and its tributaries that can be set aside for formal conservation.<br>• Rehabilitation measures should be considered.<br>• Alien Bass and Carp should be removed from the TKO Dam and Der Brochen Dams.<br>• A Biodiversity Management Plan should be compiled for the Booysendal Mine.<br>• A comprehensive study must be conducted to fully understand the distribution, ecology and genetic lineage of *E. cf. motebensis* within the study area and adjacent sub-catchments.<br>• This species should be monitored biannually as part of a biomonitoring programme | | |
| Required Monitoring (if any) | Long-term monitoring of water quality and aquatic fauna (fish, macroinvertebrates) and instream and riparian habitat integrity. | | |
| Responsibility for implementation | Environmental Manager and Mine Manager. Appointed aquatic specialist | | |
| Impact Finding | | | |
| Impact Finding | The likelihood of localised extinctions and habitat loss can be decreased through responsible mitigation. However, it remains likely that diversity and overall present ecological state of the Groot Dwars River will be reduced. The resource quality objectives for the upper reach of the Dwars sub-catchment (RU62) (DWS 2014) is specified as Category C. As the downstream reach is already classified as a category C, it seems likely that further declines will result in this objective not being met. | | |

### 10.10.2.3 Decommissioning and Closure Phase

The greatest threat to the aquatic environment during the decommissioning and closure is an increase in sedimentation (see Table 10-34).

Table 10-34 Closure Sedimentation on Aquatic Biodiversity

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Earth-moving activities during infrastructure removal | | |
| Risk/ Impact | Soils exposed during decommissioning are likely to erode, causing sediments to be carried into receiving wetlands and watercourses. The greatest risk will be posed by the removal of the ARC towers (towers 6 and 7), the process and potable water pipelines and the 11kVA powerline which are located within 100 metres of the Groot Dwars River. | | |

| | | | |
|---|---|---|---|
| | The Groot Dwars River will be most affected between the bridge and the confluence with the Everest tributary (Middle Reach). The Waterfall tributary will be impacted by a pipeline crossing. The Everest tributary will be affected by a powerline crossing. Runoff from BCM1 and BCM2, as well as the Emergency Escape Portal, may also have additional impacts via non-perennial drainage lines which feed into the river.<br><br>Sediments that are washed from construction activities into the river will result in a higher turbidity (affecting aquatic species with a high requirement for good water quality) and sedimentation of the riverbed (negatively affecting aquatic species that require clear, cobbled substrates and favouring more common, widespread species, such as *Clarias gariepinus*). Considering the prevalence of sensitive species, particularly fish species, within this reach of the Groot Dwars River, this impact is considered significant and could result in a decline in overall integrity and aquatic biodiversity. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, CL<br><br>Negative | | |
| Type of Impact | Direct: clearance will lead directly to impact. Direct and cumulative impacts will apply. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Definite | 4 | 3 |
| Duration | Short-term | 2 | 2 |
| Extent | Wider area of influence | 3 | 3 |
| Receptor Sensitivity | High<br>NFEPA catchment | 4 | 4 |
| Magnitude | Moderate | 3 | 2 |
| Impact Significance | Moderate significance to aquatic ecosystems. | High<br>13<br>3 | Minor<br>12<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • It is recommended that the pipeline route be moved to follow the access road, rather than running alongside the Groot Dwars River.<br>• The disturbance footprint in wetland areas should be kept to a minimum. To achieve this, wetland and riparian areas should be cordoned off and considered no-go areas to vehicles during the decommissioning and rehabilitation phase. Access by construction vehicles should be avoided or minimised as far as possible.<br>• Decommissioning should take place during winter (dry season only). Sediments should be trapped and prevented from entering receiving watercourses.<br>• Soil stockpiles and cement batching areas should be located outside of wetland areas and their buffers (at least >30 metres from the delineated watercourse).<br>• Storm water management systems must remain intact until after the removal of infrastructure.<br>• Any damage to riparian or wetland areas should be rehabilitated (reshaped and revegetated) after construction to prevent subsequent erosion. | | |
| Required Monitoring (if any) | Long-term monitoring of water quality (including turbidity and SS), wetland integrity and aquatic fauna (biomonitoring). See section 8.4 | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be minimised by mitigation measures | | |

It is expected that the main residual impact on aquatic biodiversity will result from erosion, siltation and the associated impacts on the aquatic environment.

#### 10.10.2.4 Cumulative Impact

Significant cumulative impacts on the aquatic regime are expected as a result of the increase in mining in the valley. The activities which could result in these impacts include dewatering, lowering of water levels that will affect species sensitive to flow changes and increased negative impacts due to contaminants.

### 10.10.3 Booysendal South Mining Right Activities Aquatic Impact Assessment

The impacts, management and monitoring requirements as a result of the Phase 2 Project are summarised here. Minor impacts are included in Annexure J.

#### 10.10.3.1 Construction Phase

Two potential impacts identified include an increase in erosion (see management and monitoring requirements included in Table 10-30) and deterioration in water quality as a result of spills from construction activities (see Table 10-35).

Table 10-35 Water Quality Deterioration due to Spills and Leaks

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Construction of pipeline crossings and backfill emergency ponds | | |
| Risk/ Impact | Water quality may be impacted in the following ways:<br>• Spills and leaks of oils, greases and fuel (e.g. from faulty equipment or vehicles), sewage effluent (from temporary ablution facilities), cement and other contaminants may be washed (in storm water) or blown into waterbodies. This may affect species highly sensitive to changes in water quality.<br>• Inappropriately stored hazardous substances (e.g. PVC piping) can produce leachate that can seep into soils or be washed into waterbodies in storm water runoff.<br>• Storm water flushing construction areas, as well as dust, can carry additional pollutants into water bodies.<br>• Water quality deterioration will cause a decline in ecological integrity as species that have a high to moderate requirement for good water quality are lost | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO<br><br>Negative | | |
| Type of Impact | Direct: Spills and leaks will directly impact on water quality | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 3 | 2 |
| Duration | Short-term (possibly long-term in the case of severe spills) | 2 | 2 |
| Extent | Wider area of influence<br>Impacts will be transferred to downstream reaches | 3 | 3 |
| Receptor Sensitivity | High<br>NFEPA catchment | 4 | 4 |
| Magnitude | Moderate (or High, depending on the type or extent of the spill). A large-scale fuel spill would have a high magnitude impact while a less severe spill will have a lower magnitude impact. A decline in water quality will result in the loss of sensitive species. | 3 | 2 |
| Impact Significance | Moderate to High significance depending on the severity of the spill | Minor to Moderate<br>12<br>3 | Minor<br>11<br>2 |
| Mitigating and Monitoring Requirements | | | |

| | |
|---|---|
| Required Management Measures | Measures to mitigate water quality impacts during the construction phase include:<br>• All potential sources of contamination (e.g. cement batching areas or temporary ablution facilities) must be located well outside of wetland areas and their buffer zones (>30 m).<br>• Cordon off wetlands streams and riparian areas and prevent access, especially by heavy machinery during the decommissioning and rehabilitation phase.<br>• All construction staff should also be educated on the importance and sensitivity of aquatic ecosystems<br>• Implement all mitigation listed above to prevent erosion and sedimentation.<br>• Ensure separation of clean and dirty water and allow clean water to enter natural water bodies after effective attenuation and sediment trapping.<br>• To prevent spillages, vehicles should be well maintained.<br>• Diesel and oil/grease should be stored in bunded areas outside of riparian zones, so that spillages to be easily and quickly isolated before contamination of any soils or water.<br>• A spill management plan should be compiled before construction. Spills should be cleaned up with approved absorbent material such as "Drizit" or "Spillsorb". These should be kept in sufficient quantities on site to deal with small spills. Absorbent material and contaminated soil should be disposed of at a registered hazardous waste site,<br>• Identify potential areas where seepage and spills can occur into the natural environment. Designated waste handling and storage facilities must be located outside of wetland and riparian areas at the start of the construction phase. These facilities must be located in bunded areas that do not allow seepage of pollutants into the ground or the run-off of polluted water. All waste, including hazardous waste, must be disposed of in registered waste disposal facilities. Take necessary precautions to reduce potential spills and seepage. Ensure that silt, lime, cement, paint, chemicals etc. do not wash into drains or nearby watercourses.<br>• Implement dust suppression methods using approved and tested methods and/or solutions.<br>• Should spills occur, these should be reported to the ECO. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. An emergency preparedness plan should be compiled for all potential major spills during all phases of the development.<br>• Water quality monitoring and biomonitoring should be undertaken<br>• The design of the storm water management system should take into account:<br>  ○ Quality of water leaving the site (separation of clean and dirty water)<br>  ○ Retention/treatment of dirty water<br>  ○ Volumes and velocities of water leaving the site<br>• Storm water management, including PCDs and storm water trenches, should be designed according to DWAF Best Practice Guidelines (2006, 2007a, b, 2008). |
| Required Monitoring (if any) | Long-term monitoring of water quality and aquatic fauna (biomonitoring). See section 8.4 |
| Responsibility for implementation | Environmental Manager and Mine Manager |
| Impact Finding | |
| Impact Finding | Impact can be mitigated (except in the case of severe spills of hazardous material) although some decline in water quality is likely |

#### 10.10.3.2 Operational Phase

The main potential impacts during the operational phase are spills from slurry and process water pipelines (Table 10-36 and a decrease in biodiversity (Table 10-37). Potential impacts related to spills and hazardous material handling are included under the hydrological section.

Table 10-36 Decrease in Water Quality due to Tailings Spillage

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Pumping of tailings from the Process Plant to the Backfill Plant | | |
| Risk/ Impact | • There is a high risk of tailings spills during the process of reworking the tailings and backfilling of underground areas. Depending on the extent and severity of the spill, this could have a significant impact on water quality within the Everest tributary, possibly extending as far as the Groot Dwars River. Sensitive species may be lost. | | |

| | | | |
|---|---|---|---|
| | • Based on leach tests (Future Flow 2017), nitrates and chromium are expected to be elements of concern in tailings. Should there be tailings leaks or spills from the pipeline or backfill emergency ponds, nitrate and chromium concentrations in the receiving Everest tributary may increase. Other metals and salts that may increase in concentration include Calcium, magnesium, sodium, silicon, iron, aluminium and manganese. This may negatively affect the survival and health of aquatic biota.<br>• Increased nitrate concentrations are likely to promote the growth of algae which, in turn, will compromise benthic habitats and cause fluctuations in oxygen concentrations (low at night and elevated during the day). Supersaturated conditions during the day can cause gas bubble disease in fish and promote the growth of blue-green algae, which may be harmful to livestock and humans). The target water quality range specified in the DWAF (1996) guidelines for aquatic ecosystems specifies a maximum increase of inorganic nitrogen by no more than 15% from baseline, unimpacted levels.<br>• Of greater concern, is that inorganic nitrogen (nitrites and nitrates), when reduced, can form ammonia. Ammonia can cause toxicity to aquatic biota. High pH values and temperatures promote this reduction. The pH within the Everest tributary is likely to increase (mainly in response to elevated calcium). Therefore, the risk of ammonia toxicity cannot be ignored. Hexavalent Chromium also poses a significant threat of toxicity to aquatic life, particularly fish. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | OP, CL<br><br>Negative | | |
| Type of Impact | Direct: Spills will lead to a decline in water quality with an indirect impact on aquatic biota that are sensitive to a decline in water quality. There will be an indirect negative impact on the ecological integrity of the Everest tributary.<br><br>Cumulative impacts are expected due to existing and proposed Phase 2 Project activities. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Long term | 3 | 3 |
| Extent | Wider area of influence | 3 | 3 |
| Receptor Sensitivity | High<br>NFEPA catchment | 4 | 4 |
| Magnitude | High<br>A major spill is likely to cause major water quality impacts, with an associated loss of aquatic biota | 4 | 2 |
| Impact Significance | High significance.<br>A major tailings spill will have significant water quality impacts on both the Everest Tributary and the Groot Dwars River downstream of the confluence. | High<br>13<br>4 | Moderate<br>13<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • The tailings pipeline must be contained in an emergency casing which will contain spillages in the event of an emergency where it crosses drainage lines. A cut-off trench must be constructed along the trench to ensure that in the event of an emergency the tailings are diverted away from drainage lines. An emergency shut-off system must ensure that in the event of spillage the feed to the pipeline is stopped. Flow meters must ensure that any losses in flow is picked up immediately.<br>• The emergency backfill ponds must be appropriately lined to prevent seepage. They must be operated as empty.<br>• An emergency preparedness plan must be compiled to address severe spills. Spills should be contained before entering watercourses.<br>• All process water and tailings pipelines must be regularly inspected to detect possible leaks. Leaks should be immediately remediated. | | |
| Required Monitoring (if any) | Long-term monitoring of flows and aquatic fauna (biomonitoring) (See EMP) | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be mitigated although water quality impacts are likely. This will have an indirect impact on the integrity of the Everest tributary (possibly extending as far as the Groot Dwars River). | | |

## Table 10-37 Loss of Biodiversity and Decline in Ecological Integrity

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | All construction and mining activities | | |
| Risk/ Impact | A decline in ecological integrity and biodiversity due to a decline in water quality and decline in habitat integrity. The risk of this impact is considered high due to the good water quality within the Everest tributary. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | OP, CL<br><br>Negative | | |
| Type of Impact | Direct and Cumulative: This impact is considered to be associated with a range of activities that impact on flow, habitats and water quality, with each activity adding to the magnitude of the impact. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 3 | 3 |
| Duration | Long term | 3 | 3 |
| Extent | Wider area of influence<br>Impacts will be transferred to downstream reaches | 3 | 3 |
| Receptor Sensitivity | High<br>NFEPA catchment | 4 | 4 |
| Magnitude | Moderate<br>The magnitude of this impact is reduced by the presence of the TKO Dam downstream of the site as this will reduce or delay impacts to downstream reaches. | 3 | 2 |
| Impact Significance | High<br>This impact is of high significance due to the FEPA status of the catchment and good water quality within the Everest tributary. Impacts may be carried downstream into the Groot Dwars River. | High<br>13<br>3 | Moderate<br>13<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • All the mitigation measures to address impacts to water quality and habitats should be implemented.<br>• Aquatic habitat within the upper Everest tributary should be protected. No developments should take place within the sub-catchments containing critical habitat of this species.<br>• An offset strategy should be implemented and should include aquatic biodiversity considerations, incorporating cumulative impacts from all present and future Phase 2 project activities.<br>• It is strongly recommended that sub-catchments be identified along the Groot Dwars River and its tributaries that can be set aside for formal conservation of *E. cf. motebensis.*<br>• Alien Bass and Carp should be removed from the TKO Dam.<br>• A Biodiversity Management Plan should be compiled for the Booysendal Mine. This should include a management plan for the sub-catchment as a whole. A cooperative approach with adjacent landowners and the DWS should be investigated with a view to removing alien Bass from the TKO and Der Brochen Dams.<br>• A comprehensive study must be conducted to fully understand the distribution, ecology and genetic lineage of *E. cf. motebensis* within the study area and adjacent sub-catchments.<br>• This species should be monitored biannually as part of a biomonitoring programme.<br>• The rehabilitation of the Everest wetland upstream of the Booysendal Mine activities is recommended.<br>• It is also recommended that the De Kaffersspruit (Eastern tributary) be included in a wetland management and rehabilitation plan and that the integrity of this wetland be regularly monitored. | | |
| Required Monitoring (if any) | Long-term monitoring of water quality and aquatic fauna (fish, macroinvertebrates) and instream and riparian habitat integrity. See section 8.4 | | |
| Responsibility for implementation | Environmental Manager and Mine Manager. Aquatic specialist appointed by Booysendal. | | |
| Impact Finding | | | |

| | |
|---|---|
| Impact Finding | Impact can be reduced by mitigation measures but an overall decline in ecological integrity and biodiversity remains likely. |

Impacts specifically related to storm water management are included under the hydrology section, while and assessment of minor impacts are included in Annexure J.

#### 10.10.3.3 Decommissioning Phase

Rehabilitation actions during the decommissioning phase can lead to increased waste steams, an increase in silt loads, spillage and leakage, loss of biodiversity and settlement of alien and invasive species, all which can impact on the aquatic environment. The detailed assessment is included in Annexure J.

All the above impacts have been assessed as being moderate without mitigation and minor should amongst others the following management measures be implemented (complete list of management measures are included in the EMP – Annexure C):

- Post-closure monitoring and maintenance until the natural environment is at least 75% recovered;
- Storage of waste streams away from water resources in compliance with best practice and disposal of waste streams at licensed landfill sites;
- Long term aquatic biodiversity monitoring (at least 5 years post-closure);
- Barricade potentially impacted streams and wetlands before decommissioning commence;
- Activities and storage of hazardous waste should take place outside of the 100m buffer zones and 1:100-year floodlines, whichever is furthest;
- A storm water management plan needs to be put in place specifically for decommissioning before it commences; and
- Alien and invasive species must be controlled post closure until natural vegetation has established.

Note that impacts addressed in the Section 24G EIR have not been repeated here.

#### 10.10.3.4 Cumulative Impacts on Aquatic Biodiversity

Clean Stream identified the following cumulative impacts which needs to be managed in accordance with the EMP (Annexure C):

- Flows: each mining area associated with the Booysendal South and North MRs will to a greater or lesser extent lead to reduced flow and habitat availability due to mine dewatering and the impact of dewatering on the baseflow of rivers and streams. Water from the combined dirty water areas will furthermore lead to reduced run-off;
- Water quality: after mine closure, decant from the various voids could lead to an increase in nitrates, metals and salts in the system impacting especially on sensitive taxa. This impact has a high significance. The end of LoM closure plan will have to consider this and ensure that impacts are avoided.
- Aquatic ecosystem: there is a high likelihood that the threatened *E. cf. motebensis* will decline or be lost from affected reaches, placing its long-term survival under significant threat. Other sensitive taxa, including *Amphilius uranoscopus* and *Chiloglanis pretoriae* may be lost from the lower reach of the Groot Dwars River. At the very least, their numbers are likely to decline, together with other sensitive species, including *Enteromius neefi, Labeo cylindricus* and *L. molybdinus.* The aquatic macroinvertebrate assemblage will also decrease in diversity, with a loss or decline in taxa sensitive to changes in water quality and flow. While the Phase 2 Project's impacts will mostly affect the reach downstream of the bridge, cumulative impacts will extend to the upstream reach due to decant from the Valley Boxcut post-closure.

- Cumulatively, the above impacts will be significant and need to be managed in terms of the EMP and additional offset.

### 10.10.4 Recommendations

Recommendations made by the aquatic specialist applicable to the Phase 2 Project:

- Location of infrastructure and activities within 100m or within the 1:100-year floodline must be avoided;
- Dust and spillages from conveyors into the streams must be avoided. Alternatives need to be investigated;
- Storm water management and erosion control must protect the aquatic environments;
- Additional aquatic biodiversity offset for the proposed development must be included in the overall offset strategy to ensure management of residual impacts. The offset strategy must be agreed with the CAs. The offset must include the identification of pristine to largely pristine catchments which will be formally conserved, including the upper reaches of the Groot Dwars River;
- Rehabilitation of the upper Everest stream must form part of the management and need to include removal of alien and invasive species, removal of predatory fish species and rehabilitation of the wetlands;
- An alien fish species management programme should be developed to reduce the threat to endemic fish species;
- Culverts and stream crossings must be designed not to cause any pooling, flow modifications or migration barriers to aquatic species;
- All dirty water infrastructure and pipelines must be HDPE lined;
- Toxicity testing as part of the water monitoring programme needs to be extended to new PCDs;
- Trend analysis on specifically Cr, Ni and P should be done to establish timeously if additional management measures need to be implemented;
- The habitat of the *Enteromius cf. motebensis* must be protected;
- Activities in reaches of rivers and streams classified as having a **VERY HIGH** sensitivity should be avoided;
- The system contains sensitive species dependant on flow and good water quality; activities and actions which could lead to a deterioration in water quality or the flow regime throughout the LoM should therefore be avoided;
- The recommended buffer for FEPA rivers is 1km. Due to the sensitivity of the system, development within the catchment should be avoided. Where activities already commenced, a 500m buffer should be applied. This need to be done in consultation with DWS;
- Bi-annual biodiversity monitoring should continue in according to the existing monitoring programme (see EMP in Annexure C) while new monitoring sites must be added to cover the Phase 2 Project;
- A biodiversity management and action plan must be compiled and implemented for the Booysendal Operation and should include management measures to protect and conserve the *Enteromius cf. motebensis*;
- To protect the B41G catchment, it is important that a cooperative approach, including mines and landowners be initiated and lead by the relevant authorities; and
- Release of process and treated effluent should be avoided.

Additional recommendations and biodiversity monitoring requirements have been captured in the EMP (Annexure C).

### 10.10.5 Limitations and Gaps

Very little is known about the *Enteromius cf. motebensis* population in the Groot Dwars River and its tributaries. Although a genetic assessment is undertaken, monitoring and follow-up studies on the exact distribution and abundance, as well as its habitat needs, within the Groot Dwars and its tributaries, and surrounding catchments, is required to determine whether the future survival of this species can be effectively achieved. The question that needs to be answered is whether there will be sufficient suitable habitat remaining in the upper Groot Dwars River to sustain the population in perpetuity. Further studies are also required to determine whether mitigation and management measures (such as translocation to identified refugia) will be effective in conserving this species.

The concentrations of chromium that may reach the Groot Dwars River because of backfilling of the underground mine with tailings from TSF1 is uncertain. Chromium in all forms (especially hexavalent chromium) is toxic to aquatic biota. It is understood that this decant will be contained in a PCD adjacent to the Valley Boxcut and reused within the Processing Plant. The fate of this water post-closure is, however, uncertain. The current prediction is that the chromium concentration in decanting mine water may increase to 0.3 mg/l (Future Flow 2017). If undiluted, this exceeds the guideline limit for aquatic ecosystems (DWAF 1996) of 0.007 mg/l.

The magnitude of the impact of dewatering on habitat for *Enteromius cf. motebensis* and other flow-dependent species, is uncertain.

Post-closure impacts are uncertain and a risk assessment for closure will need to be carried out and closure plan developed accordingly.

The hydrogeological report considers the impact of dewatering on flow rates and volumes within the Groot Dwars River. However, this does not necessarily equate to impacts to aquatic habitats (i.e. pool depth and presence of overhanging vegetation or undercut banks, etc.), particularly during low flow periods (June to August). As such, the magnitude of the impact of dewatering on habitat for *E. cf. motebensis* and other flow-dependent species, is not entirely certain but could be considerable.

Although the hydrogeological report indicates that undermining of the Waterfall tributary should not impact on the flows of the tributaries, this will only become clear once mining commences.

### 10.10.6 Impact Statement

Considered in isolation, the proposed Phase 2 Project activities can be mitigated to an acceptable level. However, the cumulative impacts due to all Phase 1 (authorised in terms of an EA granted on 24 May 2010 by DEA, Reference No.: 17/2/1/15E/5) and planned future Phase 2 Project expansion activities in the valley will be of very high significance. Impacts to flows and water quality, in particular, will result in a decline in ecological integrity and a loss of habitat and species. However, as certain activities have already commenced and, as such, certain irreversible impacts have resulted, the focus should be on limiting and managing the current and potential future impacts as comprehensively and effectively as possible and applying comprehensive rehabilitation measures.

Approval could be granted subject to the conditions included under Section 11.

# 10.11 Terrestrial Ecology

## 10.11.1 Terrestrial Ecology Impact Assessment

### *10.11.1.1 Pycna Sylvia*

RD Stephens' monitoring between 2015 to 2017 was focussed on the Phase 1 and Phase 2 Project areas. This is important for purposes of assessing the potential cumulative impacts that development in the Groot Dwars River valley can have on this species. Findings from the 2017 report further indicates that:

- The pre-construction numbers of *Pycna sylvia* in the area around BS1/2, were limited.
- The area around one of the new vent shafts housed a large population of the *Pycna sylvia* and that disturbance in this area should be avoided, however, during the 2017 survey it was indicated that sections were cleared (refer to Photographs on next page).
- Encroachment onto *Pycna sylvia* habitat along the main access road closer to BN has taken place.
- An area demarcated as an *Pycna sylvia* reserve close to BN has been compromised through the construction of a PCD, powerline towers and the main access road crossing through this area. Annual monitoring of this reserve indicates that the adult population in this area is decreasing over time. This indicates that mining development is leading to migration away from disturbance. It also emphasises the need to conserve the Vitex habitats, especially in undisturbed areas.
- The Groot Dwars River bridge and road on the eastern side cuts through Vitex habitat, furthermore reducing the *Pycna sylvia* habitat, leading to habitat fragmentation.
- Some small scattered *Pycna sylvia* and associated habitat were identified elsewhere, but in limited numbers.

Offset of disturbed Pycna sylvia habitat will need to be considered and no encroachment into undisturbed areas must be allowed.

An assessment of the impacts on Pycna sylvia is included in

Table 10-38.

**Vent shaft location pre-and during construction**

***Pycna sylvia* reserve encroachment**

## Table 10-38 Impact of the Booysendal Expansion Project on the *Pycna sylvia*

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Clearance activities for construction<br>Operational activities | | |
| Risk/ Impact | Loss of *Vitex Obovate* subs, *wimsii*<br>Habitat fragmentation<br>Mining activities displacing the *Pycna sylvia*<br>Encroachment into remaining habitat<br>Reduction in numbers of the *Pycna sylvia* | | |
| Project Phase:<br>Nature of Impact | CO, OP and CL<br>Negative | | |

| | | | |
|---|---|---|---|
| Type of Impact | Direct: Clearance and construction activities.<br>Cumulative: cumulative displacement of *Pycna Sylvia*<br>Increased loss in habitat<br>Conservation is of national importance | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Definite | 4 | 3 |
| Duration | Long term | 4 | 3 |
| Extent | Wider area of influence | 4 | 2 |
| Receptor Sensitivity | High | 4 | 4 |
| Magnitude | High<br>Reversible but potentially substantial erosion | 4 | 2 |
| Impact Significance | High | High<br>16<br>4 | Minor<br>12<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Offset of *Vitex Obovate* subs, *wimsii*<br>• No activities in buffer zone and encroachment must be avoided<br>• Development areas must be concentrated in less sensitive areas<br>• Habitat fragmentation must be avoided | | |
| Required Monitoring (if any) | Long-term annual monitoring | | |
| Responsibility for implementation | Environmental Manager and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be minimised by mitigation measures | | |

A summary of the impacts and the significance of the impacts identified by NSS are included in Table 10-39 for the Booysendal North and Booysendal South MR Activities and potential cumulative impacts.

## Table 10-39 Summary of Terrestrial Impacts Identified by NSS, 2018

| Impact | Impact Significance | Significance Prior to Mitigation | Significance With Mitigation |
|---|---|---|---|
| **Widespread destruction of floral communities and faunal habitats** | As it w ill be impossible to fully reverse destruction of (mostly High and Moderate-High CI) communities, habitats and buffers caused by commenced activities, this must be appropriately and adequately offset. Furthermore, as it w ill be impossible to avoid destroying High and Moderate-High CI communities, habitats and buffers that coincide w ith the footprint of proposed activities in the Valley, additional offsetting for this is required, and rigorous mitigation is critical w here possible. | High<br>15<br>-4 | High<br>14<br>-3 |
| **Extensive fragmentation of floral communities and faunal habitats** | As it w ill be impossible to fully reverse fragmentation of (mostly High and Moderate-High CI) communities, habitats and buffers caused by commenced activities, this must be appropriately and adequately offset. Furthermore, as it w ill be impossible to avoid fragmenting High and Moderate-High CI communities, habitats and buffers that coincide w ith the footprint of proposed activities in the Valley, additional offsetting for this is required, and rigorous mitigation is critical w here possible. | High<br>16<br>-4 | High<br>15<br>-3 |
| **Widespread dust** | Although dust is inevitable and could disperse w ell beyond the infrastructural footprint, its impact is relatively Minor in magnitude and w as, therefore, rated w ith Moderate significance, w hich can be reduced (in duration, extent and magnitude) w ith diligent mitigation. | Moderate<br>15<br>-2 | Moderate<br>13<br>-1 |
| **Severe and extensive erosion and sedimentation** | Inevitable erosion and sedimentation, w hich w ithout mitigation w ill exert a permanent, High magnitude impact on biodiversity of High conservation importance w ithin a large section of the Groot-Dw ars River Valley, deserves to be rated w ith very High significance - especially because the high levels of floral and faunal endemism are rooted in the Valley's unique soils. | High<br>16<br>-4 | High<br>14<br>-3 |
| **Considerable environmental contamination** | Environmental contamination from the immense introduction of man-made things into Booysendal, the construction of considerable (nonbiodegradable) infrastructure, the production of large volumes of w aste, backfilling, and possible accidental hazardous contamination events in the Groot-Dw ars River FEPA, the Sekhukhuneland Centre of Plant Endemism, an EN Ecosystem, and provincial CBAs, deserves to be rated w ith very High significance, and requires considerable mitigation and offsetting. | High<br>16<br>-4 | High<br>15<br>-3 |
| **Widespread change in riparian vegetation** | Domination of the Groot-Dw ars River FEPA by *Phragmites* , and its possible densification and spread around the main BS4 w etland and TKO Dam, w ith subsequent disappearance of certain VU and other CI faunal taxa, w as rated w ith High significance. | High<br>15<br>-3 | Moderate<br>14<br>-2 |
| **Widespread establishment of invasive alien flora** | Without mitigation, the definite, permanent, w idespread and severe impact of invasive alien flora on a broad spectrum of biodiversity of High conservation importance deserves to be rated w ith very High significance. | High<br>16<br>-4 | Minor<br>13<br>-2 |
| **Widespread loss of CI and other flora** | Definite, permanent destruction of CI and numerous other floral species specimens throughout the extensive Booysendal infrastructural footprint w as rated w ith High significance. | High<br>15<br>-4 | Moderate<br>12<br>-3 |
| **Widespread loss of CI and other fauna** | Definite destruction of CI and numerous other faunal species specimens throughout the Life of Mine, w hich could affect certain species at a regional, provincial or national scale, deserves to be rated w ith High magnitude. | High<br>16<br>-4 | Moderate<br>13<br>-2 |
| **Widespread disturbance of CI and other fauna from noise, vibrations and lighting** | Definite, far-reaching and long term disturbance of possibly numerous fauna including a number of EN, VU and NT species, w as rated w ith High significance. | High<br>15<br>-3 | Moderate<br>14<br>-2 |
| **Growing loss of CI and other flora and fauna from harvesting, hunting and livestock** | As many CI flora and faunal taxa could be extirpated by uncontrolled harvesting, hunting and livestock activity, this impact has High overall signficance. | High<br>15<br>-4 | Moderate<br>14<br>-2 |

#### 10.11.1.2 Terrestrial Impact Assessment

The development area at BS4 is mainly disturbed although the sensitive Everest tributary and associated wetland may potentially be impacted together with CI fauna which migrates in the area. With mitigating measures implemented, all the impacts will be minor to not significant.

Development at the Booysendal North MR Phase 2 Area will be larger in extent while the terrestrial ecology in general is also more sensitive, although the impacts will be similar than that at BS4. The cumulative impacts are also similar that that which could occur at BS and BN, although the significance of the cumulative impacts are generally higher. The mitigating measures are also the same. Not to repeat the impact assessment and management measures, an assessment of worst-case scenario (cumulative impacts for both Phase 1 and Phase 2) is included Table 10-40 to Table 10-49.

For detail around the impact assessment, refer to Section E in Annexure K.

## Table 10-40 Cumulative Destruction of Floral Communities and Faunal Habitats (Source: NSS, 2018)

| **Cumulative** | **Impact: Widespread destruction of floral communities and faunal habitats** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines. | | |
| Risk / Impact | The above-mentioned activities for Booysendal have and will continue to cause severe, widespread destruction of areas that have mostly been rated with High and Moderate-High conservation importance. CI floral communities that have and will continue to be destroyed include the High CI *Lydenburgia-Vitex-Kirkia* Rocky Thicket, *Fauria-Combretum-Halleria* Riparian Vegetation, *Tulbaghia-Eleocharis* Sheetrock Wetland and *Phragmites-Schoenoplectus* Vlei System, *Fuirena-Leersia-Phragmites* Vlei System, *Brachiaria-Tristachya* Exposed Rock and *Aloe-Myrothamnus-Xerophyta* Sheet Rock, and Moderate-High CI *Acacia-Euclea-Hippobromus-Scolopia* Thicket, *Acacia caffra-Ozoroa-Tristachya* Eastern Slope Grassland and *Loudetia-Themeda* Western Slope Grassland. CI habitats that have and will continue to be destroyed include the High CI Groot-Dwars River and numerous other smaller drainage lines and wetlands in the catchment, riparian vegetation, the Cliff Face and Kloof Habitat, sheet rock and numerous *Vitex o. wilmsii* trees. In addition, the recommended 1km buffer around the Groot-Dwars River FEPA, and various recommended Moderate-High CI buffers including the 500m buffer around the Valley golden mole population, 100m buffer around all wetlands, 30m buffer around all sheet rock, and 500-600m buffer around all VU *Zantedeschia pentlandii*, will be increasingly destroyed. | | |
| Project Phase | CO, OP | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct<br>Clearing of vegetation, blasting, earth-moving activities, and development of infrastructure has and will continue to directly destroy communities, habitats and buffers. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Development of the infrastructure has and will definitely continue to cause destruction of floral communities, faunal habitats and buffers around High CI areas. | 4 | 4 |
| Duration | Permanent<br>Constructed infrastructure will remain permanently unless removed during closure. | 4 | 3 |
| Extent | Area of Influence<br>Clearing of vegetation, blasting, earth-moving activities and development of infrastructure is supposed to be limited to the infrastructural footprint. However, commenced activities for Booysendal have in many places disturbed areas adjacent to infrastructural footprints (e.g. the ridge and cliff line west of BS4, alongside the Main Access Road and around the BS1/2 Complex and the access roads and footings for the South ARC). In addition to this there has been destruction (with some regeneration) of communities along old exploration tracks. Collectively, therefore, there has been widespread destruction of natural areas in Booysendal. | 3 | 3 |
| Receptor Sensitivity | High<br>Most of Booysendal's infrastructural footprint coincides with High or Moderate-High CI floral communities, habitats and recommended buffers, which support a large diversity of locally endemic and CI floral and faunal taxa. Most existing and proposed infrastructure in the Valley will also be situated within the recommended 1km buffer around the Groot-Dwars River FEPA, and linear infrastructure including the ARC, powerlines, pipelines and various access roads, will intersect a large number of smaller drainage lines and other wetlands. Collectively these areas are representative of the Sekhukhuneland Centre of Plant Endemism, the EN Sekhukhune Mountainlands Threatened Ecosystem, and provincial CBAs. | 4 | 4 |
| Magnitude | High<br>Within the Booysendal infrastructural footprint (and some adjacent disturbed areas) there has and will continue to be a complete loss or dramatic transformation of affected communities and habitats. Along existing exploration tracks there has also been significant disturbance of communities and habitats. | -4 | -3 |
| **Impact Significance** | As it will be impossible to fully reverse destruction of (mostly High and Moderate-High CI) communities, habitats and buffers caused by commenced activities, this must be appropriately and adequately offset. Furthermore, as it will be impossible to avoid destroying High and Moderate-High CI communities, habitats and buffers that coincide with the footprint of proposed activities in the Valley, additional offsetting for this is required, and rigorous mitigation is critical where possible. | **High**<br>**15**<br>**-4** | **High**<br>**14**<br>**-3** |

| | |
|---|---|
| **Mitigating and Monitoring Requirements** | |
| Required Management Measures | Avoid destruction of High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydown areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road between BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | Shift the pipeline between the BS4 RWD and PCD ca. 200m south-westwards to minimize the length of its intersection with the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the proposed process and potable water pipelines alongside the Groot-Dwars River to the recently disturbed verge of the Main Access Road. |
| | Mount all pipelines off the ground (e.g. on concrete blocks) to minimize vegetation clearing and earth-moving activities (during construction, operation and closure) and thus, destruction of floral communities and faunal habitats and the hydrological functioning of intersected wetlands. |
| | Elevate pipelines over all wetlands and drainage lines to avoid destruction of these High CI areas. |
| | Fence the infrastructural footprint where practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence wires adjacent to roads. |
| | Avoid destruction of rocky habitat including isolated boulders, and termitaria. |
| | Excavated topsoil must be stored with associated native vegetation debris for subsequent use in rehabilitation. |
| | Topsoil stockpiles must be managed to ensure that the viability of the seed bank is retained. |
| | Establish a nursery for transplanting and cultivation of local indigenous flora for rehabilitation (focussed on bulbs and other flora that can handle transport and storage). |
| | Vegetate all exposed road side slopes, and the walls of all PCDs a.s.a.p. using local indigenous flora. |
| | Establish a Rehabilitation Plan(s) for all areas that are disturbed during construction, operation and closure. |
| | Remove all (especially portal) infrastructure during closure, without causing disturbance to undisturbed areas. |
| | Rehabilitate using, inter alia, local indigenous plants from the recommended nursery, and an appropriate indigenous seed mix that excludes TEF, aliens, hybrids, cultivars and other unfavourable flora. |
| | Offset unavoidable destruction of floral communities and faunal habitats by rehabilitating or protecting the same communities and habitats outside Booysendal, based on the 1:30 offset ratio for provincial CBAs. |
| Required Monitoring (if any) | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| | Commission an annual Land Function Assessment to monitor plant succession and the overall success of rehabilitation efforts. |
| | Monitor the condition of protected offset areas, as per the Offset Strategy recommendations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | As destruction of High and Moderate-High CI communities, habitats and buffers has already occurred in many areas, and will be impossible to avoid where most additional activities are proposed, considerable offsetting will be required, and rigorous mitigation is critical where possible. Recommended mitigation includes, inter alia, that the Escape Portal and pipelines be shifted as suggested, that no new roads are created for the North ARC, that clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, that all pipelines be mounted off the ground and elevated over wetlands and drainage lines, and that all (especially all road and portal) infrastructure is removed during closure. Offsetting for the commenced and the proposed activities needs to be based on the 1:30 offset ratio for provincial CBAs. |

Table 10-41 Cumulative Fragmentation of Floral Communities and Faunal Habitats (Source: NSS, 2018)

| **Cumulative** | **Impact: Extensive fragmentation of floral communities and faunal habitats** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines. | | |
| Risk / Impact | The above-mentioned activities (especially the Main Access Road, all other access roads, the ARC, all powerlines and pipelines) for Booysendal have and will continue to cause severe, widespread fragmentation of areas that have mostly been rated with High and Moderate-High conservation importance. CI floral communities that have and will continue to be fragmented include the High CI Lydenburgia-Vitex-Kirkia Rocky Thicket, Fauria-Combretum-Halleria Riparian Vegetation, Tulbaghia-Eleocharis Sheetrock Wetland and Phragmites-Schoenoplectus Vlei System, Fuirena-Leersia-Phragmites Vlei System, Brachiaria-Tristachya Exposed Rock and Aloe-Myrothamnus-Xerophyta Sheet Rock, and Moderate-High CI Acacia-Euclea-Hippobromus-Scolopia Thicket, Acacia caffra-Ozoroa-Tristachya Eastern Slope Grassland and Loudetia-Themeda Western Slope Grassland. CI habitats that have and will continue to be fragmented include the High CI Groot-Dwars River and numerous other smaller drainage lines and wetlands in the catchment, riparian vegetation, the Cliff Face and Kloof Habitat and sheet rock. Of particular concern is the fragmentation of the recommended Moderate-High CI 500m buffer around the Valley golden mole population by the dirt service road and proposed Escape Portal and pipelines alongside the River, considerable fragmentation of the aerial space between BN and BS4 by the ARC and the 132kV powerline, and especially the increasingly severe and extensive fragmentation of the recommended 1km buffer around the Groot-Dwars River FEPA by the Main Access Road and other recently commenced and proposed activities for Booysendal in the Valley. | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct<br>Clearing of vegetation, blasting, earth-moving activities, and constructed infrastructure (especially the Main Access Road, all other access roads, the ARC, all powerlines and pipelines) has and will continue to directly fragment communities, habitats and buffers. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Development of the infrastructure has and will definitely continue to cause fragmentation of floral communities, faunal habitats (including aerial space or habitat) and buffers around High CI areas. | 4 | 4 |
| Duration | Permanent<br>Constructed infrastructure will remain permanently unless removed during closure. | 4 | 3 |
| Extent | Regional/Provincial/National<br>Although clearing of vegetation, blasting and earth-moving activities are supposed to be limited to the infrastructural footprint, the constructed Main Access Road, all other access roads, the ARC, all powerlines and pipelines will effectively fragment 8km (almost 60%) of what was until recently 14km of the remaining relatively undisturbed and contiguous upper reaches of the Groot-Dwars River Valley. | 4 | 4 |
| Receptor Sensitivity | High<br>Most of Booysendal's infrastructural footprint coincides with High or Moderate-High CI floral communities, habitats and recommended buffers, which support a large diversity of locally endemic and CI floral and faunal taxa. Most existing and proposed infrastructure in the Valley will also be situated within the recommended 1km buffer around the Groot-Dwars River FEPA, and linear infrastructure including the ARC, powerlines, pipelines and various access roads, will intersect a large number of smaller drainage lines and other wetlands. Collectively these areas are representative of the Sekhukhuneland Centre of Plant Endemism, the EN Sekhukhune Mountainlands Threatened Ecosystem, and provincial CBAs. | 4 | 4 |
| Magnitude | High<br>Within the Booysendal infrastructural footprint (and some adjacent disturbed areas) there has and will continue to be a complete loss or dramatic transformation of affected communities and habitats. | -4 | -3 |
| **Impact Significance** | As it will be impossible to fully reverse fragmentation of (mostly High and Moderate-High CI) communities, habitats and buffers caused by commenced activities, this must be appropriately and adequately offset. Furthermore, as it will be impossible to avoid fragmenting High and Moderate-High CI communities, habitats and buffers that coincide with the footprint of proposed activities in the Valley, additional offsetting for this is required, and rigorous mitigation is critical where possible. | **High**<br>**16**<br>**-4** | **High**<br>**15**<br>**-3** |

| **Mitigating and Monitoring Requirements** | |
|---|---|
| Required Management Measures | Avoid fragmentation of High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydown areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road between BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | Shift the pipeline between the BS4 RWD and PCD ca. 200m south-westwards to minimize the length of its intersection with the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Carefully remove the existing water pipeline between BN and BS1/2. No pipeline infrastructure must remain, and all disturbed areas must be rehabilitated. |
| | Shift the process and potable water pipelines to the recently disturbed verge of the Main Access Road. |
| | Design and install all pipelines to cause minimal fragmentation of biodiversity. Ideally, all pipelines should be made of metal, and mounted off the ground (preferably at varying height e.g. on concrete blocks), to minimize vegetation clearing, earth-moving activities (during construction, operation and closure), obstruction of movement by small and large subterranean, terrestrial, wetland and aquatic fauna, accidental pipeline damage (e.g. from wild fires) and potential environmental contamination. |
| | Elevate pipelines over all wetlands and drainage lines to avoid destruction of these High CI areas. |
| | Where roads and other infrastructure intersects drainage lines, bridges or other appropriate crossings should be constructed to avoid creating barriers across these. |
| | Fence the infrastructural footprint where practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. Otherwise avoid unnecessary fencing within natural areas as far as possible. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence wires adjacent to roads. |
| | Excavated topsoil must be stored with associated native vegetation debris for subsequent use in rehabilitation. |
| | Topsoil stockpiles must be managed to ensure that the viability of the seed bank is retained. |
| | Establish a nursery for transplanting and cultivation of local indigenous flora for rehabilitation (focussed on bulbs and other flora that can handle transport and storage). |
| | Vegetate all exposed road side slopes, and the walls of all PCDs a.s.a.p. using local indigenous flora. |
| | Establish a Rehabilitation Plan(s) for all areas that are disturbed during construction, operation and closure. |
| | Remove all (especially all ARC and pipeline) infrastructure during closure, without causing disturbance to undisturbed areas. |
| | Rehabilitate using, inter alia, local indigenous plants from the recommended nursery, and an appropriate indigenous seed mix that excludes TEF, aliens, hybrids, cultivars and other unfavourable flora. |
| | Offset unavoidable fragmentation of floral communities and faunal habitats by rehabilitating or protecting the same communities and habitats outside Booysendal, based on the 1:30 offset ratio for provincial CBAs. |
| Required Monitoring (if any) | Check quarterly, and after heavy rainfall events, that all road and pipeline crossings over wetlands and drainage lines are in good working order (i.e that there are no obstructions, blockages, erosion, etc). Major pipeline maintenance work should be conducted during dry periods. |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| | Monitor the condition of protected offset areas, as per the Offset Strategy recommendations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | As fragmentation of High and Moderate-High CI communities, habitats and buffers has already occurred in many areas, and will be impossible to avoid where most additional activities are proposed, considerable offsetting will be required, and rigorous mitigation is critical where possible. Recommended mitigation includes, inter alia, that the Escape Portal and pipelines be shifted as suggested, that no new roads are created for the North ARC, that clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, that all pipelines be mounted off the ground and elevated over wetlands and drainage lines, and that all (especially all road, ARC, powerline and pipeline) infrastructure is removed during closure. Offsetting for the commenced and the proposed activities needs to be based on the 1:30 offset ratio for provincial CBAs. |

Table 10-42 Cumulative Dust (Source: NSS, 2018)

| **Cumulative** | **Impact: Widespread dust** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Vehicle traffic; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines; Operation of crushers, conveyors and the ARC. | | |
| Risk / Impact | Dust has and will continue to be generated, especially during the dry season, wherever there is exposed soil, including where vegetation is cleared, blasting is performed, earth is excavated, moved or stockpiled, where the portals and other infrastructure (especially PCDs) are developed, where there is (especially regular) vehicle traffic on dirt access, service and other roads, and where TSF1 is re-worked. Dust will also be generated by drills, crushers, conveyors and possibly the ARC. Excessive dust is known to adversely affect plant photosynthesis and growth, forage availability and quality, and the foraging behaviour, dentition and health of herbivorous fauna. | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Indirect<br>Dust is an indirect impact from clearing vegetation, blasting, earth-moving activities, vehicle traffic, development, operation (re-working and removal) of infrastructure. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Dust from the commenced activities is obvious, and dust from the proposed activities is inevitable. | 4 | 4 |
| Duration | Permanent<br>Infrastructural areas (especially the portal areas, dirt roads and TSF1) will generate dust for as long as these remain exposed. Crushers, conveyors and possibly the ARC will generate dust throughout the Life of Mine. | 4 | 3 |
| Extent | Area of Influence<br>Dust (especially from the portal areas, dirt roads and possibly the ARC) will disperse beyond the infrastructural footprint into surrounding parts of the Valley. Dust from especially the re-working of TSF1 is likely to disperse beyond the boundaries of BS4. | 3 | 2 |
| Receptor Sensitivity | High<br>Dust from the activities will settle on multiple High and Moderate-High CI floral communities, habitats and recommended buffers, which support a large diversity of locally endemic and CI floral and faunal taxa. Dust will also disperse across a sizeable portion of the recommended 1km buffer around the Groot-Dwars River FEPA. Collectively these areas are representative of the Sekhukhuneland Centre of Plant Endemism, the EN Sekhukhune Mountainlands Threatened Ecosystem, and provincial CBAs. | 4 | 4 |
| Magnitude | Minor<br>The magnitude of this impact is Minor compared to that of certain other impacts (e.g. habitat destruction and fragmentation). | -2 | -1 |
| **Impact Significance** | Although dust is inevitable and could disperse well beyond the infrastructural footprint, its impact is relatively Minor in magnitude and was, therefore, rated with Moderate significance, which can be reduced (in duration, extent and magnitude) with diligent mitigation. | **Moderate**<br>**15**<br>**-2** | **Moderate**<br>**13**<br>**-1** |

| **Mitigating and Monitoring Requirements** | |
|---|---|
| Required Management Measures | Avoid creating exposed areas and dust in High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydow n areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road betw een BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | The design of the ARC must comply w ith international best practice standards on high w ind speed to avoid excessive dust pollution. To this end the ARC must, inter alia, be fitted w ith a roof that extends along the conveyer length and the tray must have sides no shorted than 200mm. |
| | Shift the pipeline betw een the BS4 RWD and PCD ca. 200m south-w estw ards to minimize the length of its intersection w ith the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable w ater pipelines to the recently disturbed verge of the Main Access Road. |
| | Mount all pipelines off the ground (e.g. on concrete blocks) to minimize vegetation clearing and earth-moving activities (during construction, operation and closure) and thus, dust. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. |
| | Avoid blasting on w indy days. |
| | Control dust on roads using environmentally-friendly methods. If suppressants are to be used, only eco-friendly products must be chosen. There are a number of products on the market that w ill need to be investigated for certifications and application success rate. |
| | Use vacuum attachments on all concrete grinding operations to capture dust. |
| | Establish a nursery for transplanting and cultivation of local indigenous flora for rehabilitation (focussed on bulbs and other flora that can handle transport and storage). |
| | Vegetate all exposed road side slopes, and the w alls of all PCDs a.s.a.p. using local indigenous flora. |
| | Establish a Rehabilitation Plan for all areas that are disturbed during construction, operation and closure. |
| | Rehabilitate using, inter alia, local indigenous plants from the recommended nursery, and an appropriate indigenous seed mix that excludes TEF, aliens, hybrids, cultivars and other unfavourable taxa. |
| Required Monitoring (if any) | Monitor dust levels to maintain them w ithin recognized safe limits (as prescribed by an Air Quality Specialist). |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction, Health, Safety and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | The significance of this impact can be reduced if the Escape Portal and pipelines are shifted as suggested, if no new roads are created for the North ARC, if clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, if the ARC does not generate significant dust during operation, if all pipelines are mounted off the ground, if blasting is avoided on w indy days, if environmentally-friendly dust control measures are used, and if all disturbed areas are effectively rehabilitated. |

## Table 10-43 Cumulative Erosion and Sedimentation (Source: NSS, 2018)

| **Cumulative** | **Impact: Severe and extensive erosion and sedimentation** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Vehicle traffic; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines. | | |
| Risk / Impact | The risk of erosion and sedimentation is very high in the Valley due to the high erosivity of local soils, the steep gradients of slopes, and the occurrence of preciptation in the form of heavy thunderstorms. Therefore, during the wet season and in the Valley especially, erosion has been and will continue to be caused wherever there is exposed soil, including where vegetation is cleared, blasting is performed, earth is excavated or moved, and where ever infrastructure is developed. When our surveys were performed following heavy rain, extensive and excessive erosion was observed along all newly scraped roads and in other recently cleared areas. The erosion has caused considerable sedimentation in existing roadside stormwater diversion channels, and in drainage lines that are intersected by or situated downslope from recently cleared areas. The main BS4 wetland could be similarly impacted by erosion and sedimentation from stockpiling and the re-working of TSF1. Apart from the impact of erosion on the unique vegetation in the Valley, and the impact of sedimentation on numerous drainage lines, other wetlands and ultimately the Groot-Dwars River, of additional concern is the impact of sedimentation on various sensitive CI taxa. The (MTPA VU) *Ledebouria (Resnova) megaphylla* , which was recorded along certain drainage lines in the Valley, bears only a few, small leaves that lie flush with the ground. If smothered by sedimentation these shade-dwelling plants will struggle to photosynthesize and survive. Sediment-sensitive fauna, which might be extirpated in Booysendal, include the recorded VU Marico Barb, Shortspine Suckermouth and Stargazer Mountain Catfish, and the potentially occurring Sawfin Suckermouth and VU Natal Ghost Frog. | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Indirect<br>Erosion and sedimentation are indirect impacts from clearing vegetation, blasting, earth-moving activities, vehicle traffic, and development of infrastructure. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Recently commenced activities for Booysendal have caused severe erosion and sedimentation, and erosion and sedimentation from proposed activities is inevitable given the high erosivity of local soils, the steep Valley slopes, the prevalence of heavy thunderstorms, and the intersection of proposed infrastructure (especially ARC access roads and pipelines) with several drainage lines. There is also existing severe erosion of old exploration tracks. | 4 | 4 |
| Duration | Permanent<br>In many areas, soil damage and loss is irreversible. Erosion and sedimentation from the portal areas, roads and other infrastructural areas will continue for as long as these remain exposed. | 4 | 3 |
| Extent | Regional/Provincial/National<br>All existing and proposed disturbed areas are susceptible to erosion. Sedimentation will extend beyond the infrastructural footprint down intersected drainage lines, and will ultimately impact the Groot-Dwars River, possibly the TKO Dam, and ultimately the Groot-Dwars catchment north of Booysendal including Der Brochen Dam. | 4 | 3 |
| Receptor Sensitivity | High<br>Local soils are unique, and highly erosive, and all wetlands are regarded by national and provincial government as sensitive and conservation important. Affected areas are representative of the Sekhukhuneland Centre of Plant Endemism, an EN Ecosystem, and provincial CBAs. The Groot-Dwars River is a national FEPA. | 4 | 4 |
| Magnitude | High<br>Erosion and sedimentation have been and will continue to be severe without mitigation. This is evident in the Valley where erosion is severe along old exploration tracks and in recently cleared areas, and sedimentation is severe in multiple drainage lines downslope / downstream of recently commenced activities for Booysendal. | -4 | -3 |
| **Impact Significance** | Inevitable erosion and sedimentation, which without mitigation will exert a permanent, High magnitude impact on biodiversity of High conservation importance within a large section of the Groot-Dwars River Valley, deserves to be rated with very High significance - especially because the high levels of floral and faunal endemism are rooted in the Valley's unique soils. | **High**<br>**16**<br>**-4** | **High**<br>**14**<br>**-3** |

| **Mitigating and Monitoring Requirements** | |
|---|---|
| Required Management Measures | Determine the baseline sediment load in the Groot-Dw ars River and its associated mountain tributaries upstream of all current activities (i.e. south of BS1/2 and BS4). |
| | Avoid causing erosion and sedimentation in High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydow n areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road betw een BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | Fence the infrastructural footprint w here practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence w ires adjacent to roads. |
| | Shift the pipeline betw een the BS4 RWD and PCD ca. 200m south-w estw ards to minimize the length of its intersection w ith the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable w ater pipelines to the recently disturbed verge of the Main Access Road. |
| | Strictly limit vehicle traffic on the dirt service road that runs adjacent to the Groot-Dw ars River betw een BN and BS1/2 by maintaining the existing boom at co-ordinates 25° 5'3.90"S and 30° 7'5.27"E, and installing an additional locked boom at co-ordinates 25° 7'41.32"S and 30° 7'8,25"E. |
| | Mount all pipelines off the ground (e.g. on concrete blocks) to minimize vegetation clearing and earth-moving activities (during construction, operation and closure) and thus, erosion and sedimentation. |
| | Elevate pipelines over all w etlands and drainage lines to prevent flow impediment, erosion and sedimentation at these. |
| | Construct suitable road crossings over all drainage lines to prevent flow impediment, erosion and sedimentation at these. Each crossing w ill need to be assessed separately as different measures for each may be needed. There must be no erosion and sedimentation at the bridge over the Groot-Dw ars River at BS1/2. |
| | Implement adequate and effective erosion control measures in all disturbed areas, especially on steep slopes. |
| | Implement adequate and effective sedimentation control measures at all disturbed drainage lines, especially the Groot-Dw ars River. Measures that have been put in place thus far are not sufficiently effective. |
| | Implement adequate and effective stormw ater control measures in and around all infrastructure. Ensure that stormw ater management planning takes cognisance of environmental integrity and the conservation of biodiversity. Refer to Booysendal's Storm Water Management Plan. Any stockpile currently w ithin the Groot-Dw ars River floodplain must be relocated and the area rehabilitated w ith appropriate indigenous vegetation. |
| | Spillw ays should be fitted w ith sediment traps and flow attenuation structures. Spillw ays should be w ide enough to prevent cannalization. |
| | Establish a nursery for transplanting and cultivation of local indigenous flora for rehabilitation (focussed on bulbs and other flora that can handle transport and storage). |
| | Vegetate all exposed road side slopes, and the w alls of all PCDs a.s.a.p. using local indigenous flora. |
| | Establish a Rehabilitation Plan for all areas that are disturbed during construction, operation and closure. |
| | Rehabilitate using, inter alia, local indigenous plants from the recommended nursery, and an appropriate indigenous seed mix that excludes TEF, aliens, hybrids, cultivars and other unfavourable taxa. |
| Required Monitoring (if any) | Perform high- and low -flow aquatic biomonitoring at appropriate points - refer to the aquatic study by Clean Stream (2017) for recommendations. |
| | Check quarterly, and after heavy rainfall events, that all pipeline crossings over w etlands and drainage lines are in good w orking order (i.e that there are no obstructions, blockages, erosion, etc). Major pipeline maintenance w ork should be conducted during dry periods. |
| | Check annually that stormw ater measures are adequate and remain effective. |
| | Check annually that erosion control measures are adequate and remain effective. |
| | Check annually that sedimentation control measures are adequate and remain effective. |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction, Maintenance and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | Urgent, effective and extensive erosion and sedimentation control measures are required to contain the existing extent and magnitude of this impact, and suitable offsetting needs to be investigated to compensate for irreversible soil damage and loss in many places. Offsetting of erosion and sedimentation caused by commenced activities needs to be based on the 1:30 offset ratio for provincial CBAs. As erosion and sedimentation from proposed activities w ill also be inevitable and severe, rigorous mitigation is critical if additional offsetting for erosion and sedimentation is to be avoided. Recommended mitigation includes, inter alia, that the Escape Portal and pipelines be shifted as suggested, that no new roads are created for the North ARC, that clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, that all pipelines be mounted off the ground and elevated over w etlands and drainage lines, that effective stormw ater, erosion and sedimentation control measures are implemented and maintained, and that all disturbed areas are effectively rehabilitated. |

## Table 10-44 Cumulative Environmental Contamination (Source: NSS, 2018)

| Cumulative | Impact: Considerable environmental contamination | | |
|---|---|---|---|
| Activities | Introduction of man-made things into Booydendal including, inter alia, all supplies, equipment, vehicles and machines; Constructed infrastructure (especially tarred, cement, steel, other metal, plastic and other non-biodegradable infrastructure); Waste production; Use, storage, possible poor management, and accidental leaks and spills of hazardous and non-hazardous materials and w aste, ranging from e.g. slurry, cement and diesel, to sew age and litter; Possible seepage, leaks or failure of tools, machines, vehicles and infrastructure e.g. TSF1, PCDs, RWDs, stockpiles, storage tanks, pipelines, etc. | | |
| Risk / Impact | The vast majority of man-made things that are introduced into Booydendal w ill, w ith time, contaminate the environment unless carefully used, managed, maintained, removed and treated or recycled. *All the constructed infrastructure aside* , throughout the Life of Mine there w ill be risk of environmental contamination from a broad spectrum of hazardous and non-hazardous materials and w aste due to possible poor planning, management and maintenance, accidents and negligence. Given the intersection and close proximity of commenced and proposed infrastructure to numerous drainage lines, seeps, the Groot-Dw ars River and a number of dams (including the TKO and Der Brochen dams), a significant contamination event could have a disastrous and potentially w idespread impact on the w ater quality and w etland and aquatic habitats, biota, processes / functioning and services in a national FEPA and EN Ecosystem. Of particular concern is the close proximity of especially the BS1/2 Complex and the proposed Escape Portal and pipelines to the Groot-Dw ars River, the outflow of possible contaminated w ater from the Valley Boxcut, the likely contamination of groundw ater from backfilling, and possible contamination of the main BS4 w etland system and dow nstream TKO Dam from the TSF1, RWD, PCD, slurry paddocks and other activities at BS4. | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct<br>Contamination directly (and indirectly) impacts habitats, biota, ecosystem processes and services (e.g. clean w ater). | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Environmental contamination from mining is inevitable. Betw een BN and BS1/2, sections of existing pipeline betw een BN and BS1/2, w hich w ere faulty, or burnt during w ild fires, remain on the ground. Current construction activities have been accompanied by localized contamination from e.g. cementing, poor sanitation and littering, and contamination from, inter alia, backfilling, re-w orking of TSF1, and multiple existing and proposed PCDs is highly likely. *Backfilling aside* , w ithout careful removal, virtually all constructed infrastructure w ill eventually contaminate the environment if not removed and treated or recycled. | 4 | 4 |
| Duration | Permanent<br>Material used for backfilling w ith remain permanently, and constructed infrastructure w ill remain permanently unless comprehensively removed during closure. Without effective remediation, a serious contamination event could have a permanent or long term impact on w ater quality, habitats, biota, and ecosystem processes and services. Non-biodegradable substances (e.g. steel, cement, w ater bottles, cigarette butts, tin cans, glass, etc) cause long term environmental contamination. | 4 | 4 |
| Extent | Regional/Provincial/National<br>Constucted infrastructure for Booysendal w ill span almost a 10km section of the Groot-Dw ars River Valley, and a serious contamination event could impact habitats, biota, and ecosystem processes and services (e.g. clean air and w ater) over a large area, underground, and/or for some distance dow nstream from Booysendal, depending on flow conditions, and the type and volume of contamination. | 4 | 3 |
| Receptor Sensitivity | High<br>Natural areas in Booysendal are representative of the Sekhukhuneland Centre of Plant Endemism, an EN Ecosystem, and provincial CBAs. The Groot-Dw ars River is a national FEPA, and all w etlands, regardless of their status, are regarded as sensitive and conservation important. Until recently at least, the Groot-Dw ars River w as in good ecological condition. These High CI ecosystems support a high diversity of flora and fauna including many locally endemic, threatened, Protected, Rare, medicinal or otherw ise conservation important taxa. | 4 | 4 |
| Magnitude | High<br>A formidable netw ork of infrastructure w ill be constructed, w hich has the potential to cause severe contamination if not carefully maintained and eventually removed. Accidental hazardous spills or possible seepage, leaks or failure of PCDs, storage tanks, process w ater pipelines, etc. could have a severe impact on w ater quality, habitats, biota, and ecosystem processes and services in the Groot-Dw ars River catchment. | -4 | -3 |
| **Impact Significance** | Environmental contamination from the immense introduction of man-made things into Booysendal, the construction of considerable (nonbiodegradable) infrastructure, the production of large volumes of w aste, backfilling, and possible accidental hazardous contamination events in the Groot-Dw ars River FEPA, the Sekhukhuneland Centre of Plant Endemism, an EN Ecosystem, and provincial CBAs, deserves to be rated w ith very High significance, and requires considerable mitigation *and* offsetting. | **High**<br>**16**<br>**-4** | **High**<br>**15**<br>**-3** |

| Mitigating and Monitoring Requirements | |
|---|---|
| Required Management Measures | Avoid use and storage of hazardous materials and w aste in High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Volcanization and laydow n areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road betw een BN and BS1/2. |
| | Fence the infrastructural footprint w here practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence w ires adjacent to roads. |
| | Ensure that there is appropriate safe storage for all hazardous materials and that all w orkers have access to appropriate, adequate and functioning receptacles for hazardous and non-hazardous w aste. |
| | Ensure that all w orkers have access to functioning ablution facilities and that these are not positioned in a w etland or w etland buffer. |
| | Strictly prohibit cement mixing in sensitive areas, especially in or near w etlands. |
| | Use nets to catch debris falling from elevated constructions such as the ARC. |
| | Shift the pipeline betw een the BS4 RWD and PCD ca. 200m south-w estw ards to minimize the length of its intersection w ith the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable w ater pipelines to the recently disturbed verge of the Main Access Road. |
| | Design and install all pipelines to cause minimal environmental contamination. Ideally, all pipelines should be made of metal, and mounted off the ground (e.g. on concrete blocks), to minimize the risk of pipeline damage and resulting environmental contamination, and the use of non-recyclable pipeline material. |
| | Elevate pipelines over all w etlands and drainage lines to facilitate the detection of pipeline damage or leaks in these CI ecosystems and habitats. |
| | Construct suitable road crossings over all drainage lines to avoid contamination at these from vehicles. |
| | Ensure that all PCDs and other areas for storage of hazardous w aste or materials are lined. |
| | Ensure that each PCD is designed, operated and maintained to minimize evaporation, and to safely contain 1 in 100 year rainfall events w ithout any overflow , seepage, damage and failure. |
| | Provision all PCDs w ith Bird Balls™. (In the US this is recommended by the U.S. Fish and Wildlife Service to prevent w aterfow l from landing or residing in a pond receiving constant discharge from underlying mine operations). |
| | Compile and implement an effective Waste Management Plan. |
| | Ensure that there are effective emergency procedures in place to deal w ith possible contamination events. |
| | Effectively rehabilitate contaminated areas w ithout delay, w ith advice from an appropriate specialist(s). |
| | Strictly prohibit further disturbance (including littering) of natural areas beyond the project footprint. |
| | Ensure that there is regular and proper maintenance of machinery, tools and vehicles. |
| | Establish a Rehabilitation Plan for all areas (especially w etlands) that are disturbed during construction, operation and closure. |
| | Remove all infrastructure during closure, w ithout causing disturbance to undisturbed areas. Dispose of hazardous materials and w aste at an appropriate licensed facility. Dispose of remaining non-hazardous materials and w aste in the most environmentally-friendly means possible. |
| Required Monitoring (if any) | Check monthly that storage areas for hazardous materials, machinery, tools and vehicles remain in good w orking condition. |
| | Check monthly to ensure that receptacles for hazardous and non-hazardous w aste are functioning and adequate. |
| | Perform high- and low -flow aquatic biomonitoring at appropriate points - refer to the Aquatic Study by Clean Stream (2017) for recommendations. |
| | Annually revise and update emergency procedures for dealing w ith possible contamination events. |
| | Check ablution facilities daily, and clean as required. Sew age tanks should be emptied fortnightly, or more frequently during w armer months and w hen otherw ise necessary, to ensure that the w aste does not exceed 50 per cent of the useable capacity of the tanks before these are scheduled to be serviced again. |
| | Check monthly to ensure that available ablution facilities are functioning and adequate. |
| | Monitor the success of Bird Balls™ on the PCDs. Intially this should be performed monthly (or as reports come in from staff), and could be increased to every tw o-three months during the dry season. |
| | Initiate litter campaigns every six months, w hich could include additional activities for staff. |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction, Maintenance, Health, Safety and Environmental teams, other employees, and contractors. |
| **Impact Finding** | |
| Impact Finding | This impact requires a multitude of stringent mitigation measures and monitoring programmes, diligent co-operation from all employees and contractors, and offsetting forf the combined infrastructural footprints of all commenced and proposed activities, based on the 1:30 offset ratio for provincial CBAs. |

Table 10-45 Cumulative Change in Riparian Vegetation (Source: NSS, 2018)

| **Cumulative** | **Impact: Widespread change in riparian vegetation** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines; Possible re-vegetation of exposed areas. | | |
| Risk / Impact | Without mitigation, the development of infrastructure has and will continue to contribute sediment and, therefore, nutrients to downslope / downstream drainage lines, possibly the main BS4 wetland system and TKO Dam, and ultimately the Groot-Dwars River. If/When disturbed areas are re-vegetated, seeding, mulching and fertilizing could cause further nutrient loading in the catchment. With time, the sedimentation and nutrient loading will cause possibly widespread change in riparian vegetation structure. Where sedges and other short, fine-leaved flora occur, these will be replaced by taller, more robust flora such as *Phragmites* , and this change in habitat will affect the assemblage of fauna in affected parts of the catchment. More sensitive CI faunal taxa will likely be replaced by common, generalist faunal taxa. Of particular concern is that change in riparian vegetation structure could impact both the Valley and Everest golden mole populations. | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Indirect<br>Sediment and nutrient loading are indirect impacts from clearing vegetation, earth-moving activities, vehicle traffic, and development of infrastructure - especially in the vicinity of drainage lines and the Groot-Dwars River. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Existing *Phragmites* and other robust riparian flora will no doubt proliferate with further disturbance, sedimentaton and nutrient loading in the Groot-Dwars River, and possibly the main BS4 wetland and TKO Dam - depending on how much sedimentation and nutrient loading especially re-working of TSF1 will cause. | 4 | 3 |
| Duration | Permanent<br>Flora like *Phragmites* are likely to remain in affected areas without human intervention. | 4 | 4 |
| Extent | Area of Influence<br>The anticipated change in riparian vegetation structure along the Groot-Dwars River and possibly the main BS4 wetland system and TKO Dam, will occur beyond the infrastructural footprint. | 3 | 3 |
| Receptor Sensitivity | High<br>The Groot-Dwars River is a national FEPA, and all wetlands, regardless of their status, are viewed as sensitive and important at a national and provincial levels. In addition to the impact of sedimentation on sediment-sensitive fauna such as the recorded VU Marico Barb, Shortspine Suckermouth and Stargazer Mountain Catfish, and the potentially occurring Sawfin Suckermouth and VU Natal Ghost Frog, change in riparian vegetation structure could impact both the Valley and Everest golden mole populations, and other CI fauna. | 4 | 4 |
| Magnitude | Moderate<br>The magnitude of this impact was rated as Moderate considering that certain sections of the Groot-Dwars River and a large portion of the main BS4 wetland and TKO Dam are already dominated by *Phragmites* and other robust riparian flora. | -3 | -2 |
| **Impact Significance** | Domination of the Groot-Dwars River FEPA by *Phragmites,* and its possible densification and spread around the main BS4 wetland and TKO Dam, with subsequent disappearance of certain VU and other CI faunal taxa, was rated with High significance. | **High**<br>**15**<br>**-3** | **Moderate**<br>**14**<br>**-2** |

| **Mitigating and Monitoring Requirements** | |
|---|---|
| Required Management Measures | Determine the baseline sediment load in the Groot-Dw ars River and its associated mountain tributaries upstream of all current activities (i.e. south of BS1/2 and BS4). |
| | Avoid causing erosion and sedimentation in High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydow n areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road betw een BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | Fence the infrastructural footprint w here practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence w ires adjacent to roads. |
| | Shift the pipeline betw een the BS4 RWD and PCD ca. 200m south-w estw ards to minimize the length of its intersection w ith the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable w ater pipelines to the recently disturbed verge of the Main Access Road. |
| | Strictly limit vehicle traffic on the dirt service road that runs adjacent to the Groot-Dw ars River betw een BN and BS1/2 by maintaining the existing boom at co-ordinates 25° 5'3.90"S and 30° 7'5.27"E, and installing an additional locked boom at co-ordinates 25° 7'41.32"S and 30° 7'8,25"E. |
| | Mount all pipelines off the ground (e.g. on concrete blocks) to minimize vegetation clearing and earth-moving activities (during construction, operation and closure) and thus, erosion and sedimentation. |
| | Elevate pipelines over all w etlands and drainage lines to prevent flow impediment, erosion and sedimentation at these. |
| | Construct suitable road crossings over all drainage lines to prevent flow impediment, erosion and sedimentation at these. Each crossing w ill need to be assessed separately as different measures for each may be needed. There must be no erosion and sedimentation at the bridge over the Groot-Dw ars River at BS1/2. |
| | Construct suitable road crossings over all drainage lines to prevent flow impediment, erosion and sedimentation at these. |
| | Implement adequate and effective erosion control measures in all disturbed areas. |
| | Implement adequate and effective sedimentation control measures at all disturbed drainage lines. |
| | Implement adequate and effective stormw ater control measures in and around all infrastructure. Ensure that stormw ater management planning takes cognisance of environmental integrity and the conservation of biodiversity. |
| | Spillw ays should be fitted w ith sediment traps and flow attenuation structures. |
| | Establish a nursery for transplanting and cultivation of local indigenous flora for rehabilitation (focussed on bulbs and other flora that can handle transport and storage). |
| | Vegetate all exposed road side slopes, and the w alls of all PCDs a.s.a.p. using local indigenous flora. |
| | Establish a Rehabilitation Plan for all areas that are disturbed during construction, operation and closure. |
| | Rehabilitate using, inter alia, local indigenous plants from the recommended nursery, and an appropriate indigenous seed mix that excludes TEF, aliens, hybrids, cultivars and other unfavourable taxa. |
| Required Monitoring (if any) | Perform high- and low -flow aquatic biomonitoring at appropriate points - refer to the aquatic study by Clean Stream (2017) for recommendations. |
| | Monitor the density and structure of *Phragmites* at the recommended Fixed Point Monitoring Stations along the Groot-Dw ars River and the main BS4 w etland system. If there is a significant increase in *Phragmites* , consult a relevant specialist(s) on w hether or not to open / clear monospecific patches - depending on the likely impacts of this on w ater quality, ecosystem processes, services and (especially CI) biota. |
| | Check quarterly, and after heavy rainfall events, that all pipeline crossings over w etlands and drainage lines are in good w orking order (i.e that there are no obstructions, blockages, erosion, etc). Major pipeline maintenance w ork should be conducted during dry periods. |
| | Check annually that stormw ater measures are adequate and remain effective. |
| | Check annually that erosion control measures are adequate and remain effective. |
| | Check annually that sedimentation control measures are adequate and remain effective. |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction, Maintenance and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | Rigorous mitigation is critical to avoid domination of the Groot-Dw ars River FEPA by Phragmites, and its possible densification and spread around the main BS4 w etland and TKO Dam, w ith subsequent disappearance of certain VU and other CI faunal taxa. Recommended mitigation includes, inter alia, that the Escape Portal and pipelines be shifted as suggested, that no new roads are created for the North ARC, that clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, that all pipelines be mounted off the ground and elevated over w etlands and drainage lines, that effective stormw ater, erosion and sedimentation control measures are implemented and maintained, and that all disturbed areas are effectively rehabilitated. |

## Table 10-46 Cumulative Establishment of Invasive Alien Flora (Source: NSS, 2018)

| **Cumulative** | **Impact: Widespread establishment of invasive alien flora** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Earth-moving activities; Vehicle traffic and transport of materials into the Valley; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines; Possible rehabilitation of disturbed areas. | | |
| Risk / Impact | In BS4, where there is already a high diversity (richness and abundance) of invasive alien flora, these will no doubt rapidly establish in areas that will be disturbed for development of the Backfill Plant, storage tanks, paddocks and pipelines. In the Valley, the growing influx of vehicles and materials will no doubt introduce invasive alien species, where a negligible diversity of invasive alien flora formerly occurred. Wherever vegetation is cleared and soil is disturbed, invasive alien flora are likely to establish. The introduction and unchecked proliferation of invasive alien flora in the Valley could be catastrophic for native floral communities, faunal habitats, and the taxa that are associated with these. | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Indirect<br>The establishment of invasive alien flora is an indirect impact from clearing vegetation, blasting, earth-moving activities, vehicle traffic and transport of materials. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>The introduction and establishment of invasive alien flora in and around Booysendal's footprint is inevitable without control. | 4 | 4 |
| Duration | Permanent<br>Without effective control, invasive alien flora will continue to proliferate. | 4 | 3 |
| Extent | Regional/Provincial/National<br>Without effective control, invasive alien flora will spread beyond the boundaries of BS4 and throughout the Valley. | 4 | 2 |
| Receptor Sensitivity | High<br>Although the footprint of the Backfill Plant and associated infrastructure mostly coincides with disturbed and transformed areas, it also in places coincides with High CI communities and recommended Moderate-High CI buffers. The Valley is home to numerous locally endemic, threatened, Protected and other CI floral taxa, and local floral communities and the vegetation in the Valley are representative of the Sekhukhune Centre of Plant Endemism, an EN Ecosystem, and provincial CBAs. The unique flora and vegetation in the Valley in turn provides unique habitat for locally endemic and other CI fauna such as the *Pycna sylvia* cicada. | 4 | 4 |
| Magnitude | High<br>Without effective control, invasive alien flora will progressively displace indigenous biodiversity from existing more or less heavily invaded areas around BS4, and will become increasingly problematic in the Valley. | -4 | -2 |
| **Impact Significance** | Without mitigation, the definite, permanent, widespread and severe impact of invasive alien flora on a broad spectrum of biodiversity of High conservation importance deserves to be rated with very High significance. | **High**<br>**16**<br>**-4** | **Minor**<br>**13**<br>**-2** |

| Mitigating and Monitoring Requirements | |
|---|---|
| Required Management Measures | Avoid disturbing High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydown areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road between BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | Shift the pipeline between the BS4 RWD and PCD ca. 200m south-westwards to minimize the length of its intersection with the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable water pipelines to the recently disturbed verge of the Main Access Road. |
| | Mount all pipelines off the ground (e.g. on concrete blocks) to minimize vegetation clearing and earth-moving activities (during construction, operation and closure) and thus, establishment of invasive alien flora. |
| | Elevate pipelines over all wetlands and drainage lines to avoid disturbance and subsequent alien invasion of these High CI areas. |
| | Fence the infrastructural footprint where practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence wires adjacent to roads. |
| | Excavated topsoil must be stored with associated native vegetation debris for subsequent use in rehabilitation. |
| | Topsoil stockpiles must be managed to ensure that the viability of the seed bank is retained. |
| | Establish a nursery for transplanting and cultivation of local indigenous flora for rehabilitation (focussed on bulbs and other flora that can handle transport and storage). |
| | Vegetate all exposed road side slopes, and the walls of all PCDs a.s.a.p. using local indigenous flora. |
| | Compile and implement an Invasive Alien Control Plan for Booysendal. |
| | Establish a Rehabilitation Plan(s) for all areas that are disturbed during construction, operation and closure. |
| | Rehabilitate using, inter alia, local indigenous plants from the recommended nursery, and an appropriate indigenous seed mix that excludes TEF, aliens, hybrids, cultivars and other unfavourable flora. |
| Required Monitoring (if any) | Monitor the prevalence of invasive alien flora throughout Booysendal, as per the Invasive Alien Control Plan. |
| | Monitor the success of invasive alien plant control measures, as per the Invasive Alien Control Plan. |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | The significance of this impact can be greatly reduced if the Escape Portal and pipelines are shifted as suggested, if no new roads are created for the North ARC, if clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, if all pipelines are mounted off the ground and elevated over wetlands and drainage lines, if an effective Invasive Alien Control Plan is implemented, and if all disturbed areas are effectively rehabilitated. |

Table 10-47 Cumulative Loss of CI and Other Flora (Source: NSS, 2018)

| **Cumulative** | **Impact: Widespread loss of CI and other flora** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines. | | |
| Risk / Impact | Where vegetation in the infrastructure footprint has or will be cleared, numerous specimens of CI and other flora have and will continue to be lost. Around BS4, susceptible CI taxa include those that are listed as occurring in the *Heteropogon-Eragrostis* Semi-natural Grassland (e.g. MTPA: VU *Eucomis autumnalis*), *Brachiaria-Tristachya* Exposed Rock community (e.g. VU *Zantedeschia pentlandii*) and the *Tulbaghia-Eleocharis* Sheetrock Wetland. An especially high diversity of flora including numerous CI taxa is present in the Valley. Of particular concern is the loss of specimens representing locally endemic and threatened or Protected species such as the VU *Zantedeschia pentlandii*, Protected *Lydenburgia cassinoides* and NT *Jamesbrittenia macrantha.* | | |
| Project Phase | CO | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct<br>Clearing of vegetation, blasting, earth-moving activities, and development of infrastructure will cause direct destruction of CI floral species specimens. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>CI (and other) floral species specimens within the infrastructural footprint have and will continue to be destroyed unless they are transplanted. | 4 | 4 |
| Duration | Permanent<br>Constructed infrastructure will remain permanently (and flora will forever be lost from the footprint) unless infrastructure is removed during closure and disturbed areas are effectively rehabilitated. | 4 | 3 |
| Extent | Area of Influence<br>Clearing of vegetation, blasting, earth-moving activities and development of infrastructure is supposed to be limited to the infrastructural footprint. However, commenced activities have in many places caused disturbance and destruction of vegetation in surrounding areas. | 3 | 2 |
| Receptor Sensitivity | High<br>Numerous floral specimens have and will continue to be lost including specimens of locally endemic, threatened and Protected species such as the VU *Zantedeschia pentlandii*, Protected *Lydenburgia cassinoides,* and NT *Jamesbrittenia macrantha.* | 4 | 3 |
| Magnitude | High<br>The loss of numerous CI (and other) floral species specimens within the extensive combined footprint of commenced and proposed activities was rated with High magnitude. | -4 | -3 |
| **Impact Significance** | Definite, permanent destruction of CI and numerous other floral species specimens throughout the extensive Booysendal infrastructural footprint was rated with High significance. | **High**<br>**15**<br>**-4** | **Moderate**<br>**12**<br>**-3** |

| **Mitigating and Monitoring Requirements** | |
|---|---|
| Required Management Measures | Obtain permits to remove CI floral species specimens from the infrastructural footprint. |
| | Put together a team of workers led by a vegetation specialist, tasked with removing all specimens of all relevant species from the infrastructural footprint prior to construction. |
| | Establish a nursery for transplanting and cultivation of local indigenous flora for rehabilitation (focussed on bulbs and other flora that can handle transport and storage). Grow also cuttings of certain tree species, and dedicate special effort to successful cultivation of *Jamesbrittenia macrantha* in a nursery environment. |
| | Avoid destruction of High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydown areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road between BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | Shift the pipeline between the BS4 RWD and PCD ca. 200m south-westwards to minimize the length of its intersection with the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable water pipelines to the recently disturbed verge of the Main Access Road. |
| | Mount all pipelines off the ground (e.g. on concrete blocks) to minimize vegetation clearing and earth-moving activities (during construction, operation and closure) and thus, destruction of flora. |
| | Elevate pipelines over all wetlands and drainage lines to avoid destruction of CI and other flora in these High CI areas. |
| | Fence the infrastructural footprint where practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence wires adjacent to roads. |
| | Excavated topsoil must be stored with associated native vegetation debris for subsequent use in rehabilitation. |
| | Topsoil stockpiles must be managed to ensure that the viability of the seed bank is retained. |
| | Establish a Rehabilitation Plan(s) for all areas that are disturbed during construction, operation and closure. |
| | Remove all (especially portal) infrastructure during closure, without causing disturbance to undisturbed areas. |
| | Rehabilitate using, inter alia, local indigenous plants from the recommended nursery, and an appropriate indigenous seed mix that excludes TEF, aliens, hybrids, cultivars and other unfavourable flora. |
| Required Monitoring (if any) | Monitor the condition of rescued CI floral species specimens in the nursery, weekly. |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | The significance of this impact can be greatly reduced if the Escape Portal and pipelines are shifted as suggested, if no new roads are created for the North ARC, if clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, if all pipelines are mounted off the ground, if topsoil is handled properly, if the recommended plant nursery is successfully operated, if CI floral species specimens are successfully rescued from the infrastructural footprint, and if all disturbed areas are effectively rehabilitated. |

## Table 10-48 Cumulative Loss of CI and Other Fauna (Source: NSS, 2018)

| **Cumulative** | **Impact: Widespread loss of CI and other fauna** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Excavation, compaction and removal of soil; Infilling; Development of seven operational areas around >11 adits i.e. at BN, the BS1/2 Complex, two Merensky Portals, Escape Portal, Valley Boxcut and BS4 (including all conveyors, crushers, PCDs, RWDs and other hazardous storage areas, stormwater, offices and other infrastructure), the ~12km Main Access Road (including the bridge over the Groot-Dwars River), the ~8km ARC, the >6km dirt service road, >5km of ARC access roads, plus volcanization and laydown areas, ~11km of powerlines, and >13km of process water, slurry and other pipelines; Vehicle traffic. | | |
| Risk / Impact | Booysendal supports a high diversity of fauna, including numerous CI taxa. Fauna that are most susceptible to destruction during construction include those that are small, slow, young, subterranean / fossorial and/or philopatric. Nocturnal fauna are especially vulnerable to collision with traffic at night, and a broad spectrum of avifauna could potentially collide with the ARC. Of particular concern is the likely loss of: i) the Valley golden mole population, which will be threatened by development of the Escape Portal and by vehicle traffic, and road maintenance along the dirt service road near the Groot-Dwars River; ii) avifauna, especially CI species such as the EN Cape Vulture, EN African Marsh Harrier, VU Verreaux's Eagle, VU Martial Eagle, VU Crowned Eagle and NT Melodious Lark, due to their possible collision with the ARC; iii) nymphs of the locally endemic *Pycna sylvia* cicada, which live underground on the roots of *Vitexo. wilmsii* trees, and which may take many years to mature (Malherbe *et al*. 2004); iv) specimens of the locally endemic and sheet-rock restricted Sekhukhune and FitzSimon's flat lizards, and the *Hadogenes polytrichobothrius* flat rock scorpion; v) the immature life stages of recorded Rare or geographically restricted butterfly species; vi) various potentially occurring CI reptile species; and vii) baboon spiders. | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct<br>Mortality of fauna from clearing of vegetation, blasting, earth-moving activities, and their collision with vehicle traffic and possibly the ARC, is a direct impact. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Mortality of fauna from the above-mentioned activities is inevitable. | 4 | 4 |
| Duration | Permanent<br>In addition to the continued loss of fauna during construction, fauna will be at risk of collision with vehicle traffic and possibly the ARC throughout the Life of Mine. Fauna with long generations (e.g. *Pycna sylvia*), low fecundity (e.g. baboon spiders), low densities (e.g. African Marsh Harriers), high mortality rates (e.g. vultures), and/or few, isolated populations (e.g. golden moles), will take a long time (years) to recover from significant mortality events, or could even be extirpated. | 4 | 3 |
| Extent | Regional/Provincial/National<br>Possible collision of highly threatened and wide-ranging CI and other avifauna could impact the affected species at a regional or provincial scale. As very few golden mole populations are known, loss of the Valley golden mole population will represent a significant national loss to the taxon. | 4 | 2 |
| Receptor Sensitivity | High<br>During construction, numerous faunal specimens will be lost including specimens of possibly locally endemic, threatened and Protected species such as nymphs of the locally endemic *Pycna sylvia* cicada, Sekhukhune and FitzSimon's flat lizards, *Hadogenes polytrichobothrius* flat rock scorpions, and baboon spiders. Vehicle traffic will impact a broad spectrum of fauna potentially including the Valley golden mole population and large CI carnivores. Multiple CI avifauna are potentially at risk of collision with the ARC, ranging from the EN Cape Vulture and African Marsh Harrier, to the NT Melodious Lark. | 4 | 4 |
| Magnitude | High<br>Destruction of CI and numerous other faunal species specimens during construction and from their collision with traffic and possibly the ARC, was rated with High magnitude. | -4 | -2 |
| **Impact Significance** | Definite destruction of CI and numerous other faunal species specimens throughout the Life of Mine, which could affect certain species at a regional, provincial or national scale, deserves to be rated with High magnitude. | **High**<br>**16**<br>**-4** | **Moderate**<br>**13**<br>**-2** |

| **Mitigating and Monitoring Requirements** | |
|---|---|
| Required Management Measures | Obtain permits to remove CI faunal species specimens from the infrastructural footprint. |
| | Rescue specimens of CI faunal taxa (especially flat lizards, dragon lizards and various other potentially occurring threatened reptile species, flat rock scorpions, baboon spiders and *Pycna sylvia* cicada nymphs) from relevant habitats (especially rocks, termitaria and *Vitex obovata* trees) remaining in the infrastructural footprint. This w ill require active searching and grab sampling by a team of people under the guidance of a zoologist. During field surveys in BS, NSS managed to find and catch flat lizards, dragon lizards and scorpions w ith relative ease. Rescued fauna w ill need to be relocated to nearby suitable and safe habitats as soon as possible, also under the guidance of a zoologist. |
| | Avoid destruction of High and Moderate-High CI areas. |
| | Avoid destruction of rocky habitat including isolated boulders, and termitaria. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydow n areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road betw een BN and BS1/2. |
| | Clearing of vegetation for the ARC should, therefore, be limited to the footings and existing tracks. |
| | Shift the pipeline betw een the BS4 RWD and PCD ca. 200m south-w estw ards to minimize the length of its intersection w ith the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable w ater pipelines to the recently disturbed verge of the Main Access Road. |
| | Mount all pipelines off the ground (e.g. on concrete blocks) to minimize vegetation clearing and earth-moving activities (during construction, operation and closure) and thus, destruction of floral communities and faunal habitats. |
| | Elevate pipelines over all w etlands and drainage lines to avoid destruction of CI and other fauna in these High CI areas. |
| | Appoint a golden mole specialist to determine the species identity of the Valley and Everest golden mole populations. The appointed specialist should also attempt to “delineate” critical habitat for the populations based, inter alia, on the soil(s) that are utilized by the populations. If existing soils maps are not sufficiently detailed, additional soil sampling and mapping w ill be required. Appropriate buffers should then be prescribed to protect the delineated critical habitat. |
| | Strictly limit vehicle traffic on the dirt service road that runs adjacent to the Groot-Dw ars River betw een BN and BS1/2 by maintaining the existing boom at co-ordinates i) 25° 5'3.90"S and 30° 7'5.27"E, and installing additional locked booms at co-ordinates ii) 25° 6'41.79"S and 30° 7'20.08"E, iii) 25° 7'14.28"S and 30° 7'12.68"E, and iv) 25° 7'41.32"S and 30° 7'8,25"E. Under absolutely no circumstance should vehicle traffic, road grading and other road maintenance w ork be allow ed on the section of road betw een co-ordinates ii) and iii) w here the Valley golden mole population is situated. |
| | Fence the infrastructural footprint w here practicable (i.e. all operational areas around adits, and the Backfill Plant and storage tanks) to avoid disturbing surrounding areas. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence w ires adjacent to roads. |
| | Construct suitable crossings over all drainage lines to prevent destruction of fauna at these localities. |
| | Ensure that measures are put in place to minimise bird collision risk as a result of the ARC. Consultation from a suitably qualified / experienced ornithologist should be sought in this regard. Input should include, inter alia, monitoring bird collision risk. It is recommended that the principles w ithin The Birds and Wind-Energy Best-Practice Guidelines, South Africa by Jenkins *et al*. (2015) should be adapted w here applicable, and adopted. |
| | Adequately provision pow erlines (especially the 137kV pow erline) w ith effective anti-bird devices w here necessary, based on advice from a suitably experienced ornithologist. |
| | Provision all PCDs w ith Bird Balls$^{TM}$. (In the US this is recommended by the U.S. Fish and Wildlife Service to prevent w aterfow l from landing or residing in a pond receiving constant discharge from underlying mine operations). |
| | Avoid unnecessary fencing w ithin natural areas as far as possible. |
| | Prohibit vehicle traffic as far as possible on the road netw ork in Booysendal at night and after heavy rainfall. |
| | Implement and maintain adequate and effective measures to control the speed of vehicles on the road netw ork. |
| | Remove all (especially ARC) infrastructure during closure, w ithout causing disturbance to undisturbed areas. |
| Required Monitoring (if any) | Monitor vehicle traffic speed, monthly throughout the Life of Mine. |
| | Check annually that all road crossings over drainage lines are kept in good w orking order. |
| | Monitor the success of rehabilitation efforts, seasonally. Use the recommended Fixed Point Monitoring Stations. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction and Environmental teams, Independant in situ ECO. |
| **Impact Finding** | |
| Impact Finding | The significance of this impact can be greatly reduced if the Escape Portal and pipelines are shifted as suggested, if no new roads are created for the North ARC, if clearing of vegetation for the ARC is strictly limited to the footings and existing tracks, if the dirt service road alongside the Groot-Dw ars River is closed, if all pipelines are mounted off the ground, if CI faunal species specimens are successfully rescued from the infrastructural footprint, if the ARC is designed to minimize its potential impacts on avifauna, if pow erlines are fitted w ith anti-bird devices w here necessary, if PCDs are provisioned w ith Bird BallsTM, if night time vehicle traffic and speed are tightly controlled, and if all (especially ARC) infrastructure is removed during closure. |

## Table 10-49 Cumulative Disturbance of CI and Other Fauna from Noise, Vibrations, and Lighting

| **Cumulative** | **Impact: Widespread disturbance of CI and other fauna from noise, vibrations and lighting** | | |
|---|---|---|---|
| Activities | Clearing of vegetation; Blasting; Earth-moving activities; Vehicle traffic; Use of machinery and tools; Lighting; Construction and operation of infrastructure (especially the ARC, other conveyors and crushers). | | |
| Risk / Impact | Fauna in and around the infrastructure footprint are likely to experience regular disturbance from noise, vibrations and lighting during construction, operation and closure. Fauna that are most susceptible to these forms of disturbance include calling, ground-dwelling, and nocturnal taxa. Of particular concern is possible auditory and vibrational disturbance of multiple CI bird and bat species from operation of the ARC; vibrational disturbance of the Valley golden mole population from blasting for the Escape Portal and from traffic on the dirt service road; auditory, vibrational and/or visual disturbance of any cliff-roosting Cape Vultures (EN), Verreaux's Eagles (VU) and other CI bird and bat species from the Backfill Plant; visual and auditory disturbance of nocturnal CI carnivores and many other fauna from lighting and night time traffic; and possible auditory disturbance of calling adult Pycna sylvia cicadas in the vicinity of regular or continuous loud noise (e.g. from crushers). | | |
| Project Phase | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Indirect<br>Disturbance of fauna from noise, vibrations and lighting is an indirect impact from various activities. | | |
| | | **Significance prior to Mitigation** | **Significance with Mitigation** |
| Likelihood / Probability | Definite<br>Disturbance of sensitive fauna is certain given: i) that until recently there was very little anthropogenic activity in the Valley; ii) the unavoidable noise, vibrations and lighting associated with commenced and proposed activities; the observed apparent displacement of certain taxa from areas where activites for BS have commenced, such as waterbirds from the Groot-Dwars River near BS1/2 and breeding Verreaux's Eagles from the cliff line west of BS4. | 4 | 4 |
| Duration | Long term<br>Fauna in and around the infrastructural footprint have and will continue to experience regular disturbance from noise, vibrations and lighting throughout the Life of Mine. | 3 | 3 |
| Extent | Regional/Provincial/National<br>Light, noise and blasting vibrations already, and will continue to extend across an increasingly large section of the Valley (from BN and BS1/2) and an increasingly large area surrounding BS4. If not already the case, light from Booysendal will be visible at night from many kilometers away. | 4 | 3 |
| Receptor Sensitivity | High<br>Recorded CI fauna that are potentially susceptible to disturbance include the (EN) Cape Vulture, (EN) African Marsh Harrier; (EN) Mountain Reedbuck; (potentially VU) Valley golden mole population and locally endemic *Pycna sylvia* cicada; (VU) Verreaux's Eagles, (VU) Cohen's Horseshoe Bat, (VU) Leopard; (NT) Geoffroy's Horseshoe Bat, (NT) Natal Long-fingered Bat, (NT) Rusty Pipistrelle, (NT) Brown Hyena; (NT) Serval and the Protected Aardvark. Potentially occurring CI fauna that might also be disturbed include e.g. the (VU) Lanner Falcon and (VU) Secretarybird, (VU) Short-tailed Pipit, (VU) Southern Bald Ibis and (VU) White-bellied Korhaan. | 4 | 4 |
| Magnitude | Moderate<br>The impact of noise, vibrations and lighting was rated with Moderate magnitude relative to the more severe impact of other impacts e.g. habitat destruction, fragmentation and erosion. | -3 | -2 |
| **Impact Significance** | Definite, far-reaching and long term disturbance of possibly numerous fauna including a number of EN, VU and NT species, was rated with High significance. | **High<br>15<br>-3** | **Moderate<br>14<br>-2** |

| **Mitigating and Monitoring Requirements** | |
|---|---|
| Required Management Measures | Avoid noise, vibrations and lighting in and near High and Moderate-High CI areas. |
| | Relocate the Escape Portal to a less conservation important area. |
| | Do not create new roads for the North ARC. Only use the Main Access Road and existing tracks for this. |
| | Volcanization and laydown areas for the ARC should only be placed in recently disturbed areas, such as along the Main Access Road between BN and BS1/2. |
| | Use all possible means to minimise harmonics that are generated by the electric drive motors and cables of the ARC, which will potentially adversely affect the communication of avifauna and bats. |
| | Shift the pipeline between the BS4 RWD and PCD ca. 200m south-westwards to minimize the length of its intersection with the High CI *Fuirena-Leersia-Phragmites* Vlei System. |
| | Shift the process and potable water pipelines to the recently disturbed verge of the Main Access Road. |
| | Keep blasting to a minimum, especially during summer, which is a peak activity and breeding period for fauna. |
| | Strictly prohibit noisy activities at night. |
| | Prohibit vehicle traffic as far as possible on the road network in Booysendal at night and after heavy rainfall. |
| | Strictly limit vehicle traffic on the dirt service road that runs adjacent to the Groot-Dwars River between BN and BS1/2 by maintaining the existing boom at co-ordinates i) 25° 5'3.90"S and 30° 7'5.27"E, and installing additional locked booms at co-ordinates ii) 25° 6'41.79"S and 30° 7'20.08"E, iii) 25° 7'14.28"S and 30° 7'12.68"E, and iv) 25° 7'41.32"S and 30° 7'8,25"E. Under absolutely no circumstance should vehicle traffic, road grading and other road maintenance work be allowed on the section of road between co-ordinates ii) and iii) where the Valley golden mole population is situated. |
| | Strictly prohibit disturbance of natural areas beyond the infrastructural footprint. Construction areas must be clearly demarcated on the ground, and signs indicating sensitive areas should be hung on single strand fence wires adjacent to roads. |
| | Minimize lighting throughout the infrastructural footprint throughout the Life of Mine. |
| | Outside lights should be directed downwards, hooded, fitted with low pressure sodium vapor lamps, and ideally, be motion-sensitive. |
| Required Monitoring (if any) | Perform quarterly checks, followed by implementation of measures where necessary, to minimize noise, lighting and vibrations from the infrastructural footprint and road traffic. |
| Responsibility for Implementation | Booysendal Management, Engineering, Construction, Maintenance, Health, Safety and Environmental teams, other employees, and contractors. |
| **Impact Finding** | |
| Impact Finding | The significance of this impact can be greatly reduced if the Escape Portal and pipelines are shifted as suggested, if no new roads are created for the North ARC, if all possible means are used to minimise harmonics that are generated by the electric drive motors and cables of the ARC, if blasting is minimized, if noisy activities are strictly prohibited at night, if vehicle traffic is prohibited as far as possible on the road network in Booysendal at night and after heavy rainfall, and if lighting throughout the infrastructural footprint is diligently minimized throughout the Life of Mine. |

### 10.11.2 Recommendations

Implementation of the following recommendations must be considered:

- Not enough data is available to understand the breeding habits, life cycle and behaviour of the *Pycna sylvia;* additional research is therefore required. RD Stephens proposed that a Phd-study be undertaken. This should be aimed at increasing the understanding of the behavioural patterns and to focussing conservation efforts through the identification of real threats gained from a better knowledge base.
- Buffer zones around the *Vitex Obovate* subs, *wimsii* must not be compromised and encroachment must be avoided.
- Offset of the *Vitex Obovate* subs, *wimsii* must form part of the offset calculations for the Phase 2 Project and past disturbances, especially the compromised conservation area at BN.
- Fragmentation of the *Vitex Obovate* subs, *wimsii* must be avoided as this will decrease the availability of suitable habitat.

- The purchase or donation and legal protection of additional offset areas to ensure that all residual Phase 2 Project impacts, are offset in accordance with the 1:30 ratio to be applied in provincial Irreplaceable Critical Biodiversity Areas, as stipulated in the draft Biodiversity Offset Policy.
- Extensive rehabilitation of redundant prospecting and temporary roads on all properties owned by Booysendal, until erosion and sedimentation have been effectively halted, and vegetation succession in these areas supports a balance of Decreaser and Increaser I climax plant taxa, as previously described to mitigate cumulative impacts.
- Comprehensive rehabilitation of all crossings over the Groot-Dwars River in BS, which are impacting flow, water quality and other aspects of the system.
- Effective, long-term and environmentally-friendly control of invasive alien flora from the off-site upstream Groot-Dwars catchment and in the De Berg Conservancy (including Davel Private Nature Reserve).

### 10.11.3 Limitations and Gaps

The following limitations and gaps were identified by the terrestrial ecologists:

- The *Pycna sylvia* survey was not done during the optimum breeding season and it might therefore be that the distribution of this sensitive species is not accurate. A precautionary approach need to be followed and disturbance of the *Vitex obovate* subsp. *wilmsii* must be avoided while follow-up studies are undertaken.
- Once-off summer studies at various areas of the overall Booysendal South Expansion Project over time. It might therefore be that not all floral species were detected, but a basic understanding of the local biodiversity was nonetheless obtained;
- Inaccuracies in mapping may occur due to the scale of the mapping and the project and interpretations by the capturer;
- The Braun-Blanquet method could be seen as subjective, accuracy with cover estimates of border classes could at times be questioned and the time of the year of field surveys could influence the outcome of species dominance, but once again it allows for an understanding of the biodiversity;
- A more thorough examination of the crags for cliff-roosting bird species is important and should be conducted; and
- NSS was unable to obtain photographic evidence of detected golden mole and baboon spider species without causing considerable damage to their burrow systems, and despite using a digital burrow probe and erecting a camera trap in one instance. Given these sampling difficulties, the deficiency of data on golden moles, their scarcity, and highly threatened status, an appraisal of the newly discovered populations by a golden mole specialist is warranted.

### 10.11.4 Impact Statement

A sustainable solution between mining and the protection of the *Pycna sylvia* habitats must be reached. It is evident that mining activities are leading to the fragmentation and destruction of these habitats and that migration away from mining activities are taking place. Offset and honouring of the offset areas is of critical importance due to the restricted habitat preference and locations in which the *Pycna sylvia* is found.

NSS is further of the opinion that due to the extent of the cumulative impacts against the unique biodiversity, conservation status, the number of conservation important species and the provincial, national and international importance of the flora and fauna, development should not have taken place in the Booysendal South Expansion Project areas in the first instance. Phase 2 Project Impacts will need to be mitigated, managed and monitored while an offset will be required to compensate for the loss in biodiversity. This offset must be formally set aside and managed as a conservation area.

## 10.12 Socio-economic Impact Assessment

A summary of expected socio-economic impacts are provided in Table 10-50. A summary of mitigating and monitoring requirement as in the previous sections is also provided. For detailed assessment and assessment of less significant impacts refer to Annexure L.

Table 10-50 Summary of Potential Socio-Economic Impacts throughout the Life of Mine

| Issue | Type of Impact | Impact |
|---|---|---|
| | | **Construction Phase** |
| Economic | Positive | • Job creation and increased employment<br>• Skills development, transfer and training<br>• Multiplier effects on the local economy |
| | Negative | • Loss of access to livelihood activities<br>• Tension over procurement contracts |
| Social | Negative | • Increase in informal settlements because of influx<br>• Increased pressure on social infrastructure and services because of influx<br>• Increased livestock theft<br>• Social unrest due to conflicts between work seekers and land occupants<br>• Increased tension between land claimants and land occupants<br>• Increase in social pathologies (teenage pregnancies, school drop-outs, alcohol and substance abuse) |
| Health and Safety | Negative | • Visual, noise and air quality impacts<br>• Increase in communicable diseases<br>• Increase in traffic and road accidents |
| | | **Operational Phase** |
| Economic | Positive | • Job creation and increased employment<br>• Skills development, transfer and training<br>• Regional economic development<br>• Contribution to the fiscals<br>• Establishment and development of SMME's<br>• Contribution to social infrastructure development through CSR and LED projects (i.e. SLP commitments) |
| | Negative | • Loss of access to livelihood activities<br>• Tensions over limited employment opportunities and procurement contracts |
| Social, Cultural and Heritage | Positive | • Improved access to social services and infrastructure<br>• Improved lifestyles |
| | Negative | • Increase in informal settlements because of influx<br>• Increased pressure on local infrastructure and services because of influx<br>• Social unrest due to conflicts between work seekers<br>• Increased livestock theft<br>• Increased tension between land claimants and land occupants<br>• Increase in social pathologies (teenage pregnancies, school drop-outs, alcohol and substance abuse)<br>• Erosion of local cultural values and morals<br>• Loss of access to medicinal plants<br>• Increased crime<br>• Loss of access to cultural heritage sites |
| Health and Safety | | • Visual, noise and air quality impacts<br>• Increase in communicable diseases<br>• Increase in traffic and road accidents |

| | | |
|---|---|---|
| | | **Decommissioning** |
| Economic | Positive | • Donation of mine infrastructure to local municipalities |
| | Negative | • Increase in job losses and unemployment<br>• Loss of income for contractors<br>• Loss of funding and support for social infrastructure development and social services<br>• Loss of revenue for local municipalities |
| Social | Negative | • Increase in alcohol and substance abuse<br>• Social dislocation due to out-migration<br>• Decline in lifestyles |
| Health and Safety | Positive | • Decrease in traffic and road accidents |
| | | **Cumulative Impacts** |
| | | • An increase in traffic, road deuteriation and road accidents<br>• Economic growth and the development of informal economies in communities neighbouring the mine site and along the R557<br>• Raised expectations regarding employment opportunities<br>• Increased demand for housing in economic hubs neighbouring the proposed mine increasing house prizes<br>• Increased loss in access to arable land, ecosystem services and cultural heritage sites |

### 10.12.1 Economic Impacts

Employment and Job Creation: It is expected that the Booysendal South Expansion Project will generate 2,746 direct and contract employment opportunities, and 4,119 indirect employment opportunities. With the high dependency ratio in the area, it is assumed that job creation will benefit some 365,882 people.

Currently, 60% of the workforce employed at Booysendal comes from local communities. This means that a significant amount of the current annual wages of R505,372,151 filters through to the local economy.

Where possible, Booysendal will prioritise local employment and procurement from HDSA. Local procurement from HDSA currently stands at 87.18%. Refer to Table 10-51 to Table 10-53 for the assessment of the anticipated most significant economic impacts.

Table 10-51 Employment and Job Creation

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Direct and indirect employment generated during the construction, operations and closure phases of the proposed mine expansion project. | | |
| Risk/ Impact | Job creation and increased employment opportunities | | |
| Project Phase: CO, OP, CL<br>Nature of Impact | CO, OP, CL<br>Positive | | |
| Type of Impact | Direct, indirect and cumulative | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 3 | 4 |
| Duration | Long-term | 3 | 3 |

| | | | |
|---|---|---|---|
| | Even though the benefits derived from employment experience, skills development and training are permanent, it is likely that the economic benefits of employment will be mostly experienced during the LoM, and seize during decommissioning and closure. | | |
| Extent | Area of Influence<br>Employment opportunities will affect the wider area of influence | 3 | 3 |
| Receptor Sensitivity | Moderate | 3 | 3 |
| Magnitude | Moderate | 3 | 4 |
| Impact Significance | Given the high levels of unemployment in the communities neighbouring the proposed mine site, the benefits of employment will be significant not only for those employed but also the wider area of influence including economic hubs and local vendors. | Moderate<br>12<br>3 | High<br>13<br>4 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Prioritise employing local workers if qualified applicants with the appropriate skills are available.<br>• Formalise local employment procedures in Human Resources policies (HR Management Plan) and contractors' agreements.<br>• Work with community representatives to develop open and transparent recruitment procedures that are disclosed to community members.<br>• Use various mechanisms to advertise employment opportunities before construction of the project is initiated.<br>• Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programmes. | | |
| Required Monitoring | Monitor the numbers of local employees | | |
| Responsibility for implementation | HR Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be enhanced through HR policies and SLP skills development and training programmes. | | |

Training and Skills Development: Although a majority of the population has received primary education, many people residing in areas surrounding the Project Area are illiterate and lack employable skills. It is envisaged that local employment opportunities will be limited to predominantly semi-skilled and unskilled persons. Skills development and capacity building initiatives will improve opportunities for future employment and enterprise development in local communities.

Table 10-52 Improved Skills Development and Training

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Provide skills development and training | | |
| Risk/ Impact | Improved skills and employability of local community members | | |
| Project Phase: CO, OP, CL<br>Nature of Impact | CO, OP, CL<br>Positive | | |
| Type of Impact | Direct | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 3 | 4 |
| Duration | Permanent<br>The benefits derived from skills development and training are permanent. | 2 | 4 |
| Extent | Area of Influence<br>Skills development and training will affect the wider area of influence | 1 | 2 |
| Receptor Sensitivity | Moderate | 1 | 3 |
| Magnitude | Moderate | 2 | 4 |
| Impact Significance | Skills development and training will assist with improving employment opportunities with the mine and other businesses in the broader Area of Influence. | Minor<br>7<br>2 | High<br>13<br>4 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Develop and implement skills development and training programmes that target both employees and the broader populations.<br>• Provide or facilitate training of local people in mining and general business skills before and during mining activities, such as through internships, scholarships, and/or vocational and skills training programmes. | | |
| Required Monitoring | • Monitor the numbers of training programmes, participants and pass rates<br>• Track employment and recruitment post training | | |
| Responsibility for implementation | Mine HR Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be enhanced through HR policies and SLP skills development and training programmes. | | |

Revenue Generation: Regional spending in support of the mining operations is another direct positive Booysendal South Expansion Project impact. The Government will derive revenue from the Booysendal

South Expansion Project through various forms of taxes and mineral royalties applicable to mining companies, including but not limited to import duties, corporate tax, contributions to social funds, and value added tax.

Currently, Booysendal contributes R86,639,513 to Government revenues, and Local economic development spent from 2014 - 2016 was R8,926,913. Booysendal has indicated that the expansion of the Booysendal Mine will assist in continuous development spend, including investment into schools and development centres. The Project has an estimated capital spend of R4,199,800,000 over 5 years. The projected turnover (2016 values) is R2.7 billion of which some 8-10% (about R250 million) will represent ongoing capital investment for the projected LoM.

Table 10-53 Income and Regional Development

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | The Government will derive revenue from the expansion project through various forms of taxes and mineral royalties applicable to mining companies, including but not limited to import duties, corporate tax, contributions to social funds, and value added tax | | |
| Risk/ Impact | Regional economic development and contributions to government revenue | | |
| Project Phase: CO, OP, CL | CO, OP | | |
| Nature of Impact | Positive | | |
| Type of Impact | Direct and cumulative | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Definite Likelihood | 4 | |
| Duration | Long Term | 3 | |
| Extent | Regional/Provincial/National | 4 | |
| Receptor Sensitivity | High | 4 | |
| Magnitude | High | 4 | |
| Impact Significance | The revenue derived from mining can be utilised by the Government, and the Greater Tubatse Local Municipality in Limpopo and the Thaba Tchweu Local Municipality in Mpumalanga in particular, for community development programmes and improved service delivery. | High<br>15<br>4 | |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Not applicable | | |
| Required Monitoring | Not applicable | | |
| Responsibility for implementation | None | | |
| Impact Finding | | | |
| Impact Finding | The positive benefits of the impact are high and do not require mitigation. | | |

### 10.12.2 Social Impact

Service Delivery (refer to Table 10-54): Currently the social services in the areas surrounding the Project Area are limited and severely under resourced. In the four communities neighbouring the Booysendal Mine, there are no clinics. Water is generally sourced from rivers and springs, and the majority of the local population make use of the bush for the toilet. There are also no formal refuse removal services and communities generally bury and burn their refuse or throw it into the surrounding bush. Even though all communities have at least one primary school nearby; only one community has access to a secondary school.

None of the towns/villages reported having shops and markets, and although all communities, except for Choma, have access to electricity, households rely primarily on wood for cooking. The secondary roads off the R577 are dirt roads and some are in poor condition. There is a complete lack of a public transport network and the community members generally walk or hike to get to their destinations. This poses a huge opportunity to Booysendal to become involved in community development and upliftment and to make a positive contribution through their SLP taking consideration of the IDPs of the two local municipalities.

Table 10-54 Social Development

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Booysendal will prepare a SLP for the Booysendal South MR that outlines service delivery and infrastructure development initiatives. | | |
| Risk/ Impact | Social infrastructure development through CSR and LED programmes | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP<br><br>Positive | | |
| Type of Impact | Direct | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Possible | 3 | 4 |
| Duration | Long Term<br>Impacts will continue beyond the LoM | 3 | 4 |
| Extent | Regional<br>The impact of SLP programmes is of regional importance | 3 | 4 |
| Receptor Sensitivity | Moderate | 2 | 3 |
| Magnitude | High | 3 | 4 |
| Impact Significance | Significant positive change will result from the development initiatives in an area currently characterised by poor infrastructure and service delivery. | Moderate<br>11<br>3 | High<br>15<br>4 |
| Mitigating and Monitoring Requirements | | | |

| | |
|---|---|
| Required Management Measures | • Review LED and IDP programmes for improved service delivery in the areas surrounding the Project Area.<br>• Prepare a SLP for the mine expansion project that outlines service delivery and infrastructure development initiatives.<br>• Where feasible, Booysendal will prioritise partnering with local government to improve the quality and sustainability of *existing* social services and infrastructure development programmes.<br>• SLP initiatives will be developed and implemented in consultation with local government and local communities.<br>• Booysendal can also consider, where feasible, donating project-related infrastructure to the local municipalities and neighbouring communities. This will be addressed in a Mine Closure Plan. |
| Required Monitoring (if any) | Monitor SLP programmes and initiatives to determine sustainability, impacts on livelihoods and improved living standards of project beneficiaries. |
| Responsibility for implementation | HR Manager |
| Impact Finding | |
| Impact Finding | Impacts can be enhanced by developing a SLP – in partnership with the Government and local communities – that aims to prioritise service delivery and infrastructure development initiatives. |

Influx of Job Seekers (refer to Table 10-55): On a project of this nature, where there are high levels of unemployment and limited economic opportunities in the area, influx into the areas surrounding the Project Area is considered a significant impact. This is made easier by a lack of land management practices, which has resulted in illegal squatting in the communities neighbouring the mine. This was most evident in the Choma and Phetla communities. This can have significant negative impacts on local communities.

Table 10-55 Influx of Job Seekers

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Influx of job seekers, informal vendors, and criminal opportunists into the areas surrounding the Project Area in search of employment and other economic opportunities. | | |
| Risk/ Impact | Increase in informal settlements as a result of influx | | |
| Project Phase: CO, OP, CL | CO, OP | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely | 4 | 3 |
| Duration | Short Term<br>Impacts can be mitigated and reversed | 3 | 2 |
| Extent | Area of Influence<br>The impact of influx will affect the wider area of influence | 3 | 3 |
| Receptor Sensitivity | Moderate | 4 | 3 |
| Magnitude | Moderate | 4 | 3 |

| | | | |
|---|---|---|---|
| Impact Significance | Influx and the establishment of informal settlement is already occurring in the communities neighbouring the proposed mine site. | High<br>14<br>-4 | Moderate<br>11<br>-3 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Identify social management plans (i.e. SLP and Stakeholder Engagement Plan) that can integrate aspects of an influx management strategy.<br>• Define and identify who qualifies as a project affected person, and what benefits these individuals will receive.<br>• Prevent illegal squatting by assisting community leaders with developing and implementing a land management system.<br>• Adopt and disseminate clear and decisive labour and recruitment policies that promote the interests of local residents and discourage opportunity seekers settling in the area. | | |
| Required Monitoring (if any) | Work closely with community leaders and representatives to monitor the number and size of informal settlements. | | |
| Responsibility for implementation | HR Manager | | |
| Impact Finding | | | |
| Impact Finding | Although influx is typically a difficult impact to manage, it is possible to reduce influx and to mitigate the impacts caused by influx by identifying social management plans (i.e. SLP and Stakeholder Engagement Plan) that can integrate aspects of an influx management strategy. | | |

Social Pathologies (Table 10-56): In the communities neighbouring the Phase 2 Project Area, livestock theft, housebreakings and petty theft were reported as the main crimes. Often an increase in social pathologies is a direct result of influx and increased income for some coupled by few economic opportunities for others, and according to community members, crime has increased substantially over the past few years as fewer jobs are available and more people move in to the area.

In the areas surrounding the Project Area there are apparently very few cases of domestic violence, rape and murder, and although unemployment is high, it was reported that there is no prostitution occurring in communities neighbouring the proposed Phase 2 Project.

With Phase 2 Project potentially increasing access to cash through income generated from employment opportunities, as well as potentially increasing in-migration to the area, existing social pathologies could be further exacerbated.

Table 10-56 Social Pathologies

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Existing social pathologies increase as a result of influx, and improved economic opportunities. | | |
| Risk/ Impact | Increase in social pathologies (teenage pregnancies, school drop-outs, alcohol and substance abuse, crime) | | |
| Project Phase: CO, OP, CL | CO, OP, CL | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct | | |

| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Likelihood/ probability | Likely | 4 | 3 |
| Duration | Short term<br>Impacts can be mitigated and reversed within a short period | 3 | 2 |
| Extent | Site<br>Impacts will be confined to site | 3 | 2 |
| Receptor Sensitivity | Moderate | 4 | 3 |
| Magnitude | Moderate | 4 | 3 |
| Impact Significance | Social pathologies are already occurring in the communities neighbouring the proposed mine site, and will be exacerbated if not managed. | High<br>14<br>-4 | Moderate<br>10<br>-3 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Adopt a clear Code of Conduct which defines the proper behaviour of employees in neighbouring communities (including contractors); and<br>• Employees must be prohibited from abusing alcohol and drugs, and stringent measures should be put in place to address offenders. | | |
| Required Monitoring (if any) | Work closely with community leaders and representatives to monitor increases in social pathologies. | | |
| Responsibility for implementation | Mine HR Manager | | |
| Impact Finding | | | |
| Impact Finding | Social pathologies can be mitigated through appropriate HR policies and interventions that aim to ensure proper employee interactions with community members. | | |

### 10.12.3 Health and Safety Impacts

Communicable Diseases (refer to Table 10-57): The most significant potential health and safety impact which will require a cooperative input from communities and Booysendal is an increase in communicable diseases. The proposed Phase 2 Project has the potential to contribute to the spread of communicable diseases, and, although HIV/AIDS and Sexually Transmitted Diseases ("**STDs**") were not common ailments reported in the areas surrounding the Project Area, Tuberculosis was identified as a public healthcare challenge in the areas falling within the immediate vicinity of the Project Area.

Communicable diseases and STDs in particular, if present and untreated, can greatly increase the risk of HIV transmission. In the communities neighbouring the mine, existing healthcare services do not have the resources to address the impact of increasing cases of communicable diseases.

Table 10-57 Communicable Diseases

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | The proposed project has the potential to contribute to the spread of communicable diseases, and although HIV/AIDS and STDs were not common ailments reported in the areas surrounding the Project Area, Tuberculosis ("**TB**") was identified as a public healthcare challenge in the areas falling in the immediate vicinity of the Project Area. | | |
| Risk/ Impact | Increase in communicable diseases | | |
| Project Phase: CO, OP, CL | CO, OP | | |
| Nature of Impact | Negative | | |
| Type of Impact | Direct | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 4 | 2 |
| Duration | Short term<br>Impacts can be mitigated and reduced | 3 | 2 |
| Extent | Site<br>Impacts will be confined to site | 3 | 2 |
| Receptor Sensitivity | Moderate | 4 | 3 |
| Magnitude | Moderate | 4 | 3 |
| Impact Significance | Communicable diseases will increase, if not managed. | High<br>14<br>-4 | Moderate<br>9<br>-3 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Work with the government and local implementing partners to support an integrated HIV and TB prevention and management programme that considers the workplace, local communities and high risk populations such as women and truckers.<br>• Develop and implement an HIV/AIDS awareness programme that includes adequate access to HIV/AIDS-related information and condoms for all employees. Contractors are expected to develop similar procedures.<br>• Support intensive information, education and communication (IEC) campaigns on communicable diseases in the workplace and neighbouring communities.<br>• Support capacity building for the local government, NGO and community partners who would provide HIV and TB prevention, diagnosis and treatment services. | | |
| Required Monitoring (if any) | Work with local government, healthcare providers and community partners to monitor HIV and TB infection rates, diagnosis and treatment services. | | |
| Responsibility for implementation | Mine HR Manager | | |
| Impact Finding | | | |
| Impact Finding | The impact can be managed through HR policies that aim to ensure proper employee interactions with community members. | | |

## 10.12.4 Cumulative Socio-economic Impacts

The following potential cumulative impacts have been identified:

- Mining will increase existing employment and job creation opportunities in the Project Area. Refer to Table 10-51 for impact assessment and management requirements;
- Vendor procurement processes will identify, develop and utilise/employ local vendors, which might already be working for other mines in the area (see Table 10-58);
- Increased money circulating in local economies will increase demand for local goods, providing opportunities for vendors and businesses operating in communities neighbouring the mine and along the R577 (see Table 10-58); and
- SLP expenditure by Booysendal Mine in the communities in which it operates have the potential to increase/improve community development projects implemented by the Government and other neighbouring businesses in the area. This includes upgrades to public infrastructure, and skills development and training programmes (refer to Table 10-53).

Table 10-58 Enhanced Local Business and Supplier Opportunities

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Contract small local businesses to provide services to the mine | | |
| Risk/ Impact | Establishment and development of SMMEs | | |
| Project Phase: CO, OP, CL | CO, OP | | |
| Nature of Impact | Positive | | |
| Type of Impact | Indirect and Cumulative | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely | 1 | 3 |
| Duration | Short Term<br>Likely that contracts will be awarded for a period of between 6 months and 3 years. | 1 | 2 |
| Extent | Area of Influence<br>The impact will affect local businesses in the wider area | 3 | 3 |
| Receptor Sensitivity | Moderate | 1 | 3 |
| Magnitude | Moderate | 1 | 3 |
| Impact Significance | Due to the resources and time required to provide support to SMMEs, moderate improvements will be experienced | Not significant<br>8<br>1 | Moderate<br>11<br>3 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measur | • Formalise local SMME procurement procedures in company procurement policies and sub-contractors' agreements.<br>• Purchase goods and services at a local level, if available.<br>• Work with community representatives to prepare open and transparent tender processes that are disclosed to local contractors in neighbouring communities.<br>• Provide training and support to SMMEs. | | |
| Required Monitoring (if any) | • Monitor the number of implemented SMME training programmes | | |

| | |
|---|---|
| | • Track SMME contracts including duration, sector and indirect employment generated from the contracts |
| Responsibility for implementation | HR Manager |
| Impact Finding | |
| Impact Finding | Impact can be enhanced through HR policies and SLP skills development and training programmes. |

### 10.12.5 Recommendations

### 10.12.6 Limitations and Gaps

The study was carried out based on the assumptions that the respondents were truthful in the information provided, that the information is accurate and that it was captured correctly by the facilitators.

Within the short period of time in which the baseline data was gathered it is not possible to gain an in-depth understanding of the community intricacies.

Mistrust in the CPA leaders prohibited community members to be total transparent during meetings.

No social data was collected from white farmers, although focus group meetings were held with them.

### 10.12.7 Impact Statement

The social specialist is of the opinion that the proposed Phase 2 Project has the potential to result in positive and negative social and economic impacts that can be mitigated and managed. As such, there is no reason from a social impact assessment point of view why the Phase 2 Project should not be allowed to proceed, if the mitigation and management measures recommended in the social impact assessment and social management plan are implemented alongside the following social management plans.

## 10.13 Cultural Heritage Assessment

### 10.13.1 Cultural Heritage Impact Assessment

#### 10.13.1.1 Booysendal South Mining Right

It is not foreseen that any direct impacts will occur on cultural heritage sites. Most of the areas where the development is proposed have already been disturbed. There are some sites in close proximity of the Backfill Plant. Precautionary measures must be put in place to ensure that these features are avoided. Refer to Figure 5-37 for location of sites. Of specific relevance are sites 54 and 55.

#### 10.13.1.2 Booysendal North Mining Right

There are four heritage sites in the footprint area of the Emergency Escape Portal which will be impacted if the position of the Portal is not moved. These sites include feature 5, 6, 7, 31, 66 and 68. The sites fall in an area of approximately 65 x 60m. The coordinates of the sites are included in Table 5-37 and described here:

- Feature 5: a small historic midden or kraal deposit of low to medium significance. The feature includes some slag, undecorated and decorated ceramics.

  Required mitigation and management: excavations through a Heritage Phase 2 Assessment or move location of Emergency Escape Portal.

- Feature 6: a stone cairn site consisting of stone dressed features. The purpose or the site is unknown and could potentially be a grave site due to the north-south orientation thereof. Should this be a grave, the significance of the anticipated impact is high.

Required mitigation and management: the site must not be disturbed and must be retained in-situ or move location of Emergency Escape Portal.

- Feature 7: a large communal grinding area of low to medium significance. There is the possibility that the site may be underlain by subsurface Iron Age remains.

Required mitigation and management: Phase 2 Assessment mapping and excavations or move location of Emergency Escape Portal.

- Feature 31: various stone-packed terrace walls from the Iron Age period. The site is of low significance

Required mitigation and management: none required.

- Feature 66: Iron Age stone packed wall of approximately 10m in diameter of low to medium significance.

Required mitigation and management: Mapping of site after which a destruction permit must be obtained from SAHRA or move location of Emergency Escape Portal.

- Feature 68: ruin of a historical homestead. Site of low to medium significance.

Required mitigation and management: ARC Tower 2 was moved. Site must be fenced.

The location of the sites is included in Figure 10-6. A rating of the significance of the impacts are included in Table 10-59.

Figure 10-6 Booysendal North Mining Right Heritage Sites (Source: HCAC, 2018)

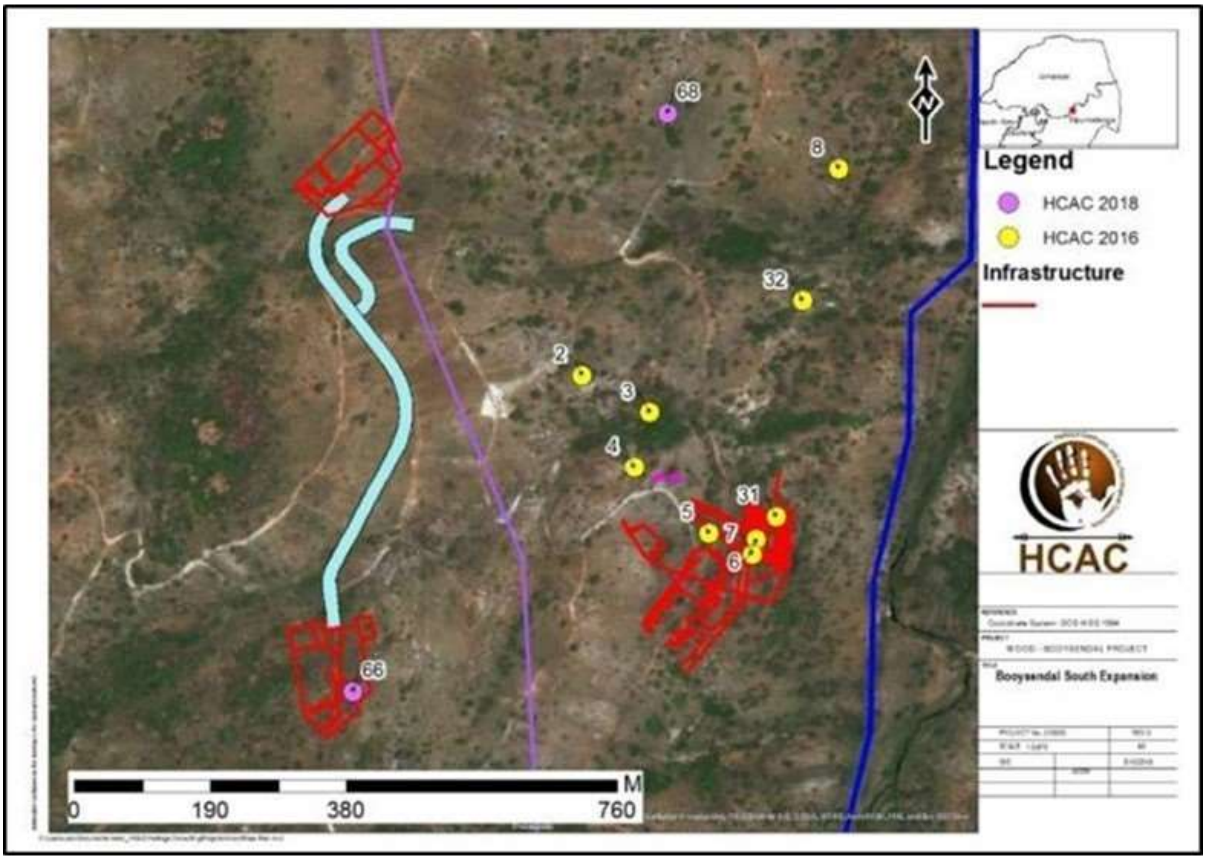


Table 10-59 Heritage Impact Assessment

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation | |
|---|---|---|---|---|
| Activity | Site clearance and construction activities. | | | |
| Risk/ Impact | Destruction of features 5, 6, 7, 31, 66 and 68 | | | |
| Project Phase: CO[3], OP, CL<br><br>Nature of Impact | CO<br><br>Negative | | | |
| Type of Impact | Direct: clearance will lead directly to loss of Heritage features<br>Cumulative: Loss of Iron and Sone Age sites in the Groot Dwars River valley and associated loss of cultural history | | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation | |
| Likelihood/ probability: | Alternative 1: Definite | 4 | 4<br>If Phase 2 | 1<br>If avoided |
| Duration | Permanent | 4 | 4<br>If Phase 2 | 1<br>If avoided |
| Extent | Regional | 4 | 4<br>If Phase 2 | 1<br>If avoided |
| Receptor Sensitivity | Low to Medium | 2.5 | 2.5<br>If Phase 2 | 1<br>If avoided |
| Magnitude | High | 4 | 4<br>If Phase 2 still irreversible loss | 1<br>If avoided |
| Impact Significance | | High<br>14.5<br>4 | High<br>14.5<br>4 | Not significant<br>4<br>1 |
| Mitigating and Monitoring Requirements | | | | |
| Required Management Measures | • Heritage Management Plan<br>• Chance-find procedure<br>• Phase 2 Heritage Assessment or alternative position for Emergency Escape Portal | | | |
| Required Monitoring | Construction phase monitoring<br>Monitoring of fencing during operational phase | | | |
| Responsibility for implementation | Environmental Manager and Mine Manager during the LoM<br>Environmental Officers of each contractor during the construction phase | | | |
| Impact Finding | | | | |
| Impact Finding | Impacts can be managed successfully if the position of the Emergency Escape Portal is moved. Impacts will be mitigated through a Phase 2 Heritage Assessment. | | | |

## 10.13.2 Paleontology Assessment

There is no paleontological resource in the Phase 2 Project Area.

[3] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

### 10.13.3 Cumulative Impact Assessment

No Phase 2 Project cumulative impacts were identified by the Heritage specialist.

### 10.13.4 Recommendations

- If impacts can't be avoided, then site-specific mitigation must be adhered to;
- If in the unlikely event that fossils are exposed in Quaternary sediments in the course of the proposed development, a qualified palaeontologist must be contacted to assess the exposure for fossils so that the necessary rescue operations are implemented;
- It is recommended that the Environmental Officers or other responsible persons be briefly inducted on heritage management and identification of heritage resources; and
- A heritage specialist should assess any material change to the conceptual layout plan.

### 10.13.5 Limitations and Gaps

The Phase 2 survey was undertaken during the summer season. Due to the preceding good rainfall, the vegetation was dense and high. However, the footprint areas were adequately surveyed.

### 10.13.6 Impact Statement

The Heritage Specialist is of the opinion that authorisation for the Phase 2 Project could be granted on conditions that the recommendations and conditions for authorisation are binding and adhered to.

## 10.14 Noise and Vibration Impact Assessment

### 10.14.1 Noise Impact Assessment

It is important to note that the Groot Dwars River valley is encompassed by mountains which act as natural noise barriers. Noise generation in the valley and specifically associated with the Booysendal North MR Activities will therefore be shielded to some extent. Other natural factors which influences noise and which were taken into consideration in the study, include wind and climate conditions (refer to Section 5.1 and 5.2 for baseline conditions). Due to the climate and topography there is a possibility that noise will escaping out of the valley during the day and retreat into the valley northwards during the night.

It is furthermore important to note that sound levels decrease by 6dBA with a doubling in distance for point source noise and 3dBA from uniform linear sounds.

The noise impact assessment was done considering the Noise Regulations of 1992, which states that noise levels should not increase by more the 7dBA as well as the World Bank Environmental and Safety Guidelines which recommends daytime noise limits of 55.0dBA and night-time limits of 45.0dBA for residential areas. Equipment sound pressure levels used to model noise impacts are included in Table 10-60.

Table 10-60 Sound Pressure Levels (Source: dBAcoustics, 2018)

| **Equipment** | **Reduction in the noise level some distance from the source - dBA** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cumulative distance from source in meters | 2m from the machinery and/or equipment | 15m | 30m | 60m | 120m | 240m | 480m | 960m | 1920m |
| Dump truck | 91.0 | 62.5 | 56.5 | 50.4 | 44.4 | 38.4 | 32.4 | 26.4 | 20.3 |
| Backhoe | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |

| Equipment | Reduction in the noise level some distance from the source - dBA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Drilling Equipment | 100.0 | 71.5 | 65.5 | 59.4 | 53.4 | 47.4 | 41.4 | 35.4 | 29.3 |
| Flatbed truck | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Pickup truck | 70.0 | 41.5 | 35.5 | 29.4 | 23.4 | 17.4 | 11.4 | 5.4 | -0.7 |
| Tractor trailer | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Crane | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Pumps | 70.0 | 41.5 | 35.5 | 29.4 | 23.4 | 17.4 | 11.4 | 5.4 | -0.7 |
| Welding Machine | 72.0 | 43.5 | 37.5 | 31.4 | 25.4 | 19.4 | 13.4 | 7.4 | 1.3 |
| Generator | 90.0 | 61.5 | 55.5 | 49.4 | 43.4 | 37.4 | 31.4 | 25.4 | 19.3 |
| Compressor | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Pile driver | 100.0 | 71.5 | 65.5 | 59.4 | 53.4 | 47.4 | 41.4 | 35.4 | 29.3 |
| Jackhammer | 90.0 | 61.5 | 55.5 | 49.4 | 43.4 | 37.4 | 31.4 | 25.4 | 19.3 |
| Rock drills | 100.0 | 71.5 | 65.5 | 59.4 | 53.4 | 47.4 | 41.4 | 35.4 | 29.3 |
| Pneumatic tools | 85.0 | 56.5 | 50.5 | 44.4 | 38.4 | 32.4 | 26.4 | 20.4 | 14.3 |
| Cumulative noise levels from the construction activities when all of such work within a radius of 30m | 105.5 | 76.9 | 70.9 | 64.9 | 58.9 | 52.9 | 46.8 | 40.8 | 34.8 |

The noise impact assessment was done based on no noise abatement measures. The results from the noise model found that construction phase noise intrusion levels for the various proposed construction areas will increase as follows:

- BCM1: maximum increase in noise levels to be experienced by surrounding inhabitants originating from BCM1 will be 0.6 dBA (winter nights at receptor K). The location of the various receptors are indicated in Figure 10-7.
- BCM2: The maximum increase in noise levels to be experienced by surrounding inhabitants originating from BCM2 will be 0.7 dBA (winter nights at receptor H).
- BS4: A maximum increase in noise intrusion levels of 1.0 dBA will be experienced at receptor locations C-F and 1.8 dBA at receptor location A.

As receptors will hear noise from all the noise emitting areas and equipment cumulatively, the cumulative increase in noise levels from all mining areas and equipment (excluding from vent shafts and traffic, which is considered later) for the various receptors were calculated. The outcome of the model indicated that the highest cumulative increase will be 0.7 dBA during the day in summer at receptor B and 3.9 dBA at receptor E during night time in winter. These intrusion levels are well below the regulated 7.0 dBA increase, although the increase will be audible mainly to the receptors to the east of BS4. At some of the receptors it might be possible that at times intrusion will exceed 5.0 dBA but never exceed 7.0 dBA.

The noise model output furthermore illustrated noise levels as it will be experienced at the various receptors during summer days, summer nights, winter days and winter nights in relation to receptor locations. This is captured in Figure 10-8 to Figure 10-11.

The residential limit of 55 dBA will not be exceeded at any of the receptors. With normal noise abatement measures all possible noise impacts were assessed to be low.

Figure 10-7 Noise, Vibration and Air Overpressure Receptors (Source: dBAcoustics, 2018)

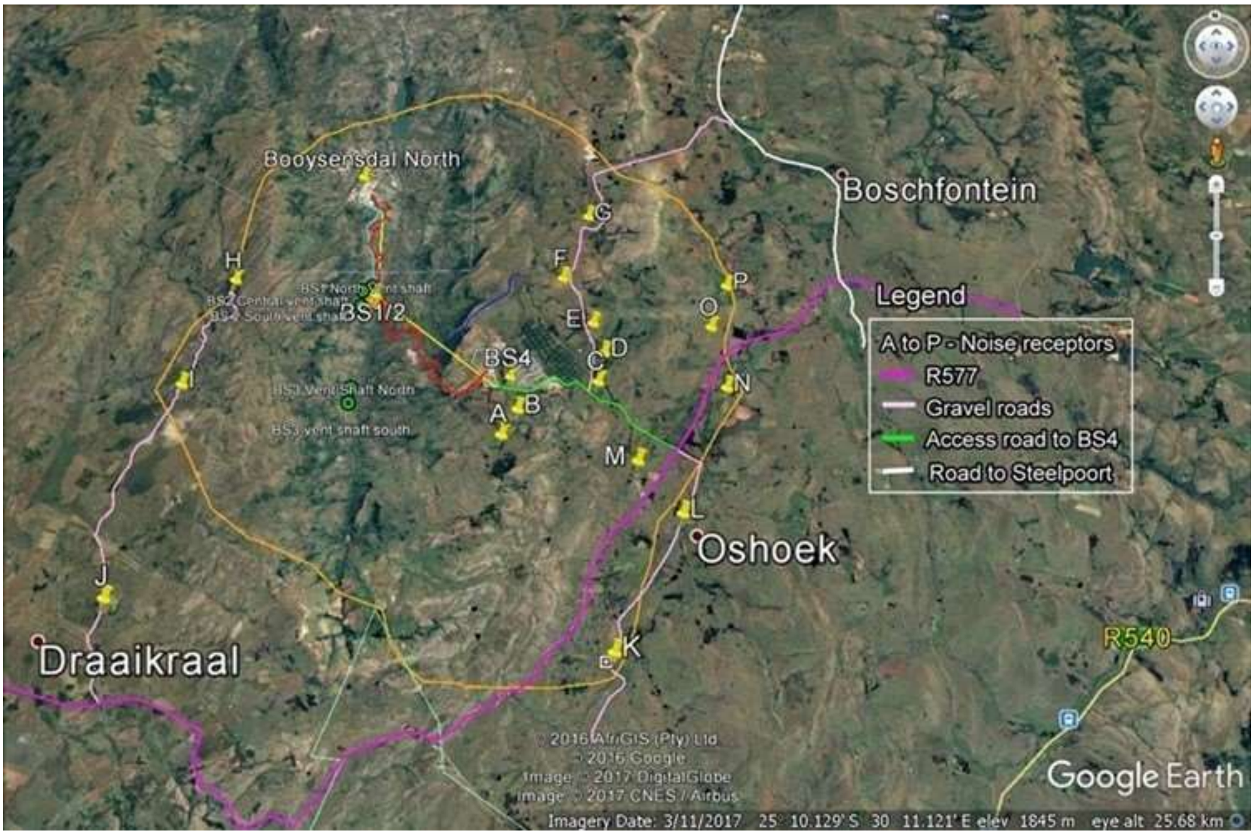


Figure 10-8 Noise Intrusion Levels During Summer Days (Source: dBAcoustics, 2018)

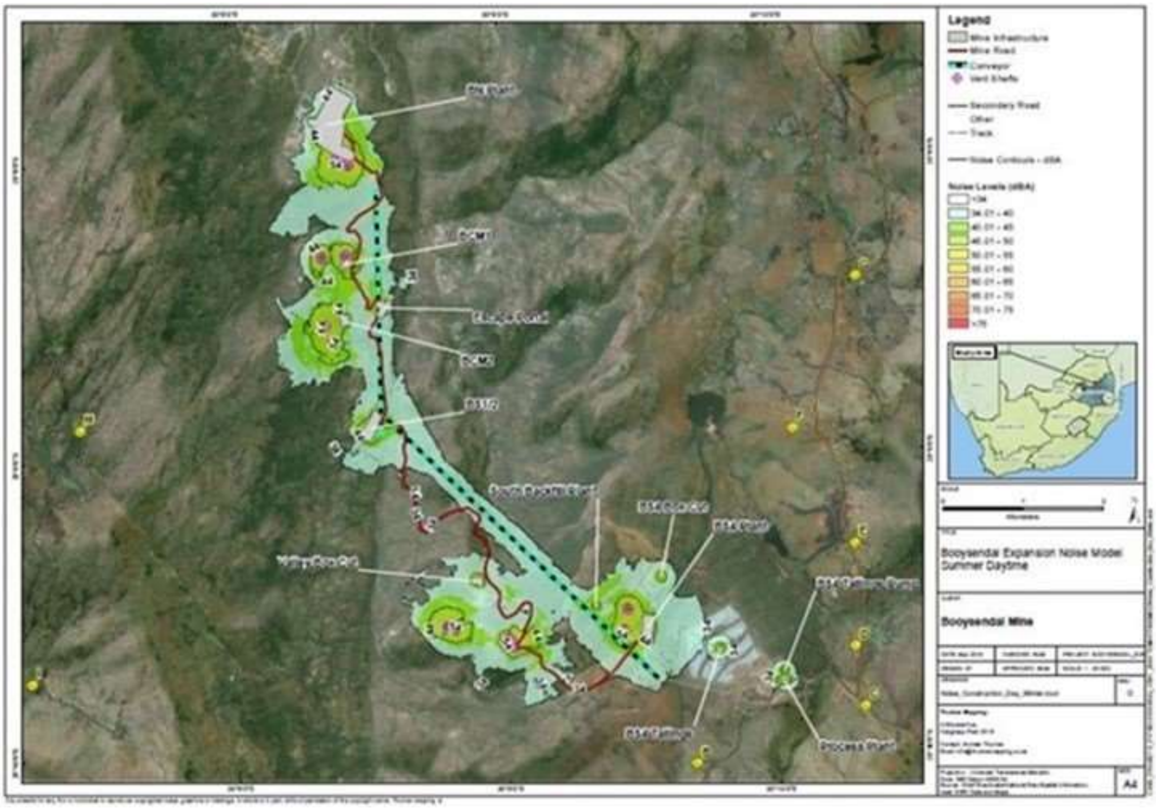



Figure 10-9 Noise Intrusion Levels During Summer Nights (Source: dBAcoustics, 2018)

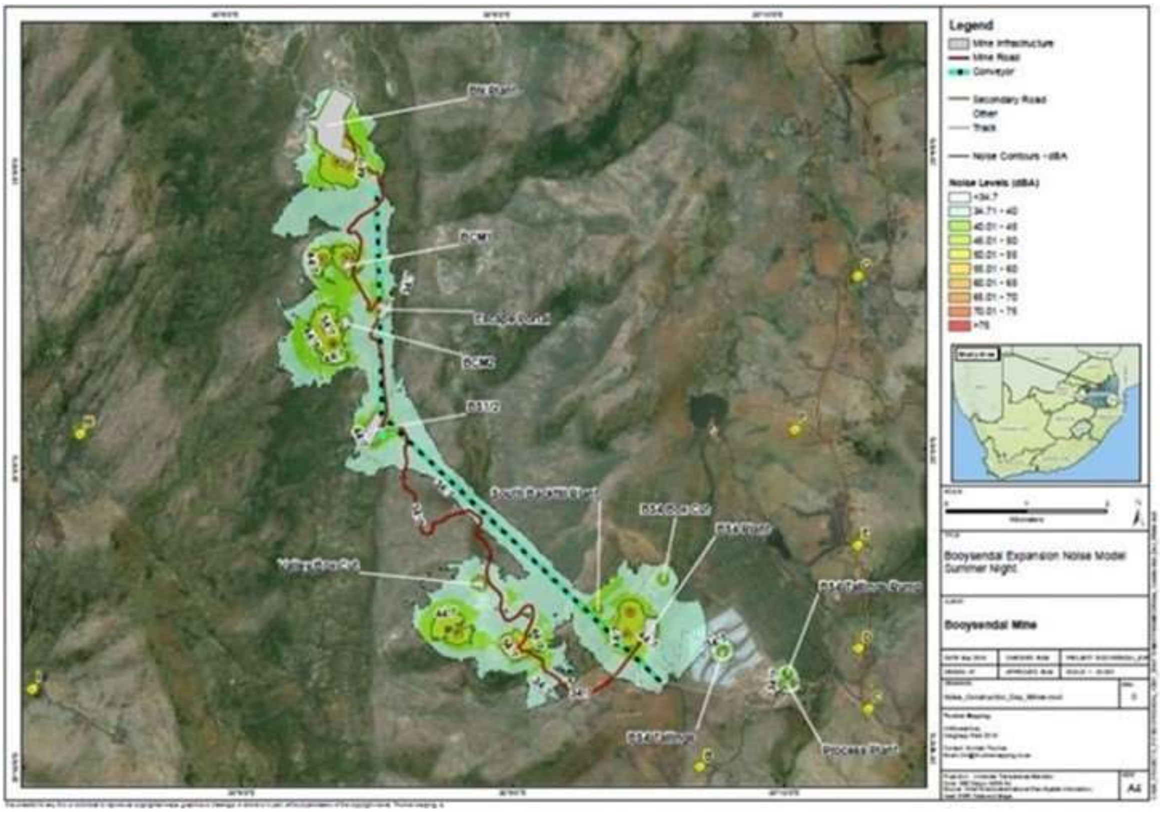


Figure 10-10 Noise Intrusion Levels During Winter Days (Source: dBAcoustics, 2018)

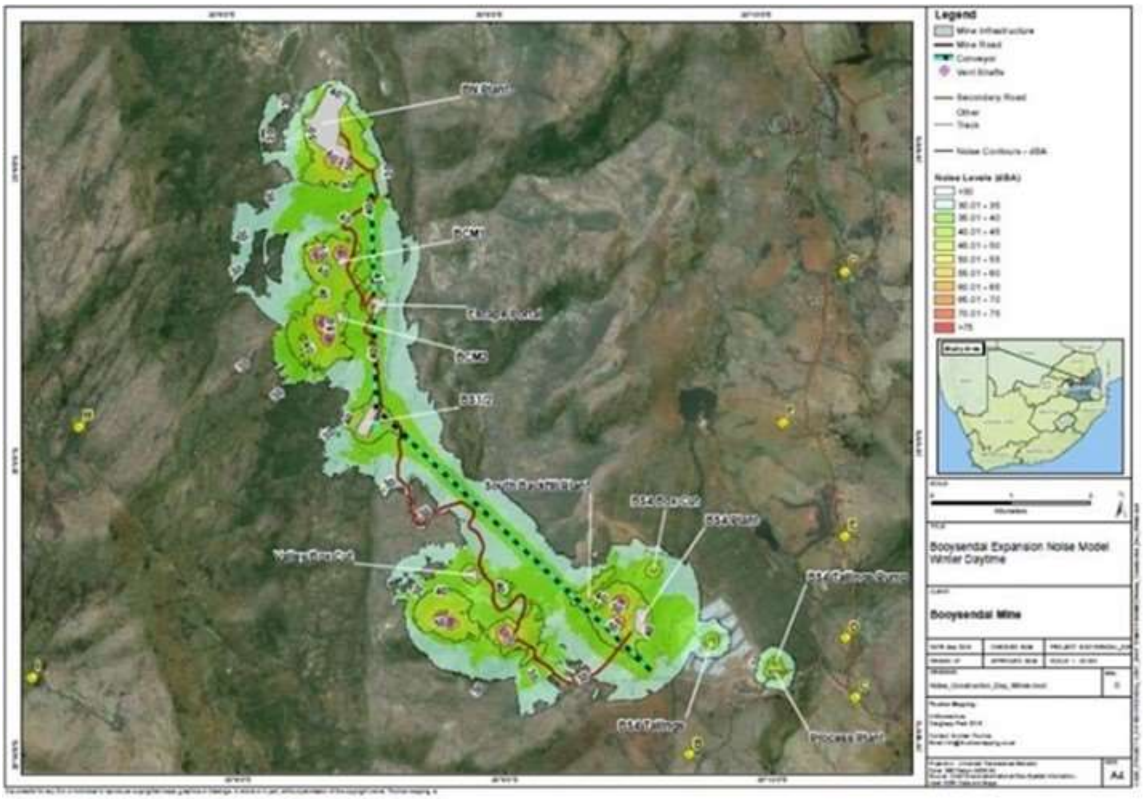
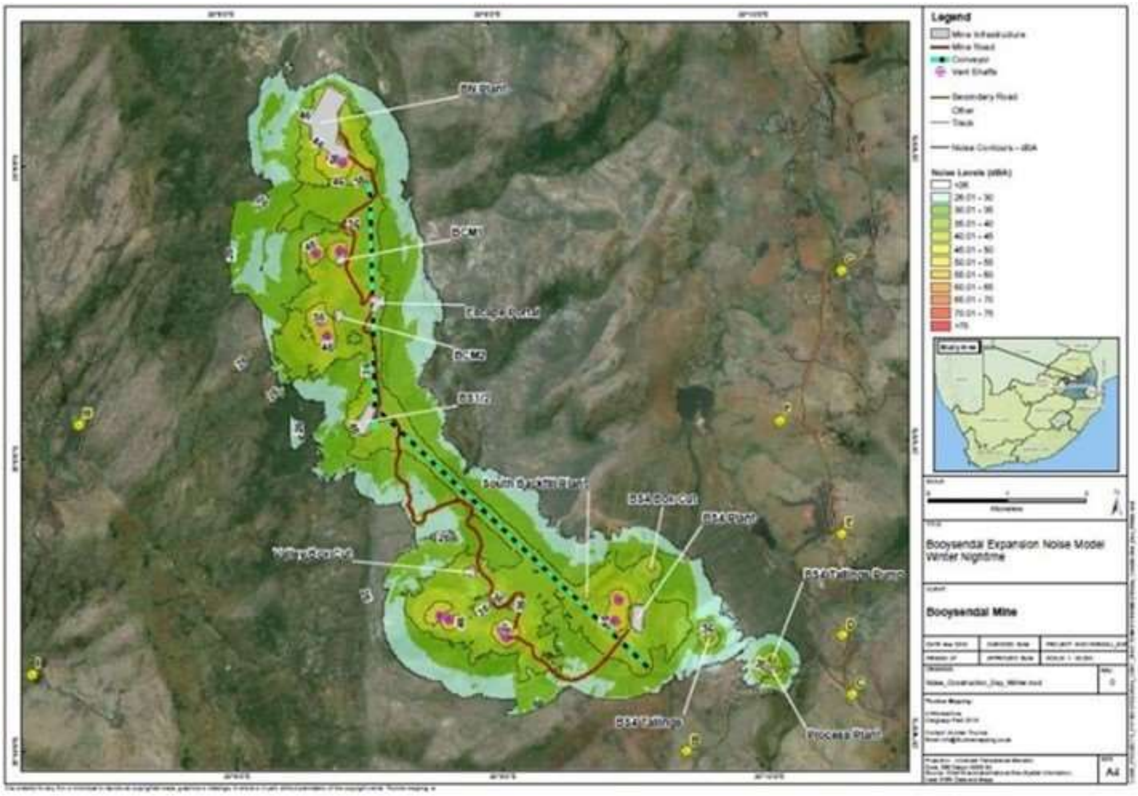



Figure 10-11 Noise Intrusion Levels During Winter Nights (Source: dBAcoustics, 2018)



An assessment of the cumulative noise impacts and required management measures are included in Table 10-61.

Table 10-61 Noise Impact Assessment

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Site clearance, materials hauling, construction activities<br>Additional traffic during the LoM<br>Noise from vent shafts during the operational phase<br>ARC during the operational phase<br>Crushing, conveyors, mining operations during the operational phase | | |
| Risk/ Impact | Increase in noise levels at sensitive receptors at the mining right boundary | | |
| Project Phase: CO[4], OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Direct: equipment and activities will individually lead to an increase in noise levels<br>Cumulative: Increase in noise levels | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability: | Possible | 2 | 2 |
| Duration | Longer term | 3 | 3 |
| Extent | Local | 1 | 1 |
| Receptor Sensitivity | Moderate-low | 2 | 2 |
| Magnitude | High | 3 | 2 |
| Impact Significance | | Moderate<br>8<br>3 | Minor<br>8<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Development and implementation of a noise management plan.<br>• Equipment and machinery used must comply with manufacturer's specifications and should not exceed 85 dBA.<br>• Vent shafts must be directed away from sensitive receptors.<br>• The crusher must be covered to capture noise. | | |
| Required Monitoring | • Noise monitoring to be done at the monitoring points included in the EMP (Annexure C) | | |
| Responsibility for implementation | Environmental Manager and Mine Manager during the LoM<br>Environmental Officers of each contractor during the construction phase | | |
| Impact Finding | | | |
| Impact Finding | With the implementation of noise abatement measures and adherence to manufacturers specification the impacts can be managed not to cause a noise intrusion and nuisance to sensitive receptors | | |

### 10.14.2 Vibration and Air Overpressure

Phase 2 blasting will only take place at the Emergency Escape Portal. Blasting associated with BCM1, BCM2 and the vent shafts were assessed as part of the Phase 1 Project; however for cumulative impact assessment purposes, blasting from these areas was also considered. The blasting vibration threshold value

[4] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

of 25mm/s for modern houses may not be exceeded. Air overpressure should not exceed 140 dBL Calculations were made on an assumed 500kg charge per delay of site mixed slurry explosives.

Blasting will only During the construction phase the air overpressure model output indicated that the highest air overpressure which will result from blasting will be 102.8 dBL at receptor H. This air blast level is regarded as insignificant.

The highest vibration will also be experienced at receptor H at 0.48mm/s, which is also insignificant in comparison with the 25mm/s limit. An assessment of the vibration and air overpressure for the Phase 2 Project is included in Table 10-62.

Table 10-62 Vibration and Air Overpressure Impact Assessment

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Blasting to establish the Emergency Escape Portal | | |
| Risk/ Impact | Ground vibration and air overpressure causing structural damage to structures | | |
| Project Phase: CO[5], OP, CL<br><br>Nature of Impact | CO<br><br>Negative | | |
| Type of Impact | Direct: blasting could directly result in ground vibration and air overpressure | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability: | Possible | 2 | 2 |
| Duration | Longer term | 2 | 1 |
| Extent | Local | 1 | 1 |
| Receptor Sensitivity | Moderate-low | 2 | 2 |
| Magnitude | High | 3 | 1 |
| Impact Significance | | Moderate<br>7<br>3 | Not significant<br>6<br>1 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Undertake a risk assessment before blasts<br>• Control blast loads based on the outcome of the risk assessment<br>• Ground vibration must be controlled not to exceed 10mm/s at residential areas<br>• Control blasting so that air overpressure does not exceed 115 mm/s | | |
| Required Monitoring | • Monitor and record ground vibration at the site boundary during blasting. See EMP Annexure C | | |
| Responsibility for implementation | Environmental Manager and Mine Manager during the construction phase<br>Blasting contractor | | |
| Impact Finding | | | |
| Impact Finding | With the implementation of noise abatement measures and adherence to manufacturers specification the impacts can be managed not to cause a noise intrusion and nuisance to sensitive receptors | | |

### 10.14.3 Recommendations

Acoustic screening must be implemented at the operational and expansion areas, including:

- Construction activities must be limited to daytime;

[5] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

- Equipment must not exceed noise levels of 85 dBA;
- Ground vibration monitoring must be done at sensitive receptors;
- A noise monitoring plan must be developed. This must included noise monitoring of baseline noise levels and trend analysis of noise levels;
- Equipment exceeding noise levels of 90 dBA must only be operated during the day;
- Equipment with noise output of between 85 and 90 dBA must be screened to reach sound below 85 dBA;
- Blasting must only be done during the day and blasting notifications must be provided to surrounding sensitive receptors;
- Vent fans must face away from sensitive receptors;
- Mufflers must be installed on engine exhausts and compressors; and
- Use vegetation and the topography to screen noise.

### 10.14.4 Limitations and Gaps

Limitations and gaps central to the noise and vibration assessment include:

- Although 10-minute noise measuring periods per monitoring point is acceptable, variances in noise levels may not be portrayed, however, the level of confidence in the study is high as various the baseline was done over various survey periods; and
- Prevailing wind during the monitoring runs may have an influence on baseline levels monitored.

### 10.14.5 Impact Statement

Noise, vibration and air overpressure impacts will not exceed regulated limits and standards. Noise impacts can be managed to not to cause intrusion or nuisance, as can vibration and air overpressure be managed not to cause structural damage or internal vibrations in houses.  The Phase 2 Project can be authorised with the condition that the management and monitoring measures proposed in the EMP (Annexure C) be implemented.

## 10.15 Traffic Impact Assessment

As part of the Phase 1 Project, Booysendal constructed an access road between BN and BS. The road will not be used by third parties but the feeder roads around it are currently used by third parties. The access road will also tie into the feeder roads. The TIA was done in accordance with the National Department of Transport, 1995, Manual for Traffic Impact Studies, Research Report PR 93/635, BKS (Pty) Ltd, Pretoria. As such, impact assessment tables were not prepared. Social traffic impacts which could result from the Phase 2 Project are addressed under Section 10.12.

#### 10.15.1.1 Road Carrying Capacity

Future expected traffic volumes and trips were generated based on traffic counts at the Mototolo intersection D212. This access road provides access to Thorncliff, Magareng, Helena, Mototolo and BN. The trip generation for the new access road is therefore based on a worst-case scenario. Most trips are expected to be associated with the operational phase.

It is expected that the Booysendal Mine will generate approximately 850 daily trips on the Access Road and R577 (Refer to the Traffic Impact Assessment; 2017), and that during the construction phase the peak hour traffic demand is expected to be 210 vehicles per peak hour, while during the operational phase the peak hour traffic demand is expected to be:

- AVT: 1020v/h (606 in, 606 out);
- Am peak: 153v/h (153 in; 27 out); and
- Pm peak: 112v/h (26 in; 106 out).

During the construction phase there will be more vehicle movements on the R577 due to the delivery of equipment, construction materials and the transportation of workers. These impacts will reduce during operational phase of the mine. Total number of trips expected is 246vph (145 in; 103 out).

The increase in traffic will influence the LOS of the intersections. A comparative summary of the LOS of the baseline vs the construction and operational phases is included in Table 10-63. The TIA indicates that the R577 / D212 intersection is reaching its full capacity. The study further indicated that by year 2023 this intersection will reach LOS F and will need to be upgraded before this.

Table 10-63 Change in Level of Service during the Construction and Operational Phases

| **Intersection** | **Level of Service and Delay** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Northbound** | | | **Southbound** | | | **Eastbound** | | | **Westbound** | | | **Intersection** | | |
| | **LOS B** | **LOC C** | **LOS O** | **LOS B** | **LOC C** | **LOS O** | **LOS B** | **LOC C** | **LOS O** | **LOS B** | **LOC C** | **LOS O** | **LOS B** | **LOC C** | **LOS O** |
| R577 / D874 | A | B | B | A | A | A | A | A | A | A | A | A | A | B | B |
| D874 / Village Intersection | A | A | A | A | A | A | n/a | n/a | n/a | A | B | B | A | B | B |
| R577 / D212 | D | E | D | C | D | D | A | A | A | A | A | A | D | E | D |
| R577 / D874 | A | B | B | A | B | A | A | A | A | A | A | A | A | B | B |
| D874 / Village Intersection | A | A | A | A | A | A | n/a | n/a | n/a | A | B | A | A | B | A |
| R577 / D212 | B | C | C | B | C | B | A | A | A | A | A | A | B | C | C |
| LOS B = LOS Baseline; LOS C = LOS Construction Phase; and LOS O = LOS Operational Phase | | | | | | | | | | | | | | | |

10.15.1.2 Road Safety

The increase in traffic could further lead to increased deterioration of the R577, potential deterioration of the D874, traffic congestion at the D212 intersection and an increase in road traffic and pedestrian accidents. The TIA considered the following:

Safety of intersections: depends on the sight distance which impacts on safe turning. The TIA found that the sight distance at the D874 / Village and the R577 / D874 intersections exceed the required standards stipulated in the South African Impact and Site Assessment Standards & Requirements Manual. However, the east turn from the D874 onto the R577 is marginally acceptable and will need to be monitored to assess if an additional turning lane will be required.

Sight distance: The traffic engineer calculated the required sight distance and the available sight and stopping distance. The study found that the sight and stopping distance at the intersections are sufficient, but that the wattle trees at the D874 / Village Intersection needs to be removed. The full analysis is included in Annexure O.

Speed limits: The TIA assessed that the section of road D874 from distance 1.85km to 3.0km is dangerous and has a high accident probability. Speed limits and calming have to be implemented. The section of the road at distance 2.45km from the R577 intersection and 400m from the Village Intersection is extremely steep and speed limits must be implemented.

### 10.15.2 Recommendations

The traffic engineer recommended that the R577 / D212 intersection be upgraded by the Department of Roads and Transport as follows:

- Convert the intersection to a four-way stop;
- Add westbound auxiliary right turn (25m);
- Add southbound left turn slip lane (60m); and
- Add westbound deceleration left turn lane (60m).

The Department of Roads and Transport need to re-gravel the Village road and upgrade the storm water management control; and

The TIA must be expanded to include the trips that are expected to distribute towards the north on the D212.

## 10.16 Visual Impact Assessment

The VIA takes consideration of various factors to model potential significance of visual impacts including:

- ZOI: inputting the topographical elements, the infrastructure components and the height of the components into the ArcGIS model gives and indication of the potential points from where the Phase 2 Project will be visible:
- The ZIV of the Booysendal North MR components are included in:
  - Figure 10-12 to Figure 10-14;
  - The ZIV of the Booysendal North MR components in Figure 10-15; and
  - The cumulative ZIV in Figure 10-16.

Viewing Distance: The visual impact of an object in the landscape diminishes at an exponential rate as the distance between the observer and the object increase, therefore the impact of an object will diminish with a quarter when viewed from a distance of 1,000m instead of a distance of 500m. The visual boundary from where most of the infrastructure will no longer be visible was determined to be at a 10km radius from the components. The only receptors within 10km from the Booysendal Mine are some of the local inhabitants immediately to the east. It is not foreseen that there will be any impact on tourists or road users. Operational and security light will be visible to the inhabitants on the eastern section but not directly visible to inhabitants on the western section. The visual distance evaluation is included in Table 10-64. Sensitive receptors within viewing distance include the Phetla and Choma settlements and Nel and Groenewald farm homesteads. The main infrastructure components are located on the Groot Dwars River valley, thereby reducing the viewing distance, especially that of the Booysendal North MR infrastructure.

Visual Absorption Capacity ("**VAC**"): include the topography, potential of the infrastructure components to blend into the natural landscape and the potential of vegetation to screen visual exposure. The landscape has a high VAC, mainly because of the topography. The VAC of the landscape is illustrated in Figure 10-17 and Figure 10-18.

Figure 10-12 BS1/2 to BN ARC Zone of Visual Influence – Booysendal North MR (Source: GISM, 2018)

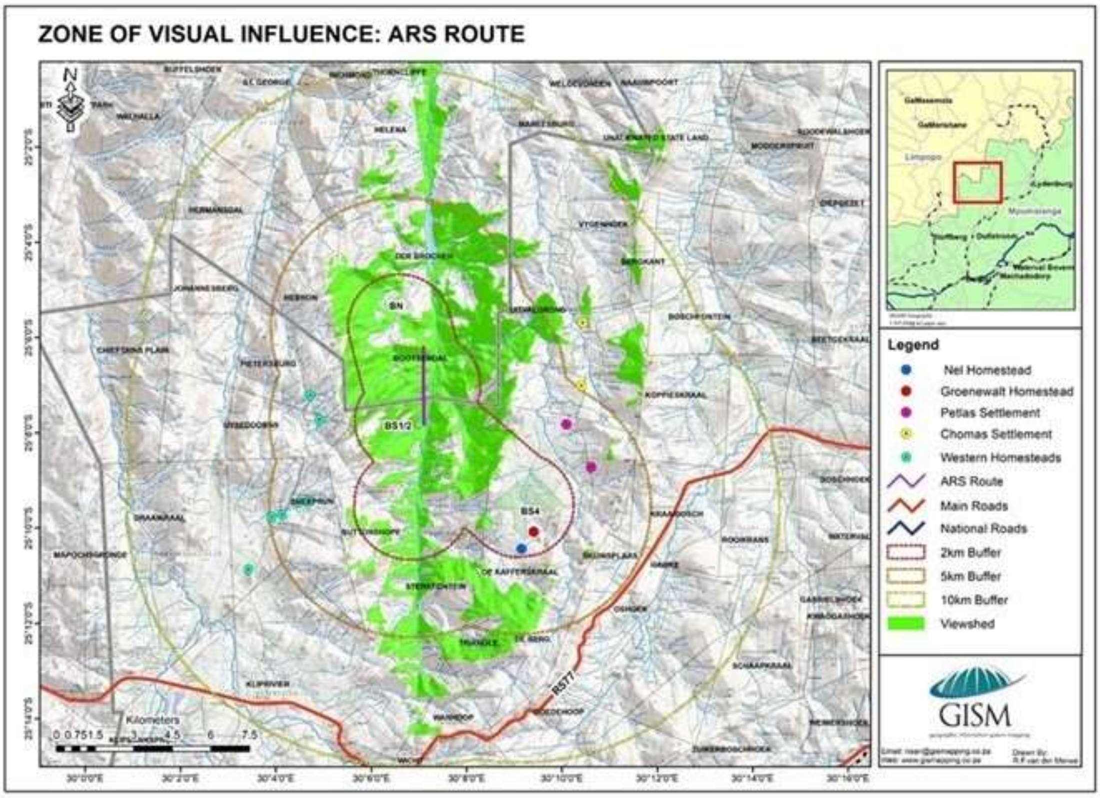



Figure 10-13 Zone of Visual Influence of BCM1 and BCM2 – Booysendal North MR (Source: GISM, 2018)

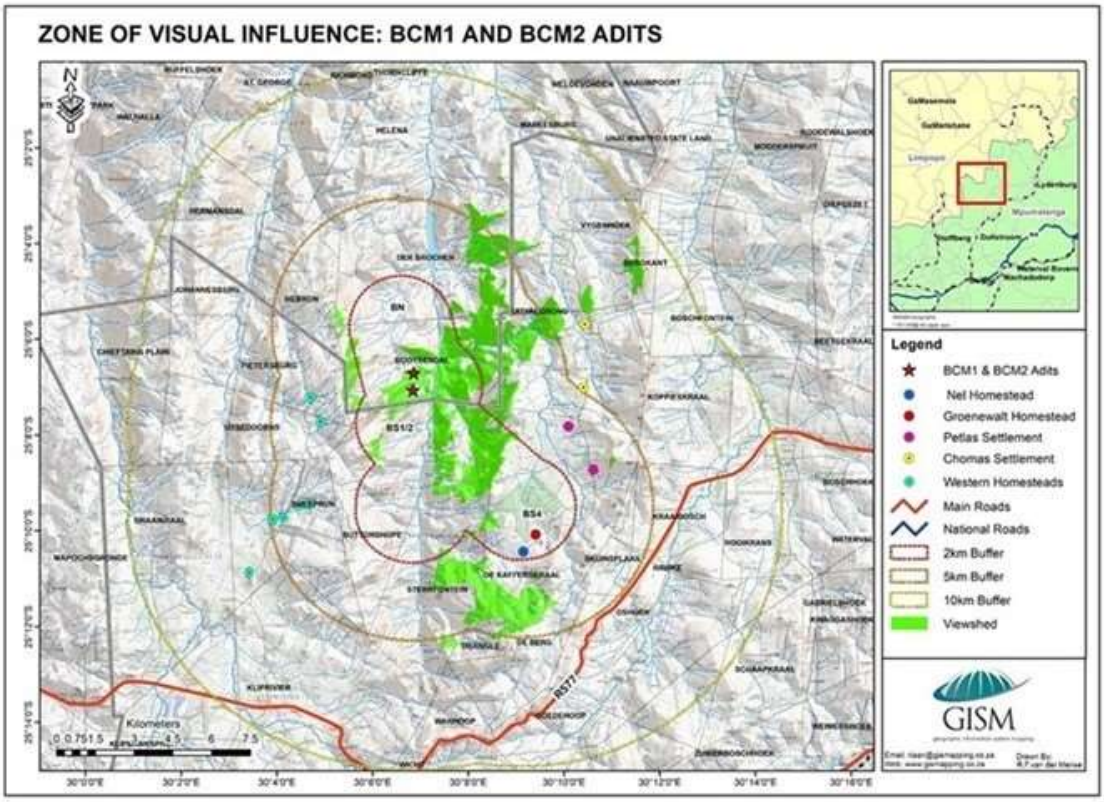


Figure 10-14 11kVA Zone of Visual Influence (Source: GISM, 2018)

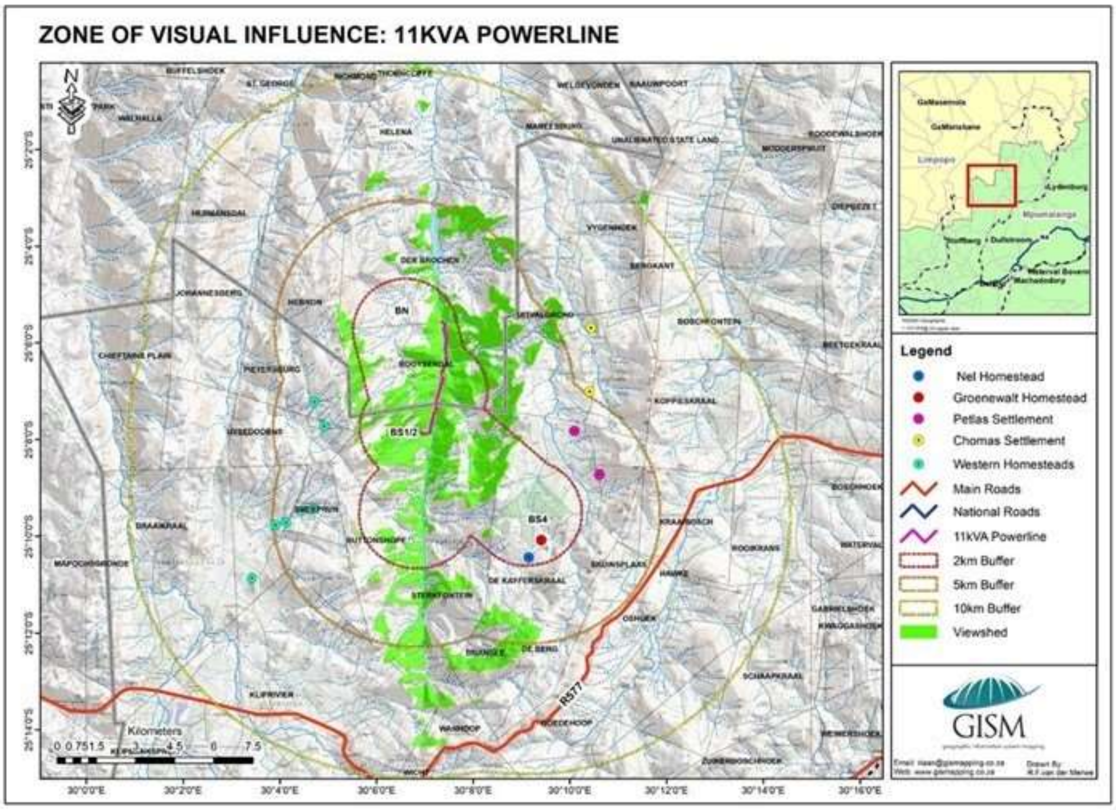



Figure 10-15 Backfill Plant Zone of Visual Influence – Booysendal South MR (Source: GISM, 2018)

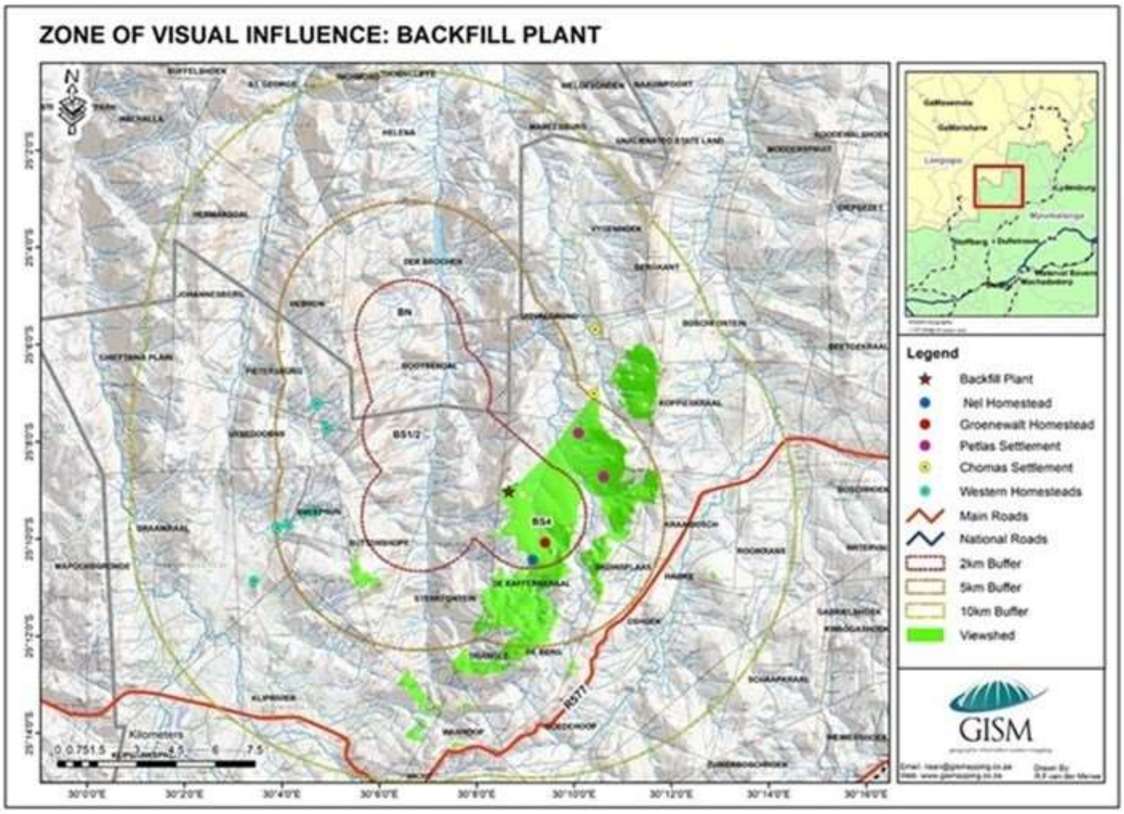


Figure 10-16 Cumulative Zone of Visual Influence (Source: GISM, 2018)

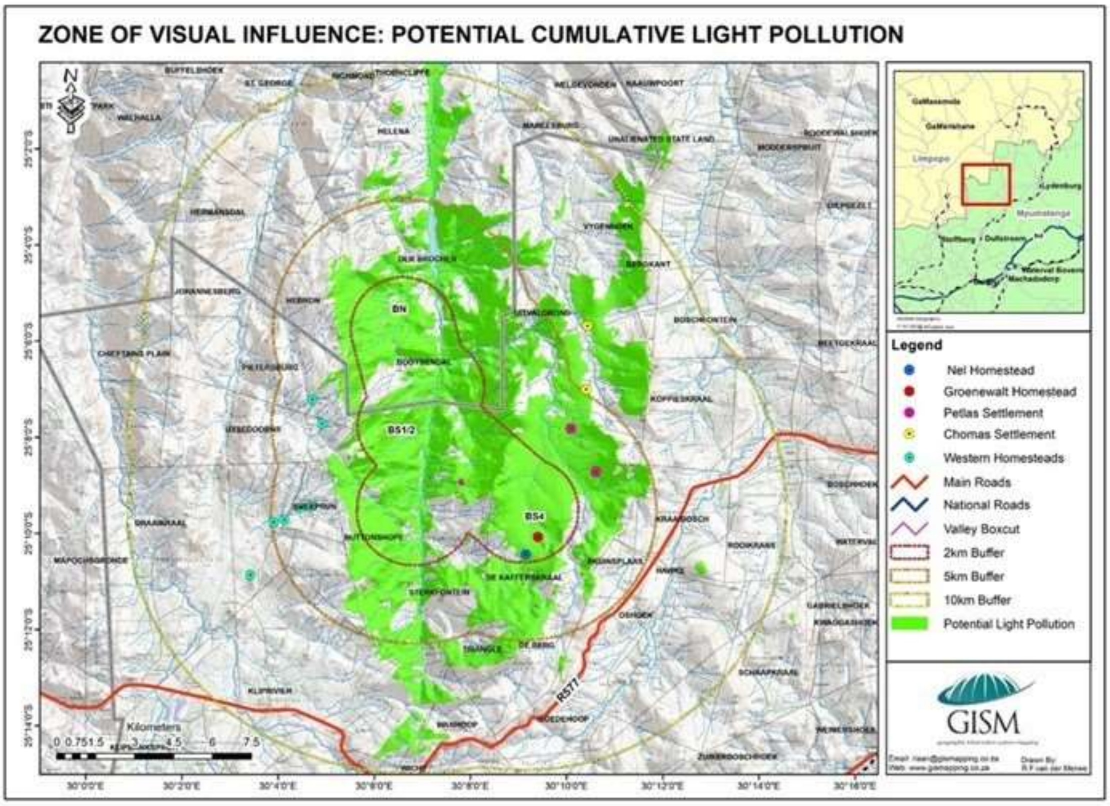



Table 10-64 Viewing Distance of the Phase 2 Project Activities (Source: GISM, 2018)

| Receptor | High Exposure (significant contribution to visual impact) 0 – 2km | Moderate Exposure (moderate contribution to visual impact) 2 - 5km | Low Exposure (minimal influence on visual impact) 5km – 10km | Insignificant Exposure (negligible influence on visual impact) Over 10km |
|---|---|---|---|---|
| Residents | Applicable | Applicable | Not Applicable | Not Applicable |
| Tourist | Not Applicable | Not Applicable | Not Applicable | Not Applicable |
| Motorist (Local traffic excluded) | Not Applicable | Not Applicable | Not Applicable | Not Applicable |

Figure 10-17 View from Groenewald Homestead in a North-westerly Direction without Infrastructure Components (Source: GISM, 2018)

Figure 10-18 View from Groenewald Homestead in a North-westerly Direction with Infrastructure Components (Source: GISM, 2018)

### 10.16.1 Visual Impact Assessment

An assessment of the Booysendal North MR infrastructure components is included in Table 10-65 to Table 10-66 and for the Booysendal South MR infrastructure components in Table 10-67 to Table 10-68.

Table 10-65 Booysendal North MR Activities Light Impact (Source: GISM, 2018)

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Operational and security lighting (construction and operational phase) | | |
| Risk/ Impact | Light sources at night, particularly poorly directed security flood lighting, can influence the visual impact of the development. Unobstructed light sources can cause a general glow in the area and will be visible from significantly longer distances than any structural features during daylight hours. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP<br><br>Negative | | |
| Type of Impact | Indirect: The impact of the proposed Phase 2 Project after sunset will be indirect for people travelling along adjacent local roads and local population living within the surrounding area. Residents and motorists would not be able to see the operational and security lighting from Booysendal North MR area but rather a general glow emanating from the valley may be present.<br><br>Cumulative: Operational and security lighting in and around the different sites might contribute to the cumulative effect of lights from the existing BS and BS4 operation (e.g. general glow). | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Likely<br>It is predicted that residents would not be able to see the operational and security lighting from Booysendal North MR area directly as topography will screen any direct views from potential sensitive receptors.<br>The cumulative impact caused by the general glow from the larger Booysendal Operation and surrounding mines and security lighting is likely without mitigation. Mitigation measures could reduce this general glow. | 3 | 2 |
| Duration | Long term: Potential impacts could be mitigated or remediated once operations cease at the end of LoM with dismantling of operational and security lighting equipment. | 3 | 3 |
| Extent | Area of Influence<br>Wider region (e.g. mainly contained within the Groot-Dwars River valley due to topography) as unobstructed light sources can cause a general glow in the area and will be visible from significantly longer distances than any structural features during daylight hours. | 3 | 2 |
| Receptor Sensitivity | Low: The localised visual perceptions of the communities to the east may be influenced rather by the short term economic and job opportunities that will exist rather than the direct visual perception of the Project.<br>Moderate: Some residents (e.g. western homestead) have reported potential sensitivity to light pollution. These residents will not be able to observe any operational and security lights directly. The cumulative impact of the additional lights may create a general glow in the Groot-Dwars River valley but it is very unlikely that it will impact the residents as the ridge line between the residents (western homesteads) and proposed operations at | 1 - 3 | 1 |

| | | | |
|---|---|---|---|
| | Booysendal North MR is around >700m in height. Mitigation measure will reduce this risk considerably. | | |
| Magnitude | Low (Negative): Refer to **Error! Reference source not found.**. | 1 | 1 |
| Impact Significance | Minor: Although the likelihood, duration, and spatial extent scores are relatively high, the magnitude score is low. This reduces the significance of the operational and security lighting impact to a minor significance score and therefore a minor impact without mitigation. | Minor<br>12<br>1 | Not Significant<br>8<br>1 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Security flood lighting and operational lighting should only be used where absolutely necessary and carefully directed, preferably away from sensitive viewing areas (e.g. Nearby homesteads and local roads). Wherever possible, lights should be directed downwards and shielded to avoid illuminating the sky and minimizing light spills. | | |
| Required Monitoring<br>(if any) | Long-term monitoring of light pollution should be implemented to assess effectiveness of mitigation measures. A grievance mechanism must be put in place in order for them to have a vehicle to raise their concerns. This could include environmental forum meetings and grievance register. | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through mitigation measures. | | |

## Table 10-66 Booysendal North MR Activities Landscape Change Impact (Source: GISM, 2018)

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Infrastructure aesthetically (e.g. ARC Route, 11kVA power line, and other surface infrastructure) incompatible with surrounding landscape (construction, operational and closure phase)<br>Scarring of the aesthetical character of the landscape<br>Changing the sense of place | | |
| Risk/ Impact | The infrastructure (ARC, power lines, BCM1 & BCM2 Adit area and Emergency Escape Portal.) and localised cuts and fills, could remain aesthetically incompatible with surrounding landscape. Edges may not blend in with the landscape or cut slopes may be too steep to be adequately re-vegetated. This may result in a permanent change to the existing visual quality of visually sensitive areas and therefore negative impact.<br>Cuts-and fill, unnatural infrastructure components not blending into the natural environment. Changes in the topography through excavations and fills. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impacts | CO, OP, CL<br><br>Negative | | |
| Type of Impact | Indirect: The impact of the proposed Phase 2 Project will be indirect for people travelling along adjacent local roads and the local population living within the surrounding area. Residents in close vicinity of the Booysendal North MR would not be able to observe any of the proposed infrastructure directly.<br><br>Cumulative: Overall cumulative degradation of the sense of place and visual resource quality is predicted.<br>Settlement of job seekers may further influence the natural character and sense of place | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability | Possible: Mitigation measures may not reduce the visual impact sufficiently due to the scale of the proposed infrastructure (ARC Route) but it is predicted/modelled that views of the proposed infrastructure will be screened completely by topography and not directly visible to any sensitive receptor | 2 | 1 |

| | | | |
|---|---|---|---|
| Duration | Long-term | 3 | 3 |
| Extent | Area of Influence: The scale dimensions and nature of the proposed ARC route will allow extended views within the Dwars River valley. | 3 | 3 |
| Receptor Sensitivity | Low: Proposed infrastructure will not be visible to any sensitive receptor. | 1 | 1 |
| Magnitude | Low (Negative): | 1 | 1 |
| Impact Significance | Minor: Although the likelihood, duration, and spatial extent scores are moderate, the Magnitude score is low. This will ultimately reduce the significance of the infrastructure aesthetically incompatible with surrounding landscape impact to a minor significance score and therefore a minor impact without mitigation. | Minor<br>9<br>1 | Not Significant<br>8<br>1 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | To reduce the potential of glare external surfaces of buildings and structures should be articulated or textured to create interplay of light and shade. Avoid shiny or bare metal. It is advisable to direct the slope of roofs away from critical views (e.g. homesteads and settlements).<br>The excavated and filled areas need to be rehabilitated.<br>An ecological approach to rehabilitation and vegetation screening as opposed to a horticultural approach to landscaping must be adopted. | | |
| Required Monitoring (if any) | Long term rehabilitation monitoring<br>At least 3 years post-closure monitoring | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Mitigation measures may not reduce the visual impact sufficiently due to the scale of the proposed infrastructure but the overall significance of the impact after mitigation will be low. | | |

## Table 10-67 Booysendal South MR Activities Light Visual Impact (Source: GISM, 2018)

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Operational and security lighting (construction and operational phase) from BS4. | | |
| Risk/ Impact | Light sources at night, particularly poorly directed security flood lighting, can influence the visual impact of the development. Unobstructed light sources can cause a general glow in the area and will be visible from significantly longer distances than any structural features during daylight hours. | | |
| Project Phase: CO, OP, CL<br><br>Nature of Impact | CO, OP<br><br>Negative | | |
| Type of Impact | Indirect: Residents and local motorists would be able to see the operational and security lighting from infrastructure located at BS4. The impact of the proposed Phase 2 Project after sunset will therefore be direct for people travelling along adjacent local roads and local population living within the surrounding area.<br><br>Cumulative Impact: Operational and security lighting in and around the different sites might contribute to the cumulative effect of lights from the existing BS4 operation (e.g. general glow). | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Likely<br>It is predicted that residents would be able to see the operational and security lighting from BS4 directly but this will be integrated with the existing lights from the BS4 operation.<br>The cumulative impact caused by the general glow from the operational and security lighting is a likely | 3 | 2 |

| | | | |
|---|---|---|---|
| | without mitigation. Mitigation measures could limit this general glow effectively. | | |
| Duration | Long term: Potential impacts could be mitigated or remediated once operations cease at the end of LoM with dismantling of operational and security lighting equipment. | 3 | 3 |
| Extent | Area of Influence<br>Wider region as unobstructed light sources can cause a general glow in the area and will be visible from significantly longer distances than any structural features during daylight hours. | 3 | 2 |
| Receptor Sensitivity | Low: The localised visual perceptions of the communities may be influenced rather by the short term economic and job opportunities that will exist rather than the direct visual perception of the Project.<br>Moderate: Some residents (e.g. western homestead) have reported potential sensitivity to light pollution. These residents will not be able to observe any operational and security lights directly. The cumulative impact of the additional lights may create a general glow in the Groot-Dwars River valley but it is very unlikely that it will impact the residents (western homesteads) as the ridge line between the residents (western homesteads) and BS4 is around >300m in height but also BS4 is located 7km to the east. Mitigation measure will reduce this risk considerably. | 1 - 3 | 1 |
| Magnitude | Low (Negative): | 1 | 1 |
| Impact Significance | Minor: Although the likelihood, duration, and spatial extent scores are relative high, the magnitude score is low. This will reduce the significance of the operational and security lighting impact to a minor significance score and therefore a minor impact without mitigation. | Minor<br>12<br>1 | Not Significant<br>8<br>1 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Security flood lighting and operational lighting should only be used where absolutely necessary and carefully directed, preferably away from sensitive viewing areas (e.g. Nearby homesteads and local roads). Wherever possible, lights should be directed downwards and shielded so as to avoid illuminating the sky and minimizing light spills. | | |
| Required Monitoring (if any) | Long-term monitoring of light pollution should be implemented to assess effectiveness of mitigation measures. | | |
| Responsibility for implementation | Environmental Officer and Mine Manager | | |
| Impact Finding | | | |
| Impact Finding | Impact can be managed through mitigation measures. | | |

Table 10-68 Booysendal South MR Activities Landscape Change Impacts (Source: GISM, 2018)

| Impact Component | Impact | | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|---|
| Activity | Alteration of current landscape character and sense of place<br>Man-made infrastructure<br>Increase in settlements in the Phetla and Choma village areas | | | |
| Risk/ Impact | The construction of the proposed Project components, associated infrastructure together with the visual impact of existing infrastructure may change the form and character of the natural landscape and thereby the current uniqueness and distinctiveness of the current sense of place, especially in the southern section. | | | |
| Project Phase: CO, OPI, CL<br><br>Nature of Impact | CO, OP CL<br><br>Negative | | | |
| Type of Impact | Direct: From the baseline information the area most vulnerable to an alteration of its current sense of place and landscape character is the southern section of the proposed Project, mainly due to the scale and extent of the proposed operations (especially the ARS Route). The "opening up" of the Groot-Dwars River valley by development will alter the sense of remoteness within this section.<br><br>The change to the fabric and character of the landscape caused by the physical presence of a development of the proposed Project will have a direct impact and will disturb a moderate percentage of the proposed Project site directly.<br><br>Cumulative Impacts: The expansion of the mining activities of the Project may increase the population growth and expand other associated infrastructure and economic activities, possibly changing the landscape character and sense of place in the eastern and northern section. Therefore, an overall cumulative impact on the current sense of place is predicted. Cumulative landscape scarring as result of cumulative clearance within the Groot-Dwars River valley. | | | |
| | Define Significance Categories | | Significance Prior to Mitigation | Significance With Mitigation |
| Likelihood/ probability | Definite likelihood: Since mitigation measures may not reduce the sense of place impact sufficiently due to the scale of the proposed infrastructure. | | 4 | 3 |
| Duration | Permanent: Potential impacts could be mitigated or remediated once operations cease at the end of LoM with rehabilitation programs but the scale and extent of the operations will modify the landscape character and sense of place of the surrounding area permanently. | | 4 | 3 |
| Extent | Area of Influence: The scale, dimensions and nature of the proposed infrastructure (ARS Route) will allow extended views within the Groot-Dwars River valley and may alter the economic activities/population growth in the region thereby influencing the landscape and sense of place in the wider region. | | 3 | 3 |
| Receptor Sensitivity | Low: Localised visual perceptions of the economically marginalised communities of the population may be influenced by the short term economic and job opportunities that will exist rather than preserving the landscape character and sense of place of the surrounding area.<br>Moderate: other residents. | | 3 | 2 |
| Magnitude | Low | | 1 | 1 |
| Impact Significance | Moderate: Although the likelihood, duration, spatial extent scores are relative high, the magnitude sensitivity score are low. This will ultimately reduce the significance of the alteration of current landscape character and sense of place impact to a moderate significance score and therefore a moderate impact without mitigation. | | Moderate<br>14<br>1 | Minor<br>11<br>1 |

| Mitigating and Monitoring Requirements | |
|---|---|
| Required Management Measures | An ecological approach to rehabilitation and vegetative screening measures, as opposed to a horticultural approach to landscaping should be adopted. For example, communities of indigenous plants enhance bio-diversity and blend well with existing vegetation. This ecological approach to landscaping costs significantly less to maintain than conventional landscaping methods and is more sustainable and would fit in more with the character of the landscape. |
| Required Monitoring (if any) | Monitoring will continue annually, and for a minimum period of 3 years after closure to ensure that the rehabilitation is successful and that the vegetation is self-sustaining. At closure the success of rehabilitation would be based on the rate and percentage of vegetation recovery. |
| Responsibility for implementation | Environmental Officer and Mine Manager |
| Impact Finding | |
| Impact Finding | Although ecological rehabilitation will assist in some degree in restoring the sense of place, the “opening up” of the Groot-Dwars River valley for development will permanently alter the sense of place and is irreversible. |

### 10.16.2 Recommendations

The VIA specialist recommended that the mitigating measures must be planned to blend in with the natural environment and to build on its distinctive natural character. The following must also be considered:

- Development footprints must be confined to the smallest possible area;
- Vegetation and topsoil should not be removed in straight lines but in such a manner that the lines represent the natural topography and landscape characteristics;
- Concurrent rehabilitation and rehabilitation monitoring must be carried out as soon as possible. An ecological approach to rehabilitation and vegetation screening must be followed that resemble the natural landscape and unnatural landscaping must be avoided as far as possible;
- Road surfaces must be paved to resemble the natural colours;
- Lights must only be installed where necessary, directed away from sensitive receptors and directed downwards;
- Olive greens and tans can be used at the base of buildings, fading to lighter colours, with the roof section of the buildings painted preferably in a light grey to merge with the skyline and the rest in olive green and Kalahari sand colours.  Tall structure’s roofs should preferably be painted a ’dirty’ grey or light blue. A principle is that lighter tones advance toward the viewer while darker tones recede from the viewer. Pure whites, blacks and bright colours must be avoided.

### 10.16.3 Limitations and gaps

The following limitations and gaps are applicable to the VIA:

- Lighting plans for the Phase 2 Project were not available at the time of undertaking the VIA, therefore the VIA is based on assumptions of similar projects. The extent of excavations, infilling and therefore environmental scarring was not available;
- The level of the VIA assessment does not include viewer preferences; and
- The VIA is based on the opinion of the specialist and a level of subjectivity is always present.

#### 10.16.4 Impact Statement

With the implementation of mitigating measures, it should be possible to mitigate the nuisance of light and the visual disturbance factor. Some residual impacts may remain post-closure due to the excavations and terraces.

## 10.17 Residual Impacts

Although the mitigating measures presented in the EIA and EMP will assist in reducing the significance of the majority of impacts, the following impacts can not be mitigated and are therefore regarded as residual impacts which will require offset:

- Loss of CI flora species;
- Loss of *Pycna sylvia* habitat and associated habitat fragmentation;
- Disturbance of CI fauna;
- Loss of the habitat integrity and riparian vegetation and aquatic macro-invertebrates in the non-perennial drainage lines at BCM2 and BCM1;
- Reduction in surface water run-off and surface water contribution to the Groot Dwars River;
- Deterioration of aquatic habitat;
- Loss in hydromorphic soils and change in end land use;

## 10.18 BCM2 New and Old Position Assessment

This section is important to inform the feasibility of the proposed new location (**"New"**) of BCM2, just south of BCM1, versus the location approved under the Section 24G EA (**"Old"**). This section is aimed at informing the feasibility of moving the BCM2 portal based on the outcome of specialist findings. The Old location approved as part of the Section 24G EA is just north of the BS1/2 complex (see Figure 2-4 and Figure 10-19 Vegetation Units Portal Old Position and Proposed New Position (Source: NSS, 2018)).

The BCM2 surface infrastructure forms part of the Phase 2 Project EA Application for the Booysendal North MR and not the EMP Amendment Application; the former is addressed separately earlier on in Section 10 of this Consultation EIR. The additional surface infrastructure proposed for BCM2 is only relevant in informing the proposed alternative position insofar it will increase the magnitude of the combined BCM1 and BCM2 components and therefore the impact significance.

The location of the BCM2 Adit is to a large extent reliant on the location of the ore and the competency of the strata in order to develop safe shaft access. The Merensky Reef outcrops at the proposed New and approved Old locations. The surface infrastructure components associated with the Adit are, however, located in a sensitive ecological area. Potential impacts on watercourse, vegetation and soil properties is of concern. It is proposed to move the position of BCM2 closer to that of BCM1.

In relation to the maps included in this section, it must be noted that "1BCM2" refers to the Section 24G EA approved position (Old) and "2BCM2" to the proposed new location (New). The approved footprint area of BCM2 is 4.5ha. According to Booysendal, the New position footprint area of BCM2, including its associated surface infrastructure, will remain 4.5ha.

#### 10.18.1 Flora

Both the Old and New positions (see Figure 10-19) fall within the Sekhukhune Mountainlands Threatened Ecosystem and the Mpumalanga CBA.

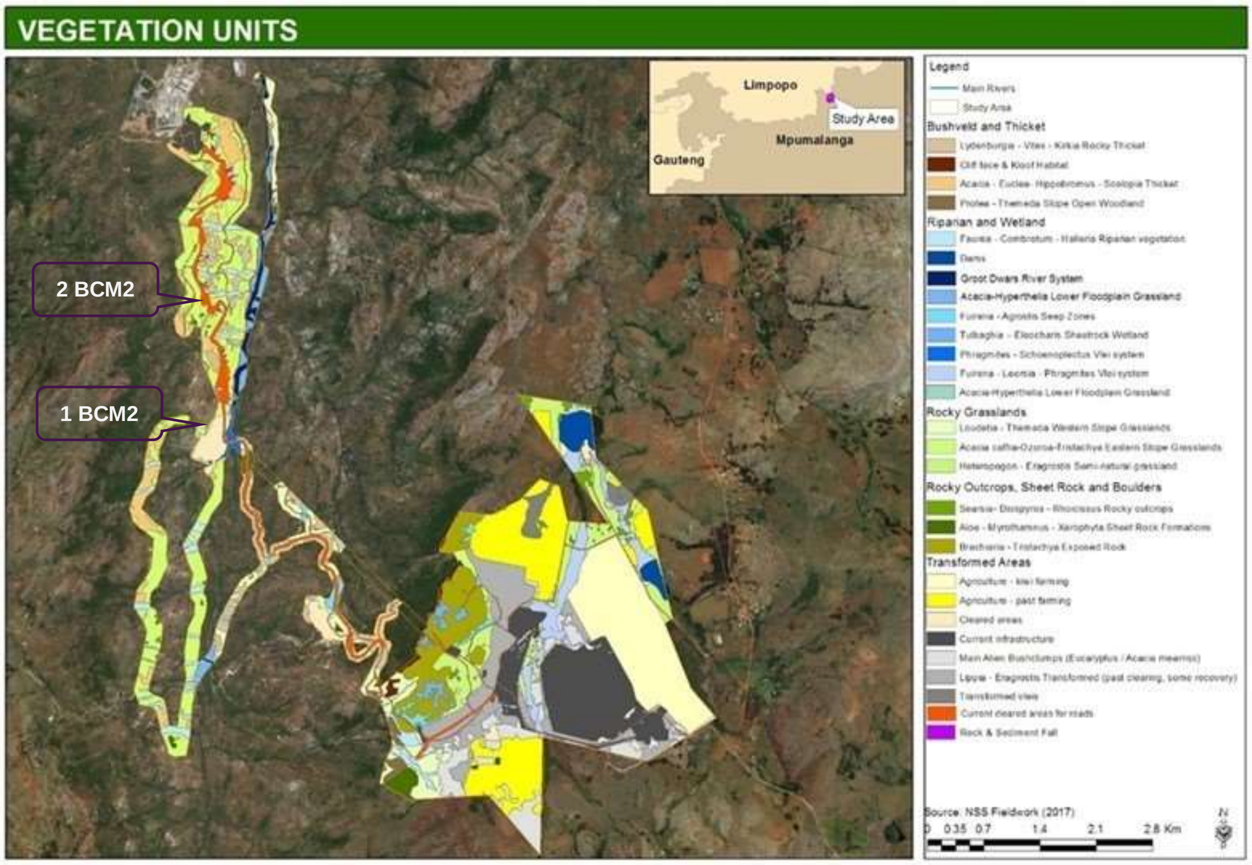
The New position is located in the Woodland and Thicket Habitat Type and the *Acacia-Euclea-Hippobromus-Scolopia* Thicket Vegetation Community. Species diversity in this unit is moderate. The vegetation communities are regarded as stable. Some weedy vegetation is present. The vegetation unit, however, is still sensitive to change.

The Old position is located in the Eastern Slopes Grassland vegetation community of the Rocky Grassland Habitat Type. The species in this unit is moderately diverse, sensitive to change and contains a large irreplaceable succulent component. This vegetation community is difficult to rehabilitate. The vegetation unit has become fragmented in the valley although still considered stable.

The vegetation survey did not indicate that any CI species were specifically present on either of the two sites.

From a vegetation point of view, the New position will be the better option as the impacts are marginally less significant (see Table 10-69).

Figure 10-19 Vegetation Units Portal Old Position and Proposed New Position (Source: NSS, 2018)



### Table 10-69 BCM2 Old and New Flora Impact Assessment

| **Impact Component** | **Impact** | **Significance prior to Mitigation** | **Significance with Mitigation** |
|---|---|---|---|
| Activity | Vegetation clearance and earth-moving activities within wetland and riparian areas. Construction of linear infrastructure crossings of rivers and wetlands. | | |
| Risk/ Impact | Old Position:<br>• Habitat fragmentation.<br>• Loss of CI succulents.<br>• Migration barriers.<br>• Erosion and further loss of vegetation. | | |
| | New Position: Habitat<br>• Habitat fragmentation.<br>• Erosion and further loss of vegetation. | | |
| Project Phase: CO[6], OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative (Old and New Position) | | |
| Type of Impact | Old and New Position:<br>Direct: clearance will lead directly to impact<br>Indirect: erosion can lead to additional vegetation loss<br>Cumulative: Loss off SCPE vegetation and associated CI species | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability: | Old Position: Definite | 4 | 3 |
| | New Position: Definite | 4 | 2 |
| Duration | Old Position:<br>Long term<br>Post-closure reversible | 4 | 2 |
| | New Position:<br>Long term<br>Post-closure reversible | 4 | 2 |
| Extent | Old and New Position:<br>Site<br>Direct impact will be limited to development footprint<br>Cumulative loss of CI, SCPE | 3 | 1 |
| | | 2 | 1 |
| Receptor Sensitivity | Old and New Position:<br>High – SCPE and CBA | 4 | 4 |
| | | 4 | 4 |
| Magnitude | Old Position: High | 4 | 1 |
| | New Position: High | 4 | 1 |
| Impact Significance | Old Position | High<br>15<br>4 | Minor<br>11<br>1 |
| | New Position | High<br>14<br>4 | Minor<br>10<br>1 |
| Mitigating and Monitoring Requirements | | | |

[6] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

| | |
|---|---|
| Required Management Measures | • Both the Old and new Position will require fencing of footprints prior to clearance or construction commencing.<br>• Vegetation needs to be rescued and transplanted in the nursery.<br>• Erosion control measure will have to be installed at both alternative sites to avoid indirect loss of vegetation and habitat. Slopes against Old Position are steeper and will require more robust erosion control measures.<br>• Concurrent construction rehabilitation .<br>• Alien and invasive control throughout the LoM.<br>• Revegetation during closure phase and post-closure monitoring. |
| Required Monitoring | Construction phase environmental monitoring<br>Post-construction rehabilitation monitoring |
| Responsibility for implementation | Environmental Manager and Mine Manager during the LoM.<br>Environmental Officers of each contractor during the construction phase. |
| Impact Finding | |
| Impact Finding | Impacts associated with the Old position are marginally higher due to the higher sensitivity of this location as a result of the type of vegetation and the topography.<br>In both instances mitigating measures will need to be implemented to confine footprint areas |

### 10.18.2 Fauna

The Phase 2 Project Area in its entirety contains a large amount of CI species (refer to Section 5.12.6) and high biodiversity and is therefore, a sensitive environment from a fauna perspective. Although no CI species were found to be present at either of the BCM2 sites, the Brown Hyena and traces of Leopard were found in close proximity of the Old position and the Flat Lizard between BCM1 and BCM2 (New position). Where the Brown Hyena and Leopard has greater mobility, construction activities at the New position may lead to mortality of the Flat Lizards.

For both the New and Old positions, the additional terrace development will lead to habitat fragmentation. The concentration of activities at BCM1 and BCM2 (New location) may lead to the migration away from this area and potentially to a greater mortality rate. On the other hand, in the case of the Old position, the impact of habitat fragmentation due to the spread of activities may be higher, therefore the significance of impacts in both locations on fauna are deemed moderate without mitigation, but low with mitigation. The impact assessment is included in Table 10-70.

Table 10-70 Fauna Impact Assessment Old and Lew Locations for BCM2

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Vegetation clearance, stripping of soil, compaction | | |
| Risk/ Impact | Old Position:<br>• Loss of habitat.<br>• Habitat fragmentation.<br>• Migration barriers.<br>• Mortality during construction | | |
| | New Position:<br>• Habitat fragmentation.<br>• Loss of CI Flat Lizard.<br>• Mortality during construction phase.<br>• Higher mortality during operational phase due to higher concentration of activities. | | |

| | | | |
|---|---|---|---|
| Project Phase: CO[7], OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative (Old and New Position) | | |
| Type of Impact | Old and New Position:<br>Direct: clearance will lead directly to impact.<br>Indirect: migration barriers and loss of species in the footprint areas.<br>Cumulative: Decrease in habitat of already vulnerable and CI species. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability: | Old Position: Likely | 3 | 2 |
| | New Position: Definite | 4 | 2 |
| Duration | Old Position:<br>Long term<br>Post-closure potentially reversible | 3 | 2 |
| | New Position:<br>Long term<br>Post-closure potentially reversible | 4 | 2 |
| Extent | Old and New Position:<br>Fauna displacement<br>Cumulative loss of CI and habitat<br>Mortality in footprints | 3 | 1 |
| | | 2 | 1 |
| Receptor Sensitivity | Old Position: High - Potential CI | 3 | 2 |
| | New Position: High – CI | 4 | 2 |
| Magnitude | Old Position: High | 4 | 2 |
| | New Position: High | 4 | 2 |
| Impact Significance | Old Position | High<br>12<br>4 | Minor<br>7<br>2 |
| | New Position | High<br>14<br>4 | Minor<br>7<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Both the Old and New position will require fencing of footprints prior to clearance or construction commencing.<br>• All movement outside of the fenced area must be prohibited.<br>• Concurrent construction rehabilitation.<br>• Speed control during the operational phase.<br>• Rehabilitation must be done on unused exploration routes, drill pads and disturbed areas to reinstate migration corridors and to reduce fragmentation.<br>• Management measures included in the EMP must be implemented.<br>• Revegetation and rehabilitation during closure phase and post-closure monitoring. | | |
| Required Monitoring | Construction phase environmental monitoring<br>Post-construction rehabilitation monitoring | | |
| Responsibility for implementation | Environmental Manager and Mine Manager during the LoM<br>Environmental Officers of each contractor during the construction phase | | |
| Impact Finding | | | |

[7] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

| | |
|---|---|
| Impact Finding | Impacts associated with the New position are marginally higher due to the potential presence of the Flat Lizard. However, keeping the footprint as small as possible and demarcating the area to avoid movement outside of the footprint will assist in mitigating the potential impacts |

### 10.18.3 Geology

Booysendal noted that results from geotechnical investigations at the Old position indicated that the site is not competent from a geology point of view. During a conversation with Mr H Wood (Booysendal SHEQ Manager) on 14 May 2018, it was indicated that, should portal and underground development occur at the Old position, it can lead to the collapse of the underground workings and potentially loss of life.

It was also indicated that the geotechnical competency of the New position is better, therefore the New position is the preferred position.

### 10.18.4 Soil

Inhoek soils underlie the Old position, while the New position is underlain by Shortland soils.

The Inhoek soil form is a younger soil of 35cm-45cm depth overlying unconsolidated sediments in which soil formation has not progressed sufficiently to form diagnostic horizons in the Phase 2 Project Area. The soil form is sensitive to erosion mainly because of the topography and young nature of the soil. As the soil is not well developed it has a grazing land capability. Current land use is wilderness.

The Shortland soil forms contain well developed A-horizons and are susceptible to erosion due to the high clay content. The soil requires special stripping and topsoil stockpiling measures as a result of the clay content and hydromorphic nature. The location of the Old and New positions within the soil forms are included in Figure 10-20. The assessment of potential impacts is included in Table 10-71.

Figure 10-20 Soil Forms Underlying the Old and Proposed New BCM2 Locations

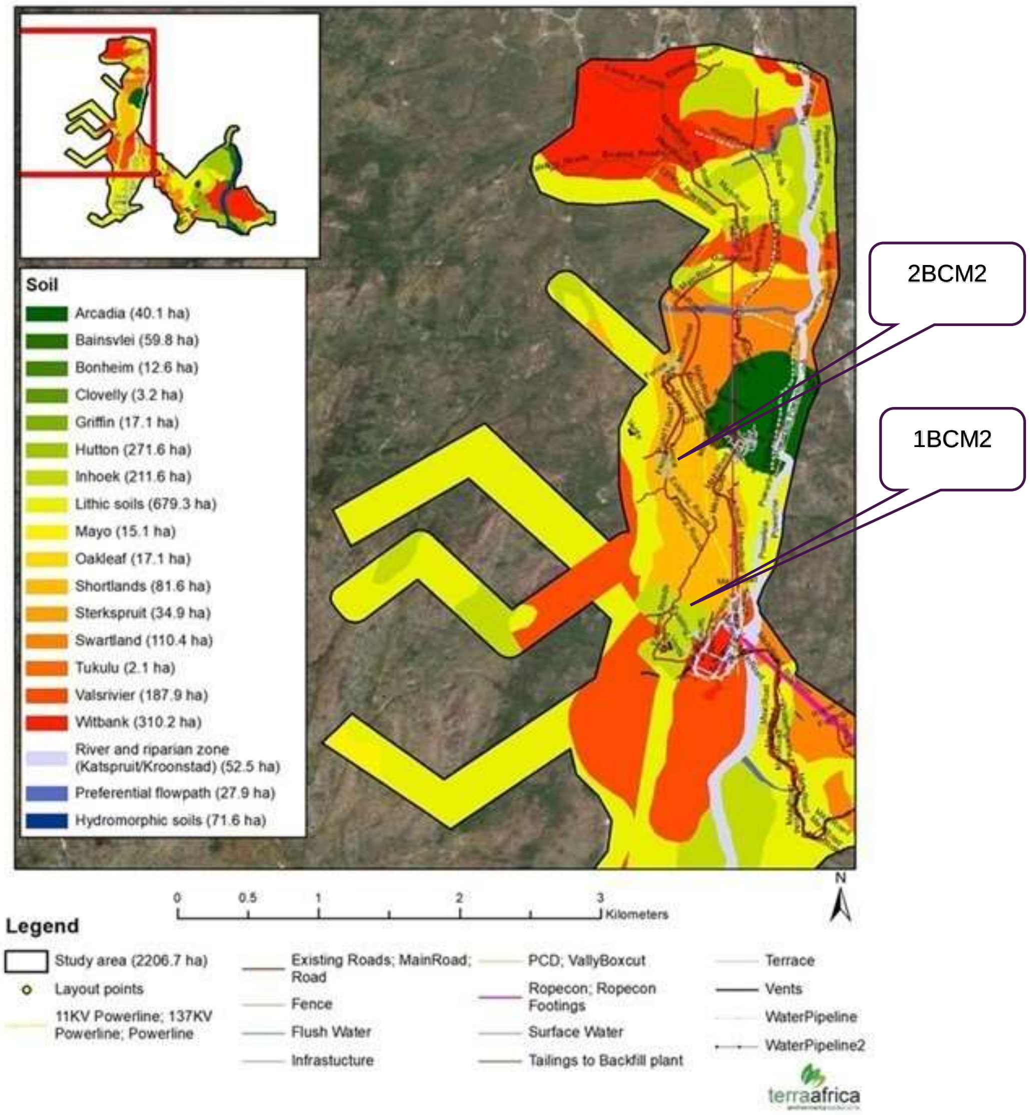



Table 10-71 Assessment of Impacts on Soil – Old and New BCM2 Portal Positions

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Soil Disturbance due to clearance, compaction, infilling, construction and closure infrastructure removal | | |
| Risk/ Impact | Old Position:<br>• Erosion due to disturbance.<br>• Increased silt loads and loss of vegetation.<br>• Loss of land capability and end land use.<br>• Peripheral encroachment and cumulative soil impacts against the steep valley slopes. | | |
| | New Position: Habitat<br>• Loss of sensitive hydromorphic soils due to stripping, incorrect stockpiling and erosion.<br>• Increase in silt loads in the bordering drainage lines. | | |

| | | | |
|---|---|---|---|
| | • Loss of fertile soil and grazing land end land use capability.<br>• Peripheral encroachment and cumulative impacts on soil as a result of increased erosion and loss of soil. | | |
| Project Phase: CO[8], OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative (Old and New Position) | | |
| Type of Impact | Old and New Position:<br>Direct: clearance will lead directly to impact due to compaction and erosion.<br>Indirect: silts could end up in the river system and lead to impacts on the aquatic environment.<br>Cumulative: Increase loss of soil and impacts on the aquatic environment. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability: | Old Position: Definite | 4 | 2 |
| | New Position: Definite | 4 | 2 |
| Duration | Old Position:<br>Long term<br>Post-closure potentially reversible | 4 | 3 |
| | New Position:<br>Long term<br>Post-closure potentially reversible | 4 | 3 |
| Extent | Old Position: Footprints and bordering areas | 1 | 1 |
| | New Position: Footprints and bordering areas including drainage lines | 2 | 1 |
| Receptor Sensitivity | Old Position: High – Steep sided valley | 3 | 1 |
| | New Position: High – sensitive hydromorphic soil | 4 | 2 |
| Magnitude | Old Position: High | 2 | 1 |
| | New Position: High | 2 | 1 |
| Impact Significance | Old Position | Minor<br>12<br>2 | Not significant<br>7<br>1 |
| | New Position | High<br>14<br>4 | Not significant<br>7<br>1 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | • Both the Old and new positions will require fencing of footprints prior to clearance or construction commencing.<br>• Erosion measures must be installed before clearance commence.<br>• Hydromorphic soil must be stripped and stockpiled separately at heights not exceeding 2m other soils stockpiles must not exceed 5m in height<br>• All movement outside of the fenced area must be prohibited.<br>• Concurrent construction rehabilitation.<br>• Rehabilitation must be done on unused exploration routes, drill pads and disturbed areas to offset soil impacts.<br>• Management measures included in the EMP must be implemented.<br>• Revegetation and rehabilitation during closure phase and post-closure monitoring. | | |
| Required Monitoring | Construction phase environmental monitoring<br>Operational phase water quality and rehabilitation monitoring<br>Post-construction rehabilitation monitoring | | |

[8] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

| | |
|---|---|
| Responsibility for implementation | Environmental Manager and Mine Manager during the LoM<br>Environmental Officers of each contractor during the construction phase |
| Impact Finding | |
| Impact Finding | Impacts associated with the New position are marginally higher due to the potential of hydromorphic soils |

With the implementation of applicable management measures the impacts on both areas could be managed successfully. From a soil, land use and land capability point of view any of the two alternative locations could then be feasible.

### 10.18.5 Wetlands

The wetland specialist concluded as part of the wetland identification and delineation that there are no wetlands located in either of the Old or New locations, therefore no impacts on wetlands are foreseen (refer to wetland delineation in Section 5.10).

### 10.18.6 Aquatic Biodiversity and Water Quality

Both the Old and New portals positions are located within the recommended 1km buffer zone of the FEPA Dwars River system. The New position is located within 100m of a non-perennial tributary of the Groot Dwars River. Potential surface water contamination could result from spillages from the PCD, contaminated run-off and discharge into the Groot Dwars River, in which case cumulative negative impacts will increase on the aquatic environment. Undermining of the afore-mentioned tributary could also lead to inflows from the drainage line into the underground workings thereby changing the characteristics of the stream and its ability to support aquatic life. An assessment of the impacts of the Old and proposed New position of the aquatic biodiversity is included in Table 10-72.

Table 10-72 Aquatic Assessment of BCM2 Old and New Positions

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Moving of BCM2 to next to BCM1 | | |
| Risk/ Impact | Old Position:<br>• Not within 100m of a drainage line.<br>• Within 1km of the FEPA Dwars River system.<br>• Spillages from dirty water infrastructure or contaminated run-off could impact on the Groot Dwars River, although the impact will be delayed due to the greater distance from the river.<br>• Cumulative impact on water quality and aquatic life in the Groot Dwars River. | | |
| | New Position:<br>• Within 100m of a non-perennial tributary of the Groot Dwars River. Direct impedance in the non-perennial tributary.<br>• Within 1km of the FEPA Dwars River system.<br>• Spillages from dirty water infrastructure, contaminated run-off, spillages from the conveyor could impact on the unnamed tributary and the Groot Dwars River water quality and aquatic life.<br>• Undermining of the unnamed tributary could impact on the flows as a result of infiltration into the underground mine, adding to changes in the flow regime and impacts on aquatic life. | | |
| Project Phase: CO[9], OP, CL | CO, OP, CL | | |
| Nature of Impact | Negative (Old and New Position) | | |

[9] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

| | | | |
|---|---|---|---|
| Type of Impact | Old and New Position:<br>Direct: the New position will result in direct impacts due the proximity to the unnamed tributary.<br>Indirect: The Old position will result in indirect impacts in the event of spillages of contaminated run-off reaching the Groot Dwars River over time.<br>Cumulative: Both Old and New position could result in negative impacts on water quality and additional impacts on the aquatic environment, although the significance and likelihood of such impacts and therefore the significance of the impacts are higher with the New position. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability: | Old Position: Likely | 2 | 1 |
| | New Position: Definite | 4 | 2 |
| Duration | Old Position:<br>Long term<br>Post-closure potentially reversible | 2 | 1 |
| | New Position:<br>Long term<br>Post-closure potentially reversible | 3 | 2 |
| Extent | Old and New Position: | 2 | 1 |
| | | 3 | 2 |
| Receptor Sensitivity | Old Position: High | 4 | 2 |
| | New Position: High | 4 | 2 |
| Magnitude | Old Position: High | 3 | 1 |
| | New Position: High | 3 | 2 |
| Impact Significance | Old Position | Minor<br>11<br>2 | Minor<br>5<br>1 |
| | New Position | High<br>14<br>3 | Minor<br>8<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Old Position:<br>• Clean and dirty water diversion channels upstream of the Portal must be put in place prior to construction of other components commences.<br>• Clean and dirty water infrastructure must be designed to accommodate a 1:100-year flood event due to its location within a FEPA system.<br>• All dirty water infrastructure must be operated as low as possible.<br>• Cut-off trenches must be installed at the workshops and any dirty water areas which poses a risk to the environment. Water from this infrastructures must be contained and either reused in the process or disposed of at a licensed facility.<br>• Cut-off trenches, oil sumps and oil separators must be cleaned regularly and maintained not to cause spillages into the environment.<br>New Position:<br>All the mitigating measures applicable to the Old position are also applicable to the New position and in additional the following must also be implemented:<br>• Design of diversion of the potentially affected non-perennial tributary must be done though consultation with an aquatic specialist and approved by the DWS.<br>• All water bearing structures which may result from the non-perennial drainage line and which may cause inflow into the underground workings must be sealed off. | | |
| Required Monitoring | Monitoring of water levels and water quality at the New position site<br>Monitoring of downstream water quality at the Old position<br>Construction phase environmental monitoring<br>Post-construction rehabilitation monitoring | | |

| | |
|---|---|
| Responsibility for implementation | Environmental Manager and Mine Manager during the LoM<br>Environmental Officers of each contractor during the construction phase |
| Impact Finding | |
| Impact Finding | Impacts associated with the New position is higher due to the its close proximity to the non-perennial tributary and the potential of undermining. |

Although the new position is not the preferred alternative, well engineered management and mitigating measures done in consultation with the aquatic specialist who carried out the aquatic study, could ensure that the aquatic environment is protected. All designs need to be approved by DWS before any construction activities commences.

### 10.18.7 Hydrology

The New position is located in sub-catchment 19 and the Old position in sub-catchment 13 (refer to section 5.7). Sub-catchment 19 covers an area of 7.39km$^2$ and has a peak flow of 29.3m$^3$, while sub-catchment 13 covers an area of 5.1km$^2$ with a peak flow of 20.2km$^2$. Clean and dirty water separation and containment structure design and construction will have to make provision for these flows.

The outcome of the water and salt balance (refer to Section 5.7.3) showed that the water quality in the Groot Dwars Rivers is better upstream and deteriorates downstream. As the New position is further downstream it may be a better option to locate BCM2 at this position.

The New position falls within 100m from a non-perennial tributary of the Groot Dwars River, while auxiliary infrastructure, including the conveyor belts will also cross additional drainage lines. Design and construction of diversions must be done in consultation with the aquatic specialist who was responsible for the Phase 2 Project aquatic assessment. These designs must be approved by DWS before any construction commences.

Conveyor systems need to be designed and constructed to capture any potential spillages within 100m of any drainage line. All potential spillages have to be cleaned up immediately.

Table 10-73 Hydrological assessment of BCM2 Alternative 1 and 2 Positions

| Impact Component | Impact | Significance prior to Mitigation | Significance with Mitigation |
|---|---|---|---|
| Activity | Alternative position of BCM2 | | |
| Risk/ Impact | Old Position:<br>• Not within 100m of a drainage line.<br>• Within 1km of the FEPA Dwars River system.<br>• Negative impact on the upstream water quality.<br>• Spillages from dirty water infrastructure or contaminated run-off could impact on the Groot Dwars River, although the impact will be delayed due to the greater distance from the river.<br>• Cumulative impact on water quality and aquatic life in the Groot Dwars River. | | |
| | New Position:<br>• Within 100m of a non-perennial tributary of the Groot Dwars River. Direct impedance in the non-perennial tributary.<br>• Within 1km of the FEPA Dwars River system.<br>• Lower in the catchment and will contribute to a larger significance to cumulative water quality deterioration<br>• Spillages from dirty water infrastructure, contaminated run-off, spillages from the conveyor could impact on the unnamed tributary and the Groot Dwars River water quality and aquatic life.<br>• Undermining of the unnamed tributary could impact on the flows therefore as a result of infiltration into the underground mine adding to changes in the flow regime and impacts on aquatic life. | | |

| | | | |
|---|---|---|---|
| Project Phase: CO[10], OP, CL<br><br>Nature of Impact | CO, OP, CL<br><br>Negative (Old and new Position) | | |
| Type of Impact | Old and new Position:<br>Direct: The New position will result in direct impacts due the proximity to the unnamed tributary.<br>Indirect: The Old position will result in indirect impacts in the event of spillages of contaminated run-off reaching the Groot Dwars River over time.<br>Negative impact on the water and salt balance.<br>Cumulative: Both the Old and proposed New position could result in negative impacts on water quality and additional impacts on the aquatic environment, although the significance and likelihood of such impacts and therefore the significance of the impacts are higher with the New position. | | |
| | Define Significance Categories | Significance Prior to Mitigation | Significance with Mitigation |
| Likelihood/ probability: | Old Position: Likely | 2 | 1 |
| | New Position: Definite | 4 | 2 |
| Duration | Old Position:<br>Long term<br>Post-closure potentially reversible | 2 | 1 |
| | New Position:<br>Long term<br>Post-closure potentially reversible | 3 | 2 |
| Extent | Old and New Position: | 2 | 1 |
| | | 3 | 2 |
| Receptor Sensitivity | Old Position: High | 4 | 2 |
| | New Position: High | 4 | 2 |
| Magnitude | Old Position: High | 3 | 1 |
| | New Position: High | 3 | 2 |
| Impact Significance | Old Position | Minor<br>11<br>2 | Minor<br>5<br>1 |
| | New Position | High<br>14<br>3 | Minor<br>8<br>2 |
| Mitigating and Monitoring Requirements | | | |
| Required Management Measures | Old Position:<br>• Conveyor belts need to be enclosed within 100m of drainage lines to ensure that any spillages are captured.<br>• Clean and dirty water diversion channels upstream of the Portal must be put in place prior to commencing with construction of other components.<br>• Clean and dirty water infrastructure must be designed to accommodate a 1:100-year flood event due to its location within a FEPA system.<br>• All dirty water infrastructure must be operated to maintain at least the 0.8m freeboard, especially during flood events.<br>• Cut-off trenches must be installed at the workshops and any dirty water areas which poses a risk to the environment. Water from these infrastructures must be contained and either reused in the process or disposed of at a licensed facility.<br>• Cut-off trenches, oil sumps and oil separators must be cleaned regularly and maintained not to cause spillages into the environment<br>New Position:<br>All the mitigating measures applicable to the Old position are also applicable to New position. In addition, the following must also be implemented: | | |

[10] CO refers to construction phase, OP to the operational phase and CL to the closure and post-closure phase.

| | |
|---|---|
| | • Design of diversion of the potentially affected non-perennial tributary must be done though consultation with an aquatic specialist and approved by the DWS.<br>• All water bearing structures which may result from the non-perennial drainage line and which may cause inflow into the underground workings must be sealed off. |
| Required Monitoring | Monitoring of water levels and water quality up and downstream at the New position<br>Monitoring of downstream water quality at the Old position<br>Construction phase environmental monitoring<br>Post-construction rehabilitation monitoring |
| Responsibility for implementation | Environmental Manager and Mine Manager during the LoM<br>Environmental Officers of each contractor during the construction phase |
| Impact Finding | |
| Impact Finding | Impacts associated with New position is higher due to the its close proximity to the non-perennial tributary, location within the 100m buffer from streams and larger catchment and run-off. Although these impacts can be managed it will require input from the MPTA, DWS, the aquatic specialist into the engineering designs. |

### 10.18.8 Geohydrology

It is anticipated that inflows into the underground workings from new position could be marginally higher should the non-perennial drainage line contribute to inflows. In general, in it is anticipated that groundwater inflows will cease where mining is deeper than 100mbs. Inflows can and must be managed by sealing off the roof where the inflows originate from the non-perennial drainage line. The difference in location in contribution to the formation of a drawdown cone of contamination transport (refer to Section 10.4) will not be significant and can be managed.

### 10.18.9 Social

As the proposed New position still falls within the wider Booysendal North MR area, it will affect the labour compliment or impact directly on local communities to the east or west. No change in the social impact is anticipated and local communities are still anticipated to benefit due to the procurement policies. The implementation of the social management plan included in Annexure L will be important to avoid, mitigate and manage any socio-economic impacts which may result from the Phase 2 Project in general.

### 10.18.10 Air Quality Impact Assessment

DRA indicated that the equipment, vehicle fleet and area of disturbance for the two alternative BCM2 locations will be the same. The location of the Old and proposed New BCM2 position is both in the valley, therefore the climatic conditions, especially the anabatic and katabatic influences on the potential dispersion of contaminants, are the same. The management measure included in Annexure C must be implemented throughout the LoM.

### 10.18.11 Noise and Vibration

The same infrastructure, equipment and machinery will be applicable to both alternatives. The Old position is located slightly higher up in the valley. This can lead to higher level of noise propagation flowing out of the valley thereby affecting sensitive receptors. Despite this, the difference in noise impact between the two alternatives is so small, that potential difference in impacts are insignificant. From a noise perspective, any one of the Old or New positions are feasible.

### 10.18.12 Visual

Both of the Old and New portal positions are located in the Groot Dwars River valley. The absorption capacity of the natural environmental will assist to reduce the visibility of the portals should remediation be done as proposed in the EMP. From a visual point of view, any of the two BCM2 positions is therefore acceptable.

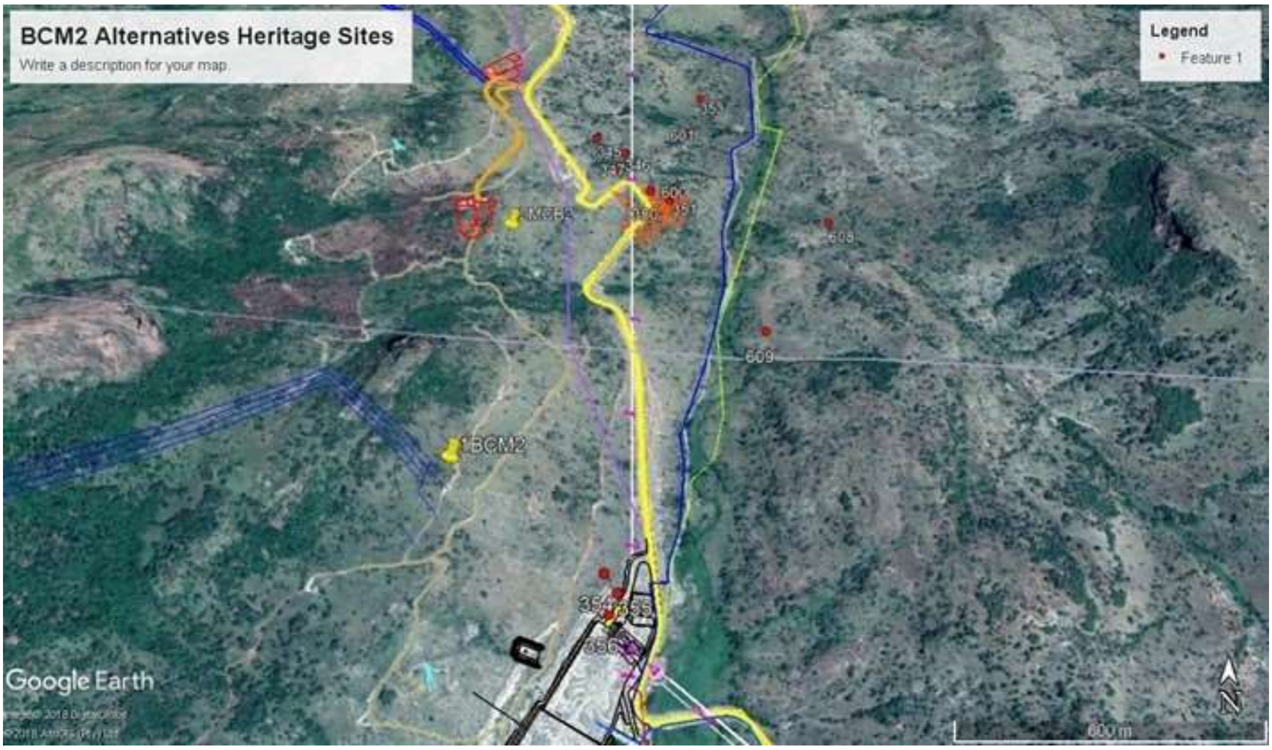
### 10.18.13 Traffic

No change in traffic impacts are expected as the traffic volumes and direction of traffic flow into and out of the Booysendal Mine will not change as a result of an alternative position of BCM2. Traffic management measures included in Annexure C must be implemented.

### 10.18.14 Cultural Heritage

No cultural heritage sites were identified close to or in the BCM2 proposed New footprint areas (see Figure 10-21). From an cultural heritage point of view any of the two e positions are therefore feasible.

Figure 10-21 BCM2 Alternatives and Heritage Sites (Source: HCAC and Google Earth Pro, AfriGIS, 2018)




### 10.18.15 Conclusion

The impacts of the two alternative positions of BCM2 do not differ significantly. The biggest risks associated with the proposed New position are the potential cumulative negative impact on surface water quality and the aquatic biodiversity and undermining of the Groot Dwars River tributary, which could cumulatively lead to an additional reduction of run-off that feeds the Groot Dwars River system.

These impacts can and must be managed in accordance with the management measures prescribed in the impact tables included in this section.

It is the EAP's opinion that, due to the unsafe working conditions that could result from the Old position, the New position should be approved, especially as there are no significant differences in relation to the other impacts assessed.

The management, mitigation and monitoring measures included in the EMP and recommended by the specialists where applicable must be adhered to.

# 11. Recommendations of the EAP

## 11.1 Reasoned Opinion and Impact Statement

Mining projects by their nature imply that there will be negative impacts to the environment. The aim should always be for the positive impacts to outweigh the negative impacts.

The outcome of the impact assessment indicates that:

- the Phase 2 Project is located in the SCPE;
- a large number of CI terrestrial fauna and flora species are present in the Project Area;
- cumulative impacts on the CBA and fauna habitats are expected;
- the sensitive nature of the Groot Dwars River FEPA catchment and the associated CI species occurring in the catchment and the potential cumulative impacts on the system could be significant;
- wetlands associated with the Phase 2 Project at BS4 will be impacted;
- there will be changes in the hydrological regime of the Groot Dwars River catchment, including potential changes in the flow characteristics due to either a reduction in baseflow and run-off or changes;
- the there is a risk that the water quality in the Groot Dwars River could further deteriorate should spillages, decant or release of process, sewage or polluted water or spillages from the conveyors occur;
- communities are reliant on groundwater resources. The hydrogeological assessment found that potential impacts of groundwater plume formation and groundwater dewatering will be localised. However, is important that trend analysis of groundwater monitoring results be done on a monthly basis to ensure that any potential impacts be identified timeously to allow for mitigating measures to be put in place;
- sensitive receptors are within 3km for the proposed Phase 2 Project to the east and could experience potential impacts of noise, night glare and dust;
- there is a risk that job seekers will flock to the area which could have negative impacts on the local communities and available services; and
- there is a definite the potential increase in habitat fragmentation, creation and migration barriers.

It is the EAPs opinion that irreversible damage will be caused to some sections of the SCPE CBA areas and to some of the CI fauna species. The Phase 2 Project at BN also holds significant risks to the aquatic biodiversity. Any change in water quality or flow could have significant risks to the CI species. Cumulative impacts can also occur on the riparian wetland of the Groot Dwars River resulting from siltation, pollutants and deterioration in water quality. It is imperative that the impacts be managed and mitigated.

For authorisation to be granted the EAP believes the biodiversity off-set strategy for the Phase 2 Project must be conclude and implemented. The off-set needs to be agreed with the relevant authorities, meet the off-set requirements stipulated in the Draft National Biodiversity Off-set Policy (GG40733 GN276 of 31 March and must take consideration of the off-set requirements stipulated in the EMP and the specialist studies.

The offset strategy must also consider the loss in habitat and habitat fragmentation of the *Pycna sylvia*. The successful conclusion of an implementation agreement (including reference to appropriate management plans for Mining Right area and Off-set area) with DMR, MTPA and DEA will be the only acceptable mitigation for the Phase 2 project. The offset-strategy must be concluded before a possible Environmental Authorisation is granted.

In addition, it is of the utmost importance that the management measures detailed in the EMP are implemented and that compliance to these be externally audited monthly for the duration of the construction phase, should the Phase 2 Project be authorised.

Due to the sensitivity of the potentially affected environment, robust risk assessments which takes consideration of the environmental sensitivities, method statements which ensures that the risks are avoided and robust pro-active management measures are required before construction commences. Unwavering commitment from all involved will be required to ensure that the impacts and risks of the proposed Project are successfully addressed to the benefit of the environment and the economy. It is important that awareness training on the sensitivity of this environment be given to all to embed a better understanding of the sensitivity of the Project Area.

The Phase 2 Project design must be finalised taking cognisance of the specialist findings. Sensitive areas must be avoided and clearance must be limited to the absolute minimum to mitigate cumulative impacts. Encroachment outside of demarcated footprints must be avoided at all cost due to the sensitivity of the environment. Buffer zones outlined in the EMP must be adhered to.

It is, acknowledged that some deterioration of habitat condition will occur due to the Phase 2 Project activities but these impacts need to be minimised through the recommended mitigation, management, monitoring and targets set out in the EMP.

Booysendal North MR Activities

- Emergency Escape Portal: it is imperative to move the Emergency Escape Portal to protect the identified and, yet, undiscovered heritage resources. A chance find procedure must communicated to all contractors and sub-contractors especially as the Project Area is known for its undiscovered heritage resources.
- BS1/2 to BN Pipelines: It is also important that the Alternative 1 of the BS1/2 to BN process and potable water pipeline be approved along the main access road.
- BCM2: The proposed new location of BCM2 could be authorised should the recommendations and management measures in the EIA and EMP be implemented.
- ARC: The road has been assessed as the alternative which will have a lower impact on the environment for the transport of ore and it is recommended that this alternative be further investigated. Should the ARC be approved, construction should be preceded by an environmental risk workshop to optimise management and mitigating measures.

Booysendal South MR Activities:

- BS4 Pipeline 3: an alternative MCC1 PCD to RWD pipeline route which will lead to a smaller area of disturbance to the wetland it will cross must be investigated.
- Backfill Plant: The proposed uncemented backfill alternative is also supported.

Monitoring should be done in accordance with the requirements (parameters, type of monitoring, frequency of monitoring etc.) included in the EMP. Additional monitoring points must be included in make provision for the Phase 2 Project, for surface-and groundwater, dust, $PM_{10}$, aquatic biodiversity and noise.

The Phase 2 Project is relatively small in comparison to the Phase 1 Project, however the anticipated cumulative impacts could be significant. To protect what is remaining of this sensitive environment and to manage the anticipated and Phase 1 impacts, it is recommended like for like offset of the impacted reaches of the Groot Dwars River be set aside and that no further impacts on the *E. motebensis* habitat south of current impacted areas take place.

The positive impacts which can result from the Phase 2 Project cannot be denied. The Project has the potential to create a significant amount of much needed local jobs, contribute to business development and social investment and be an economic impetus in an area where socio-economic conditions can, from the social data provided, be described as dire. The positive socio-economic trickle-down effect that a development of this nature can have can be significant in terms of social upliftment, investment, skills development and investment into community infrastructure as stipulated in the SLP. The national and regional socio-economic advantages through tax contribution is also significance in an industry where it becomes increasingly difficult to operate in. With a LoM of more than 40 years, the long term positive socio-economic impacts are much needed. The potential negative social impacts which are normally associated with mining developments could be manged and mitigated but it will be necessary to take hands with local government and develop and implement strategies.

The EAP is of the opinion that authorisation be granted with the condition that the off-set strategy for the Phase 2 Project be concluded before authorisation is granted. The strategy must take consideration of the EIA findings and must be agreed by the relevant authorities, including DMR, DEA, DWS and the MPTA. The requirements set out in the EMP, requirements of the commenting authorities or competent authority must be met.

## 11.2 Conditions for Authorisation Applicable to the Booysendal North and Booysendal South Mining Rights

Based on the findings of the EIA, the EAP and specialist is of the opinion that the following conditions for authorisation should be included should an EA be granted:

- The dust outfall monitoring network must be expanded in accordance with the EMP and monthly $PM_{10}$ monitoring must be undertaken as part of the air quality monitoring campaign.
- Activities on sensitive soil (see Figure 5-20) must be avoided.
- All specialist management plans, management measures and monitoring programmes included in the specialist reports and incorporated in the EMP (Annexure C) must be implemented.
- To mitigate potential Phase 2 Project impacts, no further direct disturbances to the Groot Dwars River and associated riparian wetland must take place as a result of the Phases 2 Project. The Groot Dwars River and associated riparian wetland/habitat as well as a 100m buffer zone must be treated as a no-go area for any Phase 2 Project developments, movement of vehicles or people other than that authorised by DWS..
- No additional road or infrastructure crossings across the Groot Dwars River other than those already in place and those proposed as part of this application must be made.
- River crossings must be designed and constructed not to cause any flow modifications or migration barriers.
- New groundwater monitoring boreholes must be drilled to cover the Phase 2 Project components. The locations of the boreholes included in the EMP must be confirmed by a qualified hydrogeologist.
- New surface water monitoring points must be included in the current monitoring programme. This need to be sighted by a hydrologist, aquatic specialist and water quality specialist to cover the Phase 2 Project run-off.
- The Groot Dwars River system is a FEPA system. DWS must be consulted to agree on appropriate buffer zones and to consult on permissible activities.

- Biomonitoring points and toxicity testing campaign must be expanded as recommended on the EMP (Annexure C). This need to be approved by DWS.
- The PES of the river downstream of the confluence with the Everest tributary should not drop below a Category C.
- Any surface-and groundwater water quality parameters and limits included in the EMP or additionally determined by the DWS as part of the Booysendal South Expansion Project IWULA must be complied with.
- Treated effluent from the STPs, PCDs, excess process water or any contaminated water source must be recycled in the process and not released into the environment.
- The current offset programme for the Phase 1 Project must be expanded to include offset for the residual impacts of the Phase 2 Project. The offset strategy and draft offset plan must be agreed before authorisation is granted. This offset must be approved by relevant authorities, must be legally binding as stated in the draft National Biodiversity Offset Policy, contain a comprehensive list of impact management, mitigation and monitoring measures and be enforced through annual inspections by relevant authorities.
- Actual disturbance footprints must be verified through an independent survey and to inform the offset requirements.
- Offset of the *Vitex obovate* subsp. *wilmsii* must be secured as part of the offset strategy to make provision for the loss in the *Pycna sylvia* habitat as a result of residual impacts.
- Any encroachment of the *Vitex obovate* subsp. *wilmsii* or any other know areas of occurrence of the *Pycna sylvia* must be avoided. Any fragmentation of this habitat must be avoided.
- Annual monitoring of the *Pycna sylvia* must be carried out, to gain a better understanding of it breading habits, distribution, impacts of mining on migration and presence and to assess if additional mitigating measures are required.
- To mitigate and manage the residual impacts and potential impacts of the Booysendal South Expansion Project on the Groot Dwars River FEPA system and the SCPE, CI fauna and flora species in the valley, and aquatic biodiversity, like for like offset of the Groot Dwars River system must be set aside, preferably the remainder of the system not yet affected by mining.
- The preferred habitat of the *E. motebensis* should not be allowed to deteriorate. No additional habitat where these species are present must be affected. Slow flowing pool habitats must be maintained. No flow modification (water abstraction, releases, transfers) should be allowed in the reaches of concern included in Figure 5-28.
- A Biodiversity Management and Action Plan must be developed and implemented in line with the recommendations in the specialist reports and the EMP.
- An emergency preparedness plan must be developed or the current plan expanded to make provision for the specific risks associated with the Phase 2 Project.
- Chromium, nitrate and phosphate concentrations in the Groot Dwars River and Everest Tributary must be carefully monitored to ensure compliance with the DWAF (1996) guidelines for aquatic ecosystems (0.007 mg/l for chromium, less than 0.5 mg/l inorganic nitrogen). Where levels are exceeded, management action must be taken.
- To mitigate and manage social and economic impacts, the following social management plans must be put in place or where the plans are in place it must be updated to address risks identified in the EIA and Social Impact Assessment: Stakeholder Engagement Plan and Road Safety and Traffic Management Plan.

- The SLP including labour and recruitment policies must be updated to ensure that potential positive socio-economic impacts are optimised.
- The existing Heritage Management Plan must updated to make provision for the potential impacts and risks associated with the Phase 2 Project and implemented for the Booysendal Operation.
- The chance-find procedure must be updated to make provision for the Phase 2 Project and an awareness programme must be rolled out to all contractors and sub-contractors.
- An alternative location for the Emergency Escape Portal must be considered alternatively a Phase 2 Heritage Assessment must be undertaken before any construction activities in this area commences.
- Acoustic screening must be put in place before commissioning of the Phase 2 Project.
- Noise monitoring, including baseline monitoring muse be undertaken as included in the EMP, including baseline monitoring, recording and trend analysis.
- The noise (Noise Control Regulations, 1992) and vibration (BRMI 8507) control legislation and /or guidelines must be adhered to at all time.
- A solution must be found to enhance the site distance and road safety at the north-western corner of the D874 / Village Intersection.
- Lights must only be installed where necessary, directed away from sensitive receptors and directed downwards.
- Paints must be chosen to blend in with the natural environment; bright colours and whites must be avoided.
- Concurrent rehabilitation and rehabilitation monitoring must be carried out as soon as possible. An ecological approach to rehabilitation and vegetation screening must be followed that resemble the natural landscape and unnatural landscaping must be avoided as far as possible

## 11.3 Conditions for Authorisation Specifically Applicable to the Booysendal North Mining Right

- Alternative 2 of the BS1/2 to BN process and potable water pipelines is recommended.
- Other than the access roads included in this Phase 2 Project application no other access roads will be permitted and available access roads to BCM1 and BCM2 should be used.
- All mitigating measures and recommendations given by DRA for managing spills from the ARC (DRA Risk Assessment Review Report JZASM0413-SHE-FO-36, 2015) and the Tailings Pipeline at BS4 must be implemented.
- Additional management measures which apply to the new location of BCM2 include:
    - Clean and dirty water diversion channels upstream of the Portal must be put in place prior to construction of other components commences. These designs must be approved by DWS and must be done in consultation with the aquatic specialist;
    - Clean and dirty water infrastructure must be designed to accommodate at least a 1:100-year flood event or as advised by DWS due to its location within a FEPA system;
    - All dirty water dams must be operated to have a minimum freeboard of 0.8m at all times including during storm events. No release of untreated water will take place;
    - Cut-off trenches must be installed at the workshops and any dirty water areas which poses a risk to the environment. Water from these infrastructures must be contained and either reused in the

process or disposed of at a licensed facility. Cut-off trenches, oil sumps and oil separators must be cleaned regularly and maintained not to cause spillages into the environment;

- All water bearing structures which may result in an inflow into the underground workings, and which are specifically linked to undermining or the non-perennial drainage line must be sealed off; and
- Water levels and quality must be monitored up-and downstream in the affected reaches and additional biomonitoring points must be identified and monitored bi-annually as part of the overall monitoring programme.

## 11.4 Conditions for Authorisation Specifically Applicable to the Booysendal South Mining Right

- All mitigating measures and recommendations provided in the Backfill Report 0003-0000-40ER-0001of 25/05/2017 for managing spills from Tailings Pipeline at BS4 must be implemented.
- There must be long-term management and monitoring of decanting water from the BS4 underground mine. Provision must be made for the long-term pumping of leachate (water draining from the backfill material) post-closure. Pumping of leachate to the surface (from the bottom barricade) should continue until water has been effectively drained from the backfill material.

## 11.5 Gaps and Disclaimer

The findings in this Consultation EIR are dependent on the information provided to Amec Foster Wheeler. Any changes not communicated to the environmental team would also not have been considered in this report.

Some geotechnical activities have been undertaken at some of the ARC towers, it was however indicated that the disturbance is less than 300m$^2$. It is also understood that some preparation work for the Backfill Plant has commenced, although falls within the disturbed areas of BS4.

Due to the extensive nature of the specialist studies it might be that not all specialist information has been captured in the EIA and EMP. Therefore, the EIA and EMP should be read together with the various specialist studies.

# 12. Declaration of Independence

I, Amanda Pyper, declare that –

**General declaration:**

- I act as the independent environmental practitioner in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the Applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of NEMA, the 2014 Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with NEMA, the 2014 EIA Regulations and all other applicable legislation
- I will take into account, to the extent possible, the matters listed in regulation 8 of the 2014 EIA Regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all interested and affected parties that participated in a PPP; and
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- all the particulars furnished by me in this form are true and correct;
- will perform all other obligations as expected from an environmental assessment practitioner in terms of the 2014 EIA Regulations;
- I realise that a false declaration is an offence in terms of regulation 71 of the 2014 EIA Regulations and is punishable in terms of section 24F of NEMA; and
- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the 2014 EIA Regulations.

Signature of the environmental assessment practitioner:

*Amec Foster Wheeler (part of Wood Group)*

Name of company:

*04 June 2018*

Date:

# 13. Bibliography

Airshed Planning Professionals, March 2017: Air Quality Impact Assessment for Booysendal Mine.

Airshed Planning Professionals, March 2018: Air Quality Impact Assessment for the Booysendal South Expansion Project (Phase II), Report No: 17AFW03.

Aquatico Scientific (Pty) Ltd, March 2018: Booysendal South Expansion Project Phase 2 Mine Environmental Authorisations Specialist Water Quality Baseline Status Quo and Scoping Report, Report No. NORBD022018.

Aquatico Scientific (Pty) Ltd, March 2017: Specialist Water Quality Baseline Status Quo and Scoping Report Northam Platinum Limited, South Africa

BBE Consulting, June 2016: Northam Platinum Booysendal Merensky Project, Ventilation Review Study, 2216/RM/RV 16-076.

Booysendal, Nov 2013: Code of Practice: Non-mandatory code of practice for waste management of Booysendal Mine, BD-COP-17 Version 2.

Clean Stream Biological Services, June 2017: Booysendal South Expansion Project (EMP, EIA and S24G): Specialist Aquatic Ecosystem Assessment.

Doppelmayr, Decmber 2016: Construction Procedure for PoreCon Installation, Complete for the Project – RopeCon Booysendal in South Africa, Ref No: FCAG000302.

DRA, May 2017: Booysendal North, Central & South Integrated Water Balance Report for Booysendal South Feasibility Study Project, GBP-ENG-REP-001.

Ehlanzeni District Municipality, 2017: Ehlanzeni District Municipality Final IDP and Budget.

Future Flow Groundwater and Project Management Solutions, May 2017: Northam Platinum Booysendal Central Complex Development EIA Study.

Future Flow Groundwater and Project Management Solutions, March 2018: BCM1/2, BCM1, BCM2, Valley Boxcut and BS4 Complex Development, Groundwater EIA Study, Reference: AFW.15.062.

Geographic Information Systems Mapping, May 2017: Booysendal South Expansion Project Phase 2: Visual Impact Assessment Specialist Report.

Geographic Information Systems Mapping, June 2017: Booysendal South Expansion: Section 24G and Environmental Authorisation Applications Visual Impact Assessment Report.

HCAC Heritage Consultants, March 2018: Heritage Impact Assessment for the Proposed Booysendal South, Phase 2 Expansion Project, Steelpoort, Limpopo and Mpumalanga Province.

ImproChem: Booysendal Platinum (Ltd) Water Treatment Plant (95m$^3$/h, 9m$^3$/h, 105m$^3$/h).

Jones and Wagner, 2016: Northam Platinum Tailings Waste Assessment for Booysendal Central Mine (JW246/16/F884).

Kirjani Green, 2017: Specialist Air Quality and Greenhouse Gas Report, issued by Simon Gear.

Letsolo Water and Environmental Services, June 2017: Booysendal Mine Section 24G and Environmental Authorisation Hydrological Impact Assessment.

Letsolo Water and Environmental Services, April 2018: Booysendal South Expansion Project (EMP, EIA): Specialist Hydrological Study.

Limpopo Province, 2007: Limpopo Province Spatial Development Framework – GA15U.

Natural Scientific Services, June 2017: Fauna and Flora Baseline and Impact Assessment Report – Booysendal South EMP Amendment and Associated Authorizations and Section 24G Rectification Application.

Natural Scientific Services, May 2018: Flora and Fauna Baseline and Impact Assessment Report – Booysendal South.

Sekhukhune District Municipality, 2017: Final IDP 2016/17 – 2020/21.

Sekhukhune District Municipality, 2016: District Rural Development Plan – Sekhukhune District Municipality, Limpopo Province

SLR, Jan 2017: Booysendal Central – Construction Phase Erosion Control and Silt Management, NFTR, File Ref. 170123.

SLR, June 2017: Surface Water Study for BS4.

SNA Civil and Structural Engineers, May 2016: Booysendal Central Permanent Access Road: Valley Boxcut to Booysendal North Mine.

SNA Civil and Structural Engineers, Augustus 2016: Booysendal to Everest Storm Water Technical Report – Permanent Road.

Social Enterprise Solutions, April 2018: Social Impact Assessment – Social Baseline Study: Booysendal South Expansion Project.

Social Enterprise Solutions, April 2018: Social Management Plan – Booysendal Operations.

Social Enterprise Solutions, April 2018: Social Impact Assessment – Social Baseline Study: Booysendal South Expansion Project.

Stephen R.D., December 2017: Follow-up Ecological Study on the Impact of Mining Infrastructure on the Population of the Endemic Cicada *Pycna Sylvia* in the Dwars River Valley, Mpumalanga between Booysendal and the Booysendal South Mines

Sustainable Slurry and Backfill Solutions, 2017: Everest Mine Concept Backfill Study, Report Ref No. 0003-0000-40ER-0001.

Terra-Africa, 2018: Booysendal South expansion Project Phase 2 Soil, Land Use and Land Capability Report.

Thaba Chweu Local Municipality, 2017: Integrated development Plan 2017 – 2022 Term.

The Greater Tubatse Municipality, 2016: Final Integrated Development Plan 2016/2017 – 2020/21.

The Greater Tubatse Local Municipality, 2007: spatial Development Framework for the Greater Tubatse Local Municipality.

Wetland Consulting Services, 2018: Wetland Specialist Report: Northam Platinum Limited, Booysendal South Expansion Project (Ref: 1225b-2017).

Wetland Consulting Services, June 2017: Wetland Environmental Management Plan (EMP), Booysendal Mine EIA/EMP Amendment and S 24 G Application (Ref: 1225a-2017).

Wetland Consulting Services, June 2017: Wetland Specialist Report: Northam Platinum Limited, Booysendal EMP Amendment and S 24 G Application (Ref: 1225a-2017).

# Annexure A

## Environmental Assessment Practitioner CV

# Annexure B

## Stakeholder Engagement Report

# Annexure C

## Environmental Management Program

# Annexure D

## Air Quality and Greenhouse Gas Assessment

# Annexure E

## Hydrogeological Assessment

# Annexure F

## Hydrology and Storm Water Management Plan

# Annexure G

## Soil, Land Use and Land Capability Assessment

# Annexure H

## Water Quality Assessment

# Annexure I

## Wetland and Wetland Delineation Report

# Annexure J

## Aquatic Biodiversity Assessment

# Annexure K

## Terrestrial Ecology Assessment

# Annexure L

## Social Study

# Annexure M

## Cultural Heritage Assessment

# Annexure N

## Noise and Vibration Assessment

# Annexure O

## Traffic Impact Assessment

# Annexure P

## Visual Impact Assessment

# Annexure Q

A3 Drawings