ENVIRONMENTAL IMPACT

MANAGEMENT SERVICES

INTEGRATED ENVIRONMENTAL SCOPING REPORT FOR THE PROPOSED PAARDEPLAATS COAL MINE

PREPARED ON BEHALF OF:

EXXARO RESOURCES (PTY) LTD

AS PER REGULATION 49 OF THE MPRDA & REGULATION 28 OF THE NEMA

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DOCUMENT CONTROL

0880: Integrated Environmental Scoping Report for the Proposed Paardeplaats Coal Mine

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REVISION AND AMENDMENTS

DATE	No.	DESCRIPTION OF REVISION OR AMENDMENT
2012/07/31	0	0880: Draft Environmental Scoping Report for the Proposed Paardeplaats Coal Mine
2012/10/10	**1**	0880: Integrated Environmental Scoping Report for the Proposed Paardeplaats Coal Mine

EXECUTIVE SUMMARY

Exxaro Coal Mpumalanga (Pty) Ltd (hereafter referred to as Exxaro), a subsidiary of Exxaro Coal (Pty) Ltd and owned by Exxaro Resources Limited submitted a New Order Mining Right Application, in terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002, MPRDA) to the DMR in 2011 for the proposed Paardeplaats Coal Mine. The application was subsequently accepted on 19 June 2012 and a Draft Scoping Report was submitted to the DMR on 19 July 2012. The Draft Scoping Report included only the details of the planned Public Particpation Process (PPP) which was to be followed but did not include the results of any I&AP interaction due to the Authority issued deadline dates. As such, the PPP notification phase and Draft Scoping Report review phase was launched on 1 August 2012. An intial Public Open Day was also held to introduce I&AP's to the proposed project and solicit further comment for inclusion/consideration into the final Scoping Report. I&AP's were afforded 45 days to register for the project, review the Draft Scoping Report and submit comment. The Initial Public Open Day was held on 31 August 2012 at the Belfast Gold Club and ran from 09:00 – 18:00. As such, this Integrated Scoping Report represents and includes any comment received from I&AP's during the period of 1 August – 15 September 2012 and is considered the final Integrated Scoping Report to be re-submitted to the DMR and submitted simultaneously to MDEDET.

The area covered by the Mining Right Application is located on Portions 13, 28, 29, 30 and 40 of the Farm Paardeplaats 380 JT and the Remaining Extent and Portion 2 of the Farm Paardeplaats 425 JS. The proposed Mining Right Application is located directly south of and on the border of the existing Exxaro owned Glisa NBC Coal Mine. The application area is approximately 1 415 Hectares and falls within the jurisdiction of the eMakhazeni Local Municipality in the Nkangala District Municipality of Mpumalanga.The closest town to the project is Belfast.

BRIEF PROJECT DESCRIPTION

The proposed Paardeplaats Coal Mine is intended to be an extension of the existing, approved Glisa NBC Coal Mine also owned and operated by Exxaro. As such, the Paardeplaats project is aimed at supplying Run of Mine (RoM) to Glisa NBC Coal Mine at a rate of 4.2 – 4.4 mtpa of which the majority of the coal will be supplied to Eskom for electricity generation. The mining method employed at Paardeplaats is a hybrid of roll-over mining as well as bench/box cut mining. The roll-over mining will be used where only one seam is present, as well as where the overburden has a thickness less than 20m. The bench/box cut mining method will be used where two or more seams are present and where the overburden has a thickness of more than 20m. This hybrid mining method will allow for the extraction of coal from both shallow and deeper target coal seams.

As an extension of Glisa, the proposed infrastructure of the Paardeplaats Coal Mine will be limited due to mineral processing and waste disposal operations occurring exlusively at Glisa Coal Mine. The limited infrastructure confirmed for the project will consist of the following:

- Mining Activities (open-cast pits);
- Pollution control and return water dams;
- Storm water management including clean and dirty water separation systems;
- Access and haul roads;
- Pipelines;
- RoM Stockpiles;
- Diesel storage;
- Mobile office and ablution block; and
- Temporary general waste storage area.

PROJECT TIMELINE

The project timeline from receipt the DMR Acceptance Letter to submission of the Final Integrated Scoping Report is provided in the Figure below.

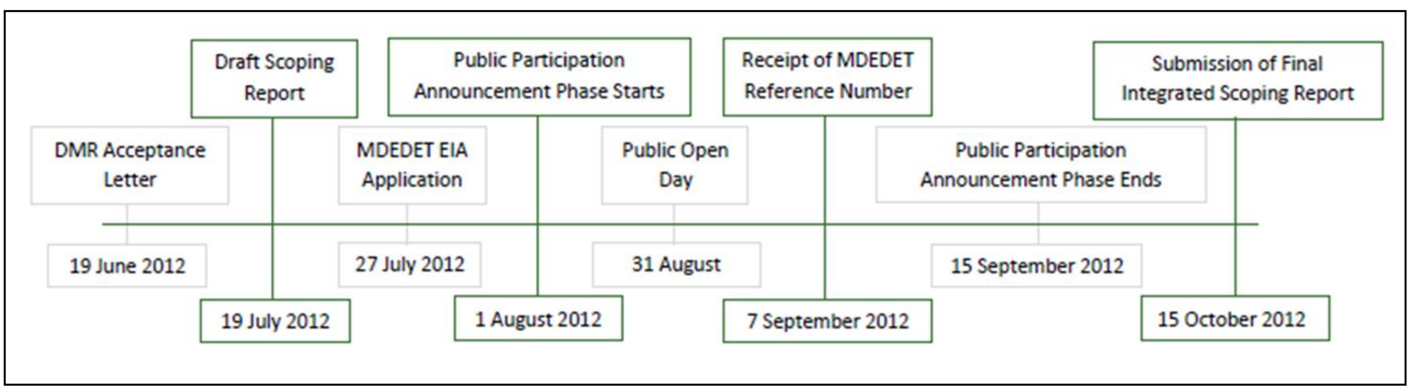

Figure 1: Project timeline for scoping phase

ENVIRONMENTAL BASELINE

This section provides a brief overview of the receiving environment. Please refer to the main document for the detailed description of the environmental baseline. All baseline information was obtained from specialists undertaking studies on the various environmental aspects listed below.

CURRENT LAND USE

The current land uses on site comprises of a mixture of commercial agriculture (arable and grazing), irrigation in the south-west for the Hadeco tulip nursery and farm homesteads for workers. Most of the commercial agriculture on site involves the farming of maize monoculture as well as grazing for livestock such as cattle, sheep, springbok and blesbok. Some dams are present and used for trout fishing on a small commercial scale and recreationally by surface rights holders.

SOILS

The area under investigation is covered by two land types, namely Ad1 (Yellow-brown, structureless, highly weathered soils); and Ib34 (Rock with shallow soils). The study area is dominated by yellow-brown, structureless soils. The texture generally varies slightly from sandy clay loam to clay, and the effective depth also varies somewhat, generally between 500 and 1000 mm. There are also significant areas of shallow soils, along with some surface rock outcrops. The agricultural potential of the site, based on soils forms varies between low and moderate.

CLIMATE

The climate of the study area is typical of the South African Highveld and is characterised by warm, moist summers with cool, dry winters. On average, 85% of the annual average rainfall of 757 mm falls in the growing season (October to March). Frost, often severe, occurs in winter. The extreme maximum temperature is 35.6^{o}C and the extreme minimum –13.3^{o}C.

ECOLOGY (FLORA AND FAUNA)

651 ha (46%) of the site is considered natural vegetation of the Eastern Highveld Grassland, according to Mucina & Rutherford (2006), which is under severe pressure from grazing. This regional vegetation unit is classified as Endangered. According to the latest national land cover 2000 dataset, 77% of the study area is considered to be natural and 20 % is considered to be transformed. The vegetation community associated with the outcrops contains the highest species richness, but in the context of study area all the remaining natural vegetation has a high sensitivity and therefore a high conservation significance. In terms of persistent grassland within the study area, two areas are of very high conservation significance, the area to the northeast (most of Portion 13 and a small area of Portion 29) and the area along the Steelpoort River (most of Portion 40, and parts of Portions 28, 29, 2, and RE). The study site sustains a remarkably high diversity of bird species including many with strong highveld affinities (Portions 13, 28, 40, 2, and RE). However, anecdotal evidence suggests that the long-term effect of the current grazing regime in the region will be detrimental for the persistence of conservation-dependant bird

species on the site, such as the Blue Crane (*Anthropoides paradiseus*), the African Marsh Harrier (*Circus ranivorus*), the Lesser Kestrel (Falco naumanni), the Southern Bald Ibis (*Geronticus calvus*), the Secretarybird (*Sagittarius serpentarius*), and the Broad-tailed Warbler (*Schoenicola brevirostris*). This study area also has two distinct areas of high herpetofauna sensitivity and it is likely that the three species of conservation concern may occur here (Portions 28, 2, and RE, most of Portions 13 and 40, and a small area of Portion 29). In addition, there is a strong presence of carnivores such as the Side-striped Jackal (*Canis adustus*), the Brown Hyaena (*Hyaena brunnea*), and the Serval (*Leptaiurus serval*), within the study area that suggests the area is exhibiting an overall sound system health. Preliminary evidence suggests that up to eight servals (IUCN Near-Threatened) are resident on the study area and in the neighbouring Glisa Coal Mine.

WETLANDS

Approximately 27% of the Paardeplaats study area is considered to be covered by wetlands, making up a combined wetland extent of over 338 ha (Table 48). A number of different wetland types were identified, with hillslope seepage wetlands being the dominant wetland type and making up more than 70% of the wetland area on site. Several dams were also identified within the wetlands, totalling just over 27 ha. According to the Ecological Importance and Sensitivity Assessment, the majority of the wetlands in the study area are considered to be of High (42.75%) and Moderate (41.78%) ecological importance and sensitivity, and a small proportion (15%) are considered to be of Low importance and sensitivity.

GROUND AND SURFACE WATER

The proposed Paardeplaats Coal Mine is located on quaternary B41A of the Olifants River catchment (Primary catchment B). A small part of the area of investigation falls into quaternary catchment X11D of the Crocodile/ Komati Catchment (Primary Catchment X). The area forms part of the headwaters of two river systems, one flowing to the northwest (Steelpoort River) and the other to the south (Komati River). The topographic elevation ranges from 1800 to 1905 metres above mean sea level (mamsl). A number of small sized dams are located on the streams feeding onto major rivers within the area. In terms of ground water, the water bearing strata is mainly the sandstones above the coal seams with the major flow path being on the contact between the sandstone and coal strata. The water quality samples on site range from relatively good to deteriorated likely due to contamination from mining and agriculture.

AIR QUALITY

Several mines are located close the proposed Paardeplaats Coal Mine, contributing to fugitive emissions and deterioration in general air quality of the area. The specific baseline air quality will be determined during the EIA level study. Emissions from opencast and underground mining operations comprise of land clearing operations, materials handling, transport of RoM, wind erosion from open areas and drilling and blasting operations. The prevailing winds come from the north-westerly and easterly sectors.

ARCHAEOLOGY AND HERITAGE

A total of approximately 55 built structures (single or groups) of possible heritage significance are indicated to be within or on the boundaries of the study area. Accurate identification and determination of these structures will be undertaken during the EIA investigation, which is currently underway.

SOCIO-ECONOMIC

The Nkangala District Municipality (NDM) is one of the three district municipalities in Mpumalanga. Local municipalities forming part of the Nkangala DM are Delmas, Dr. JS Moroka, Emalahleni, eMakhazeni, Steve Tshwete, and Thembisile, as well as the Mdala District Management Area. The district is approximately 17 000 km^2 and consists of about 165 towns and villages, with Emalahleni and Middelburg being the primary towns. The Nkangala DM has a population of approximately 1.1 million people.The district's economy is dominated by electricity, manufacturing and mining. Community services, trade, finance, transport, agriculture and construction) are also important sectors. Nkangala's Integrated Development Plan (IDP) states that the district has extensive mineral deposits, including chrome and coal. Another important economic activity in Nkangala is agriculture. The southern regions of the municipality are suitable for crop farming, specifically for fresh produce such as maize and vegetables, while cattle and game farming occur in the northern regions.

In terms of the population profile of the Nkangala DM, the majority of its inhabitants are extremely poor and do not have access to mainstream economic activities. The main poverty concentration is amongst the communities residing in Dr. JS Moroka and Thembisile Local Municipalities. The most important employment centre for these communities is the City of Tshwane, reducing their reliance on NDM and daily commuting by means of public transport is a necessity.

LIST OF POTENTIAL IMPACTS

The following potential impacts have been identified during the Scoping Investigation. These are preliminary impacts only and further identification will be undertaken during the detailed EIA investigation. Impact identification and calculation as well as consideration of appropriate mitigation measures will be undertakenby relevant specialists for their particular environmental aspects.

SOILS, LAND USE AND CAPABILITY

- Loss of agricultural land;
- Change in future land use options;
- Contamination/pollution of soil resource;
- Erosion;
- Damage to natural drainage systems; and
- Damage to prevailing topography.

ECOLOGY (FLORA AND FAUNA)

- Ecosystem fragmentation;
- Damage to sensitive and conservation important vegetation types/habitats;
- Death/disturbance of fauna and flora;
- Disruption of habitat range for sensitive and conservation important species;
- Loss of availbale habitat for red list data and conservation important species;
- General loss of biodiversity; and
- Introduction or spread of declared Category 1, 2 & 3 invader species and alien invasive vegetation.

WETLANDS

- Damage to or destruction of wetlands;
- Changes to water quality of wetlands;
- Changes to availbale water quanitity for wetlands; and
- Alteration/damage/disturbance to aquatic ecology

GROUND AND SURFACE WATER

- Alteration of current groundwater regime and levels;
- Increase in total dissolved solids in the groundwater;
- Potential acidification of ground water due to oxidation of pyrite;

- Contaminants from the mine (including backfilled opencast pits and return water dams) can seep through the unsaturated zone into the groundwater system;
- If groundwater feeds surface water bodies such as wetlands and streams, these can also be polluted;
- Alteration/destruction/damage to surface water bodies such as streams due to mining operations; and
- Changes in surface water quality and quantity

AIR QUALITY

- Increase in gaseous and particulate emissions (including VOCs);
- Increase in Fugitive dust emmissions;
- Increase in fallout dust from mining activities and traffic;
- Possible PM_{10} molecule generation; and
- Health concerns for sensitive receptors

CULTURAL AND HERITAGE

- Destruction or damage to palaeontological resources;
- Destruction or damage to archaeological sites;
- Destruction or damage to historical sites; and
- Disturbance to cemeteries or grave sites.

SOCIO-ECONOMIC

- Expectations regarding social and economic benefits;
- Expectations regarding creation of opportunities (Jobs etc.);
- Impacts of traffic on people – dust, noise, safety – from a social and nuisance perspective;
- Safety of community – possible increase in crime due to increased number of strangers in community.
- Negative community relations due to conduct of contractors / representatives from mine.
- Impacts of construction camp – HIV/AIDS, movement of people etc. (This impact would only occur if there is a construction camp);

- Influx of people – also possible social disintegration and cultural differentiation;
- Creation of jobs and other economic opportunities;
- For some stakeholders their sense of place may change;
- Visual – the landscape will look different;
- Noise and vibrations resulting from blasting damage surrounding properties;
- Concerns that quality and quantity of underground water impacted on by mine will affect livelihoods (Especially since water is a scarce commodity in the area);
- Negative community relations due to conduct of contractors / representatives from mine;
- Additional social infrastructure; and
- Historical grievances with Glisa Coal Mine.

NOISE

- Noise nuisance;
- Source noise from construction activities;
- Increased sound pressure levels;
- Noise from mining activites such as drilling, blasting and hauling operations; and
- Increase in noise from increased traffic.

VISUAL

- Loss of landscape value; and
- Change in sense of place

BLASTING AND VIBRATION

- Increased noise and vibration nuisance ;
- Damage to structures;
- Loss of productivity of farm animals due to vibration;
- Damage to roads;
- Damage to boreholes;
- Air blast;

- Pollution of borehole water;
- Fly rock; and
- Noxious fumes.

The list of potential impacts identified during the Scoping Investigation represents a preliminary list of impacts. These impacts will be further refined through accurate identification, calculation and suggestion of appropriate mitigation measures during the detailed EIA investigation currently underway. During the EIA investigation and through consultation with Interested and Affected Parties (I&AP's) the potential impacts on the receiving environment, as a result of the proposed Paardeplaats projects both real and perceived, will be clearly identified, assessed and appropriate mitigation measures provided.

LIST OF ALTERNATIVES

Three feasible alternatives have been identified and will be further assessed during the detailed EIA investigation. The alternatives include:

- The No-Go Alternative;
- Sensitivity Approach Alternative; and
- Maximum Mine Production Alternative.

The No-Go Alternative will assess the environmental impact of the propsed project in the event that it is not authorised or approved. This is the least preferred alternative. The most preferred alternative is the Sensitivity Approach which will be used to assess which portions and site specific features are of high sensitivity and warrant careful planning in order to avoid or minimise the impact on highly sensitive receptors. The Maximum Mine Production Approach will assess the environmental impact of the proposed project as per the mining schedule included in the Mines Work Programme (MWP).

All of the above feasible alternatives identified will be comparatively assessed during the detailed EIA investigation.

PUBLIC PARTICIPATION PROCESS

The Integrated public participation process was initiated on 1 August 2012. I&AP's were identified through Windeed searches for property owners, on site and surrounding owners. In addition, the existing Glisa Coal Mine I&AP database was also used to identify I&AP's to be notified of the proposed project. Notification documents were drafted and sent via registered post, facsimile, and e-mail on 31 July 2012 to all I&AP's in the identified and captured in the I&AP project register.

The notification documents included a Background Information Document (BID), the details of which are provided below. A copy of the Draft Scoping Report was made available in the Belfast Library and on the EIMs website on 1 August 2012. Site notices and posters were placed in Belfast and around the study area on 1 August 2012 and an advertisement was placed in the legal section of the Beeld national newspaper also on 1 August 2012. The first public open day was held on 31 August 2012. IAP's were given until the 15th September 2012 for initial notification, registration, and comment on the Draft Scoping Report. A second newspaper adverstiment was place in the Middleburg Herald on 28 September 2012 in order to remind I&AP's of the project and request their continued involvement. An additional Open Day will be held at a date to be determined to inform I&AP's of the results of the EIA investigation and solict further comment. The results of which and any further I&AP comment will be included in the EIA.

The majority of I&AP's, including those present at the Open Day were concerned with blasting, socio-economic impacts, noise, rehabilitation, and the effect of mining activities on the current receiving environment.

- The effect of blasting on the the surrounding environment was raised by 64% of the I&AP's (14);
- The effect of the proposed project on the current receiving environment on was raised by 59% of the I&AP's (13);
- The socio-economic impacts of the mining activities, rehabilitation of the area, and the impact of noise on the surrounding environment were each raised by 50% of the I&AP's (11);
- The impacts of dust, vibration, air quality, and run-off management were each raised by 45% of the I&AP's (10); and
- Historical grievances with Glisa Coal Mine, the extent of the mining area, and the impact on drainage were each raised by 41% of the I&AP's (9).

Two objections were recorded from Birdlife SA and Hadeco respectively who object to the project. Birdlife SA's objection is based on the project area falling within the Steenkampsberg Important Bird Area (IBA) and is considered important in terms of avifauna conservation and Hadecos objection is based on the potential impact mining may have on their current tulip farming operations.

CONCLUSION

This document represents the completion of the Scoping Report and has been formulated with due regard to the regulations of both the MPRDA and NEMA. All baseline environmental information was compiled by specialists and sourced from existing background information of relevance to the project such information on the existing Glisa Coal Mine.

The preliminary environmental impacts identified will be further refined, calculated and assessed for all the feasible alternatives identified.Mitigation and management measures will also be indeitfied and suggested for all impacts by specialists. The document also includes I&AP comment received during the PPP notification phase and collected during the initial Public Open Day. The PPP is on-going and any additional comment collected from I&AP's during the EIA investigation will be included in the EIA report, which like the scoping report, will also be reviewed by I&AP prior to submission

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1 PROJECT BACKGROUND

1.1 INTRODUCTION

The proposed Paardeplaats Project will comprise of an opencast coal mine and the mining method employed will be a hybrid of roll-over and bench/box cut mining designed to target both shallow and deeper target coal seams. As a result of detailed geological and engineering investigations undertaken the creation of an opencast coal mine as opposed to underground mining is feasible and due primarlilly the depths of the target coal seams present within the proposed mining area. The proposed operation is located near the town of eMakhazeni (Belfast), Mpumalanga (Figure 2). The current land uses in the region mainly include crop and livestock farming activities and adjacent coal mining operations. The closest residential development to the project area is EMakhazeni ~2 km to the north-east and Siyathuthuka ~3km north. The general topography of the site is characterised by gently rolling terrain with no steep inclines.

1.2 PROJECT LOCATION

The proposed Paardeplaats Coal Mine is located on Portions 13, 28, 29, 30 and 40 of the farm Paardeplaats 380 JT and Remaining Extent and Portion 2 of the farm Paardeplaats 425 JS. The proposed site covers an area of approximately 1 415 ha and falls within the jurisdiction of the eMakhazeni Local Municipality in the Nkangala District Municipality.

The study area lies approximately 2 km west of eMakhazeni (formerly Belfast) in the Mpumalanga Province (Figure 3). It is linked to Mhluzi via the N4 highway.

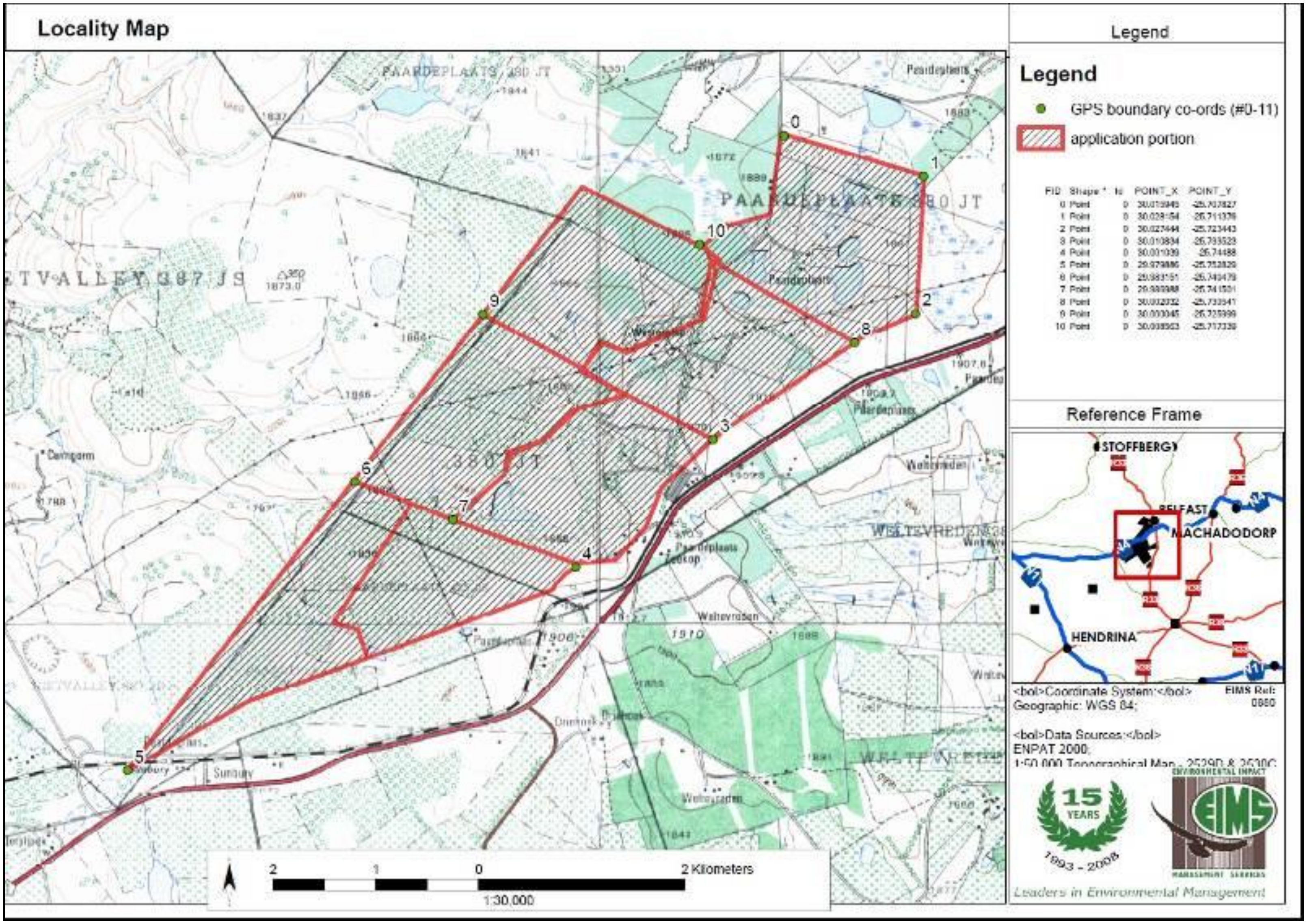


Figure 2: Map of the Paardeplaats project area

1.2.1 SURFACE OWNERSHIP

A list of farm portions and registered surface rights owners for the proposed project is provided below:

Table 1: List of farm portions and registered landowners in the project area

Farm Name	Farm Portion	Registered Owner
Paardeplaats 380 JT	13	Neville Wilke & Marquerite Eiselen
Paardeplaats 380 JT	28	Exxaro
Paardeplaats 380 JT	29	Hadeco
Paardeplaats 380 JT	30	Exxaro
Paardeplaats 380 JT	40	Hadeco
Paardeplaats 425 JS	2	Exxaro
Paardeplaats 425 JS	Remaining Extent	Exxaro

1.2.2 COMMUNITY DESCRIPTION

The proposed Paardeplaats project falls within the jurisdiction of the eMakhazeni Local Municipality in the Nkangala District Municipality. Most people in the surrounding area are fairly poor with a relatively low standard of living and high levels of unemployment. Educational and skills levels are not very high. The Hadeco Village is the only community identified within the project application area and is comprised of farm/nursery workers for Hadeco’s tulip nursey operations. No other communities were identified within the study area. Hadeco has 60 direct employees with between 12 and 150 seasonal employees. Schooling and housing amenities are provided by Hadeco for the employees. A further 85 jobs (as explained by Mr. Stuart Baarnhoorn of Hadeco) are created directly at the Hadeco Head Office due to the Paardeplaats operation, with further jobs created indirectly.

1.3 BRIEF PROJECT DESCRIPTION

This section provides a brief overview of the proposed Paardeplaats project. Please refer to Section 4 for a detailed project description.

The proposed Paardeplaats project will supply Run of Mine (RoM) to the existing Glisa Coal Mine beneficiation plant at a rate of 4.2 – 4.4 mtpa and supply final product to Eskom at a rate of 2.4 mtpa. The mining method will be a hybrid between roll-over mining as well as bench/box cut mining. The roll-over mining will be used where only one seam is present, as well as where the overburden has a thickness less than 20m. The bench mining will be used where two or more seams are present and where the overburden has a thickness of more than 20m. This hybrid mining method will allow for the extraction of coal from both shallow and deeper targeted seams.

The stripping operation removes the topsoil and exposes the overburden of the next cut. The continuity of this process is essential in order to ensure that sufficient workroom is maintained. The initial topsoil will be hauled to a designated area and be used for rehabilitation of the last cuts of opencast mining. When steady state is reached, topsoil is replaced in a continuous operation. The overburden will be drilled and blasted. The overburden removal operation will be done in two phases. The top portion will be loaded and hauled; the lower portion will be done via a dozing process. This will ensure that the rehabilitation is adequately addressed by means of a backfilling process. Once the overburden has been removed, the coal (RoM) is transferred to the Glisa Coal Mine plant by means of a load and hauls operation (haul trucks). The mineral deposit consists of the No. 2 seam of the Springs-Witbank Coalfield in Mpumalanga.

The proposed Paardeplaats Coal Mine and associated mining surface infrastructure is limited due to all mineral processing occurring on the adjacent established Exxaro owned and operated Glisa Coal Mine. As such the mining and surface infrastructure, if approved, of the Paardeplaats project will consist of the following:

- Mining Activities (opencast pits);
- Pollution control and return water dams;
- Storm water management including clean and dirty water separation systems;
- Access and haul roads;
- Pipelines;
- RoM Stockpiles;
- Diesel storage;
- Mobile office and ablution block; and
- Temporary general waste storage area.

1.4 MOTIVATION FOR THE PROJECT

Coal is one of the five minerals selected for local beneficiation by the Department of Mineral Resources (DMR) because of its strategic importance and is considered critical to the on-going development of South Africa (Beneficiation Strategy for the Minerals Industry, June 2011). The driving force behind the emphasis of the importance of coal and coal mining is primarily due to concerns voiced by Eskom over the future security of coal supply in both the medium and long term, to its electricity generating power stations in order to meet the growing energy requirements of the country as detailed in the Eskom Transmission Ten Year Development Plan 2011-2020 (Eskom, 2011).

Eskom's concern over coal supply to its power stations has been heightened due to competition from Indian buyers for the low grade coal required by that country's power stations and for which, until recently, there has been no viable export markets. As such, the proposed Exxaro Paardeplaats Coal Mine is required by Exxaro Coal Mpumalanga (Pty) Ltd. in order to extend the Life of Mine (LoM) of the existing approved Glisa North Block Complex (NBC) Coal Mine. Glisa NBC Coal Mine has an existing agreement to supply Eskom with coal for their Tutuka, Komati, Arnot, Camden, and Majuba coal fired power stations. As a result of the reduction in RoM and corresponding reduction in LoM of Glisa NBC, the Paardeplaats Coal Mine is required in order to extend coal mining and supply by Exxaro in order to fulfil its obligation to provide secure steady supply of coal to Eskom for power generation. The LOM of Glisa Coal Mine is estimated at between 4-8 years worth of supply.

It is anticipated that the proposed Paardeplaats Coal Mine will target a RoM production rate of between 4.2 – 4.4 million tonnes per annum (mtpa) and the available reserve is approximately 76.65 million tonnes which equates to approximately 20 years' worth of coal production and 20 years' worth of secure supply to Eskom in order to meet South Africa's growing energy needs. On occasion the Paardeplaats Coal Mine may also produce coal of export quality namely A-Grade and P-58 coal which will be exported to markets in Asia, Europe and the USA (Exxaro Paardeplaats Mine Work Programme, 2011). The proposed Paardeplaats Coal Mine will also provide limited additional employment opportunities as well as benefits in the form of:

- Long-term employment retention at Paardeplaats of existing Glisa Coal Mine staff;
- On-going economic input into the area;
- Establishment of infrastructure;
- Maintenance of the regional socio-economic benefit;
- Secure on-going local supply of coal to Eskom which will ensure supply of electricity to South Africa; and

- Supply markets in Asia, Europe, and the USA with export quality coal.

In summary, the Paardeplaats Coal Mine is of critical importance and will align directly with the goals of Eskom in order to meet the rising energy demand of South Africa by producing 20 years' (according to the Mine Works Programme) worth of secure, steady coal supply for power generation and occasional export to other markets abroad as well as increasing the LOM of Glisa Coal Mine.

1.5 ENVIRONMENTAL SPECIALIST TEAM

Exxaro has appointed Environmental Impact Management Services (Pty) Ltd (hereafter referred to as EIMS) to act as the independent Environmental Assessment Practitioner (EAP) for the proposed Paardeplaats project. EIMS consists of a team of specialists from a broad range of fields.

1.5.1 ENVIRONMENTAL IMPACT MANAGEMENT SERVICES (PTY) LTD

Environmental Impact Management Services (Pty) Ltd (EIMS) was founded in 1993 and has steadily grown to be a significant player in the environmental management consulting industry in South Africa and the rest of Africa. Environmental management and sustainable development have become business imperatives in the 21st century. EIMS is responsible for project management and the compilation of the, EIA, EMP (EMPR), and WULA for the Paardeplaats project with the guidance from the independant specialists listed below.

1.5.2 SPECIALIST CONSULTANTS

The following table lists the specialists responsible for each component of the scoping report and EIA investigation which is currently underway:

Table 2: Components of the scoping phase study and the specialist companies responsible

Component	Company Responsible
Air Quality	Airshed Planning Professionals (Pty) Ltd.
Blasting and Vibration	Blast Management & Consulting
Ecology (Fauna and Flora)	EkoInfo CC & Associates
Heritage	PGS Heritage & Grave Relocation

	Consultants
Hydrology (Ground and Surface Water)	Aqua Earth Consulting (AEC)
Noise	Jongens Keet Associates (JKA
Rehabilitation, Final Land Use and Closure	Reichardt and Reichardt Consulting
Sensitive Receptors Screening	GCS (Pty) Ltd
Social and Economic	Ptersa Environmental Management Consultants and Strategy4Good
Soils, Land Use and Land Capability	The ARC-Institute for Soil, Climate and Water (ARC-ISCW)
Traffic	Arup Consulting
Visual	Newtown Landscape Architects (NLA)
Wetlands and Aquatic Ecology	Wetland Consulting Services (Pty) Ltd

2 LEGAL FRAMEWORK

2.1 APPLICABLE LEGISLATION

The legal framework within which the proposed Paardeplaats Coal Mine is governed by many Acts, Regulations, Standards, Guidelines and Treaties on an international, national, provincial and local level. Legislation applicable to the project includes (but is not limited to):

2.1.1 THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT

The Mineral and Petroleum Resources Development Act (Act No. 28 of 2002, MPRDA) aims is to “make provision for equitable access to and sustainable development of the nation’s mineral and petroleum resources”. The MPRDA outlines the procedural requirements that need to be met to acquire mineral rights in South Africa. In this regard Exxaro have compiled and submitted a new order mining right application to the DMR. The application was consequently accepted and the applicant is now required to, as per Section 22(4)(a) & (b) to conduct an environmental impact assessment and submit an environmental management programme for approval as well as to notify in writing and consult with interested and affected parties within 180 days of acceptance.

The MPRDA also requires adherence with related legislation, chief amongst them is the National Environmental Management Act (Act No. 107 of 1998, NEMA) and the National Water Act (Act No. 36 of 1998, NWA).

2.1.2 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT

The National Environmental Management Act (Act No. 107 of 1998, NEMA) aim is to "provide for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; and to provide for matters connected therewith." The Act outlines the procedural requirements that need to be met to achieve this. The following table identifies the Listed Activities the proposed Paardeplaats project triggers and consequently requires authorisation in terms of NEMA prior to commencement:

Table 3: Listed Activities triggered by the proposed Paardeplaats project

Indicate the number and date of the relevant notice:	Activity No (s) (in terms of the relevant or notice) :	Describe each listed activity as per the detailed project description (and not as per wording of the relevant Government Notice):	Triggered by:
Activities for Basic Assessment:			
GNR 544 of 18 June 2010	Activity 9	The construction of a pipeline exceeding 1000m in length for the transportation of water	Pipeline construction
GNR 544 of 18 June 2010	Activity 11	The construction of canals, channels, dams and bulk stormwater outlets to be constructed within a watercourse	Pollution Control Dam & Storm water management infrastructure
GNR 544 of 18 June 2010	Activity 12	The construction of infrastructure for the off-stream storage of water with a combined capacity of 5000 cubic m	Pollution Control Dam Construction
GNR 544 of 18 June 2010	Activity 13	The construction 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 but not exceeding 500 cubic metres	Construction of diesel storage area.
GNR 544 of 18 June	Activity 22	The construction of a road outside of urban areas:	Haul roads.

2010		(i) with a reserve wider than 13,5m (ii) where no reserve exists where the road is wider than 8m	
GNR 544 of 18 June 2010	Activity 26	Any process of activity identified in terms of Section 53(1) of the National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004)	Proposed project is located in a vulnerable eco-system namely Easter Highveld Grassland.
GNR 544 of 18 June 2010	Activity 47	The widening of a road by more than 6m or the lengthening of a road by more than 1Km: (i) where the existing reserve is wider than 13,5m (ii) Where no road reserve exists, where the existing road is wider than 8m	Haul roads
Activities for Scoping, EIA and EMP:			
GNR 545 of 18 June2010	Activity 5	The construction of facilities/infrastructure for any process or activity which requires a permit or license in terms of the national or provincial legislation governing the generation/release of emissions, pollution or effluent and which is not identified in GNR 544 or included in the list of Waste Management Activities published in terms of NEMWA.	Construction and operation of the temporary general waste storage area. Activity 5 will be applied for under the NEMWA Category A Activity 1
GNR 545 of 18 June2010	Activity 15	Physical alteration of undeveloped, vacant or derelict land for industrial use where the total area to be transformed is 20 hectares or more	Open pit creation
GNR 545 of 18 June2010	Activity 19	The construction of a dam where the highest part of the wall is 5m or higher or where the high water mark of the dam covers an area of 10 hectares or more	Construction of Pollution Control Dams.
GNR 545 of 18 June2010	Activity 20	Any activity which requires a mining right or renewal thereof as contemplated in Section 22 and 24 respectively of the	Construction and operation of the pollution control

		MPRDA (Act. No. 28 of 2002)	dam
Provincial Specific Activities:			
GNR 546 of 18 June 201	Activity 12	The clearance of an area of 300 square metres of more where 75% constitutes indigenous vegetation within a critically endangered or endangered eco-system listed in terms of Section 52 of the NEMBA	Vegetation clearance of Eastern Highveld Grassland for the proposed mine.
GNR 546 of 18 June 2012	Activity 14	The clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative covers constitutes indigenous vegetation in all areas outside of urban area.	Vegetation clearance for the proposed mine
GNR 546 of 18 June 2010	Activity 16	The construction of : (iii) Buildings with a footprint exceeding 10 square metres in size or (iv) Infrastructure covering 10 square metres or more Where such construction occurs within 32m of a watercourse	Construction of the mobile office and ablution block as well as storm water management infrastructure and pollution control dam.
Activities for Waste Management License (WML) for Basic Assessment:			
Category A of July 2009	Activity 1	Construction and operation of the waste storage facility The storage, including temporary storage of general waste at a facility that can store in excess of 100 cubic m of waste at one time, excluding waste stored in a lagoon.	Storage of general waste

The requirements of the NEMA also includes due consideration of the following Acts:

- National Environmental Management: Waste Management Act (Act No. 59 of 2008, NEM:WA);
- The National Environmental Management: Air Quality Act (Act No. 39 of 2004, NEM:AQA); and
- The National Environmental Management: Biodiversity Act (Act No. 10 of 2004, NEM:BA).

2.1.3 THE NATIONAL WATER ACT

The National Water Act (Act No. 36 of 1998, NWA) aims to "provide for fundamental reform of the law relating to water resources; to repeal certain laws; and to provide for matters connected therewith." To comply with this Act Exxaro will need to apply for the following Section 21 water uses:

- Section 21 (a) – Taking water from a water resource;
- Section 21(b) – Storing water;
- Section 21(c) - Impeding or diverting the flow of water in a watercourse;
- Section 21(d) - Engaging in a stream flow reduction activity contemplated in section 36;
- Section 21(f) – Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
- Section 21(g) - Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21 (i) – Altering the beds, banks, course or characteristics of a water course; and
- Section 21(j) - Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people;

2.1.4 THE NATIONAL HERITAGE RESOURCES ACT

The primary piece of legislation protecting national heritage in South Africa, is the South African Heritage Resources Act (Act No. 25) of 1999. In accordance with Section 38 (Heritage Resources Management) of the Act, developers must apply to the relevant authority (South African Heritage Resources Agency - SAHRA) for authorisation to proceed with their planned activities. This application must be accompanied by documentation detailing the expected impact this will have on national heritage in particular.

Categories of heritage resources recognised as part of the National Estate in Section 3 of the Heritage Resources Act, and which therefore fall under its protection, include among other categories:

- Geological sites of scientific or cultural importance;
- Objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
- Objects with the potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.

To address concerns relating to the protection of these particular heritage resources, a Heritage Impact Assessment (HIA) may be required to assess any potential impacts to archaeological and palaeontological heritage within the footprint of the proposed development.

2.2 DETERMINED LICENSING REQUIREMENTS

In order to comply with National legislation the proposed Paardeplaats Coal Mine project will require authorisation in terms of the MPRDA, NEMA, NEMWA, and NWA as well as permitting requirements from other, related Acts. This application for authorisation for the Paardeplaats project falls under the Integrated Environmental Approach which is described below in detail.

2.3 THE INTEGRATED ENVIRONMENTAL IMPACT APPROACH

The Paardeplaats project requires authorisation and approval in terms of several pieces of South African legislation, chief amongst them are the MPRDA, NEMA, NEMWA, and NWA. As such the project is required to undertake and submit the following reports for adjudication by the relevant Authorities:

- Scoping Report and EMPR as per the requirements of the MPRDA;
- Scoping, EIA and EMPr as per the requirements of the NEMA and NEMWA; and
- Integrated Water Use License (and waste management plan) as per the requirements of the NWA

Thus, in parallel to the application in terms of the MPRDA, an application in terms of NEMA and NEMWA, and an application in terms the NWA will be compiled and submitted to the relevant Government Authorities for decision-making. Each of the applications, in terms of the legislation listed above, require public involvement and interaction, and as such a joint Public Participation Process will be implemented to engage with I&AP's and meet the requirements for Public Participation as stipulated by the above mentioned legislation. This will ensure public involvement at each key step in the process and allow for comments, concerns, suggestions, and objections to the proposed Paardeplaats Coal Mine to be included in each of the submissions to the relevant Government Authorities. To date the following has been submitted to authorities:

- Draft Scoping Report been submitted to the DMR on 19 July 2012; and
- NEMA Application form submitted on 27 August 2012.

2.4 SCOPING REPORT FRAMEWORK AND STRUCTURE OF THE REPORT

The Integrated Scoping Report comprises the following broad framework:

- The project background, including the introduction, project location, project description, and motivation for the project;
- The Legal framework;
- The existing status of the cultural and heritage, socio-economic, and biophysical environment;
- A detailed description of the project;
- Potential impacts associated with the project.
- Land use and development alternatives;
- Stakeholder engagement;
- Finally, a plan of study for the EIA phase of the project; and
- Relevant Appendices

This document is compiled as an Integrated Scoping Report in order to meet the legislative requirements for scoping as stipulated in the respective regulations of the MPRDA and NEMA. The following reference documents, listed below were consulted to develop the framework and reporting structure of this Integrated Scoping Report. The reference documents include, at a minimum, the following resources:

- MPRDA Scoping Requirements:
  - Regulation 49 of GNR. 527 of 23 April 2001: Mineral and Petroleum Resources Development Regulations – Contents of a Scoping Report; and
  - The DMR Scoping Report Guideline and Template (2011).
- NEMA Scoping Requirements
  - Regulation 28 of GNR 543 of 18 June 2010: Environmental Impact Assessment Regulations – Contents of a Scoping Report.

The structure of the report is tailored to meet the requirements of the above mentioned regulations and as such the information presented and its location in reference to the requirements of the regulations listed above is provided below in tabular form for ease of reference.

Table 4: Integrated Scoping Report Framework

MPRDA Scoping Requirements	NEMA Scoping Requirements	Integrated Scoping and Corresponding Location
• Name the community, or explain why no such community was identified. • Specifically state whether or not the Community is also the landowner. • State whether or not the Department of Land Affairs has been identified as an interested and affected party. • State specifically whether or not a land claim is involved. • Name the traditional Authority identified by the applicant. • List the landowners identified by the applicant. (Traditional and Title Deed owners). • List the lawful occupiers of the land concerned. • Explain whether or not other persons' (including on adjacent and non-adjacent properties) socio-economic conditions will be directly affected by the proposed prospecting or mining operation and if not, explain why not. • Name the Local Municipality identified by the applicant. • Name the relevant Government Departments, agencies and institutions responsible for the	• Description of the property on which the activity is to be undertaken and the location of the activity on the property, or if it (i) a linear activity, a description of the route of the activity; or (ii) an ocean-based activity, the coordinates where the activity is to be undertaken. • Description of the proposed activity. • A description of the need and desirability of the proposed activity. • Details of (i) the EAP who prepared the report; and (ii) the expertise of the EAP to carry out scoping procedures.	1 Project Background 1.1 Introduction 1.2 Project Location - Surface Ownership - Community Description 1.3 Brief Project description 1.4 Motivation for the Project 1.5 Environmental Specialist Team - EIMS - Specialist Consultants Appendix R – I&AP Database

MPRDA Scoping Requirements	NEMA Scoping Requirements	Integrated Scoping and Corresponding Location
various aspects of the environment, land and infrastructure which may be affected by the proposed project.		
	• An identification of all legislation and guidelines that have been considered in the preparation of the scoping report.	2 Legal Framework 2.1 Applicable Legislation 2.2 Determined Licensing Requirements 2.3 Integrated Environmental Impact Approach 2.4 Scoping Report Framework
• A description of the existing status of the cultural environment that may be affected. • A description of the existing status of any heritage environment that may be affected. • A description of the existing status of any current land uses and the socio-economic environment that may be directly affected. • A description of the existing status of any infrastructure that maybe affected. • A description of the existing status of the biophysical environment that will be affected, including the main aspects such as water resources, flora, fauna, air, soil, topography etc.	• A description of the environment that may be affected by the activity and the manner in which the activity may be affected by the environment.	3 Existing Status of the Cultural, Socio-Economic, and Biophysical Environment 3.1 Cultural and Heritage Resources 3.2 Socio-Economic Environment 3.3 Biophysical Environment 3.4 Built Environment
• Provide a description of the proposed project including a map showing the spatial locality of	• Description of the proposed activity.	4 Detailed Project Description

MPRDA Scoping Requirements	NEMA Scoping Requirements	Integrated Scoping and Corresponding Location
infrastructure, extraction area, and any associated activities. • Describe any listed activities (in terms of the NEMA EIA regulations) which will be occurring within the proposed project.		4.1 Mining Operations 4.2 Coal Processing 4.3 Surface Infrastructure 4.4 Bulk Power Supply 4.5 Water Management 4.6 Logistics 4.7 Discard and Waste Management 2.1.2 The National Environmental Management Act
• Identify the anticipated environmental, social or cultural impacts. (Including the cumulative impacts). • Provide a list of potential impacts on the cultural environment. • Provide a list of potential impacts on the heritage environment, if applicable. • Provide a list of potential impacts on the socio-economic conditions of any person on the property and on any adjacent or non-adjacent property who may be affected by the proposed mining operation. • Provide a list of potential impacts (positive and	• A description of environmental issues and potential impacts, including cumulative impacts that have been identified.	5 Description of Potential Impacts Associated with Activity 5.1 Cultural and Heritage Resources 5.2 Socio-Economic Environment 5.3 Biophysical Environment 5.4 Built Environment 5.5 Cumulative Impacts

MPRDA Scoping Requirements	NEMA Scoping Requirements	Integrated Scoping and Corresponding Location
negative) on: employment opportunities, community health, community proximity, and provide a link to the Social and Labour Plan. • Provide a list of potential impacts on the biophysical environment including but not be limited on: flora, fauna, water resources, air, noise, soil etc. • Provide a description of potential cumulative impacts that the proposed mining operation may contribute to considering other identified land uses which may have potential environmental linkages to the land concerned.		
• A description of any proposed land use or development alternatives: ○ Provide a list of any alternative land uses that exist on the property or on adjacent or non-adjacent properties that may be affected by the proposed mining operation. ○ Provide a list of any land developments identified by the community or interested and affected parties that are in progress and which may be affected by the proposed mining operation. ○ Provide a list of any proposals made in the consultation process to adjust the operational plans of the mine to accommodate the needs of the community,	• Description of any feasible and reasonable alternatives that have been identified. • A description of identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity.	6 Land Use or Development Alternatives 6.1 Land Use Alternatives 6.2 Development Alternatives 6.3 Most Appropriate Alternative Going Forward

MPRDA Scoping Requirements	NEMA Scoping Requirements	Integrated Scoping and Corresponding Location
landowners and interested and affected parties. ○ Provide information in relation to the consequences of not proceeding with proposed operation. • Provide information on its response to the findings of the consultation process and the possible options to adjust the mining project proposal to avoid potential impacts identified in the consultation phase. • Describe accordingly the most appropriate procedure to plan and develop the proposed mining operation with due consideration of the issues raised in the consultation process.		
• A description of the process of engagement referred to above with identified communities, landowners and interested and affected parties; the applicant must: ○ Provide a description of the information provided to the community, landowners, and interested and affected parties to inform them in sufficient detail of what the prospecting or mining operation will entail on the land, in order for them to assess what impact the prospecting will have on them or on the use of their land; ○ Provide a list of which of the identified	• Details of the public participation process conducted in terms of regulation 27(a), including: ○ The steps that were taken to notify potentially interested and affected parties of the application; ○ Proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the application have been displayed, placed or give; ○ A list of all persons or organisations that	7 Stakeholder Engagement 7.1 Legal Compliance 7.2 General Approach to Scoping and Public Participation 7.3 Announcement of the Project 7.4 Consultation Meetings 7.5 Issues and Responses by I&APs Appendix N Appendix O

MPRDA Scoping Requirements	NEMA Scoping Requirements	Integrated Scoping and Corresponding Location
communities, landowners, lawful occupiers, and other interested and affected parties were in fact consulted; ○ Provide a list of their views in regard to the existing cultural, socioeconomic or biophysical environment, as the case may be; ○ Provide a list of their views raised on how their existing cultural, socio-economic or biophysical environment potentially will be impacted on by the proposed prospecting or mining operation; ○ Provide a list of any other concerns raised by the aforesaid parties; ○ Provide the applicable minutes and records of the consultations; ○ Provide information with regard to any objections received. • Confirmation that the identified and consulted interested and affected parties agree on the description of the existing status of the environment. • Specifically confirm that the community and identified interested and affected parties have been consulted and that they agree that the potential impacts identified include those	were identified and registered in terms of regulation 55 as interested and affected parties in relation to the application; and ○ A summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues. • Copies of any representations, and comments received in connection with the application or the scoping report from interested and affected parties. • Copies of the minutes of any meetings held by the EAP with interested and affected parties and other role players which record the views of the participants. • Any responses by the EAP to those representations and comments and views.	Appendix P Appendix Q Appendix S

MPRDA Scoping Requirements	NEMA Scoping Requirements	Integrated Scoping and Corresponding Location
identified by them • Submit evidence that the landowner or lawful occupier of the land in question, and any other interested and affected parties including all those listed above, were notified.		
• Describe the nature and extent of further investigations required in the environmental impact assessment report, including any specialist reports that may be required.	• A plan of study for environmental impact assessment which sets out the proposed approach to the environmental impact assessment of the application, which must include: ○ A description of the tasks that will be undertaken as part of the environmental impact assessment process, including any specialist reports or specialised processes, and the manner in which such tasks will be undertaken; ○ An indication of the stages at which the competent authority will be consulted; ○ A description of the proposed method of assessing the environmental issues and alternatives, including the option of not proceeding with the activity; and ○ Particulars of the public participation process that will be conducted during the environmental impact assessment process.	8 Plan of Study 8.1 Specialist Studies 8.2 Impact Assessment Methodology 8.3 Timeframe

3 EXISTING STATUS OF THE CULTURAL, SOCIO-ECONOMIC AND BIOPHYSICAL ENVIRONMENT

The following information is based on studies done by the appointed specialists. The studies undertaken are of a scoping nature and will be further refined during the EIA Investigation.

3.1 CULTURAL AND HERITAGE RESOURCES

An evaluation of the palaeontological, archaeological and historical background of the study area was required to establish the possible heritage resources to be found. Therefore a literature search of published sources (Academic Literature, national Archives and popular publications), an examination of topographical maps and an examination of the study area by means of Google Earth were conducted by the heritage specialists, Wouter Fourie and Jennifer Kitto, appointed for the Scoping investigation.

3.1.1 BASELINE INFORMATION

3.1.1.1 Archaeological Background

The Mpumalanga Province is known to be rich in archaeological sites that tell the story of humans and their predecessors in the region going back 1.7 million years (Delius & Hay, 2009). The pre-colonial period is divided broadly into the Stone Age and the Iron Age (Refer to Figure 3 for a visual representation of the human time line).

The Stone Age refers to the earliest people of South Africa who relied mainly on stone for their tools and were hunter-gatherers. This period is divided into the Earlier, Middle and Later Stone Age:

- *Earlier Stone Age:* The period from ± 2.5 million yrs. - ± 250 000 yrs. ago. Acheulean stone tools are dominant;
- *Middle Stone Age:* Various stone tool industries in SA dating from ± 250 000 yrs. – 40 000 yrs. before present; and
- *Later Stone Age:* The period from ± 40 000 yrs. before present to the period of contact with either Iron Age farmers or European colonists. (Delius & Hay, 2009; Morris, 2008).

The Iron Age as a whole represents the spread of Bantu speaking people whose way of life was pastoral-agricultural and includes both the Pre-Historic and Historic periods. As indicated by the name, this period is distinguished by the knowledge of extraction and use of various metals, mainly iron. Similarly to the Stone Age, it can also be divided into three periods:

- The Early Iron Age: Most of the first millennium AD;
- The Middle Iron Age: 10th to 13th centuries AD; and
- The Late Iron Age: 14th century to colonial period. (Delius & Hay, 2009; Morris, 2008).

The archaeological literature does not contain much information on the Stone Age archaeology of this area, since this period has not been researched extensively in Mpumalanga Province (Esterhuysen & Smith, 2007). However, it is clear from the general archaeological record that the larger Mpumalanga region has been inhabited by humans since Earlier Stone Age (ESA) times. Although no Stone Age sites are known from the immediate vicinity of the study area, there are some sites recorded in the greater region (Esterhuysen & Smith, 2007). Examples of such sites are noted below.

3.1.1.1.1 Stone Age Sites

An Earlier Stone Age site is located at Maleoskop near Groblersdal. Concentrations of ESA stone tools were found in erosion gullies along the Rietspruit (Esterhuysen & Smith, 2007). Evidence for the Middle Stone Age (MSA) period has been excavated from Bushman Rock Shelter, situated on the farm Klipfonteinhoek in the Ohrigstad District. The MSA layers indicated that the cave was visited repeatedly over a long period, between approximately 40 000 years ago and 27 000 Before Present (Esterhuysen & Smith, 2007). Two Later Stone Age (LSA) sites were found at the farm Honingklip near Badplaas in the Carolina District, (Esterhuysen & Smith, 2007).

3.1.1.1.2 Iron Age Sites

3.1.1.1.2.1 Early Iron Age

Early farming communities moved into the Mpumalanga Province area around AD 500. These early farmers used metal tools and pottery and lived in fairly permanent agricultural villages. The most well-known EIA site in the area is the Lydenburg Heads site in the Sterkstroom Valley. A brief account of the discovery is provided by Esterhuysen and Smith (2007):

In 1957 a young boy, Ludwig von Bezing, found some strangely shaped pieces of pottery on his father’s farm near Lydenburg, which seemed like pieces of human masks. Over the next few years he collected more fragments as well as other artefacts, including pot shards, iron and copper beads, ostrich eggshell beads, and millstones. Whilst studying at the University of Cape Town, he brought the fragments to the attention of Ray Inskeep, professor of archaeology. Inskeep then excavated the site and supervised the masks’ reconstruction. Known as the Lydenburg Heads, they immediately became famous, partly because of their rarity and intriguing appearance, and partly because they reveal aspects of past cultural and ritual practices. They are on permanent display at the South African Museum in Cape Town. The heads have been carbondated to about AD 500. Similar pottery heads dating to the same period have been found near the KwaZulu-Natal coast.

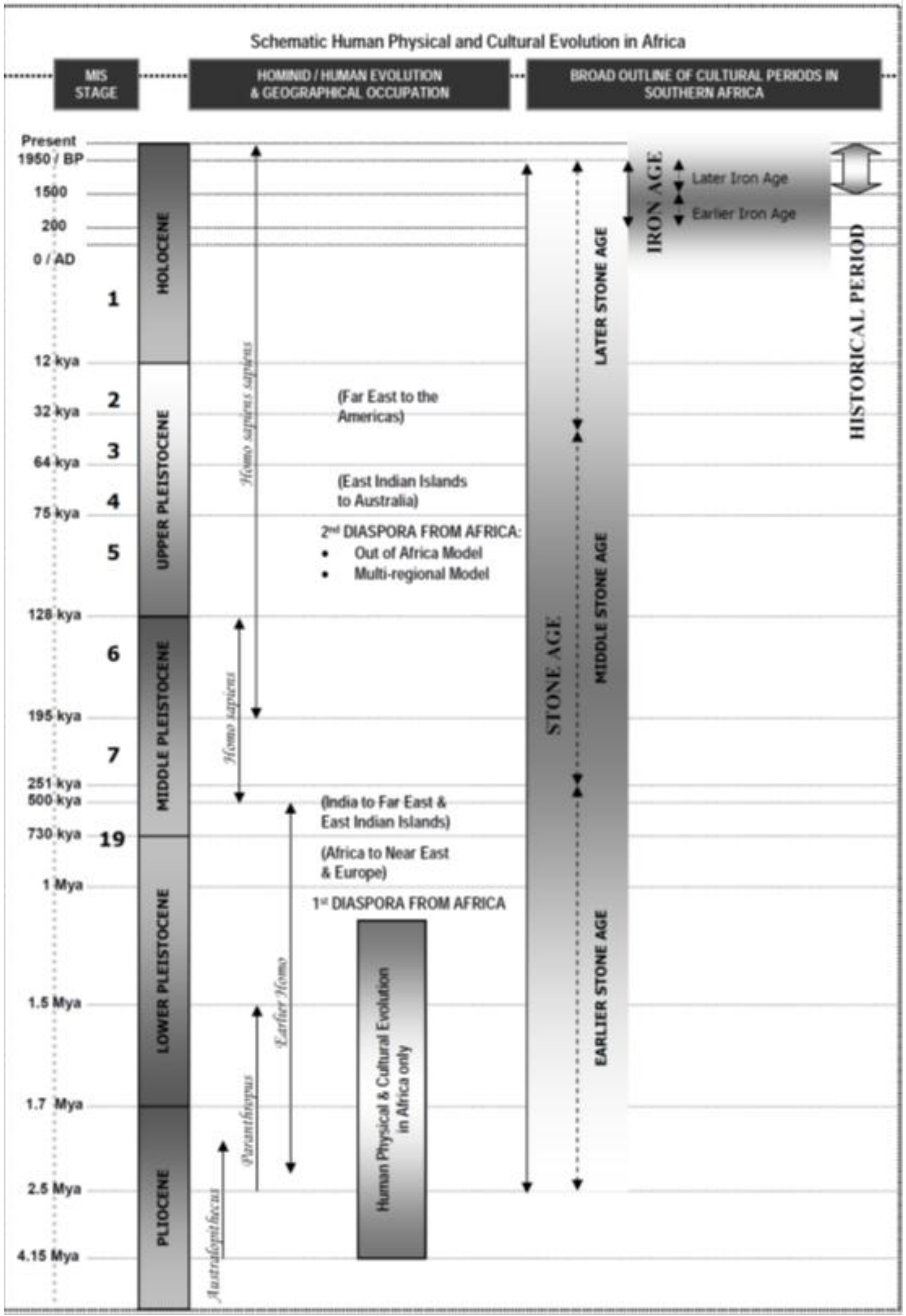


Figure 3: Human and Cultural Timeline in Africa (Morris, 2008)

Figure 4: Lydenburg Heads (Iziko Museum; from Delius, 2007)

3.1.1.1.2.2 Late Iron Age

Late Farmer societies developed extensive stone settlements around Lydenburg, Badfontein, Sekhukhuneland, Roossenekal and Steelpoort (Delius & Hay, 2009). The greater Belfast area specifically, is known for its large complexes of LIA stonewalling. Although there was some early research on the stone ruins in the general region of the then-named eastern Transvaal, systematic investigation of the ruins only began in the last decade (Collett, 1982). Evers (1975) and Mason (1968) both undertook surveys of aerial photographs of the general area and identified a vast number of such settlements between Lydenburg and Machadodorp. Evers (1975) noted that settlements are not evenly distributed over the area, largely for topographical reasons. These settlements typically consisted of three interrelated elements: homesteads, with cattle kraals surrounded by enclosures for human habitation; stone-edged paths or roadways, probably for movement of cattle; and stone terraces, for agricultural cultivation. Most of the homesteads were built in symmetrical patterns, some of which were reproduced in rock engravings found close to these settlements (Delius and Hay; 2009).

With regard to dating, the beginning of the Late Iron Age in this region is obscure. At the time of Evers' article (1975) there were no sites known that were intermediate in age between the Early Iron Age sites and the later stone-walled sites. However, since elsewhere in the then-named Transvaal and Orange Free State, stone-walled building appeared to start around A.D. 1450-1500, this was thought to be true in this region as well (Evers, 1975).

3.1.1.1.2.3 Rock Engravings

An article by Maggs (1995), explains that these agriculturist engravings are mainly dominated by depictions of ground plans representing the shape of settlements people built and lived in. Virtually all known engraved sites are in the vicinity of Late Iron Age settlements and it is now known that such engravings are much more common than was previously thought. Fieldwork in several such regions has produced many formerly unrecorded sites within the limited areas searched. Therefore, Maggs recommended that future fieldwork on the stone-built settlements should incorporate an examination of neighbouring rock outcrops for possible engravings (ibid). Maggs' article (1995) highlights that such images may represent abstract or symbolic spatial arrangements reflecting the cosmology of the society that made them. He uses an example taken from the Pedi, a northern Sotho group linked geographically and culturally with the Mpumalanga engravings. Within this system, social and religious structure was, and among many rural communities still is, clearly inseparable. Each member literally knows their place within the homestead according to their age, sex and status (ibid).

3.1.1.2 Historical Background

3.1.1.2.1 The South African (Anglo-Boer) War

Delius & Hay (2009) note that the area between Belfast and Machadodorp was very active during the Anglo Boer War (1899-1902) with numerous skirmishes, railway sabotage and battle sites occurring in the Mpumalanga Highveld area. The Anglo-Boer War or South African War was waged between Great Britain and the two Boer Republics, the ZAR and the Oranje Vrystaat, from 1899 to 1902 (ibid). Pretoria was captured by the British on 5 June 1900, but this did not result in the end of the war, as had been anticipated. British forces then embarked upon the defeat of the Boer forces still occupying the then Eastern ZAR. Various British forces advanced towards the ridge of the eastern Highveld, (Jooste, 2002). In August 1900, it was decided by the Boer forces that the line must be defended at all costs, as Machadodorp, the temporary seat of the ZAR government (5 June 1900 – 27 August 1900), was to be protected to safeguard a retreat toward Lydenburg and Barberton (Fourie, 2008a). After the battle of Bergendal (see below), where the Boer forces were defeated; on 28 August 1900, and the town of Machadodorp was occupied by the British troops and on 1 September 1900, Lord Roberts, Commander-in-chief of the British troops in Southern Africa, proclaimed the Transvaal as part of the British Empire (Jooste, 2008).

3.1.1.2.2 Belfast and the Battle of Bergendal

The Battle of Bergendal, also known as the Battle of Belfast and the Battle of Dalmanutha, is called the "last set-piece battle of any size in the [Anglo-Boer] war" by Pakenham (1979). However, although the Boer forces were defeated and the British won the battle, Botha's main force remained intact. The commandos dispersed to Lydenburg and Barberton, and a phase of guerrilla warfare began. This second phase of the war lasted even longer than the first. Peace would only be declared at the end of May 1902 (Jooste, 2002). Jooste (ibid) provides a brief summary of the Battle of Bergendal in an article in the Military History Journal of December 2002. Because Machadodorp had become the temporary seat of the ZAR government (5 June 1900 – 27 August 1900), a defensive line was set up with the central part occupied by the Zuid Afrikaansche Republiek Politie (ZARP) under command of Commandant G.M.J. van Dam on a rocky outcrop on the farm Bergendal. On 26 August 1900, the Battle of Bergendal commenced and the British forces advanced on the Boer Lines. The Boer lines were breached in certain sections but the main resistance was coming from the ZARP position. On 27 August 1900 a major offensive was concentrated on the ZARP position, with a three hour bombardment of the ZARP kopje commencing at 11 am. The Boer defences were breached on 28 August 1900 and Buller's troops marched into Machadodorp. Five days later, on 1 September 1900, Lord Roberts proclaimed the annexation of the ZAR as the Transvaal Colony.

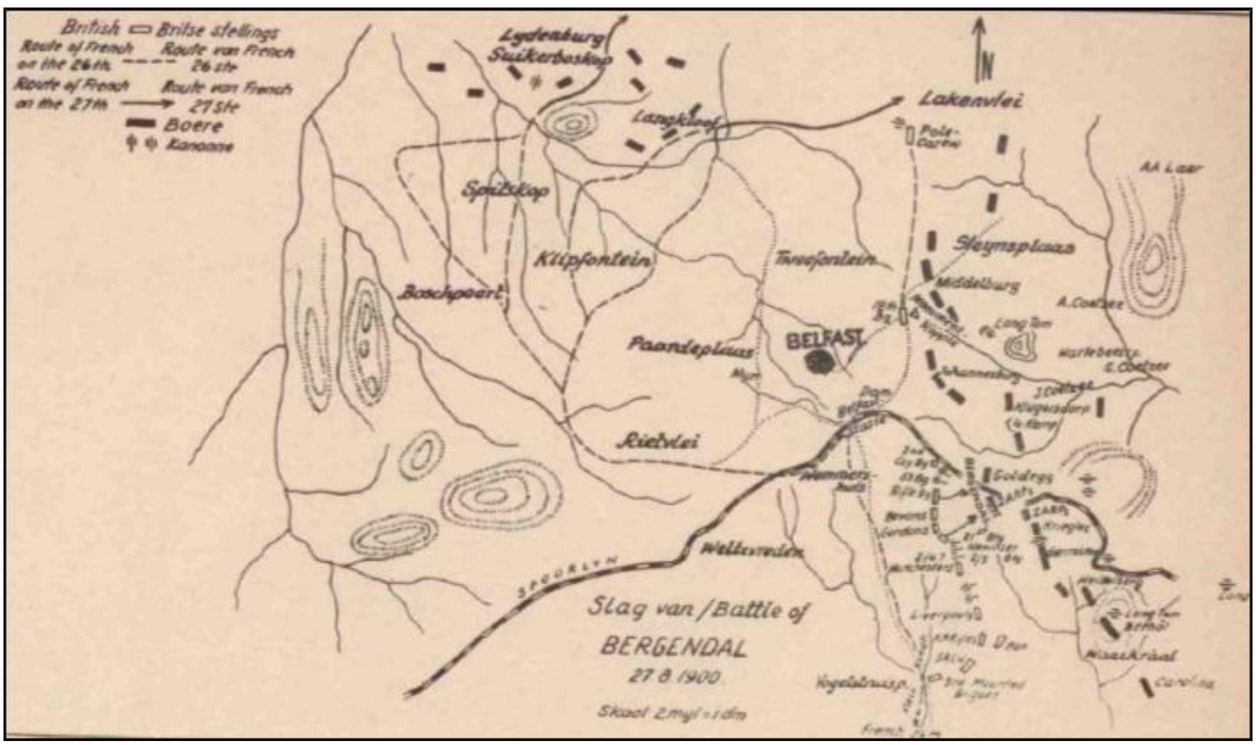


Figure 5: Map - Battle of Bergendal (VD Merwe, 1952)

3.1.1.2.3 Belfast Concentration Camp Graves and British Military Graves

During the Second South African (Anglo-Boer) War, the British established a concentration camp in and around Belfast. The cemetery containing the graves of Boer/Afrikaans civilians who died in the camp is located on the outskirts of the south-western edge of the town. The cemetery also contains British and Commonwealth military graves from the Second South African War. (UCT database of British Concentration Camps of the South African War 1900-1902; http://www2.lib.uct.ac.za/mss/bccd/).

3.1.1.3 Palaeontological Background

3.1.1.3.1 General Approach and Methodology

Geological maps (1:250 000) of the development area are consulted to gain an understanding of the local and regional geology. Various sources such as the scientific literature, previous heritage impact assessments, institutional collections and prior personal experience, are drawn upon to identify potentially fossiliferous rock units and the fossil taxa that have been previously recorded from these units. This information is then used to assess the palaeontological sensitivity of the rock units.

Topographic maps and Google Earth images of the development site are examined to assess the topography and potential for surface outcrops of palaeontologically sensitive rock strata.

3.1.1.3.2 Assumptions and Limitations

A heritage desktop survey does not obviate the need for a field examination of the site. This report represents a preliminary, scoping phase assessment of the potential of the development to impact of fossil heritage. A field examination may reveal high quality fossil material exposed at surface, but it is far more likely that the majority of the envisioned impacts, both positive and negative, will occur during the mining process itself, and for the entire duration of the mining activity.

The distribution of fossil plant material within coal mines is in many cases extremely localised, so for effective mitigation measures to be employed repeated evaluation of exposed bedrock would be required as mining efforts progress.

3.1.1.3.3 Palaeontological Heritage

The Quaternary deposits in the far north-east of the development area are unlikely to contain fossils and are considered to be of low palaeontological sensitivity. That said fossils have been found occasionally in coeval deposits elsewhere, such as mammal bones and teeth, early humans, trace fossils, non-marine invertebrates.

Any sedimentary rocks of the Vryheid Formation, and particularly those in close spatial proximity to coal seams, have a high potential for containing fossilised plants.

The Early Permian, coal associated, Glossopteris-dominated floras of South Africa are World famous, and this reputation has been built on fossils described from only a handful of localities. The most well-known and best documented localities are the quarries near Vereeniging in the Gauteng Province, and at Hammanskraal, north of Pretoria in Mpumalanga Province. The spectacular fossil floras from these localities have been documented by a number of palaeobotanists over the years (e.g. Leslie, 1903; Plumstead, 1952, 1956a,b, 1958, 1969; Kovacs-Endrody, 1976, 1991; Le Roux & Anderson, 1977; Smithies, 1977; Anderson & Anderson, 1985), and elements of this flora continue to stimulate palaeontological debate on the *Glossopteris* plant and associated elements (e.g. Adendorff et al., 2002, 2003; Prevec et al., 2008; Prevec, 2011).

Table 5: Fossil floral elements previously recorded from coal deposits of the Vryheid Formation (and equivalents) of South Africa (only key and recent references included)

Plant group	Taxon	Localities	References
Lycopods	*Azaniodendron fertile*	Vereeniging, Hammanskraal	Anderson & Anderson, 1985
	Cyclodendron leslii	Vereeniging, Hammanskraal, Ermelo, Hlobane	Anderson & Anderson, 1985
Sphenophytes (horsetail ferns)	*Sphenophyllum hammanskraalense, S. mesoeccaense*	Hammanskraal	Smithies, 1977; Anderson & Anderson, 1985
	Annularia hammanskraalensis	Hammanskraal	Anderson & Anderson, 1985
Ferns	*Asterotheca hammanskraalensis*	Hammanskraal,	Anderson & Anderson, 1985
	Asterotheca leeukuilensis	Vereeniging	Anderson & Anderson, 1985
	Sphenopteris lobifolia	Vereeniging, Hammanskraal	Anderson & Anderson, 1985
	Liknopetalon enigmata	Vereeniging, Hammanskraal	Anderson & Anderson, 1985; Adendorff *et al.*, 2003
Glossopterid and affiliated leaves	*Palaeovittaria kurtzii;* '*Gangamopteris*'; *Glossopteris* (multiple species)	Ermelo, Hlobane, Vereeniging, Hammanskraal	Kovács-Endrödy, 1976, 1991; Anderson & Anderson, 1985
Glossopterid fertile organs (see Prevec 2005 for a review)	*Arberia madagascariensis*	Hammanskraal	Smithies, 1977; Anderson & Anderson, 1985
	Arberia hlobanensis	Hlobane	Plumstead, 1969; Anderson & Anderson, 1985; Plumstead, 1969
	Arberia leeukuilensis	Vereeniging	Plumstead, 1969; Anderson & Anderson, 1985
	Bifariala (Hirsutum)	Vereeniging	Plumstead, 1952, 1956a, 1958;

	intermittens		Anderson & Anderson, 1985; Prevec *et al.*, 2008
	Gladiopomum elongatum	Rietspruit	Adendorff *et al.* 2002
	Gladiopomum (*Hirsutum) dutoitides*	Vereeniging, Hlobane	Plumstead, 1952, 1956a, 1958; Anderson & Anderson, 1985; Adendorff *et al.* 2002
	Ottokaria buriadica	Vereeniging, Hlobane	Plumstead, 1956b, 1969; Smithies, 1978; Anderson & Anderson, 1985
	Ottokaria hammanskraalensis	Hammanskraal	Smithies, 1978; Anderson & Anderson, 1985
	Ottokaria transvaalensis	Vereeniging	Smithies, 1978; Plumstead, 1956b; Anderson & Anderson, 1985
	Plumsteadia (Lanceolatus) lerouxii	Vereeniging	Plumstead, 1952, 1956a, 1969; Anderson & Anderson, 1985
	Gonophylloides (Lanceolatus) strictum	Vereeniging, Hammanskraal	Plumstead, 1952, 1956a, 1969; Smithies, 1978; Anderson & Anderson, 1985
	Gonophylloides (Lanceolatus) waltonii	Vereeniging	Plumstead, 1952, 1956a, 1969; Anderson & Anderson, 1985
	Elatra (Hirsutum) leslii	Vereeniging, Hammanskraal	Smithies, 1978; Anderson & Anderson, 1985
	Scutum leslii	Vereeniging, Ermelo	Plumstead, 1952, 1956a, 1958, 1969; Anderson & Anderson, 1985; Prevec, 2011
Ginkgoalean elements	*Sphenobaeira eccaensis*, *Metreophyllum lerouxii, Ginkgophyllum kidstonii, Ginkgophyllum spatulifolia, Flabellofolium leeukuilensis*	Vereeniging	Plumstead, 1969; Anderson & Anderson, 1985
Conifers	*Noeggerathiopsis hislopii*	Vereeniging, Hammanskraal, Ermelo, Hlobane	Anderson & Anderson, 1985
	Walkomiella transvaalensis	Vereenging	Plumstead, 1969; Anderson & Anderson, 1985
	Podozamites hlobanensis	Hlobane	Anderson & Anderson, 1985
incertae sedis	*Botrychiopsis valida*	Vereeniging, Hammanskraal	Plumstead, 1969; Anderson & Anderson, 1985

3.1.2 RESULTS OF THE SCOPING PHASE INVESTIGATION

3.1.2.1 Examination of Topographical Maps

An examination of the 1:50 000 topographical maps for the area in which the study area is located (2529D and 2530C), identified the following heritage resources:

- In the immediately surrounding area (outside of the immediate study area):
  - A site of English War graves on the outskirts of Belfast town (S25^0 41’ 19.0’’ E30^0 01’ 36.9’’);
  - The site of the Bergendal battle (on the farm Berg-en-dal 378 JT, SE of the study area) (S25^0 44’ 04.5” E30^0 06’ 03.9”);
  - Gelofte Monument Feeshuis (NE of Belfast) (S25^0 40’ 23.2” E30^0 0’4 22.8”);
  - Various kraals (possible Iron Age/historical sites) (S25^0 40’ 33.7” E30^0 08’ 15.4”);
  - Various ruins (possible Iron Age/historical sites); and
  - Various built structures, some of which may be of historical date.Refer to Figure 9.
- Within the study area:
  - Various (+/-9) built structures, some of which may be of historical date. Refer to Table 6.

3.1.2.2 Examination of Google Earth satellite imagery

A copy of the locality plan of the study area was overlaid on Google Earth satellite images to compare and verify the presence of built structures. No indications of possible archaeological sites were visible, which is probably due to the current use of the land for agriculture. This usually destroys any above ground archaeological remains; however, there is still a possibility that archaeological material is present under the ground surface, which could be exposed during construction excavations.

3.1.2.3 Observations within the study area

A total of approximately fourteen built structures (single or groups) are indicated within or on the boundaries of the study area on the topographic map section provided by EIMS. However, when the study area was overlaid on the same area in Google Earth images, the number of visible built structures and possible sensitive areas appeared to be approximately 55. Some of the structures indicated on the locality map are not visible on the Google Earth images, while other structures are visible that are probably more recent. The demarcated sensitive areas were processed to produce a centroid for each area and are listed in Table 6.

Table 6: List of structures/features with coordinates within study area of possible heritage value

Name	X	Y
Train Station	29.9617	-25.7629
Structure	29.9653	-25.7616
Structure	29.9655	-25.7605
Structure	29.9617	-25.7614
Structure	29.9663	-25.7598
Structure	29.9659	-25.7576
Structure	29.9657	-25.7566
Old Mining Infrastructure?	29.9747	-25.7488
Exposed bedrock	29.9731	-25.7539
Exposed bedrock	29.9758	-25.7539
Exposed Bedrock - Possible Rock Art areas	29.9794	-25.7511
Structures	29.9807	-25.7551
Structures	29.9832	-25.7544
Exposed bedrock	29.9822	-25.7538
Structures	29.9846	-25.7512
Homestead	29.9892	-25.7513
Structures	29.9901	-25.7490
Structure	29.9853	-25.7455
Structure	29.9864	-25.7478
Structure	29.9849	-25.7534
Structure	29.9916	-25.7514
Structure	29.9968	-25.7494
Structure	29.9920	-25.7461
Structure	29.9960	-25.7464
Structure	29.9968	-25.7457
Structure	29.9824	-25.7409
Exposed bedrock	29.9833	-25.7376
Exposed bedrock - Rock art	29.9921	-25.7373
Structure	29.9934	-25.7352
Exposed bedrock	29.9950	-25.7409
Farmstead and infrastructure	30.0027	-25.7437
Farmstead	30.0004	-25.7381
Farmstead	30.0028	-25.7365
Structure	30.0033	-25.7351
Workers housing	30.0066	-25.7381
Structure	29.9933	-25.7323
Structure	29.9940	-25.7248

Name	X	Y
Structure	30.0028	-25.7219
Farmstead	30.0035	-25.7264
Workers housing	30.0089	-25.7291
Structure	30.0135	-25.7296
Structure	30.0107	-25.7269
Farmstead	30.0174	-25.7188
Structure	30.0257	-25.7138
Structure	29.9625	-25.7618
Structures	29.9633	-25.7634
Structures	29.9944	-25.7320
Structures	30.0003	-25.7300
Structures	30.0032	-25.7187
Structures	30.0100	-25.7225
Structure	30.0127	-25.7252
Structure	30.0168	-25.7254
Structure	30.0240	-25.7133
Structure	30.0184	-25.7127

3.1.2.4 Observations outside the study area

Approximately 65 built structures/clusters of potential heritage importance are indicated on the topographic locality map/Google overlay as being situated outside the study area, but within the 3500 m blasting impact circle (developed for the study by the blasting specialist) This does not include the large sections of Belfast town and Siyathuthuka Township that are situated on the north western edge of the blast circle. These structures and clusters are shown in Figure 6.

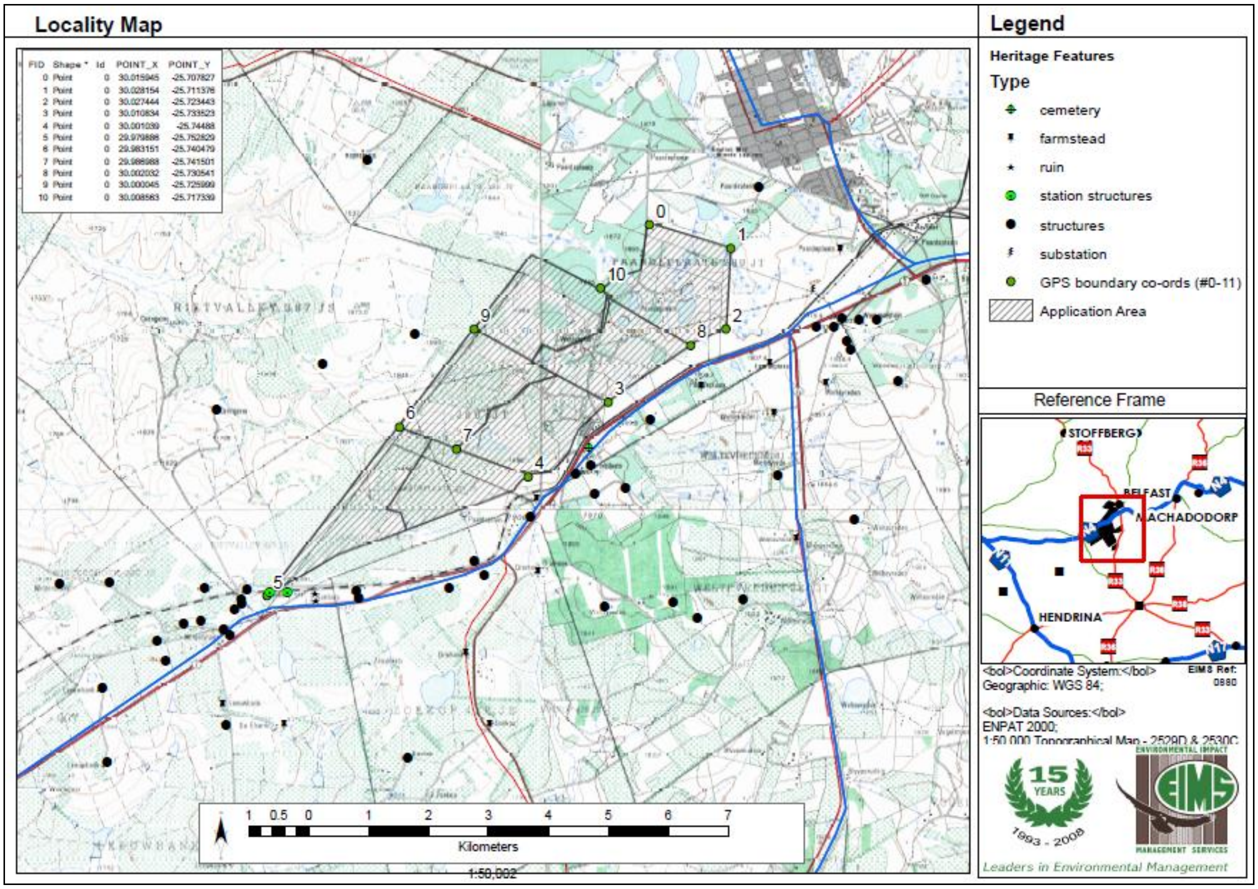


Figure 6: Map showing structures/features outside the study area, but within the potential blasting impact zone

3.1.2.5 Archival research of specific farm portions

A search of documents held at the National Archives in Pretoria did not locate any documents with information on the two farms on which the study area is located.

3.2 SOCIO-ECONOMIC ENVIRONMENT

The data used for the socio-economic description was sourced from the Community Survey (CS) conducted by Statistics South Africa in 2007. The Community Survey is a large-scale household survey conducted by Statistics South Africa to bridge the gap between censuses. It served as a mini census and its purpose (www.statssa.gov.za) is to collect information on the trends and level of demographic and socio-economic data; the extent of poor households; access to facilities and services; levels of employment/unemployment; in order to assist government and private sector in planning, evaluation and monitoring of programmes and policies.

Community Survey 2007 yields more up-to-date information than Census 2001 that used to be the most recent source of demographic and socio-economic data on national, district and municipal level. It should however be noted that Community Survey 2007 is not a replacement of the Census (Statistics South Africa, 2007a) and that there are certain limitations inherent to the study that should be taken into consideration when interpreting the results (Statistics South Africa, 2007b):

- The scope of the study only included household and individuals. Institutions such as military bases, national parks, prisons, hotels, hospitals, military barracks, etc were excluded from the fieldwork. The institutional population is an approximation based on 2001 figures and not new data.
- The measurement of unemployment is higher and less reliable due to the differences in questions asked relative to the normal Labour Force Surveys.
- The income includes unreasonably high income for children probably due to misinterpretation of the question, e.g. listing parent's income for the child.
- The distribution of households by province has very little congruence with the General Household Survey or Census 2001. It is not yet clear whether these changes are real or whether they are due to variables that could be ascribed to the study.
- Since the Community Survey is based on a random sample and not a Census, any interpretation should be understood to have some random fluctuation in data, particularly concerning the small population for some cells. It should be understood that the figures are within a certain interval of confidence. This applies in particular to cross-tabulations on municipal level where small numbers are likely to give an under or overestimation of the true population (due to group not present in sample or number realised for sample very small). The aggregated total number per municipality however provides more reliable estimates (Statistics South Africa, 2007a).
- Further it should be noted that the estimates were done with the use of the de-facto population (the group of population who were enumerated according to where they stayed on a specific night) and not the de-jure population (the group of population who were enumerated according to where they usually live). These results are presented as the de-jure population.

Based on this the results should be viewed as indicative of the population characteristics in the area and should not be interpreted as absolute.

3.2.1 GEOGRAPHICAL DESCRIPTION OF THE AREA

3.2.1.1 The Mpumalanga Province

The proposed mine will be located in the eMakhazeni Local Municipality that forms part of the Nkangala District Municipality in Mpumalanga Province. The baseline description of the environment will include these areas.

The Mpumalanga Province is located in the north eastern part of South Africa and covers an area of approximately 82 333 km^2 (www.mputopbusiness.co.za). It borders the Limpopo Province, Gauteng, the Free State, KwaZulu-Natal and internationally Swaziland and Mozambique. The word Mpumalanga means “place where the sun rises”.

The province consists of three district municipalities, namely Gert Sibande, Nkangala and Ehlanzeni. Nelspruit is the provincial capital and other major towns include Barberton, Delmas, Ermelo, Hazyview, Komatipoort, Malelane, Mashishing (Lydenburg), Middelburg, Piet Retief, Sabie, Secunda, Standerton, Volksrust, White River as well as eMalahleni (Witbank) (www.mpumalanga.com).

Mpumalanga Province is South Africa’s major forestry production area and is also the world’s largest producer of electrolytic manganese metal. Six major industrial clusters have been identified in Mpumalanga Province (Mpumalanga PGDS) in which numerous investment opportunities exists, namely:

- Stainless steel;
- Agri-processing;
- Wood products;
- Chemical industry and chemical products; and
- Agri-products and tourism.

Extensive mining is done in the province. Minerals found include:

- Gold;
- Platinum group metals;
- Silica;
- Chromite;
- Vanadiferous magnetite;
- Argentiferous zinc;

- Antimony;
- Cobalt;
- Copper;
- Iron;
- Manganese;
- Tin;
- Coal;
- Andalusite;
- Chrysotile asbestos;
- Kieselguhr;
- Limestone;
- Magnesite; and
- Shale.

Mpumalanga Province also accounts for 83% of South Africa's coal production. Ninety per cent of South Africa's coal consumption is used for electricity generation and the synthetic fuel industry. Coal-fired power stations are situated close to the coal deposits.

The Mpumalanga province mainly exports primary products from its mining and agricultural activities with little value addition. Mpumalanga Province will be able to increase its share of export contribution towards the provincial GDP by adding value to its export products through beneficiation (Mpumalanga Economic Profile).

3.2.1.2 The Local District and Local Municipality

3.2.1.2.1 The Nkangala District Municipality

The Nkangala District Municipality (NDM) is one of the three district municipalities in Mpumalanga. Local municipalities forming part of the Nkangala DM are Delmas, Dr. JS Moroka, eMalahleni, eMakhazeni, Steve Tshwete, and Thembisile, as well as the Mdala District Management Area.

The district is approximately 17 000 km^2 and consists of about 165 towns and villages, with eMalahleni and Middelburg being the primary towns. The Nkangala DM has a population of approximately 1.1 million people, which constitutes almost a third of Mpumalanga’s population.

According to the municipality's website, the Nkangala DM is at the economic hub of Mpumalanga and is rich in minerals and natural resources. The district's economy is dominated by electricity, manufacturing and mining. Community services, trade, finance, transport, agriculture and construction (www.nkangaladm.org.za) are also important sectors. Nkangala's Integrated Development Plan (IDP) states that the district has extensive mineral deposits, including chrome and coal.

Another important economic activity in Nkangala is agriculture. The southern regions of the municipality are suitable for crop farming, specifically for fresh produce such as maize and vegetables, while cattle and game farming occur in the northern regions.

In terms of the population profile of the Nkangala DM, the majority of its inhabitants are extremely poor and do not have access to mainstream economic activities. The main poverty concentration is amongst the communities residing in Dr JS Moroka and Thembisile Local Municipalities. The most important employment centre for these communities is the City of Tshwane, reducing their reliance on NDM. Daily commuting by means of public transport is a necessity (Nkangala IDP 2008/2009).

3.2.1.2.2 The eMakhazeni Local Municipality

The eMakhazeni Local Municipality is at the heart of the Mpumalanga Province and is bordered by the Greater Groblersdal, Thaba-Chweu, Steve Tshwete, Albert Luthuli and Mbombela Local Municipalities. The municipality is strategically located between the Pretoria/Johannesburg complex in Gauteng and Nelspruit in Mpumalanga Province and is situated on the N4 Maputo corridor.

The dominant economic activity in the area is farming (eMakhazeni Local Municipality IDP 2012-2013). Farming occupies the largest part of the physical area. There are a number of small towns in the area that serve as service centres for the agricultural sector, namely:

- eMakhazeni (Belfast) and Siyathuthuka;
- Dullstroom and Sakhelwe;
- Entokozweni (Machadodorp) and Emthonjeni; and
- Waterval-Boven and Emgwenya.

The area has a high environmental and aesthetical value with numerous wetlands and sensitive environmental areas, particularly around Dullstroom. The area is popular for fly-fishing that attracts a large number of tourists to the area. There are four nature reserves in the area, namely the Tullach-Mohr Reserve, the Dullstroom Nature Reserve, the Verloren Valley Nature Reserve and the Ntsinini Nature Reserve. The eMakhazeni LM sees the town of eMakhazeni as the tourism gateway for attractions in the eMakhazeni area as well as the Lowveld areas (eMakhazeni Local Municipality IDP, 2011-2016) and is of the opinion that it should be promoted as such. The area between eMakhazeni, Dullstroom, Lydenburg, Entokozweni and Waterval-Boven was earmarked as the “Trout Triangle.” This initiative has been incorporated into the Spatial Development Framework and should be supported through local initiatives.

Several minerals can be found in the region, for example gold and black granite. The viability of the diamond deposits in the area is currently being investigated. There are two coal mines in the vicinity, namely the eMakhazeni and Glisa mines that are operated as open quarry mines. A large coal deposit has been discovered towards the south of eMakhazeni. The presence of lime deposits in the municipal boundaries has also been indicated. Other minerals found in the area include copper, nickel, cobalt, arsenic, platinum, zinc, silver, and flint clay.

3.2.2 DEMOGRAPHIC PROFILE

3.2.2.1 Population and Population Growth

According to the Community Survey 2007, the population of South Africa is approximately 48.5 million and has shown an increase of about 8.2% since 2001. The household density for the country is estimated at approximately 3.87 people per household, slightly down from the 2001 average household size of 4 people per household.

As shown in Table 7, the growth rate in Mpumalanga was very similar to the national average, with Nkangala DM experiencing growth rates well above the national average and the population in the eMakhazeni LM showing a decrease of more than one fifth since 2001. It must be noted though that according to a survey done by the eMakhazeni LM in 2007, the population has grown to 59,000 (eMakhazeni Local Municipality IDP, 2012-2013). The results of Census 2011 should be able to shed light on which population size is correct. Although the population size in the eMakhazeni LM has decreased, there was a great increase in the number of households, indicating fewer people per household.

Table 7: Community Survey 2007 Population, growth and household estimates

	Mpumalanga Province	Nkangala DM	eMakhazeni LM
Approximate population size	3,643,435	1,226,500	32,840
Approximate number of households	940,403	305,567	12,127
Average population density (number of people per km^2)	45.84	73.19	6.95
Average household density (number of people per household)	3.87	4.01	2.71
Estimated growth in population size since 2001 (in %)	8.25%	20.38%	-23.64%

	Mpumalanga Province	Nkangala DM	eMakhazeni LM
Estimated growth in number of households since 2001 (in %)	19.73%	24.48%	24.72%
Estimated change in household sizes since 2001 (in %)	-0.41	-0.14	-1.72
Total dependency ratio (youth (aged 0 – 14 years) and aged (65 years or older) to economically active population (aged 15 - 64 years)	61,41	55,56	53,69
Youth dependency ratio	54,03	48,37	45,62
Aged dependency ratio	7,38	7,19	8,07

While the population density in the Nkangala DM is much higher than on provincial level, the population density in the eMakhazeni LM is relatively low, although it can be expected that it would be much higher in the urban areas of Belfast and Siyathuthuka. The average household size in the Nkangala DM is larger than on provincial level, but on local level the average household size is much smaller and has shown a significant decrease in size since 2001. This can indicate that a number of people of economically active age (aged 15 – 65 years) have moved out of the area in search of job opportunities, leaving old people and children behind, and also that a number of people of economically active age moved to the area in search of jobs due to the increasing mining activities in the area, leaving their families behind elsewhere.

The total dependency ratio is used to measure the pressure on the productive population. As the ratio increases, there may be an increased burden on the productive part of the population to maintain the upbringing and pensions of the economically dependent. A high dependency ratio can cause serious problems for a country as the largest proportion of a government's expenditure is on health, social grants and education that are most used by the old and young population. The total dependency ratio as well as the youth dependency ratio for the eMakhazeni LM is lower than on district or provincial level, indicating a smaller proportion of youth in this area, while the aged dependency ratio is higher than on provincial and district level, indicating an aging population in the area. Although this ratio is calculated on the number of people of economically active age, it must be kept in mind that many people in this age group are not employed, thus placing even an even heavier burden on those that are employed.

The majority of residents in the on provincial, district and local level belong to the Black population (Figure 7). The proportion of people belonging to the Black population group in the eMakhazeni LM is lower than on district and provincial level, with a higher proportion of people belonging to the White population group. As such the local municipality can be expected to be culturally different from the district in certain areas.

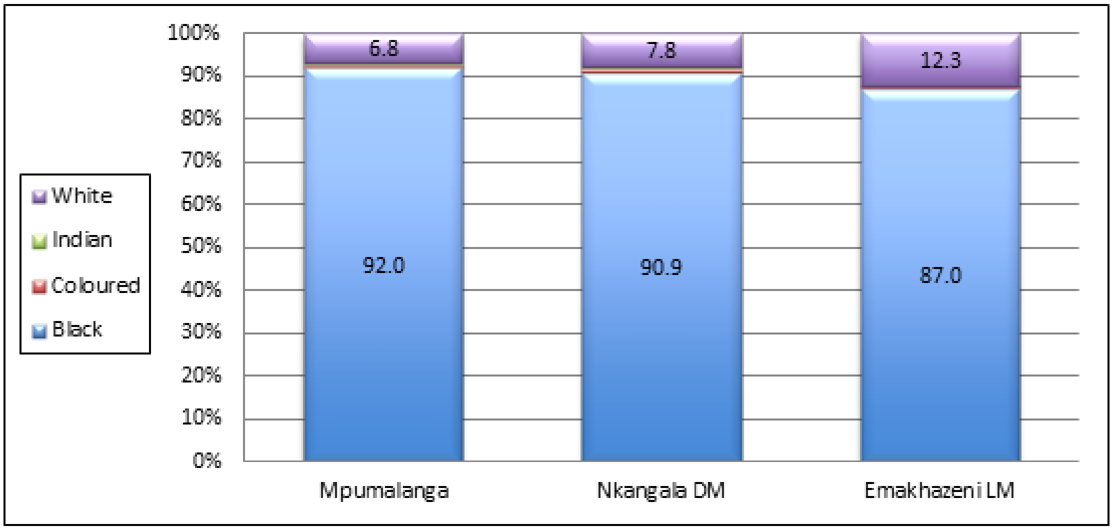


Figure 7: Population distribution (shown in percentage, source: CS 2007)

3.2.2.2 Gender and Age Distribution

3.2.2.2.1 Gender

The gender distribution is fairly equal (Figure 8), with a slight biased towards females on provincial, district as well as local level.

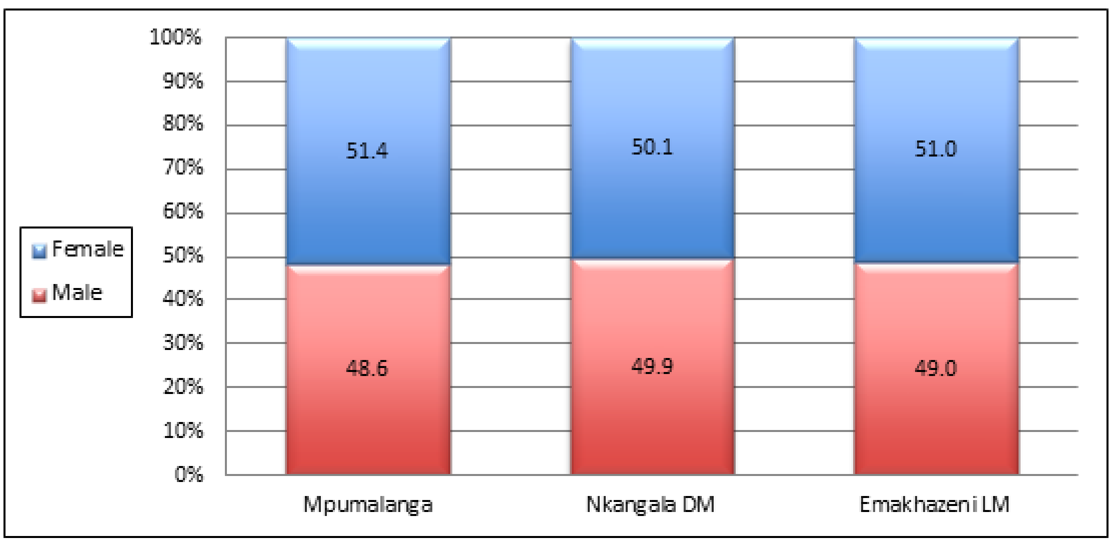


Figure 8: Gender distribution (shown in percentage, source: CS 2007)

3.2.2.2.2 Marital Status

Almost half of the people living in eMakhazeni LM have indicated that they have never been married (Figure 9), while just over a fifth have indicated that they have been married in a civil or religious ceremony while about 16% have indicated that they are in traditional or customary marriages and about 7% are living together as married partners. Almost no one has indicated that they are in polygamous marriages while a relatively small proportion has indicated that they are divorced or separated. It must be noted these figures would reflect a person's status at the time of the Community Survey 2007.

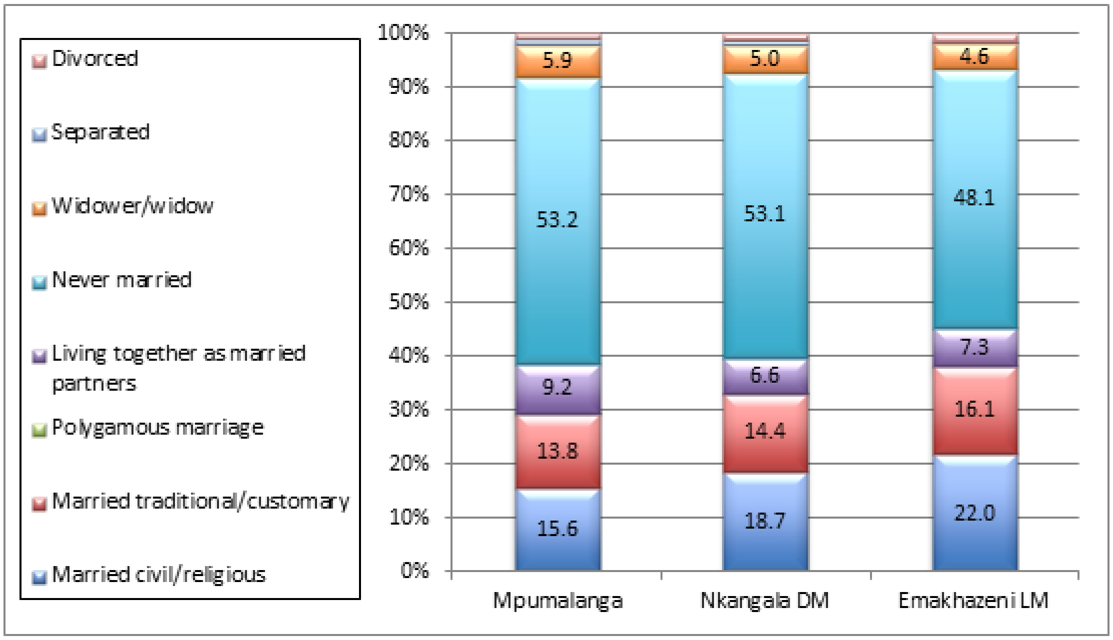


Figure 9: Marital status - people aged 15 years or older (shown in percentage, source: CS 2007)

3.2.2.2.3 Age

A closer look at the age distribution (Figure 10) shows that the eMakhazeni LM has a smaller proportion of children, youth and young adults (aged 24 years or younger) than the district or the province and proportionately more people aged between 25 – 64 years, which are of economically active aged. On provincial and district level 50% or more of the population are younger than 25 years. The higher proportion of children younger than 15 years on provincial and district level places a heavier burden on those who are economically active to take care of their needs. It also indicates high potential for future population growth as Census 2001 (Stages in the life cycle of South Africans, 2005) indicates that at the age of nineteen; about 30.5% of women have given birth to at least one child. The high proportion of children and youth further indicates that there will be a higher future demand for employment and potentially a much bigger need for infrastructure, should all these people choose to remain in the area and not to migrate to urban areas. It also suggests that people may migrate to areas where new job opportunities are created.

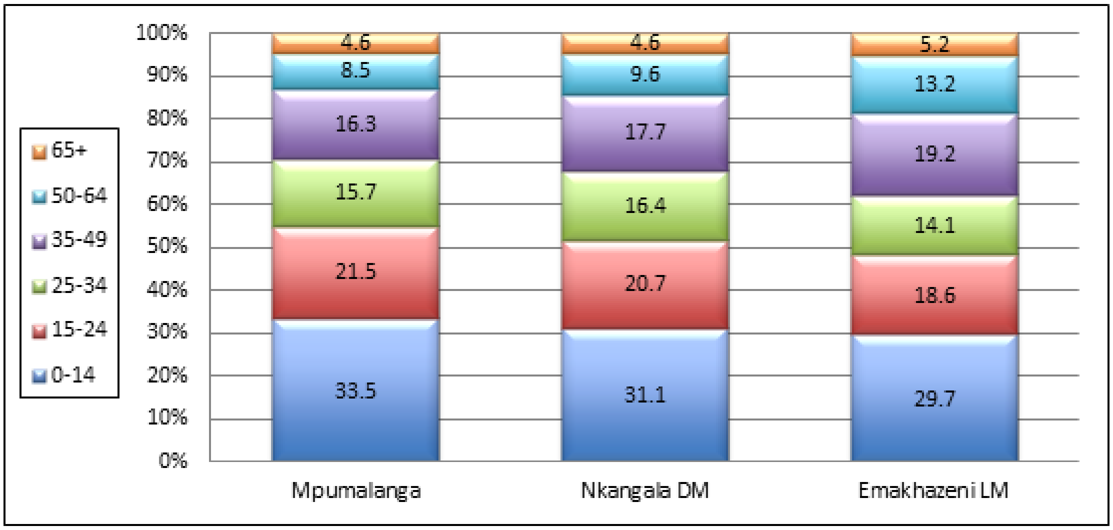


Figure 10: Age distribution (shown in percentage, source: CS 2007)

No recent data is available for the district on mortality and fertility (eMakhazeni Local Municipality IDP, 2012-2013).

3.2.2.3 Education and Skill Levels

The dilemma in the South African labour market is to find the right balance between high levels of unemployment and the shortage of skills as demanded in the economy (Department of Labour, 2011). Unemployment is high among people with no tertiary education and low among people with a tertiary education. A worrying factor is that unemployment among the educated is increasingly becoming a phenomenon. Although youth unemployment is very challenging, it is also important to emphasise the importance of promoting effective integral policies. There is a need for a coherent system that might link the educational system to labour market outcomes. As long as large numbers of youth are skilled in fields that are not in demand in the economy, the problem of youth unemployment will persist.

Lack of schooling is not necessarily the reason for unemployment, but employers often use educational level as a selection device. If the average level of education increases, the selection criteria may also be raised. Lack of education and training contributes to low job security and can also increase the number of the long-term unemployed.

The unemployed represent an important target group for the National Skills Development Strategy. It is vital that their skills be upgraded in order to facilitate their transition into active employment and lifelong learning and to grow the skills pool from which the employers can recruit (Department Of Labour, 2003).

3.2.2.3.1 Education

Education is a major challenge in the area as about 30% of children in the area of school-going age do not have access to quality education (eMakhazeni Local Municipality IDP, 2012-2013). This is due to the rural nature of the area. The majority of schools are farm schools which are multi-graded, and that lack quality infrastructure and adequate human resources. The majority of primary schools are on the NSNP (National Schools Nutrition Programme) and the municipality welcomes the proposal of the Department of Education to extend the programme to high schools. There is only on one tertiary education facility in the area, namely a FET College at Emgwenya. Table 8 gives a summary of the number and type of schools in the eMakhazeni Local Municipality (IDP, 2012-2013).

Table 8: Summary of schools in the eMakhazeni Local Municipality

Type of School	Number
Primary Schools	7
Primary Schools (Farms)	13
Secondary Schools	5
Secondary Schools (Farms)	4
Private Schools	4
Schools for learners with special education needs	1
FET	1
Total	**35**

Education deprivation is one of the domains of Multiple Deprivation that was used to calculate the Provincial Indices of Multiple Deprivation. There is a close link between educational attainment, the type of work an individual is engaged in and the associated earnings potential. The level of education achieved by an individual, determines current income and savings potential, as well as future opportunities for individuals and their dependants (Noble *et. al.*, 2006).

The eMakhazeni LM has a lower proportion of people indicating that they have obtained Grade 12 or a higher qualification than on district or provincial level (Figure 11), suggesting skills in the area will be limited. According to the eMakhazeni Local Municipality IDP (2012-2013), the proportion of people who have completed Grade 12 has declined since 2001, which could be a comment on the educational system, but does not bode well for skills potential in the area. The high proportion of people who did not attend an educational institution has resulted in a generation of illiterate young people with a future of unemployment. This also poses a significant problem within communities as dependency as well as criminal activities increases.

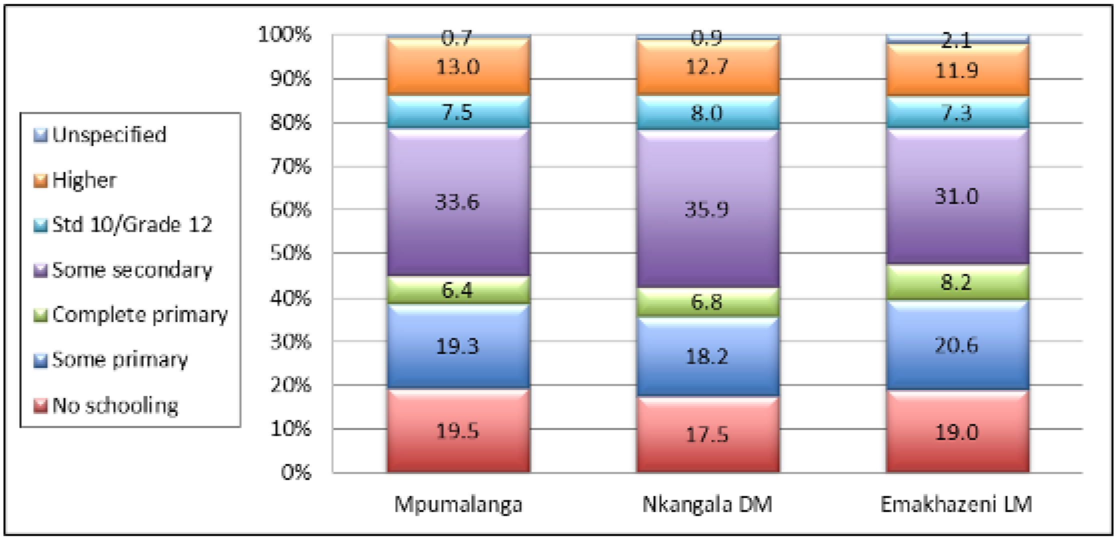


Figure 11: Highest education level – people 20 years or older (shown in percentage, source: CS 2007)

The Nkangala District Municipality's IDP identified some challenges with regard to education in the district as decaying schools, lack of learner transport and lack of facilities, e.g. libraries, sport facilities and basic necessities such as ablution facilities. Other important social issues affecting the school attendance rate include drug abuse, teenage pregnancy and violence at schools (Nkangala IDP 2008/2009).

3.2.2.3.2 Language

The language profiles for the areas are very different from one another (Figure 12). In 2001, the dominant home language in the eMakhazeni LM was SiSwati (33.4%), followed by isiNdebele (23.1%), IsiZulu (16.1%) and Afrikaans (9.3%). On a district level, isiNdebele (31.3%) was the most dominant home language, followed by isiZulu (22.8%) and Sepedi (15.8%). Home language gives an indication of the cultural makeup of the area. Knowing the culture of the area would help the outsider to connect more easily with the local communities.

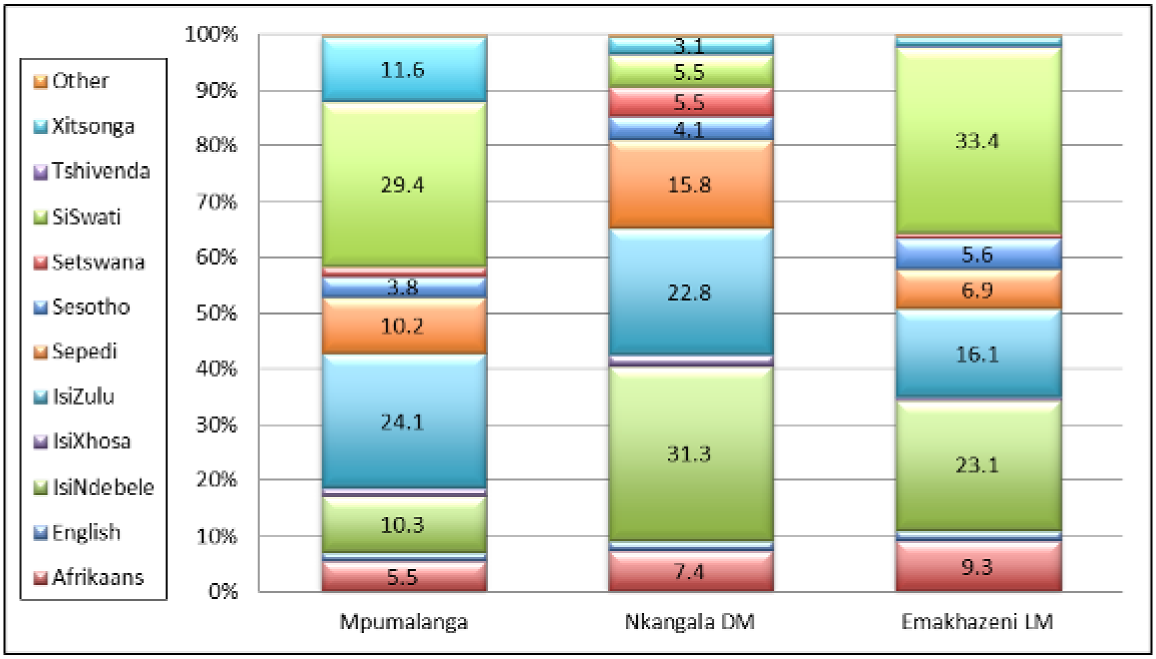


Figure 12: Language distribution (shown in percentage, source: Census 2001)

3.2.2.4 Community Power Structures

The municipal area is divided in a number of wards, each with a ward councillor representing the ward. Each ward also has a ward committee. There are no areas in the municipal area that are under the management of traditional authorities. Other potential power structures in the community can include agricultural associations, residents associations and community property associations. These may be explored further during fieldwork.

3.2.3 PROVISION OF SERVICES

Access to piped water, electricity and sanitation services relate to the domain of Living Environment Deprivation as identified by Noble *et. al.* (2006).

3.2.3.1 Electricity

In the eMakhazeni LM almost 90% of the households in the study area use electricity as source for lighting (Figure 13), followed by candles and paraffin. This is higher than on district or provincial level where just over 80% of households use electricity for lighting purposes.

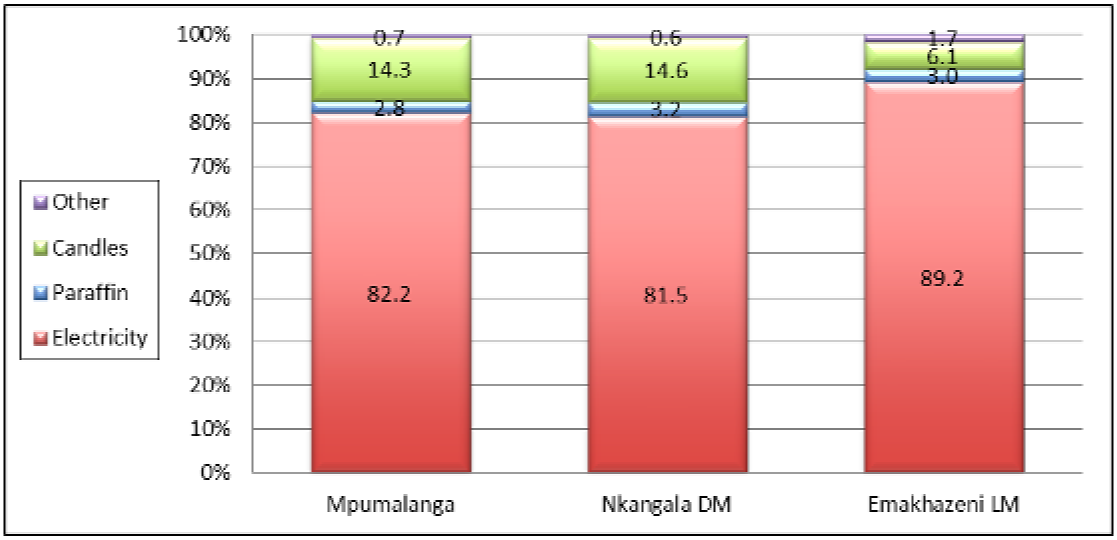


Figure 13: Distribution of energy source for lighting (households, shown in percentage, source: CS 2007)

3.2.3.2 Refuse

The profiles for refuse removal on a provincial and district level are very similar (Figure 14). This figure is much higher for the eMakhazeni LM with more than two thirds of the households having their refuse removed once a week.

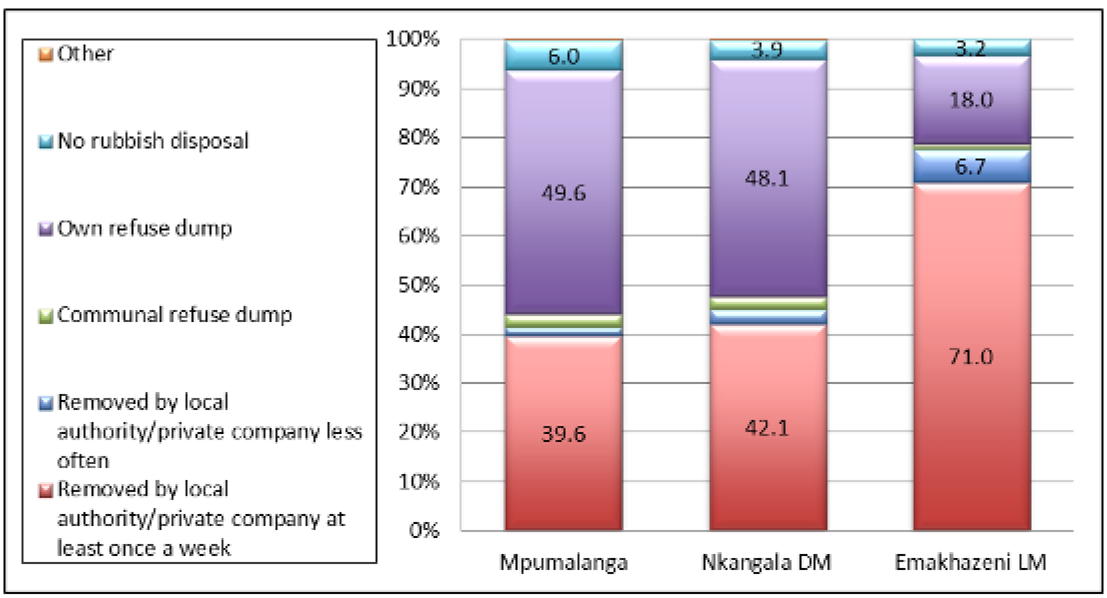


Figure 14: Refuse removal distribution (households, shown in percentage, source: CS 2007)

Almost half of the households on provincial and district level and about a fifth of households in the eMakhazeni LM have reported that they have their own refuse dumps. Some of these households are likely to be situated on farms and in rural areas that are far away from infrastructure and municipal facilities.

Households with their own refuse dumps rely mostly on backyard dumping, burial and burning. These practices adversely impact on human health and the environment, specifically:

- Air pollution from smoke;
- Pollution of ground and surface water resources and home grown fruit and vegetables;
- People inhaling smoke from fires at risk of contracting disease (cancer, respiratory related illness); and
- Fires can destroy property.

3.2.3.3 Sanitation

The absence of a flush toilet or a pit toilet with ventilation is one of the indicators of Living Environment deprivation (Noble et al, 2006). From this perspective, the eMakhazeni LM is the least deprived area in terms of sanitation services with more than 80% of households having access to flush toilets (Figure 15), which is about double the proportion on district or provincial level.

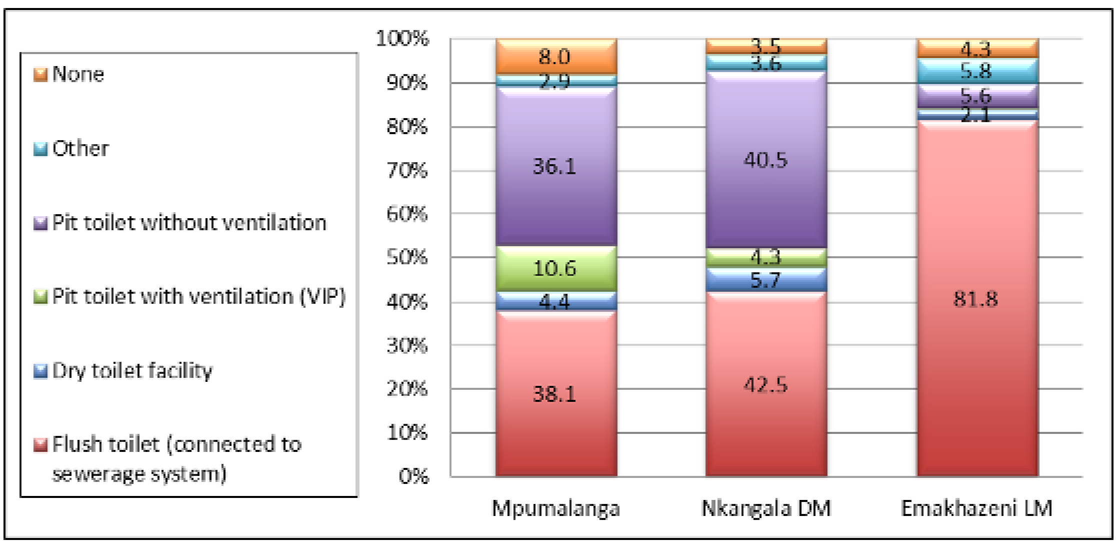


Figure 15: Sanitation distribution (households, shown in percentage, source: CS 2007)

There are four wastewater treatment plants in the eMakhazeni LM. Due to lack of adequate maintenance of the plants the operations are not 100% compliant with legislation; therefore there is a need for the upgrade of facilities (eMakhazeni Local Municipality IDP, 2011-2016).

3.2.3.4 Water

On a provincial level, almost 70% of the households in Mpumalanga had access to piped water inside the dwelling or yard (Figure 16) in 2007, compared to more than 75% on district level and just over 84% on local level.

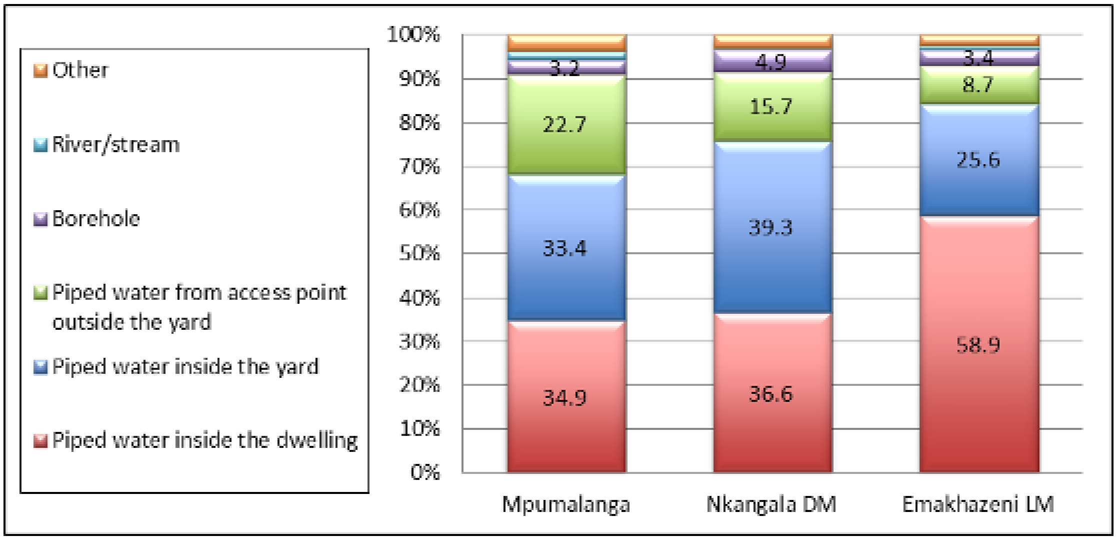


Figure 16: Distribution of water supply (households, shown in percentage, source: CS 2007)

3.2.3.5 Transport, Roads and Storm Water

In Mpumalanga almost 70% of people travel by foot as the mode of travel that they use when travelling to their place of work or school (Figure 17). The category "on foot" also includes people who work from home and live-in domestics, in other words people who do not use any transport to get to their place of work or school. This proportion is the lowest for the Nkangala DM where only about 61.8% of people travel by foot to their place of work or school.

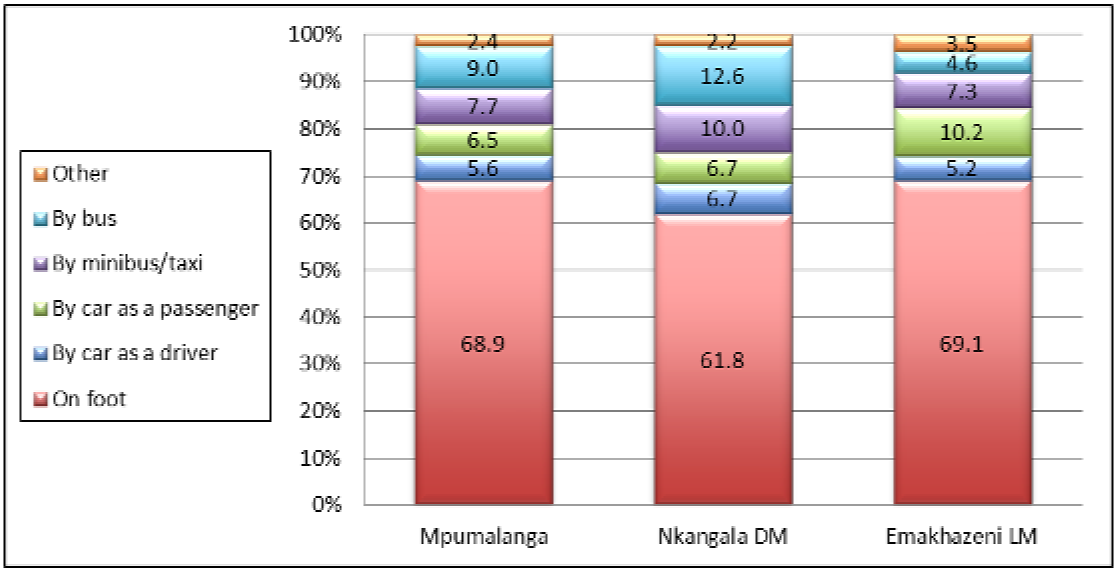


Figure 17: Mode of travel (shown in percentage, source: Census 2001)

The roads in the eMakhazeni LM area were not constructed for the use of the heavy vehicle traffic that passes the towns on a daily basis due to the opening of new mines and transportation of goods from Steelpoort and other area (IDP, 2011-2016). The past five years have seen a great increase in the number of heavy vehicles that pass through the eMakhazeni area. There is also no proper truck stop facility in eMakhazeni therefore trucks are stopping everywhere. eMakhazeni and Dullstroom do not have weighbridges, meaning trucks that are overloaded can pass through without monitoring. eMakhazeni LM does not get any assistance to maintain the roads from the truck owners and are experiencing a lot of civil claims from motorists for damage caused by potholes.

Figure 18 shows the location of social infrastructure in relation to the proposed location of the mine.

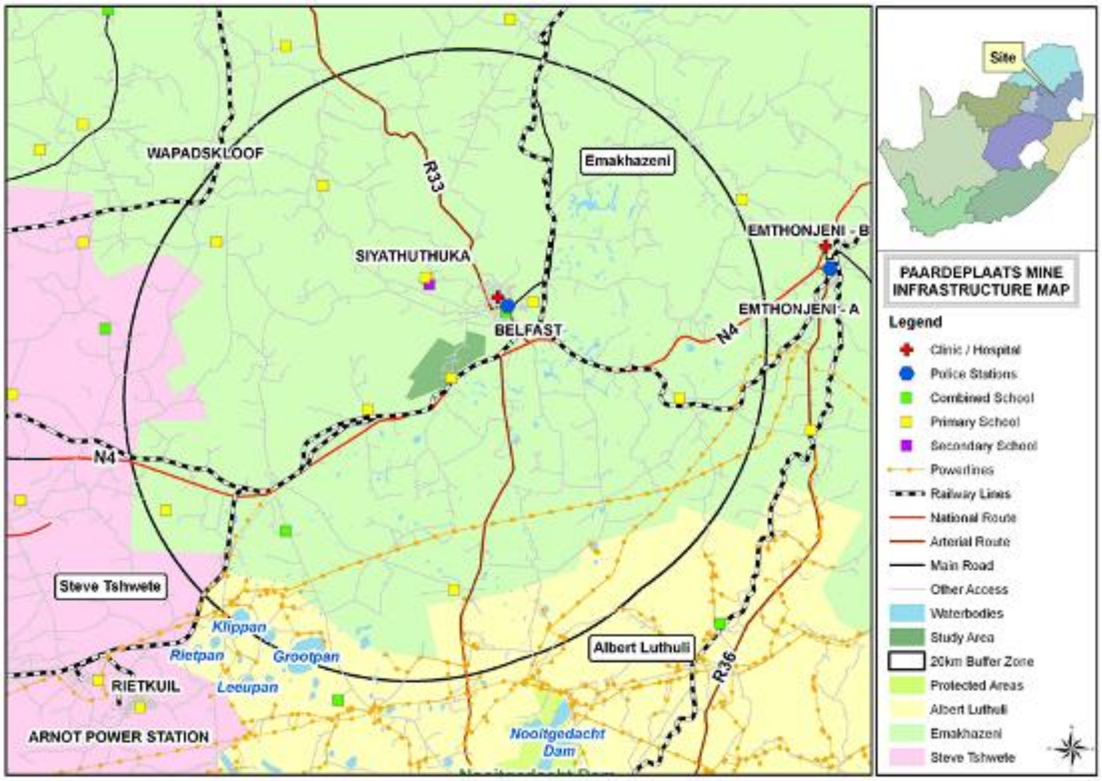


Figure 18: Infrastructure surrounding the proposed mine

3.2.3.6 Housing

Farming occupies most of the physical land, which means that land ownership in the area rests with a minority of the community. On many farms there are farm workers residing, but they do not own the land that they live on. In the formal township areas, plots tend to be small, while in informal settlements, the land on which the dwellings are situated usually does not belong to the residents. Tenure status and type of dwelling is discussed below.

The eMakhazeni LM has the lowest proportion of who own their dwellings and have paid them off in full (Figure 19), compared to 49.2% in the Delmas LM, 58.5% on district level and 62.7% on provincial level. Almost a quarter of the households in Emalahleni LM as well as the Delmas LM have indicated that they occupy their dwellings rent-free, which is much higher than on district or provincial level.

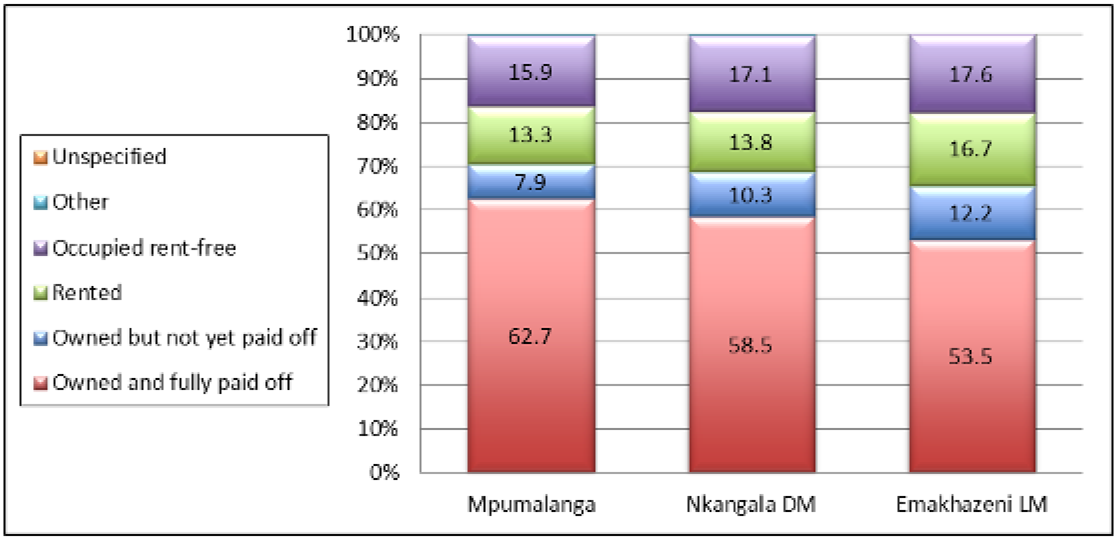


Figure 19: Tenure status distribution (shown in percentage, source: CS 2007)

Most dwellings in the eMakhazeni LM are houses or brick structures that are on a separate stand or yard (Figure 20), with a higher incidence than on district or provincial level. The incidence of informal dwellings in the eMakhazeni LM is relatively low compared to the incidence on district and provincial level, which may suggest that there are not that many opportunities in the area that would attract opportunistic job seekers from outside the area. The incidence of traditional dwellings made of traditional material is higher on local level, than on district and provincial level, which is unexpected as there are no areas under traditional authority on local level. The incidence for people staying in workers' hostels is also higher than on district or provincial level.

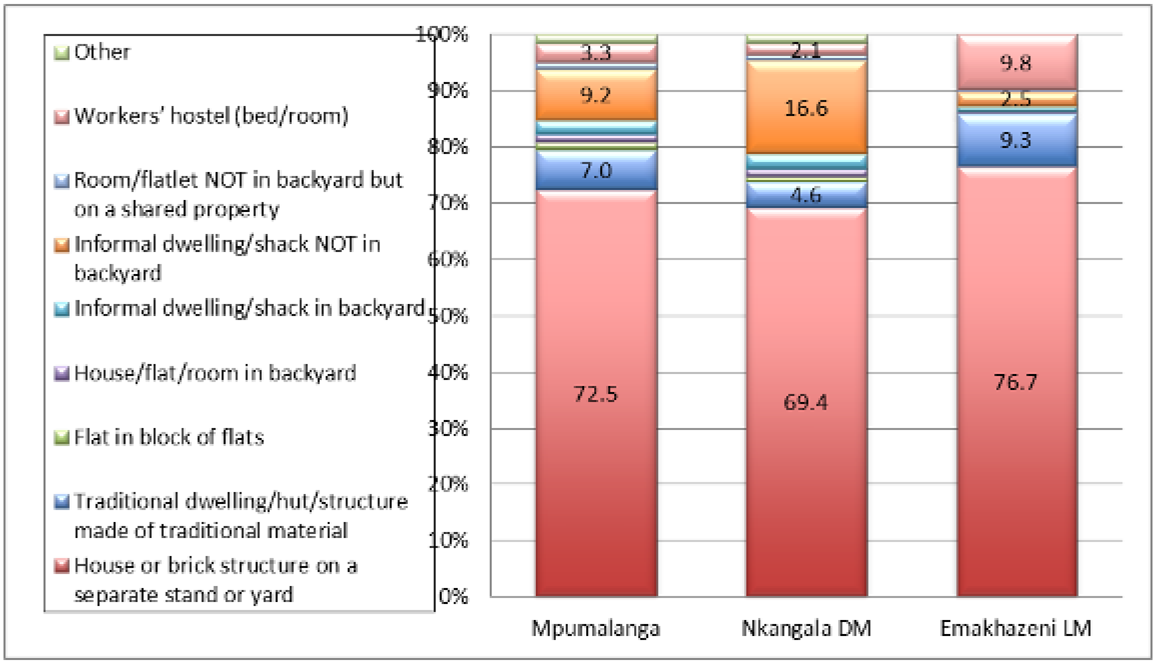


Figure 20: Type of dwelling (shown in percentage, source: CS 2007)

According to the eMakhazeni Local Municipality IDP (2012-2013) the type of household where a dwelling resides is directly linked to the wellbeing of household members. There is evidence that suggests that children under age 5 who reside in dwellings that have poor floor, wall and roof materials have higher prevalence of negative developmental outcomes (eMakhazeni Local Municipality IDP, 2012-2013). They have higher mortality during childhood, higher morbidity and lower school attendance. This is also because households in dwellings with poor building structures are often poor; have little to no access to other basic services such as safe water and sanitation.

3.2.3.7 Other Social Facilities

Especially the farming community is in dire need of social facilities (eMakhazeni Local Municipality IDP, 2012-2013), and to this extent a multi-purpose community centre was constructed at Wonderfontein. The municipality is currently trying to solicit funds to establish multi-purpose community centres at other locations as well.

There is a need to upgrade cemeteries in the ELM, seeing as graveyards were not properly fenced and the access roads were not well planned making it difficult to access graves, especially during rainy seasons. The lack of security around some municipal cemeteries has led to vandalism and some have become grazing land for livestock. In response to this challenge, the Municipality fenced existing graveyards, and established and fenced new gravesites.

The Municipality has addressed the issue of underdevelopment in existing sports infrastructure by means of upgrading sports facilities in Siyathuthuka, Sakhelwe, Emgwenya and Emthonyeni. However, vandalism of sports facilities, particularly in Emgwenya, remains a challenge.

Municipal libraries contribute to the promotion of a culture of learning amongst community members. However, the reading material in existing libraries is relevant to adults, since these are public libraries and not necessarily school libraries. Improving the library readership remains a challenge particularly amongst young children, seeing as resources in African languages (the majority population home languages) are limited.

3.2.4 HEALTH AND SAFETY PROFILE

3.2.4.1 Health and Social Welfare

3.2.4.1.1 Health

There is a general lack of health facilities in the eMakhazeni LM, especially clinics, hospitals and ambulances, particularly in the rural areas (eMakhazeni Local Municipality IDP, 2012-2013). There is also a shortage of medical staff, especially doctors and specialists, paramedics and nurses, as well as of relevant medicine. Other issues include a lack of support from the sector departments and the hospice; poor co-ordination of HIV and AIDS related activities in the Municipality; and the fact that primary health services remain limited to some communities within the municipal jurisdiction. The rural areas are service by mobile clinics, but which have been reported to be unreliable at times.

In 2008, the HIV prevalence for Mpumalanga was 11%, for the Nkangala district, 11.3% and for the eMakhazeni Local Municipality 11.2% (Nkangala District Municipality IDP, 2012-2013). Although the HIV estimates reflect a declining trend, it remains problematic.

The strategy for the eMakhazeni Local Municipality (IDP, 2012-2013) regarding health is as follows:

- The Introduction of PMTCT campaigns to high school learners to promote access to information through lifelong learning;
- The extension of health services especially to the poor through a multi-sectoral approach and collaboration with the Department of Health and Social Services so that adequate safety nets are created and the provision of ARV's and condoms becomes widespread;
- Special attention be given to augmenting Home-based care and encouraging disclosure amongst those infected;
- Encouraging voluntary testing amongst all community members; and

- Appointment of an HIV/ AIDS co-ordinator.

3.2.4.1.2 Welfare

The eMakhazeni Local Municipality (IDP, 2012-2013) has reported a number of issues that relates to the general welfare of the community:

- High rate of unemployment;
- Teenage pregnancy;
- Poverty;
- HIV/AIDS prevelance;
- Substance abuse;
- Inadequacy of recreational and entertainment facilities, especially in entertainment;
- The majority of households in the Emakhazini LM is child-headed;
- Lack of facilitation of early childhood development;
- Lack of career guidance and development of young entrepreneurs;
- Lack of mainstreaming and exit plan for youth development at local government level;
- Lack of Education and Skilling response plan;
- Lack of support from departments and private sector for youth development co-operatives;
- Youth delinquency; and
- Lack of interest in issues of local government.

3.2.4.1.3 Social Grants

For many people receiving a social grant is an important source of income, as it may be the only source of income. About a quarter of the people on provincial, district or local level is receiving a social grant. On district and local level, slightly less people than on provincial level are receiving social grants. The most frequently received grant is a child support grant that is linked to a child, followed by old age pension and disability grants (Figure 21).

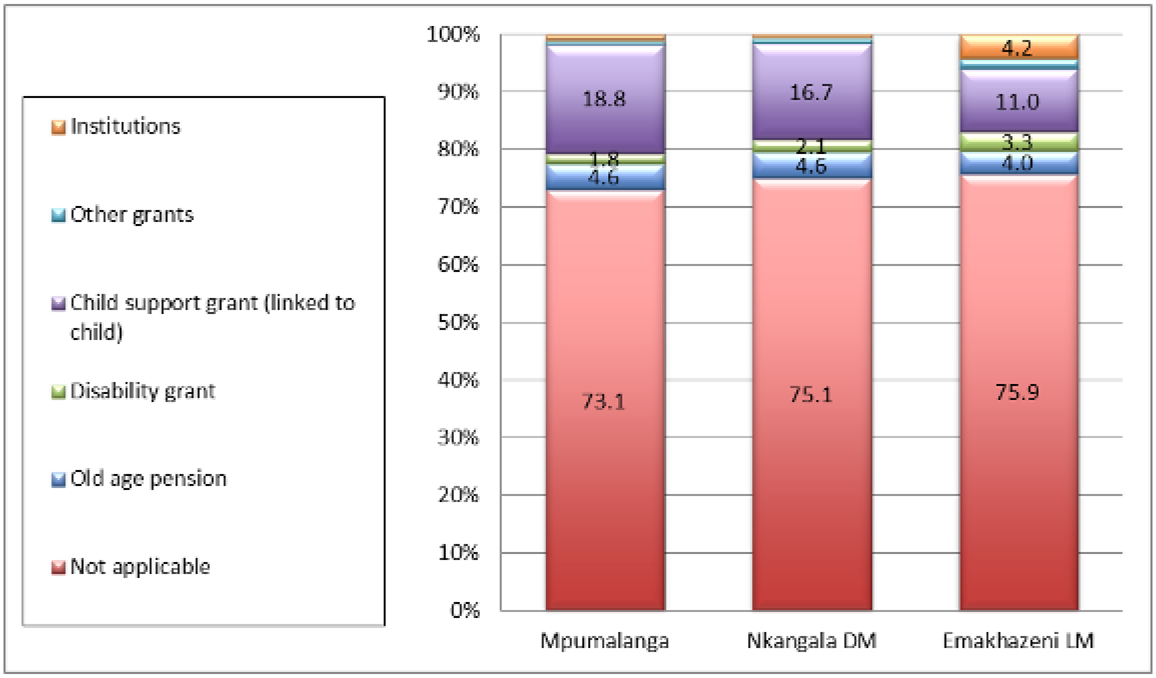


Figure 21: Social grants profile (shown in percentage, base: those of economically active age (15-65 years), source: Community Survey 2007)

3.2.4.2 Safety and Security

The crime statistics for the SAPS are not grouped according to district municipalities, but according to SAPS regions. For this reason, the statistics will be reviewed on national and provincial level as well as for the local police station, namely the Belfast Police Station.

Figure 22 gives a comparison of the distribution of crime by main category in the area with national and provincial profiles for the April 2009 to March 2010 reporting period. The highest frequency of crimes reported in South Africa and Mpumalanga is contact crimes (crimes against the person). These include crimes such as murder, assault, robbery and sexual crimes. In the Belfast police precinct the highest frequency of crimes is property-related crime, which includes burglary at residential and non-residential premises, theft of motor vehicle and motorcycle, theft out of or from motor vehicle and stock theft.

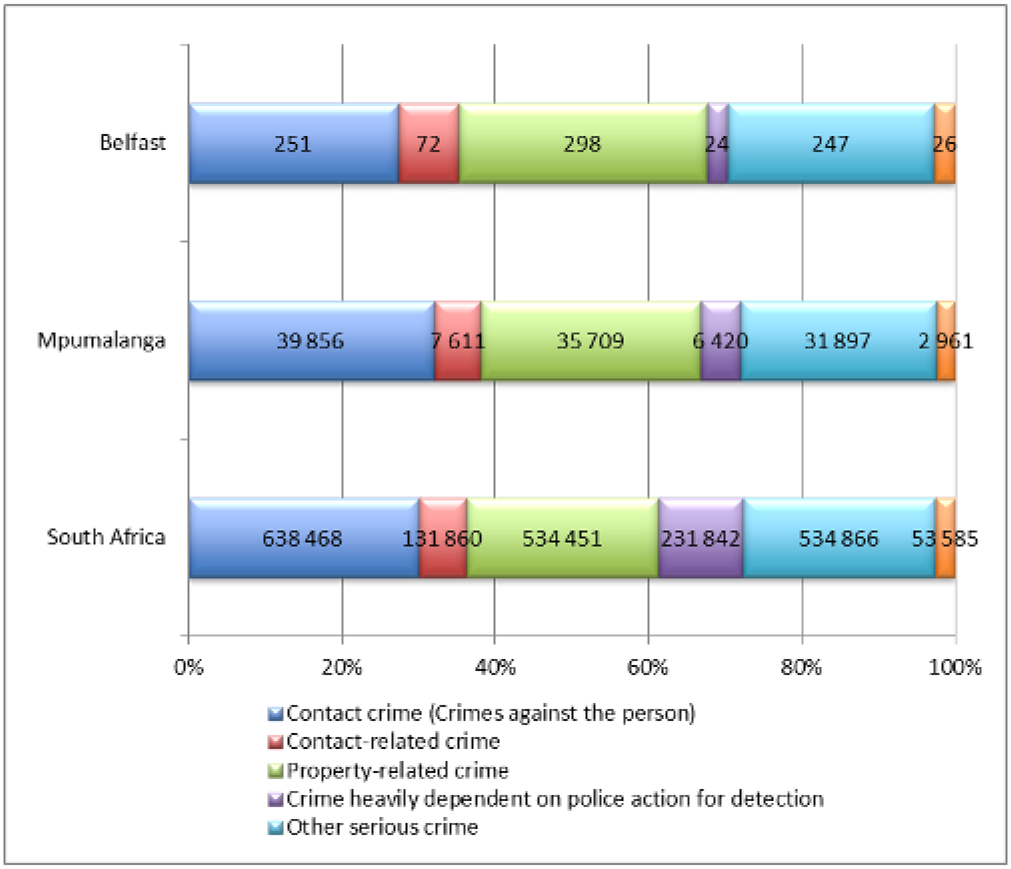


Figure 22: Crime for the April 2010 – March 2011 reporting period by main crime categories (source: www.saps.gov.za)

Figure 23 shows the crimes in the areas under discussion in percentage. The crime patterns for Mpumalanga look very similar to that of South Africa with contact crimes being the crime category with the highest proportions. In the Belfast Police Precinct there are proportionately more property-related and contact-related crimes and proportionately less crime heavily dependent on police action for detection, which can indicate that there is less detection actions implemented at the Belfast police precinct.

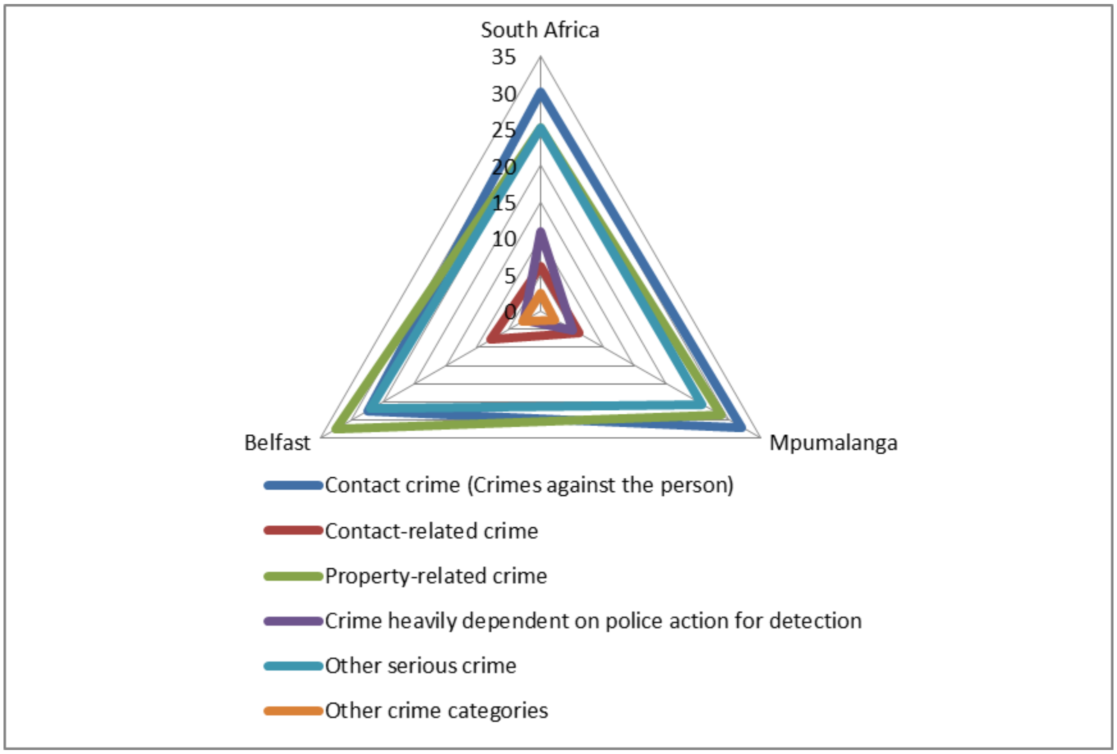


Figure 23: Crime for the April 2010 – March 2011 reporting period by main crime category (shown in percentage, source: www.saps.gov.za)

Contact crimes involve physical contact between the victims and perpetrators and as such are almost always violent in nature. For the victim, contact crime can lead to death, serious injury, psychological trauma and/or the loss of property which can especially for poorer victims have detrimental consequences. A number of contact crimes are crimes that are social or domestic in nature and usually take place between people who know each other such as friends, family and acquaintances. An analysis of dockets (SAPS, 2007) showed that in almost 90% of assault cases the people involved knew one another. In most instances the motivation for social crimes relate to a misunderstanding (SAPS, 2009), indicating that people in these communities do not have the necessary social skills to deal with these issues in another, less violent way. It also seems as if there is a close relationship between some contact crimes, particularly all categories of assault and factors and conditions like urbanisation, poverty and unemployment, vigilantism, previous offenders as well as alcohol and drugs. Urbanisation causes urban unemployment, a massive growth of informal settlements (especially in or adjacent to existing poor areas) and the disappearance of the rural subsistence economy and social support network. It also creates rising expectations and new needs (SAPS, 2007).

Contact-related crimes cover the crimes of arson and malicious damage to property. Such crimes can flow from either individual behaviour (someone in bad faith causing damage to another person's property for whatever reason) or from collective behaviour (a group of people going on the rampage as a result of industrial action; out of frustration with, for example. trains running late or a lack of service delivery; or from being swept along by a frenzy, for example xenophobic fury). In this regard it has to be kept in mind that if a train is set alight a charge of malicious damage to property will be registered, as arson usually only occurs when immovable property is set alight. On a national level, incidences for both arson and malicious damage to property have decreased. The seriousness of this type of crime is often overlooked (SAPS, 2011). Deliberate destruction of or damage to equipment can cause disruption and losses running to millions of Rands to both the private and public sector in material terms alone and can result in loss of employment opportunities when concerns are ruined. In a similar vein, deliberate or even negligently started veld or forest fires (whether resulting from pure maliciousness, intended as an act of intimidation, meant as revenge or originating form from whatever purpose) can have unseen consequences such as loss of life, destroying heritage sites, productive farmland, invaluable natural resources or irreplaceable assets.

3.2.5 ECONOMIC PROFILE

The three largest contributors (Nkangala District Municipality IDP, 2012-2013) in terms of gross value added (GVA) to the district economy were mining (29.7%), community services (14.0%) and finance (13.5%). The three largest contributors in the eMakhazeni LM were Transport (26.8%), Mining (23.3%) and Community Services (16%). The primary sector in the Nkangala DM contributed 31.6% to the GVA, the secondary sector 23.2% and tertiary sector 45.2%, while in eMakhazeni LM the primary sector contributed 27.2%, the secondary sector 11.8% and the tertiary sector 60.9%.

The formal sector (non-agricultural) in Nkangala was responsible for 66.3% of total employment in the district in 2009, the informal sector (non-agricultural) 21.0%, agriculture 5.0% and private households 7.7%. Towns in the eMakhazeni Local Municipality are primarily associated with agriculture, tourism and forestry activities (Nkangala District Municipality IDP, 2012-2013). Dullstroom provides some avenues for tourism and is in essence a service centre for the surrounding agricultural communities.

3.2.5.1 Industry

The industry profiles for the different areas under investigation look different from one another (Figure 24). It must be noted that a large proportion is indicated as either unspecified or as other and not adequately defined. Sorting this issue out could lead to a change in the profiles. The main industry of employment in Mpumalanga as well as in the eMakhazeni LM is Manufacturing; Community, social and personal services and Wholesale and retail trade. The Community; social and personal services sector includes public administration and defence activities, education and health and social work. Other large employment sectors in the eMakhazeni LM are wholesale and retail trade and manufacturing.

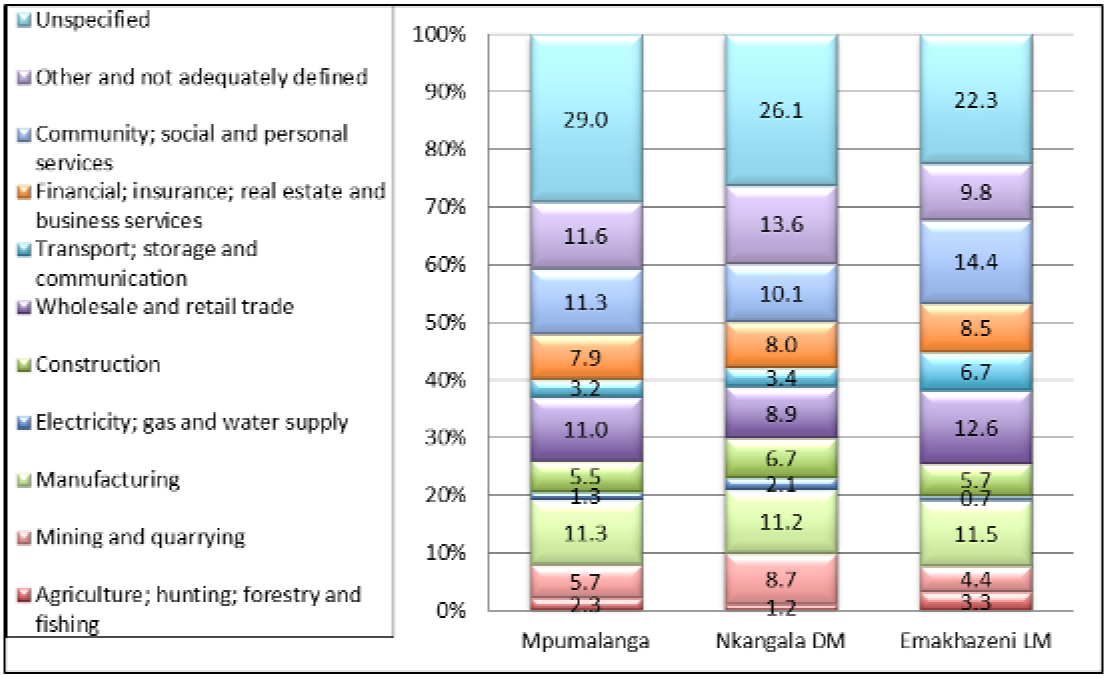


Figure 24: Industry distribution of the employed (shown in percentage, source: CS 2007)

3.2.5.2 Employment

Approximately half of the people in the eMakhazeni LM who are of economically active age (aged between 15 and 65 years) have indicated that they are employed (Figure 25), compared to 42.1% in Nkangala and 40.1% in Mpumalanga, indicating the greater concentration of economic activities in the area.

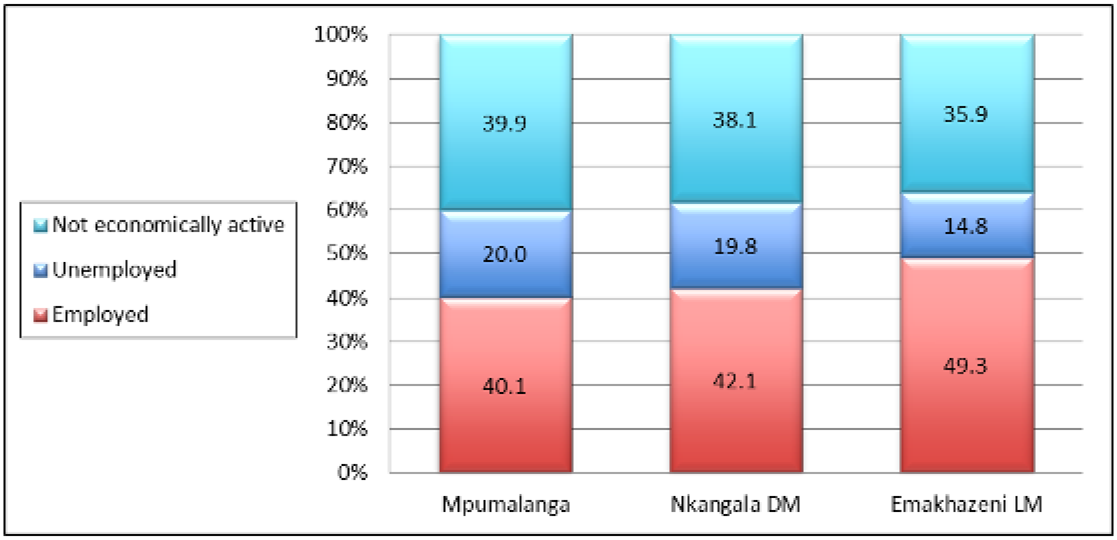


Figure 25: Employment status distribution (shown in percentage, source: CS 2007)

Only about 15% of the inhabitants of the eMakhazeni LM have indicated that they wanted to work and had taken active steps around the time of the survey to find employment. The proportions for eMakhazeni LM are different from the proportions on district and provincial level. The eMakhazeni LM has the smallest proportion of people who have described themselves as not economically active. People who are not economically active are people from economically active age who do not form part of the labour force such as housewives/homemakers, students and scholars, pensioners and retired people, and any others who do not seek to work during the period of reference (at the time of data collection). This group also include discouraged work seekers, who have either given up on finding a job, or who live too far or who do not have the means to travel around seeking a job.

Efforts to support employment creation in the following key sectors will be prioritised (eMakhazeni Local Municipality IDP, 2011-2016):

- Infrastructure;
- The agriculture value chain;
- The mining value chain;
- The green economy;
- Manufacturing sectors; and
- Tourism.

To this extent, the objectives of the eMakhazeni LM (IDP, 2011-2016) are:

- To ensure economic growth and that all capital projects contribute towards the alleviation of poverty and job creation;
- To increase the labour intensity of government funded infrastructure projects, environmental programmes and public social grants; and
- To achieve the objectives of the National and Mpumalanga Economic Growth and Development Path as linked to the LED strategy.

The strategy of the eMakhazeni LM to reach these objectives is:

- To upgrade infrastructure in order to boost tourism in the eMakhazeni LM area;
- To ensure that all the poverty alleviation and job creation projects are implemented and sustained all costs; and
- To partner with social partners to create job opportunities in our area.

In general the largest proportion of the employed people in the study area on district and provincial level (Figure 25) are working in elementary occupations such as domestic workers, street vendors, shoe cleaners, building caretakers, messengers, porters, garbage collectors, agricultural workers, mining and construction labourers, manufacturing labourers, transport labourers and freight handlers. In the eMakhazeni LM, Craft and related trades workers is the second biggest occupational category. The category of Craft and related trades workers include extraction and building trades workers, metal, machinery and related trades workers, handicraft, printing and related trades workers and other craft and related trades workers such as food processing. It must be noted that there is a high proportion of occupations that are indicated as unspecified and not elsewhere classified, which may modify the profiles should they be classified.

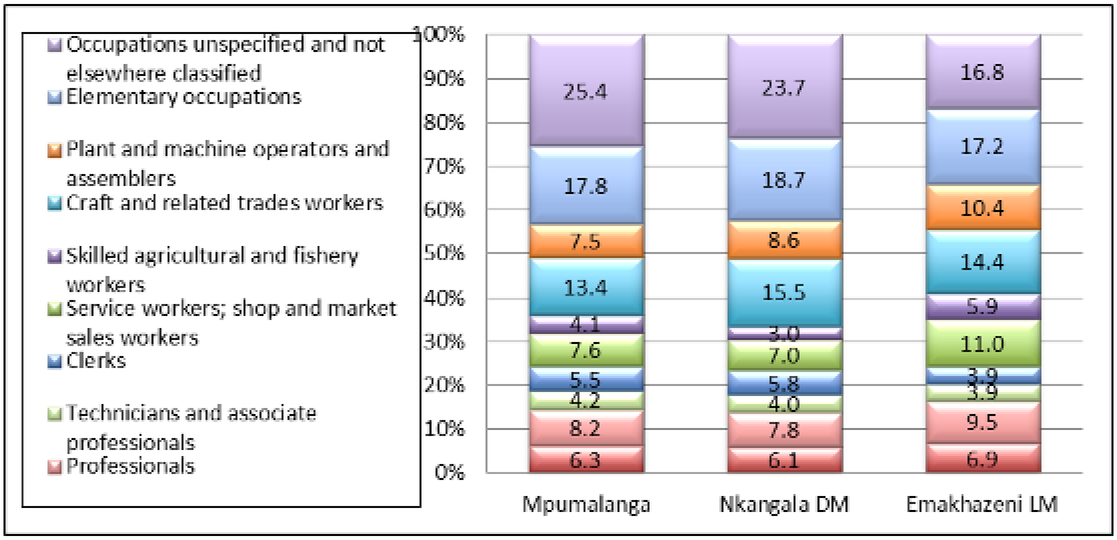


Figure 26: Occupation distribution of the employed (shown in percentage, source: CS 2007)

3.2.5.3 Household Income, Expenditure and Poverty Levels

On district and provincial level, approximately 55% of the population between the ages of 15 and 65 years have indicated that they did not have any income (Figure 27) in 2007, compared to just over 40% on local level. People in the eMakhazeni LM are financially slightly better off than the district and the province, but the levels of poverty are still high.

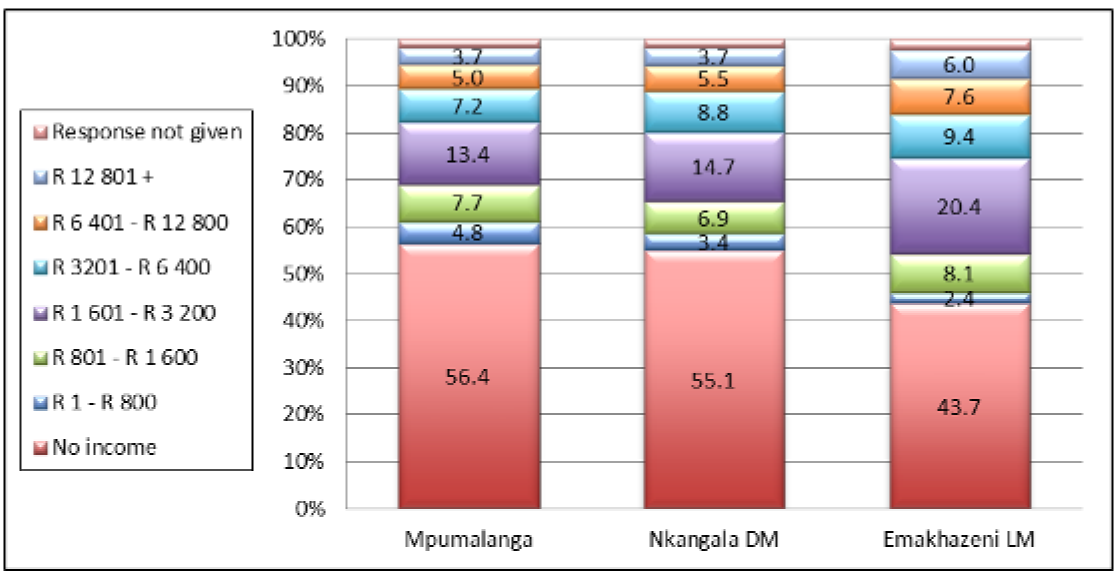


Figure 27: Individual Monthly Income distribution (shown in percentage, source: CS 2007)

3.2.5.4 Standard of Living

In South Africa there is no specific measure for social class or standard of living. The SAARF Universal LSM (Living Standard Measure) is a segmentation tool that is widely used in the marketing industry to segment the South African market into 10 LSM groups with LSM 10 being the highest and LSM 1 the lowest. It groups people according to their living standards using criteria such as degree of urbanisation and ownership of cars and major appliances (www.saarf.co.za). It is does not give an indication of disposable income or the size of a person's income, as a person with a high income who chooses to live a fairly simple life with very few appliances may have a lower LSM than a person with a lower income, a lot of debt, but much more appliances. It must be kept in mind that there are other equally valid ways to segment the population, for example in terms of lifestyle, life stages or attitudes.

Based on the characteristics of the population, it is anticipated that most would fall into the LSM 1-4 groups, maybe some LSM 5. Most would have completed some schooling, but not many would have completed high school. Radio would be the major media communication channel with the incidence of reading newspapers being fairly low. Access to services would range from basic (water, electricity, sanitation) to none, with minimal ownership of durables. Participation in activities would include singing, attending gatherings and maybe going to clubs.

3.2.5.5 GDP Growth

Nkangala's contribution to Mpumalanga's economy showed a marginal increase from 37.0 per cent in 1996, to 39.9 per cent in 2009 (Nkangala District Municipality IDP, 2012-2013). The economic growth of the district, as measured by GDP growth, was lower than the provincial rate in 2009. The average annual growth rate for the district and the province over the period 1996 to 2009 was 3.1% and 2.6%, respectively. Despite the economic recession experienced in 2008 and 2009, the forecasted annual growth rate going forward (2009-2014) is 3.4% for the province and 3.3% for the district. Over the period under review, the economy of the eMakhazeni LM (6%) grew at a faster pace than that of the provincial economy.

3.3 BIOPHYSICAL ENVIRONMENT

3.3.1 GEOLOGY

3.3.1.1 Regional Geology

As a result of the economic importance of the coal seams developed in Southern Africa, a significant amount of research has been conducted and numerous coalfields have been identified and defined. Typically five seams are developed (i.e. from the base up, the 1, 2, 3, 4 and 5

Seams) of which up to four can be mined. The 3 seam is persistent across the entire coalfield but is too thin (i.e. generally < 0.5m thick) to be economically viable.

South African coal seams are hosted by sedimentary strata of the Karoo Supergroup. These sediments were deposited during the Permian, Triassic and Jurassic Periods over a time span in excess of 70 million years (from ~ 270Ma to 200Ma). Sedimentary strata accumulated on a gently subsiding shelf platform which was in turn part of a large and relatively stable intra-cratonic basin. Stratigraphically, the sedimentary sequence has been broadly sub-divided into the following units which are described from the base upwards.

3.3.1.1.1 Dwyka Group

At the base of the Karoo Supergroup is the Dwyka Group (Late Carboniferous to Early Permian ~320 million years (Ma)) which comprises a mixed sequence of glacial and periglacial sedimentary strata including diamictite, till, moraine, conglomerate, grits, sandstone and mudstone.

3.3.1.1.2 Ecca Group

Sedimentary strata of the Ecca Group overlie the glacial sediments of the Dwyka Group. Ecca Group sediments are an Early to Late Permian (~260 Ma) sequence comprising sandstone, shale, mudstone with several significant coal seams which were deposited in a fluvio-deltaic environment. Coal seams of the Witbank Coalfield are found in the Vryheid Formation of the lower Ecca Group.

3.3.1.1.3 Beaufort Group

The Beaufort Group overlies the Ecca Group and is of Early Triassic age (~260-210 Ma). Strata are typically comprised of multicoloured mudstone and sandstone units with very minor coal. These sediments were deposited in a predominately fluvial environment.

Other sedimentary and volcanic strata of the Karoo Supergroup overlie the Beaufort Group.

3.3.1.2 Local Geology and Geological Structure

The geology is similar to the other mines within the Mpumalanga coal mines region, as described below.

The study area is located within the Karoo Sequence (Vryheid Formation). The Vryheid Formation comprises mudrock, shales, rhythmite, siltstone and fine- to coarse-grained sandstone (pebbly in places). The Formation contains up to five (mineable) coal seams. The different lithofacies are mainly arranged in upward coarsening deltaic cycles. Since the shales are very dense, they are often overlooked as significant sources of groundwater. The permeabilities of these sandstones are also usually very low. The main reason for this is that the sandstones are usually poorly sorted, and that their primary porosities have been lowered considerably by diagenesis. These sedimentary formations have been extensively intruded by dolerite dykes.

The Karoo dolerite, which includes a wide range of petrological facies, consists of an interconnected network of dykes and sills and it is nearly impossible to single out any particular intrusive or tectonic event. Dolerite dykes are vertical to sub-vertical discontinuities that, in general, represent thin, linear zones of a lower permeability sandwiched between fracture zones. These fracture zones can have a relatively higher permeability and can therefore act as conduits for groundwater flow within the aquifer. The dykes on the other hand may also act as semi- to impermeable barriers to the movement of groundwater. The dykes are commonly expressed on the surface as a line of green bushes, which can be readily observed during the dry season. The generalised stratigraphy is summarised in Table 9 below.

Table 9: Generalised stratigraphy

Stratigraphic section		Description
Transport and residual soils	Increasing with depth	- topsoil - clayey hillwash - clayey siltstone and sandstone
Vryheid Formation		-silty, laminated shale - laminated siltstone with sandstone - No 2 seam (coal) - ripple cross-bedded fine grained sandstone
Dwyka Group		Tillite, diamictite and glacial shales
Pre-Karoo basement		Paleo-weathered Selonsrivier felsite

There are numerous fractures within the study area - these fractures can form conduits for groundwater flow. Figure 28 depicts a typical borehole log of the area, around the Glisa Coal Mine, while geology of the area is shown in Figure 29 (Mabenge B, 2011).

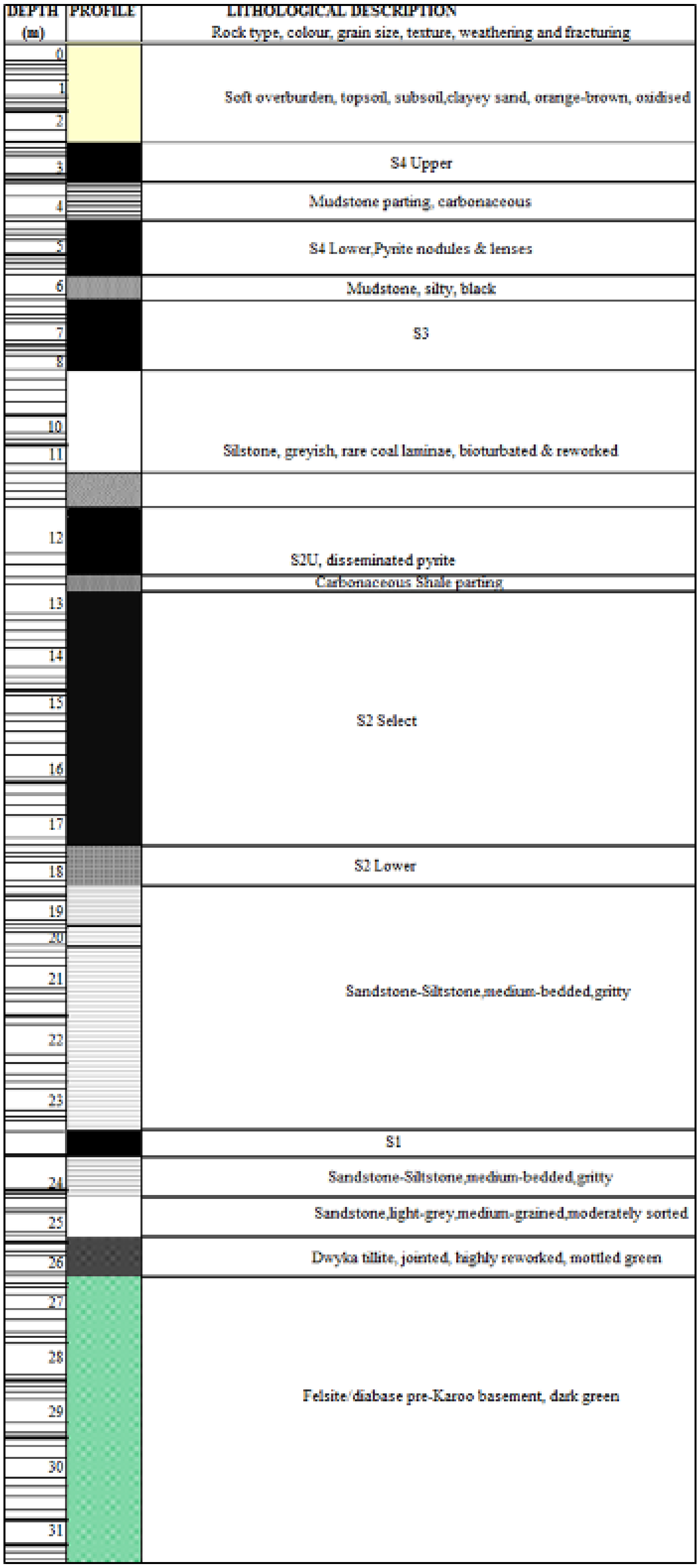


Figure 28: Typical stratigraphical profile around Paardeplaats (GCS - Glisa colliery mine)

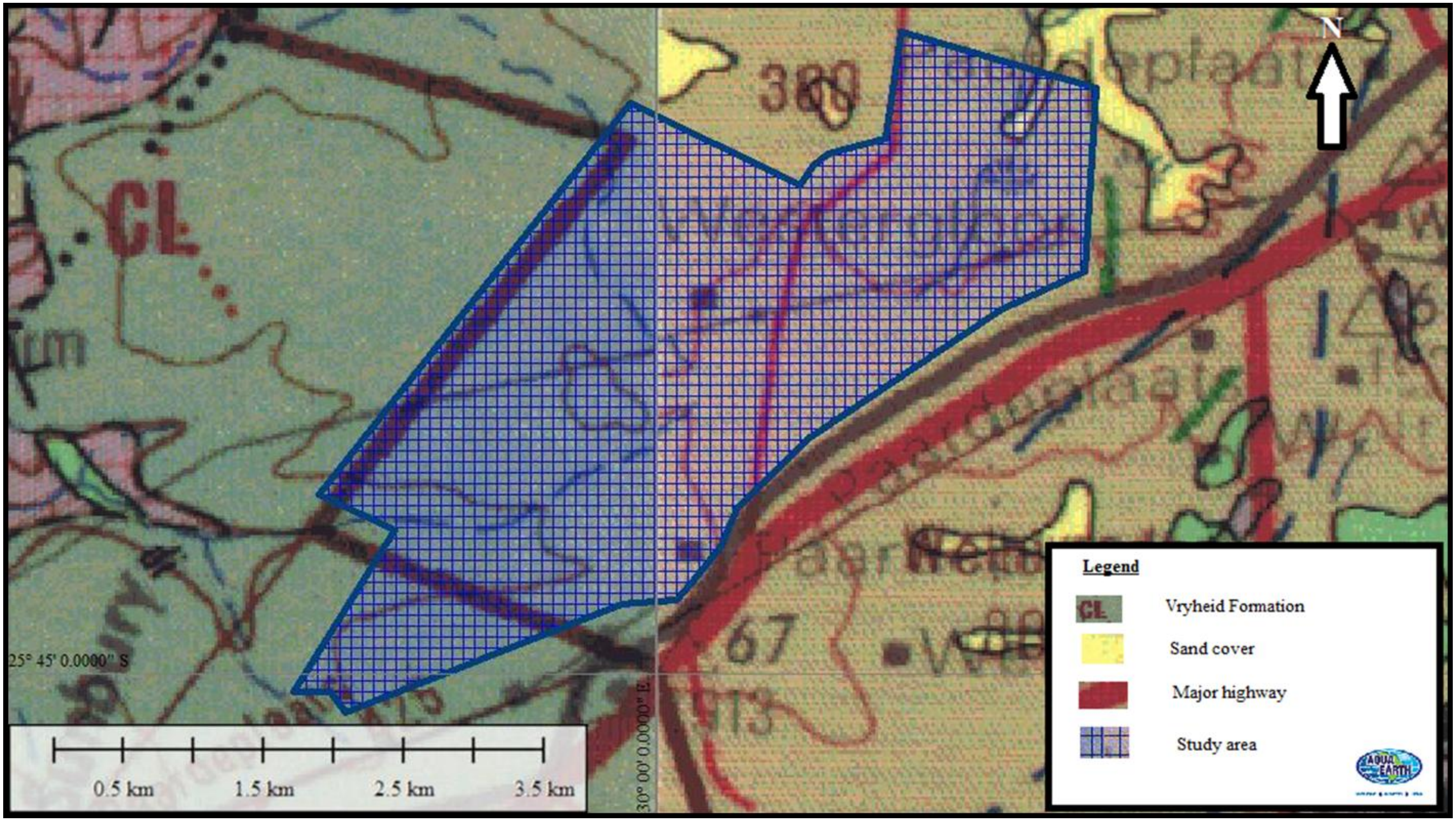


Figure 29: Geology Map

The study area overlays arenite (coarse sandstone), shale and coal. These lithological units represent sedimentary rocks. In high rainfall areas these rocks provide resistance against weathering due to the stability of the minerals, while the igneous rock succumbs to chemical weathering (Read & Watson 1983; Strahler & Strahler 1987; Johnson, Anhaeusser & Thomas 2006). The landscape reflects this trend with the study area located within strongly undulating plains, while the surface slopes and drains towards the north - northwest where igneous rocks dominate the landscape.

It is expected that the weathering of the arenite and shale will result in the formation of sandy to sandy-loam soils within the flat area (slope less than 8%) of the study area. In these conditions rainfall tends to infiltrate rather than runoff, resulting in water moving within the soil profile.

3.3.2 SOILS, LAND USE AND LAND CAPABILITY

3.3.2.1 Soil Types Located within the Study Area

Existing soil information was obtained from the map sheet 2528 Pretoria (Schoeman *et. al*., 1978) from the national Land Type Survey, published at a 1:250 000 scale. A land type is defined as an area with a uniform terrain type, macroclimate and broad soil pattern. The soils are classified according to MacVicar *et. al.* (1977).

The area under investigation is covered by two land types, namely:

- Ad1 (Yellow-brown, structureless, highly weathered soils); and
- Ib34 (Rock with shallow soils).

It should be clearly noted that, since the information contained in the land type survey is of a reconnaissance nature, only the general dominance of the soils in the landscape can be given, and not the actual areas of occurrence within a specific land type. Also, other soils that were not identified due to the scale of the survey may also occur. The site was not visited during the course of this study, and so the detailed composition of the specific land types has not been ground-truthed. Ground-truthing will occur during the EIA phase.

A summary of the dominant soil characteristics of each land type is given in Table 10 below. The distribution of soils with high, medium and low agricultural potential within each land type is also given, with the dominant class shown in bold type.

The study area is dominated by yellow-brown, structureless soils. The texture generally varies slightly from sandy clay loam to clay, and the effective depth also varies somewhat, generally between 500 and 1000 mm. There are also significant areas of shallow soils, along with some surface rock outcrops.

Table 10: Land types occurring (with soils in order of dominance), (Schoeman *et. al.,* 1978)

Land Type	Dominant soils	Depth (mm)	Percent of land type	Characteristics	Agric. Potential (%)
Ad1	Clovelly 16/17	400-900	37%	Yellow-brown, structureless, sandy clay loam soils on weathering rock	High: 20.8 **Mod: 47.2** Low: 32.0
	Mispah 10/11	100-400	13%	Grey-brown, structureless sandy loam to sandy clay loam topsoils on rock or ferricrete.	
	Avalon 16	500-1000	10%	Yellow-brown, structureless, sandy clay loam soils, on mottled soft plinthite.	
Ib34	Rock	-	65%	Surface rock outcrops	High: 0.0 Mod: 3.0 **Low: 97.0**
	Mispah + Glenrosa	100-450	31%	Grey-brown, structureless sandy loam to sandy clay loam topsoils on hard or weathering rock.	
	Hutton + Clovelly	450-1200	3%	Red and yellow-brown, structureless, sandy clay loam soils, on rock.	

It should be noted that the Agricultural Potential referred to in column 6 refers to soil potential only and does not take prevailing climatic conditions into account.

3.3.2.2 Agricultural Potential

The prevailing agricultural potential of the area is low to moderate, defined mainly by the available soil depth, but significant areas of both deeper, high potential soils and shallower, rocky, low potential soils will probably also occur.

3.3.2.3 Pre-Mining Land Uses

As far as can be ascertained prior to a site visit, the current land uses on site comprises of a mixture of commercial agriculture (arable and grazing), irrigation in the south-west for the Hadeco tulip nursery and farm homesteads for workers and stands of exotic plantations. Most of the commercial agriculture on site involves the farming of maize monoculture as well as grazing for livestock such as cattle, sheep, springbok, and blesbok. Some dams are present and used for trout fishing on a small commercial scale and recreationally by surface rights holders.

3.3.2.4 Pre-Mining Land Capability

It is not possible to provide a detailed land capability map, as the specific distribution within each land type must be established by means of a more detailed soil assessment and land capability survey. However, it can be expected that, if the expected soil distribution from the land type survey is found, the pre-mining land capability would be:

- Arable: + 73%
- Grazing: + 20%
- Wetland: + 5%
- Wilderness: + 2%

Within the Arable class, it can be expected that the land capability will vary and that certain soils will have a higher potential for arable cultivation than others. A detailed survey is currently being undertaken as part of the EIAInvestigation

3.3.3 CLIMATE

3.3.3.1 Regional Climate

A description of the climate of the study area is based on the climate of the closest town, Belfast. The climate of the study area is typical of the South African Highveld; warm summers and cold winters. Climate data was obtained from the Agroclimatology database at ARC-ISCW (ARC-ISCW, 2011).

The climate has warm, moist summers with cool, dry winters. On average, 85% of the annual average rainfall of 757 mm falls in the growing season (October to March). Frost, often severe, occurs in winter. The extreme maximum temperature is 35.6°C and the extreme minimum –13.3°C.

The climatic data is given in Table 11 below.

Table 11: Climate data for Belfast area

Month	Rainfall (mm)	Min. Temp (°C)	Max. Temp (°C)	Average frost dates
Jan	128.1	11.8	23.1	Start date: 11/05
Feb	99.8	11.7	22.5	End date: 01/09
Mar	81.7	10.1	21.9	Days with frost: ±25
Apr	41.8	7.5	19.9	
May	16.8	4.0	18.1	
Jun	6.4	1.2	15.5	
Jul	7.9	1.2	15.9	**Heat units (hrs > 10°C)**
Aug	8.6	3.1	18.3	Summer (Oct-Mar): 1419
Sep	25.7	6.7	21.2	
Oct	76.2	8.1	21.8	Winter (Apr-Sept): 353
Nov	126.9	10.0	21.8	
Dec	137.2	11.3	22.7	
Year	**757.2**	**(Average) 13.7°C**		

3.3.3.2 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers (Tiwary and Colls, 2010). Temperature provides an indication of the extent of insolation, and therefore of the rate of development and dissipation of the mixing layer.

A monthly-average ambient temperature trend (Figure 30) shows temperatures typically range between 13°C and 24°C during summer months, with daily-averages in the order of 18°C. During winter months, temperature ranges of between 3°C and 16°C are typical, with average temperatures of 8°C in June and 10°C in August.

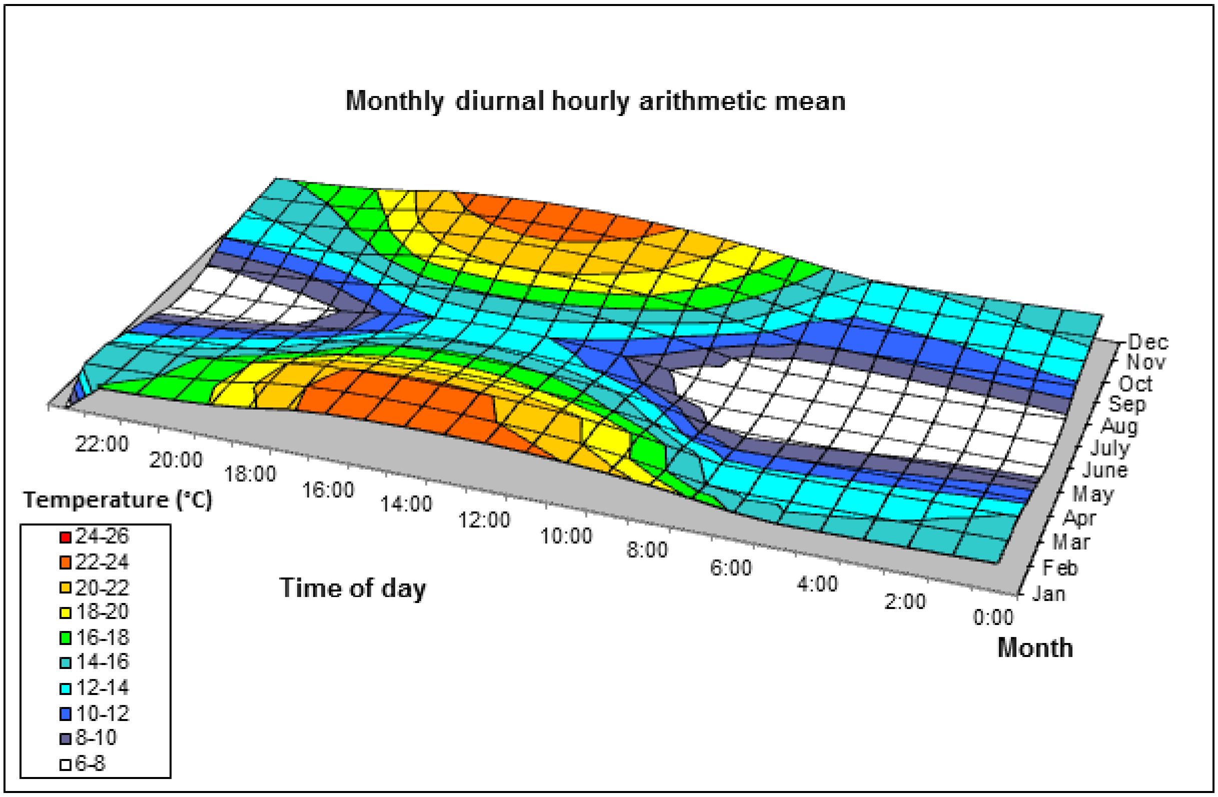


Figure 30: Monthly temperature variation at Paardeplaats Project site for 2009 – 2011, based on MM5 modelled data.

The long-term temperature trends recorded for Belfast from 1920-1959 were considered to be representative of the proposed mine site (Table 12). Minimum long-term temperatures have been recorded as ranging from -1.6°C to 16.6°C with maximum temperatures ranging between 15.2°C and 22.8°C (Table 12). Mean temperatures, recorded over the long-term, ranged between 6.6°C and 16.6°C.

Table 12: Long-term minimum, maximum and mean temperature for Belfast (1920 -1959) (Schulze, 1986)

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Belfast	Maximum	22.3	22.2	21.3	20.1	17.6	15.2	15.3	17.8	20.4	22.2	22.0	22.8
	Mean	16.6	16.4	15.2	12.9	9.5	6.6	6.8	9.0	12.0	14.7	15.5	16.5
	Minimum	10.9	10.7	9.1	5.8	1.4	-1.8	-1.6	0.2	3.6	7.4	9.0	10.2

3.3.3.3 Winds

The vertical dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness (Tiwary and Colls, 2010).

MM5 modelled meteorological data for the Paardeplaats Project site (25.729289°S; 30.004964°E) were used to generate wind roses based on 16 spokes, representing the directions from which winds blew during the period, 2009 - 2011 (Figure 31). The colours reflected the different categories of wind speeds with the dotted circles indicating the frequency of occurrence. The flow field is dominated by winds from the east and north-west. During day-time conditions, frequency of wind from the north-western sector increases while winds from the north-eastern sector are more common at night.

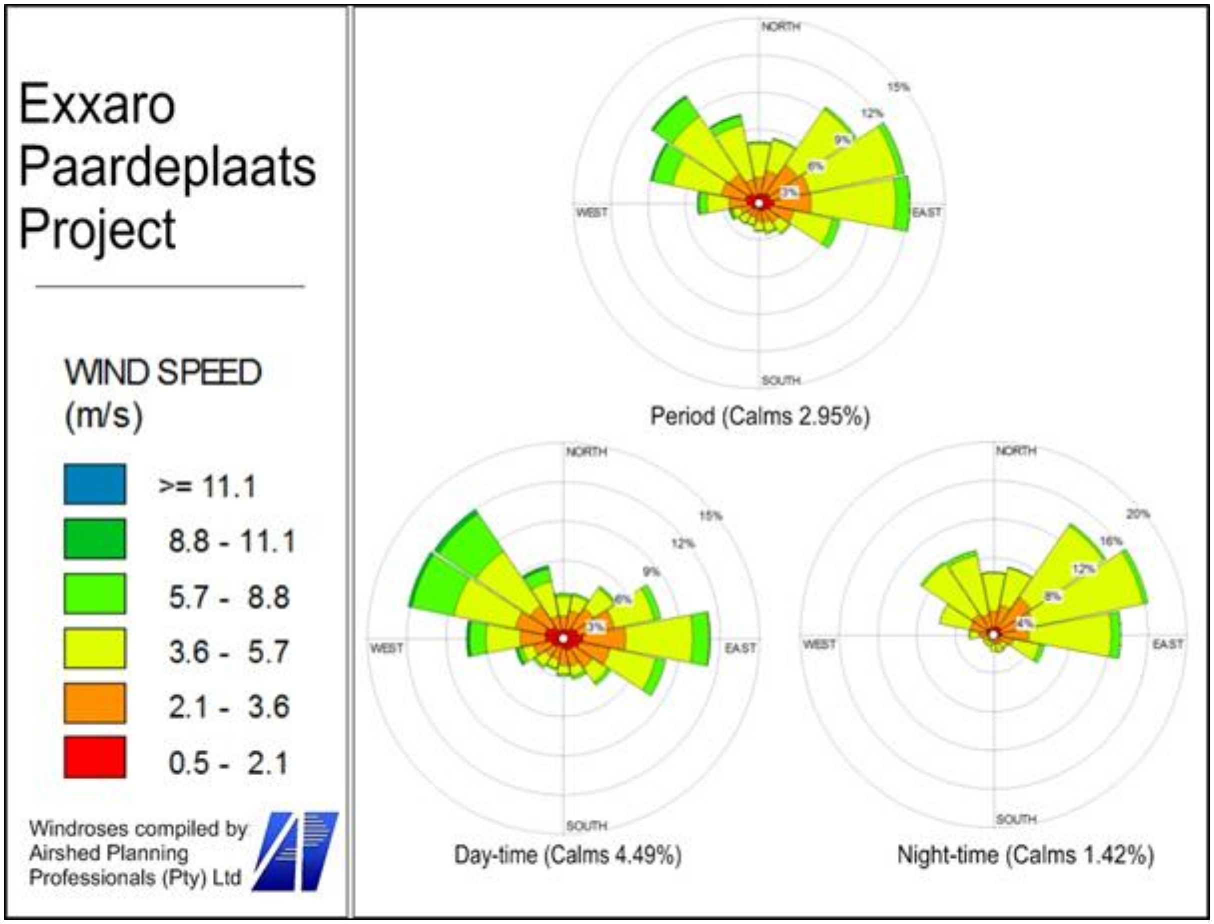


Figure 31: Period, day and night wind roses for the Paardeplaats project site for the period 2009 – 2011, based on MM5 model data.

Seasonal variation in wind direction is also evident (Figure 32) with winds from the north-western sector dominating during spring and summer. Easterly winds are more frequent in autumn and winter.

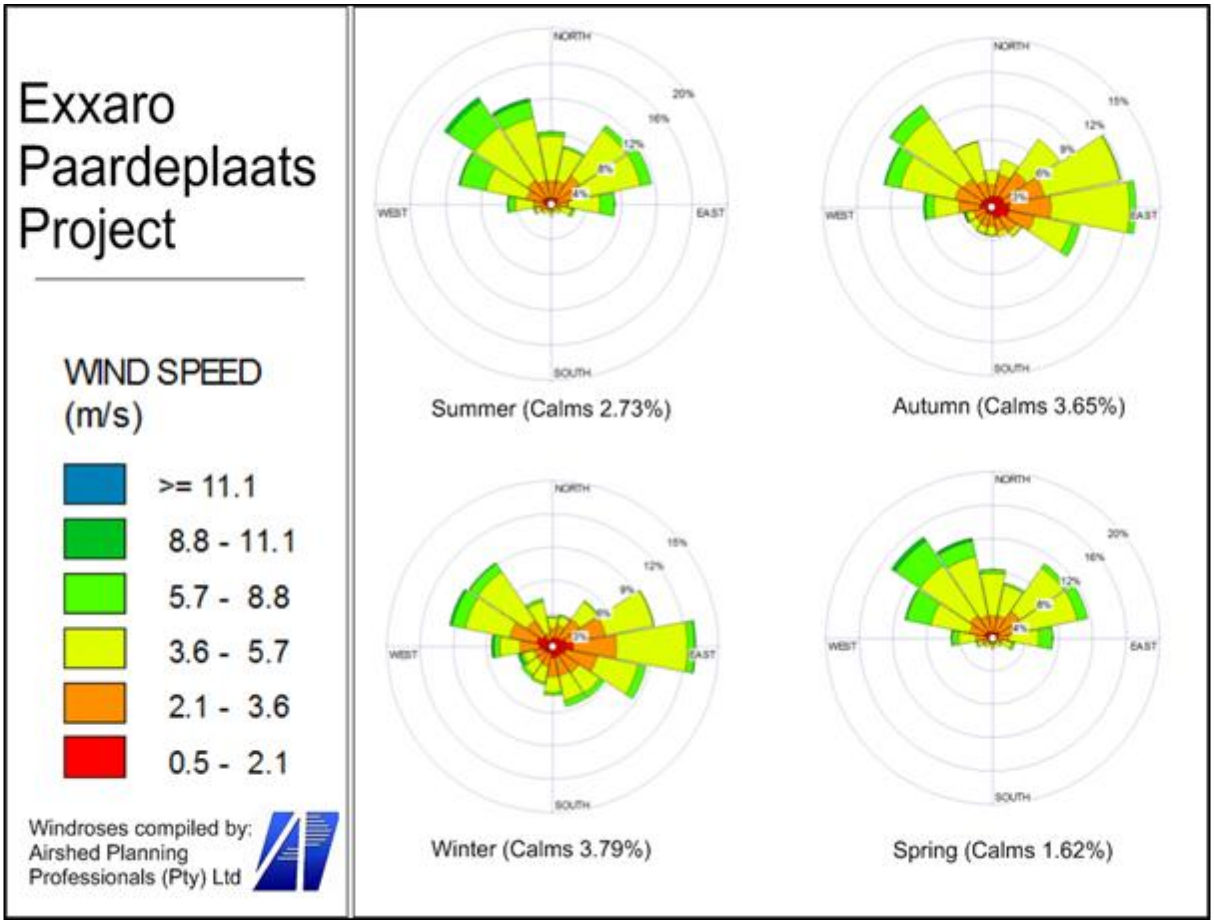


Figure 32: Seasonal wind roses for the Paardeplaats project site for the period 2009 – 2011, based on MM5 model data.

3.3.3.4 Mean Annual Precipitation and Mean Monthly Rainfall

The precipitation is important to air pollution studies since it represents an effective removal mechanism for atmospheric pollutants and inhibits dust generation potentials. The long-term average total annual rainfall for Belfast is ~842 mm (Table 13). Long-term monthly average rainfall data (Table 13) shows that rain falls mainly in summer from October to April (Figure 33), with the peak being in January (Schulze, 1986). Between 2009 and 2011 MM5 modelled data shows higher than average annual rainfall, especially in January and December (Figure 33). While snow and hail are relatively rare, fog is a common phenomenon in the vicinity of Belfast; more common (on average) than thunderstorms (Table 14).

Table 13: Long-term average monthly rainfall (mm) for Belfast (1905-1959) (Schulze, 1986)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Belfast	145	116	101	50	25	8	9	11	33	81	131	132	842

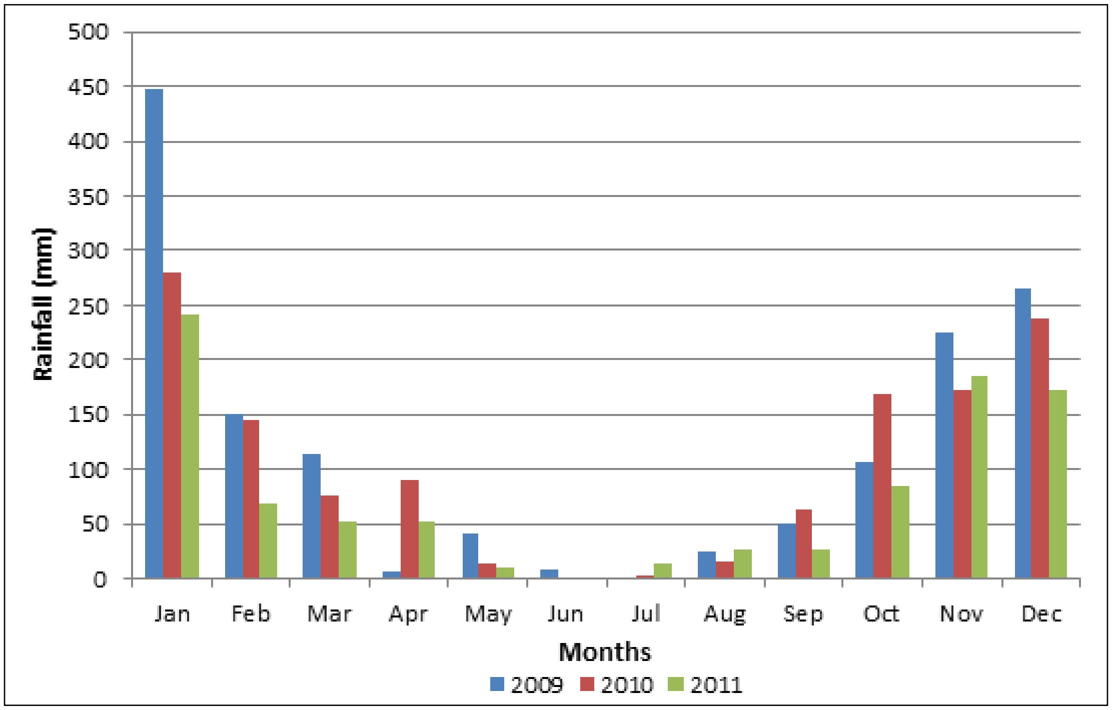


Figure 33: Monthly precipitation (mm) at the Paardeplaats Project site, based on MM5 modelled data, for the period 2009 – 2011. Annual average for the three years is 1 213 mm.

Table 14: Monthly rainfall maximums and average thunderstorm, hail, snow and fog days observed to occur at Belfast during the period 1905 to 1959 (Schulze, 1986)

Month	Maximum Monthly Rainfall (mm)	Maximum No. of Rain-days	Average No. Days Experiencing:			
			Thunder-storms	Hail	Snow	Fog
Jan	122	20	5.4	0.2	0.0	4.0
Feb	72	15	4.7	0.0	0.0	3.8
Mar	56	12	4.8	0.0	0.0	3.0
Apr	112	11	2.8	0.0	0.0	4.8
May	76	11	1.6	0.0	0.0	2.3
June	36	3	0.4	0.0	0.3	2.2
July	30	6	0.6	0.0	0.0	1.6
Aug	56	6	0.5	0.0	0.0	4.6
Sep	53	9	2.3	0.1	0.1	3.3
Oct	60	16	5.4	0.5	0.0	6.3
Nov	76	16	6.8	0.4	0.0	5.2
Dec	103	17	6.3	0.1	0.0	2.0
Annual	964		41.6	1.3	0.4	43.1

Fog is a cloud that is in contact with the ground and forms when the difference between temperature and dew point is generally less than 2.5°C. Fog begins to form when water vapour condenses into tiny liquid water droplets in the air. Since water vapour is colourless, fog is actually small liquid water droplets that have condensed from water vapour suspended in the atmosphere. Fog normally occurs at a relative humidity near 100%. This can be achieved by either adding moisture to the air or dropping the ambient air temperature.

Fog formation requires all of the elements required for normal cloud formation, the most important being condensation nuclei, in the form of dust, aerosols, pollutants, etc., on which water vapour can condense. When there are exceptional amounts of condensation nuclei present, especially hygroscopic (water seeking) particles such as salt, then the water vapour may condense below 100% relative humidity. Fog can form suddenly, and can dissipate just as rapidly, depending on the relative difference between ambient and dew-point temperatures. This phenomenon is known as flash fog.

The types of fog include advection fog, occurring when moist air is advected over a cool surface; and radiation fog, forming under very stable atmospheric conditions with clear skies, leading to heat radiation from the ground upward. Radiation fog is characteristic around Belfast, mostly occurring in the morning and is proposed to aid in cleaning up air pollution. Fog will contribute to collection of particles depending on the particle size distribution; particle collection efficiency is known to decrease as the particle sizes fall below 10µm (Ma *et. al*., 2004). As the sun rises, the water droplets evaporate, thereby dissipating the fog, cleaning the particles out of the air and leaving dirt and dust on the ground. The extent of this removal process could not be verified because site specific information on fog scavenging in the Belfast area is not available.

3.3.3.5 Runoff and Evaporation

The mean annual run-off and evaporation for the study area is provided in the table below:

Table 15: Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990)

Quaternary Catchment	Catchment Surface Area (ha)	Mean Annual Rainfall (MAP) in mm	Mean Annual Run-off (MAR) in mm	MAR as a % of MAP	Study area as % of catchment
B41A	68 724	714.5	65	9.1 %	1.75 %
X11D	53 153	744.0	87.8	11.8 %	0.08 %

3.3.4 SURFACE WATER

3.3.4.1 Site Locality in Relation to River Catchment Areas

The study area is located along the watershed between the Olifants River Catchment (Primary Catchment B) and the Crocodile/Komati Catchment (Primary Catchment X). Two quarternary catchments are affected, with most of the study area falling within quarternary catchment B41A which is drained by the Steelpoort River. A small portion of the study area, roughly 3.4 %, or 42.8 ha, falls within quarternary catchment X11D.

The proposed coal mine is located on quaternary B41A of the Olifants River catchment (Primary catchment B). A small part of the area of investigation falls into quaternary catchment X11D of the Crocodile/ Komati Catchment (Primary Catchment X). The area forms the headwaters of two river systems, one flowing to the northwest (Steelpoort River) and the other to the south (Komati River). The topographic elevation ranges from 1800 to 1905 metres above mean sea level (mamsl). A number of small sized dams are located on the streams feeding onto major rivers within the area. The area is characterised by a diverse land use including urban development, game reserve, farming, agriculture and mining.

Table 16: Information concerning quaternary catchment

Catchment	B41A	X11D
Area (km²)	1687	531
Mean annual runoff (mm/a)	64.7	87.8
Study area % of catchment	1.75	0.08

3.3.4.2 Locations of Water Resources within the Study Area

Approximately 27% of the Paardeplaats study area is considered to be covered by wetlands, making up a combined wetland extent of over 338 ha (Table 21). A number of different wetland types were identified, with hillslope seepage wetlands being the dominant wetland type and making up more than 70% of the wetland area on site. Several dams were also identified within the wetlands, totalling just over 27 ha.

The following data was recorded for sensitive receptors, dams, wetlands, springs and boreholes in the study area for evaluation:

- GPS coordinates and elevation of the borehole or spring;
- Water levels of the boreholes, where accessible;
- Estimated abstraction volumes, where provided;
- The condition of the boreholes; and
- Any other information regarding the water reliability or quality.

During the sensitive receptor survey a total of five (5) boreholes, four (4) wetlands, thirteen (13) dams and ten (10) springs were identified and is summarized in Table 17 to Table 20 below.

Table 17: Sensitive Receptors - Springs

ID	Coordinates		Farm Name	Yield	Signs of Pollution	Use
Springs	X	Y				
VSSP1	30.001151	-25.732064	Paardeplaats 29	Unknown	No	None
VSSP2	30.001034	-25.731837	Paardeplaats 29	Unknown	No	None
VSSP3	30.001361	-25.730792	Paardeplaats 29	Unknown	No	None
VSSP4	30.001594	-25.731552	Paardeplaats 29	Unknown	No	None
VSSP5	30.001964	-25.727818	Paardeplaats 29	Unknown	No	Domestic use (2)
WPSP1	29.981569	-25.754351	Paardeplaats Rmd	Unknown	No	None
HSP1	30.001605	-25.745229	Hadeco 29, 40	Unknown	No	Stockwatering (80 now, 200 seasonal
HSP2	30.001797	-25.745016	Hadeco 29, 40	Unknown	No	None
HSP3	29.997141	-25.744089	Hadeco 29, 40	Unknown	No	None
WSP1	30.021161	-25.725881	Paardeplaats 13	Unknown	No	None

Table 18: Sensitive Receptors - Dams

ID	Coordinates		Farm Name	Signs of Pollution	Use
Dams	X	Y			
VSSW1	30.000055	-25.727802	Paardeplaats 29	No	Plan to irrigate vegetables
VSSW2	29.997585	-25.723224	Paardeplaats 29	No	None
VSSW3	29.997217	-25.716443	Paardeplaats 29	No	None
VSSW4	30.004385	-25.722407	Paardeplaats 29	No	Stock watering for 120 Egyptian horses in near future
WPSW1	29.979764	-25.753755	Paardeplaats Rmd	No	None
WPSW2	29.988321	-25.751678	Paardeplaats Rmd	No	Stock watering for ± 120 cattle
HSW1	29.999811	-25.744845	Hadeco 29, 40	No	None
HSW2	29.992207	-25.74186	Hadeco 29, 40	No	Used for irrigation (1mil M/day)
WSW1	30.019685	-25.722487	Paardeplaats 13	No	Stockwater (± 100 sheep, 120 blesbok, 20 springbok) and Fishing

WSW2	30.022863	-25.717244	Paardeplaats 13	No	Stockwater (± 100 sheep, 120 blesbok, 20 springbok) and Fishing
WSW3	30.023166	-25.713023	Paardeplaats 13	No	Stockwater (± 100 sheep, 120 blesbok, 20 springbok) and Fishing
WSW4	30.013225	-25.722625	Paardeplaats 13	No	Stockwater (± 25 cattle) and Fishing
WSW5	30.014429	-25.720664	Paardeplaats 13	No	Stockwater (± 25 cattle) and Fishing

Table 19: Sensitive Receptors - Boreholes

ID	Coordinates		Farm Name	BH Yield	SWL	Signs of Pollution	Use
Bore-holes	X	Y		(l/h)			
WPBH1	29.987737	-25.750039	Paardeplaats Rmd	2500	No access	No	Domestic use (16)
HBH1	30.003057	-25.737745	Hadeco 29, 40	Unknown	No access	No	None
HBH2	30.003245	-25.743382	Hadeco 29, 40	Unknown	Dry at 4.88	No	None
HBH3	30.009753	-25.72825	Hadeco 29, 40	2500	No access	No	Domestic use (200)
WBH1	30.018945	-25.722762	Paardeplaats 13	Unknown	1.56	No	Domestic use (5+ tourists)

Table 20: Sensitive Receptors - Wetlands

ID	Coordinates		Farm Name	Signs of Pollution	Use
Wetlands	X	Y			
HWL1	30.002702	-25.737264	Hadeco 29, 40	No	None
HWL2	30.011621	-25.726395	Hadeco 29, 40	No	None
HWL3	30.013258	-25.72912	Hadeco 29, 40	No	None
HWL4	30.013045	-25.732172	Hadeco 29, 40	No	None

Table 21: Areas of different wetland types recorded on site by GCS & WCS

Wetland	Type Area (ha)	% of wetland area
Channelled valley bottom	20.87	6.17%
Depression/Pan	5.59	1.65%
Hillslope seepage	249.22	73.72%
Unchannelled valley bottom	33.31	9.85%
Sheet-rock wetland	2.05	0.61%
Dams	27.01	7.99

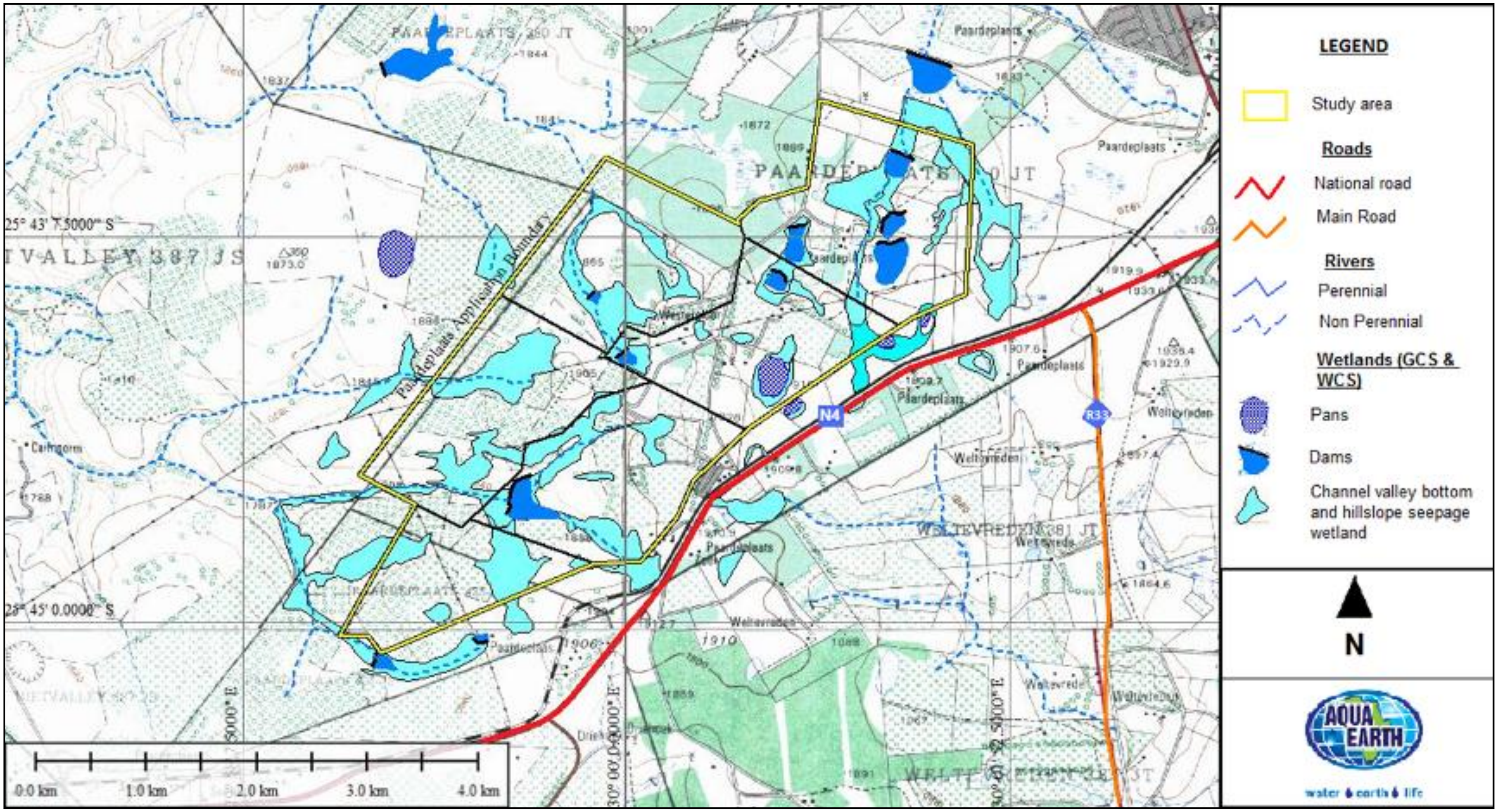


Figure 34: Map indicating delineated and classified wetlands (WCS)

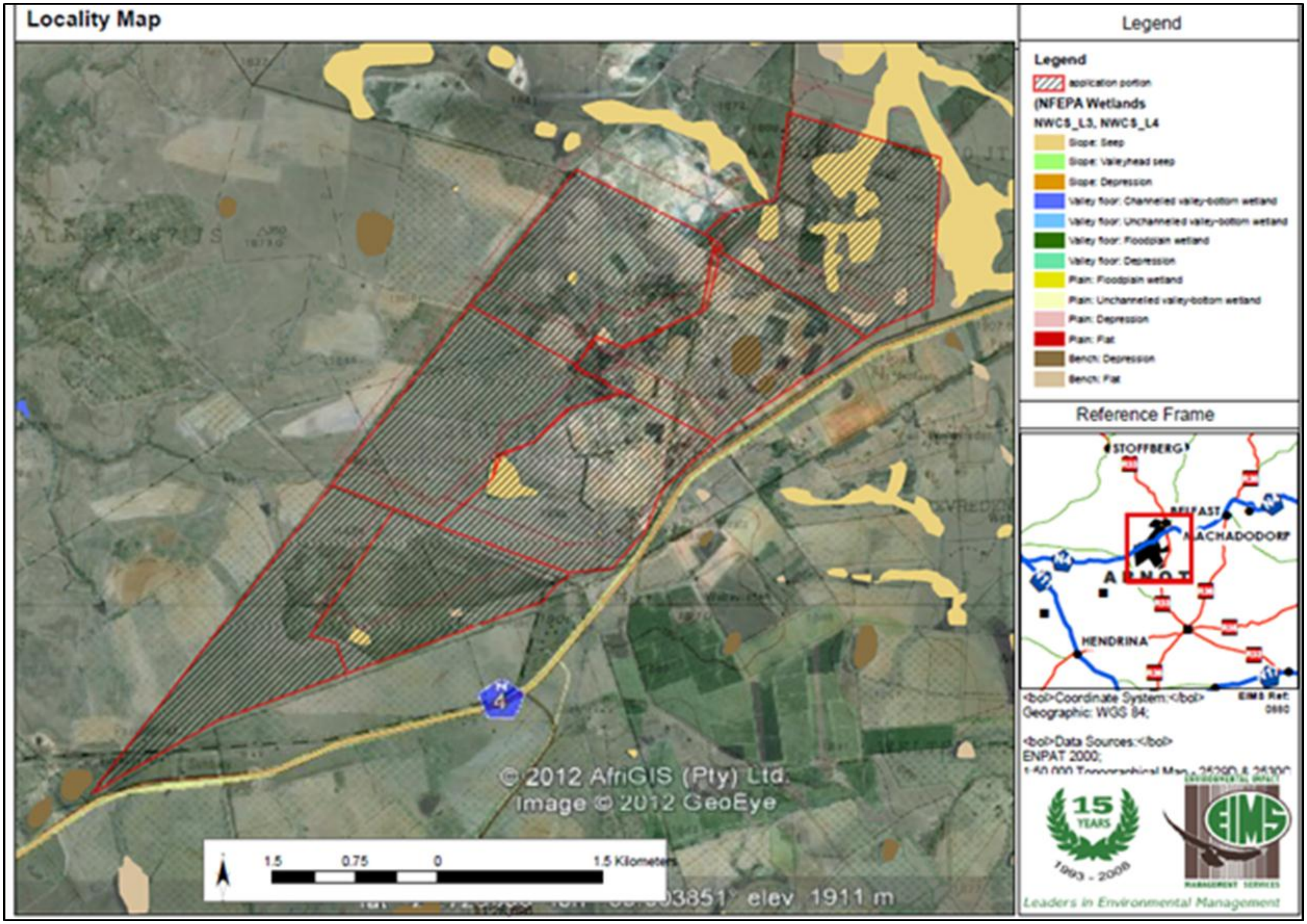


Figure 35: Study area in relation to the National Freshwater Ecosystem Priority Areas (NFEPA)

3.3.4.3 National Freshwater Environmental Priority Areas

NFEPA wetlands are present in the study area as is indicated in Figure 35 above.

3.3.4.4 Floodline

The floodlines within the study area will only be determined through the analysis of data collected during the EIA phase.

3.3.4.5 Flood Peak Estimations

Flood peak estimations will only be determined after data collection during the EIA phase.

3.3.4.6 Surface Water Quality

During November 2011 Wetland Consulting Services (WCS) conducted aquatic ecology assessment for the affected portions of Paardeplaats 380 JT and Paardeplaats 425 JS on behalf of Groundwater Consulting Services (GCS). During that study surface water samples were collected from nine points around the area (Table 22).

A total of 21 water quality field parameter readings were taken but most of the wetlands and boreholes were inaccessible for sampling. The wetlands were overgrown with grass and weeds. The boreholes were predominantly enclosed by man-made structures. Wherever samples could be obtained, field measurements together with water quality were tested. No water samples were collected for chemical analyses as no visible sign of pollution or contamination were present. The results of the data obtained from the field measurements on site are summarized in Table 34 in Section 3.3.6.2.3.

The location of the surface water samples are indicated in Figure 36.

Figure 36: Surface sampling points for the WCS aquatic study

The water quality data indicates the following (WCS 2011):

- Good quality water at sites 1, 4, 6 and 7. Salinities were relatively low and pH was circumneutral at these sites;
- The high salinities and sulphate concentrations (that greatly exceed chloride concentrations) at sites 2, 3 and 8, strongly suggest contamination by acid mine water. Sites 2 and 3 may have groundwater links with mined areas at the neighbouring Glisa Coal MIne. Site 8 is additionally likely to receive coal dust from coal trucks travelling between Glisa and Belfast; and
- Site 5 also had elevated salinities but these are likely to be related to fertilisers and irrigation in the surrounding Hadeco cultivated fields.

Table 22: Water quality data for the aquatic surface water samples (WCS 2011). Relatively high levels that are possible indications of human-related contamination are highlighted in yellow.

Parameters	pH	EC(mS/m)	TDS	Sulphate	Chloride	Phosphate	Nitrate	Sodium	Potassium	Calcium	Magnesium
P1 (Dam)	7.33	16	80.1	1.73	3.89	0	0.11	3.95	0.54	6.96	8.12
P2 (Dam)	7.87	48	291	33.43	18.74	0	0.22	9.96	9	29.86	26.04
P3 (Dam)	7.8	50	246.68	69.45	31.3	0	1.13	8.92	9.98	31.86	26.2
P4 (Dam)	7.57	13	51.26	0.61	12.28	0	0	6.45	3.41	4.1	4.38
P5 (Dam)	7.83	42	189.62	4.13	18.76	0	0.36	7.42	10.9	31.09	20.64
P6 (Dam)	6.95	10	53.42	1.58	3.14	0	0.29	6.64	1.6	6.53	5.74
P7 (Stream)	7.3	11	56.99	5.51	3.54	0	0.18	5.95	6.08	6.57	5.08
P8 (Wetland)	7.02	34	188.25	43.41	12.17	0	18.41	8.91	13.61	29.09	17.83

3.3.4.7 Existing Surface Water Uses

A number of small sized dams are located on the streams feeding onto major rivers within the study area. These dams are used for agricultural purposes, which include drinking water for cattle irrigation and small scale trout fishing both for commercial and recreational purposes. There are four small pans located on the eastern boundary of the study area.

3.3.5 GROUNDWATER

The water bearing strata is mainly the sandstones above the coal seams with the major flow path being on the contact between the sandstone and coal strata. Since the study area falls within a predominantly farming region, it is anticipated that there are a large number of production holes. Information from the National Groundwater Database (NGDB) shows that the depth to groundwater is generally shallow (5 – 15 mbgl). The information is, however, from old monitoring records and may not reflect current groundwater levels (Table 23).

The locations of monitoring boreholes are shown in Figure 37.

Table 23: Boreholes in the vicinity of the Colliery

NGDB Borehole ID	Coordinates		Locality	Date Drilled	Static Water Level (mbgl)	Static Water Level Measurement
	Latitude	Longitude				
2529DD00058	-25.78151	29.98307	Zoekop	1943/01/04	13.71	1943/01/04
2530CC00041	-25.76177	30.03034	Weltevreden (Ged7(Ged Van Ged3)	1990/06/20	5	1990/06/20
2530CA00027	-25.74646	30.03034	Paardeplaats Restant	1989/06/21	15	1989/06/21
2530CA00009	-25.73119	30.02339	Paardeplaats Restant	1989/07/28		1989/07/28
2530CA00013	-25.73119	30.05672	Wemmershuis Restant	1992/03/07		1992/03/07
2529DB00016	-25.7173	29.94974	Rietvalley	1975/08/04	10	1975/08/04
2529DB00035	-25.71729	29.93306	Boschpoort	1981/06/29	3	1981/06/29
2529DB00006	-25.71729	29.94974	Rietvalley	1975/07/23	14	1975/07/23
2530CA00060	-25.71371	30.01645	Paardeplaats	1942/11/14	3.04	1942/11/14
2530CA00097	-25.69813	30.03922	Paardefontein Livestock Farmers	2002/07/04		2002/07/04
2530CA00098	-25.69813	30.04339	Paardefontein Livestock Farmers	2002/08/15		2002/08/15
WPBH1	-25.750039	29.987737	Paardeplaats Rmd	Unknown	No access	Unknown
HBH1	-25.737745	30.003057	Hadeco 29,40	Unknown	No access	Unknown
HBH2	-25.743382	30.003245	Hadeco 29,40	Unknown	Dry at 4.88	Unknown
HBH3	-25.72825	30.009753	Hadeco 29,40	Unknown	No access	Unknown
WBH1	-25.722762	30.018945	Paardeplaats B	Unknown	1.56	Unknown

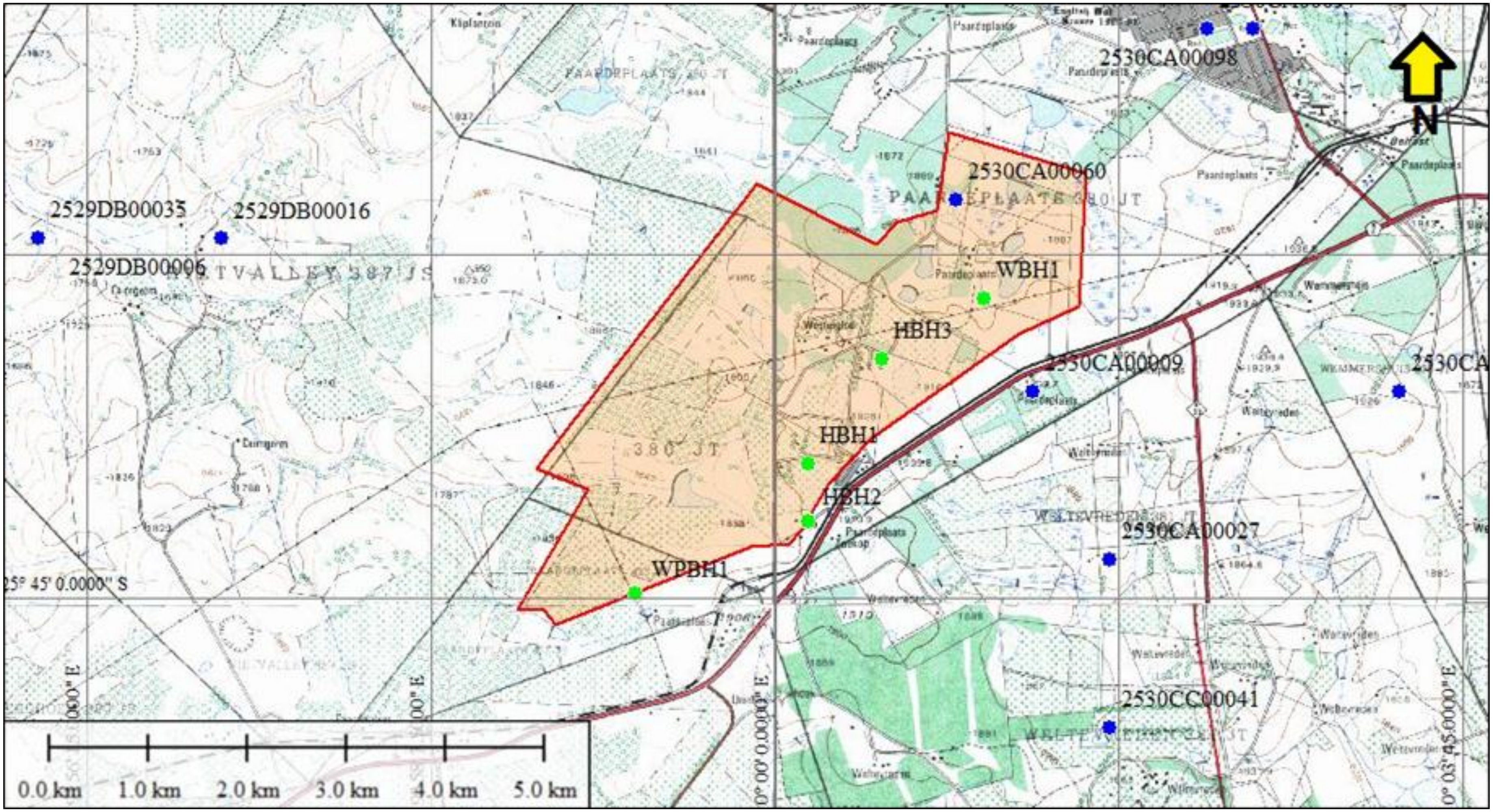


Figure 37: Location of boreholes

3.3.5.1 Hydrocensus

During October 2010 GSC conducted hydrocensus for the Exxaro's Glisa Coal Mine located north of Paardeplaat mining right area. GCS located four boreholes which fall into Paardeplaats mining right area during their hydrocensus (Figure 38). The boreholes located during GCS's hydrocensus are provided in Table 24.

Table 24: GCS Hydrocensus borehole (Oct 2010)

Site Name	Coordinates (Gape L031)		Elevation (mamsl)	SWL (mbgl)	Location or Farm Portion
	Ycoord	Xcoord			
HBH	-2847563.00	99988.00	1919.00	No access	Paardeplaats 380 JT Rem Ptn 29, Ptn 34, 35, 36 & 40
WBH	-2845920.61	102315.00	1884.00	1.74	Paardeplaats 380 JT Ptn13
VSFtn1	-2846466.00	100107.00	1899.00	Spring	Paardeplaats 380 JT Ptn30
VSFtn2	-2846596.00	100121.00	1903.00	Spring	Paardeplaats 380 JT Ptn30
EvD1	-2845889.80	98410.00	1871.00	7.38	Rietvalley 387 JS Ptn2

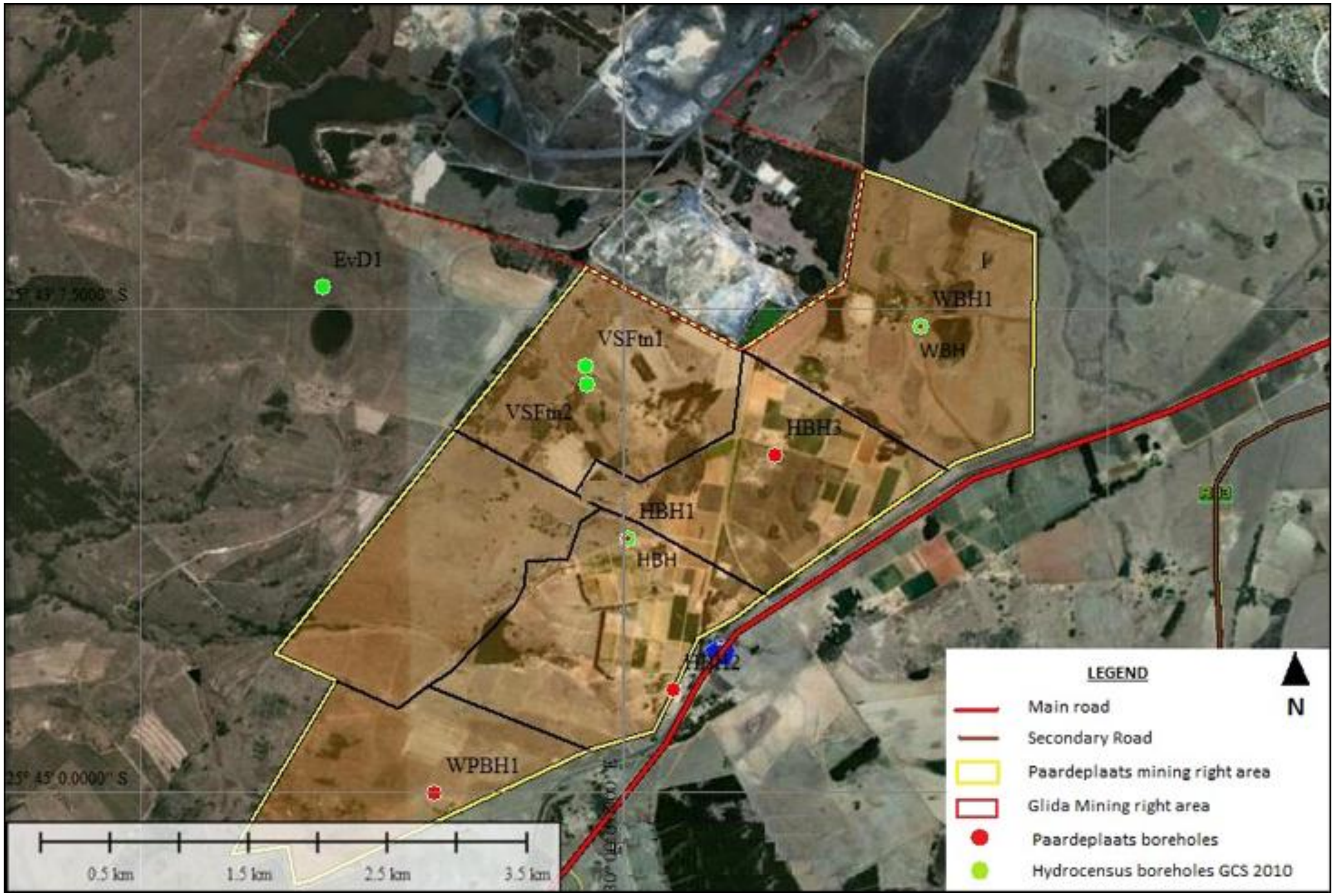


Figure 38: Indicate GCS hydrocensus boreholes and Paardeplaats boreholes

3.3.5.2 Groundwater Flow

In order to set up a groundwater flow model for the area, a water level contour map must be generated. An interpolation technique, using the available data, must be used to simulate water levels over the entire model area. The interpolation technique used is referred to as Bayesian interpolation where water levels are correlated with the surface topography.

3.3.5.3 Groundwater Quality

Three samples were collected from the boreholes located in the proposed Paardeplaats Project area (GCS hydrocensus) and submitted to the lab for analysis (Table 25). The results of the analysis where then compared to the South African National Standards for drinking water (SANS 241: 2006).

The results of the analysis revealed the following:

- The VSFtn1 spring has pH and nitrate values that exceed Class II limits and manganese concentrations that exceed the Class I limits, typically associated with agricultural activities;
- Boreholes HBH falls into Class II limits for nitrate, typical for contamination by agricultural practices;
- Borehole WBH falls into Class II limits for lead.

Table 25: Chemistry data as compared to the SANS 241: 2006

Parameter	WBH	VsFtn 1	H BH
pH	7.2	4.7	6.6
Conductivity mS/m	10.2	47.1	38.7
Total Dissolved Solids	90	452	372
Calcium,Ca	7.9	19.7	27
Calcium Hardness as CaCO3	20	49	67
Magnesium, Mg	5.7	13.2	12.1
Magnesium Hardness as CaCO3	23	54	50
Total Hardness as CaCO3	43	104	117
Sodium,Na	9	21	10.1
Potassium,K	0.4	27	12.5
Total Acidity as CaCO3	2	5	2
Total Alkalinity as CaCO3	43	1	25
P Alk as CaCO3	0	0	0
Bicarbonate,HCO3	52	1	30
Carbonate, CO3	0	0	0
Chloride,Cl	2.9	37	21

Parameter	WBH	VsFtn 1	H BH
Sulfate,SO4	<0.2	2.2	13.3
Nitrate,NO3	<0.1	178	90
Nitrate as N	<0.1	40	20
Fluoride,F	<0.1	<0.1	<0.1
Arsenic, As	<0.02	<0.02	<0.02
Selenium, Se	<0.03	<0.03	<0.03
Titanium, Ti	<0.001	<0.001	<0.001
Aluminium, Al	<0.009	<0.009	<0.009
Nickel, Ni	<0.003	0.012	<0003
Manganese, Mn	<0.001	0.23	0.005
Iron, Fe	<0.001	<0.001	<0.001
Vanadium, V	<0.002	<0.002	<0.002
Zinc, Zn	0.17	0.25	0.18
Antimony, Sb	<0.01	0.01	<0.01
Lead, Pb	0.12	<0.01	<0.01
Cobalt, Co	0.011	0.039	0.007
Copper, Cu	<0.002	<0.002	0.002
Total Chromium, Cr	<0.003	<0.003	<0.003
Silicon, Si	15.7	4.4	10.7
Tin, Sn	<0.02	<0.02	<0.02
Zirconium, Zr	<0.001	<0.001	<0.001
Bismuth, Bi	<0.005	<0.005	0.007
Thallium, Tl	<0.009	<0.009	<0.009
Beryllium, Be	<0.002	<0.002	<0.002
Cadmium, Cd	0.001	0.001	0.001
Strontium, Sr	0.028	0.33	0.31
Boron, B	0.032	0.012	<0.006
Phosphorus, P	<0.04	<0.04	<0.04
Uranium, U	<0.004	0.008	<0.004
Molybdenum, Mo	<0.001	<0.001	<0.001
Barium, Ba	0.4	0.1	0.83
Silver, Ag	0.005	0.006	0.005
Thorium, Th	<0.002	<0.002	<0.002
Mercury, Hg	<0.001	<0.001	<0.001
SANS 241: 2006	**Class I**	**Recommended Limits**	
	Class II	**Acceptable Limit**	
	Above Class II	**Above Limit**	

3.3.5.4 Groundwater Availability

The groundwater availability will only be estimated through the analysis of data collected during the EIA Phase currently underway.

3.3.5.5 Groundwater Recharge

Recharge is defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation. The recharge will only be estimated through the analysis of groundwater levels or water chemistry data once it has been collected.

3.3.5.6 Estimated Yields

The estimated yields for groundwater will only be estimated through the analysis of data collected during the EIA Phase currently underway.

3.3.5.7 Sustainable Yields

The sustainable yields for groundwater will only be estimated through the analysis of data collected during the EIA Phase currently underway.

3.3.5.8 Existing Groundwater Uses

The classification scheme (Parsons, 1995) was created for strategic purposes as it allows the grouping of aquifer areas into types according to their associated supply potential, water quality and local importance as a resource. Parson's classification system together with the revised version produced by DWA in 1998 is shown in Table 26. The farmers and residents in the area are dependent on groundwater. The water is used for domestic as well as agricultural uses. The geology underlying the site was classified according to the Parsons (and DWAF) system using current information as a minor aquifer system.

Table 26: Aquifer Classification scheme

Aquifer System	Defined by Parsons (1995)	Defined by DWAF Min Requirements (1998)
Sole Source Aquifer	An aquifer which is used to supply 50 % or more of domestic water for a given area, and for which there are no reasonably available alternative sources should the aquifer be impacted upon or depleted. Aquifer yields and natural water quality	An aquifer, which is used to supply 50% or more of urban domestic water for a given area for which there are no reasonably available

	are immaterial.	alternative sources should this aquifer be impacted upon or depleted.
Major Aquifer	High permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good (<150 mS/m).	High yielding aquifer (5-20 L/s) of acceptable water quality.
Minor Aquifer	These can be fractured or potentially fractured rocks, which do not have a high primary permeability or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although these aquifers seldom produce large quantities of water, they are important both for local supplies and in supplying baseflow for rivers.	Moderately yielding aquifer (1-5 L/s) of acceptable quality or high yielding aquifer (5-20 L/s) of poor quality water.
Non-Aquifer	These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer as unusable. However, groundwater flow through such rocks, although imperceptible, does take place, and need to be considered when assessing the risk associated with persistent pollutants.	Insignificantly yielding aquifer (< 1 L/s) of good quality water or moderately yielding aquifer (1-5 L/s) of poor quality or aquifer which will never be utilised for water supply and which will not contaminate other aquifers.
Special Aquifer	An aquifer designated as such by the Minister of Water Affairs, after due process.	An aquifer designated as such by the Minister of Water Affairs, after due process.

3.3.6 WETLANDS AND DRAINAGE AREAS

3.3.6.1 Location of Wetlands and Drainage Area

Use was made of 1:50 000 topographical maps, 1:10 000 orthophotos and Google Earth Imagery to create digital base maps of the study area onto which the wetland boundaries could be delineated using ArcView 3.2. A desktop delineation of suspected wetland areas was undertaken by identifying rivers and wetness signatures on the digital base maps. All identified areas suspected to be wetlands were then further investigated in the field.

Wetlands were identified and delineated according to the delineation procedure as set out by the "A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas" document, as described by DWAF (2005). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

For the purposes of delineating the actual wetland boundaries use is made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within 50cm of the soil surface for an area to be classified as a wetland (A practical field procedure for identification and delineation of wetlands and riparian areas, DWAF (2005).

The delineated wetlands were then classified using a hydro-geomorphic classification system based on the system proposed by Brinson (1993), and modified for use in South African conditions by Marneweck and Batchelor (2002).

Table 27: Hydro-geomorphic classification system (adapted from Brinson, 1993; Kotze, 1999; and Marneweck and Batchelor, 2002)

Hydro-geomorphic Type	Description
Channelled Valley Bottom	Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from the main channel and adjacent slopes.
Unchannelled Valley Bottom	Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.
Hillslope Seepage	Slopes on hillsides which are characterised by the colluvial movement of materials. Water inputs are mainly from subsurface flow and outflow can be via a well-defined stream channel connecting the area directly to a stream channel or outflow can be through diffuse subsurface and/or surface flow but with no direct surface water connection to a stream channel.
Pan/Depression	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this wetland type is usually isolated from the stream channel network.
Riparian Zone	Riparian habitat are associated with watercourses and consist of the physical structure and associated vegetation of these areas which are commonly characterised by alluvial soils and are inundated or flooded to an extent an frequency to influence the vegetation, but not to allow the development of hydromorphic soils.

3.3.6.2 Wetland Types and Ecological Importance

A functional assessment of the wetlands on site will be undertaken using the level 2 assessment as described in "Wet-EcoServices" (Kotze *et. al*., 2005). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions.

A PES and EIS assessment was conducted for every hydro-geomorphic wetland unit identified and delineated within the study area. This was done in order to establish a baseline of the current state of the wetlands and to provide an indication of the conservation value and sensitivity of the wetlands in the study area.

For the purpose of this study, the scoring system as described in the document "Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems" (DWAF, 1999) was applied for the determination of the PES and EIS.

Approximately 27% of the Paardeplaats study area is considered to be covered by wetlands, making up a combined wetland extent of over 338 ha. A number of different wetland types were identified, with hillslope seepage wetlands being the dominant wetland type and making up more than 70% of the wetland area on site. Several dams were also identified within the wetlands, totalling just over 27 ha.

Table 28: Areas of the different wetland types recorded on site

Wetland Type	Area (ha)	% of wetland area
Channelled valley bottom	20.87	6.17 %
Depression/pan	5.59	1.65 %
Hillslope seepage	249.22	73.72 %
Unchannelled valley bottom	33.31	9.85 %
Sheet rock wetland	2.05	0.61 %
Dams	27.01	7.99 %
TOTAL	338.05	100.00%

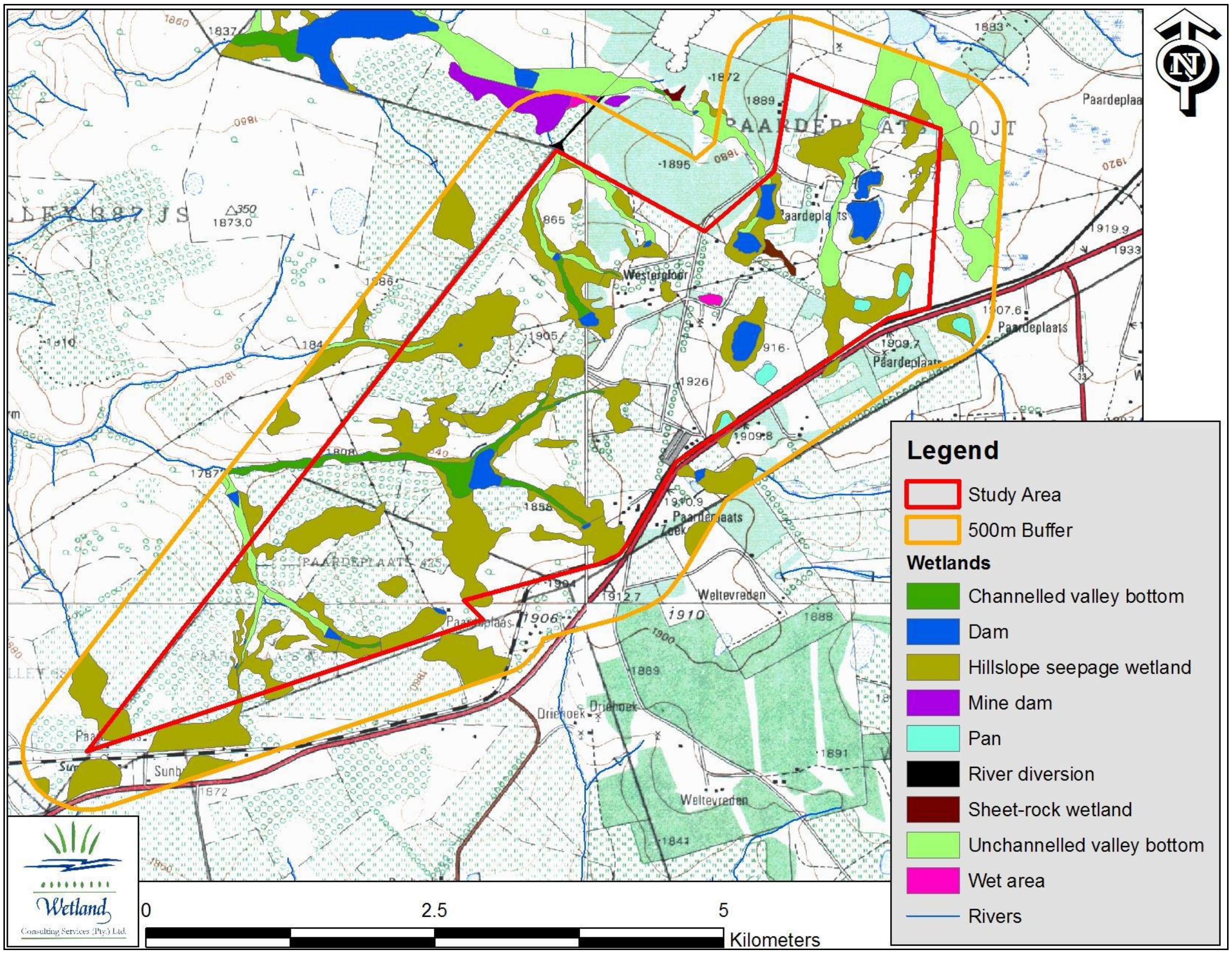


Figure 39: Map showing the delineated and classified wetlands on site. Wetlands outside the study area are based on desktop delineation only.

The extensive hillslope seepage wetlands are typical of areas on the Mpumalanga Highveld underlain by sandstones and characterised by mostly sandy soils. Wetlands, especially hillslope seepage wetlands, in these areas are mostly supported by rainfall that infiltrates the soil profile and then moves laterally through the soil profile along an aquitard. Where saturation of the top 50cm of the soil profile occurs, wetland conditions develop. Flows from the hillslope seepage wetlands are discharged into downslope valley bottom or pan wetlands and play an important role as water source for these wetlands, which also receive surface run-off.

3.3.6.2.1 Functional Assessment

For the purpose of the functional assessment and the PES and EIS assessments which follow, the delineated wetlands on site were grouped into functional wetland units based on a sub-catchment approach. The identified wetland units are illustrated in Figure 40 below.

Within the study area the wetlands represent the most extensive areas of remaining natural vegetation within a landscape otherwise largely altered by agriculture and mining. As such, all of the wetlands are expected to play a role in biodiversity support to a greater or lesser degree.

Numerous other functions are typically attributed to wetlands, which include nutrient removal (and more specifically nitrate removal), sediment trapping (and associated with this is the trapping of phosphates bound to iron as a component of the sediment), stream flow augmentation, flood attenuation, trapping of pollutants and erosion control. Many of these functions attributed to wetlands are wetland type specific and can be linked to the position of wetlands in the landscape as well as to the way in which water enters and flows through the wetland. Thus not all wetlands can be expected to perform all functions, or to perform these functions with the same efficiency.

However, based on the hydro-geomorphic wetland type, which classifies wetlands on the way that water moves through the wetland as well as the position of the wetland within the landscape, certain assumptions on the functions supported by wetlands can be made.

The results of the WET-EcoServices assessment (Kotze *et. al.,* 2004) are summarised in Table 29 below. The functions that scored the highest and would appear to be the most important functions performed by the wetlands on site are highlighted in red. Note however that no consultation with local residents was undertaken to provide additional information in terms of direct use benefits of the wetlands or possible cultural significance of the wetlands.

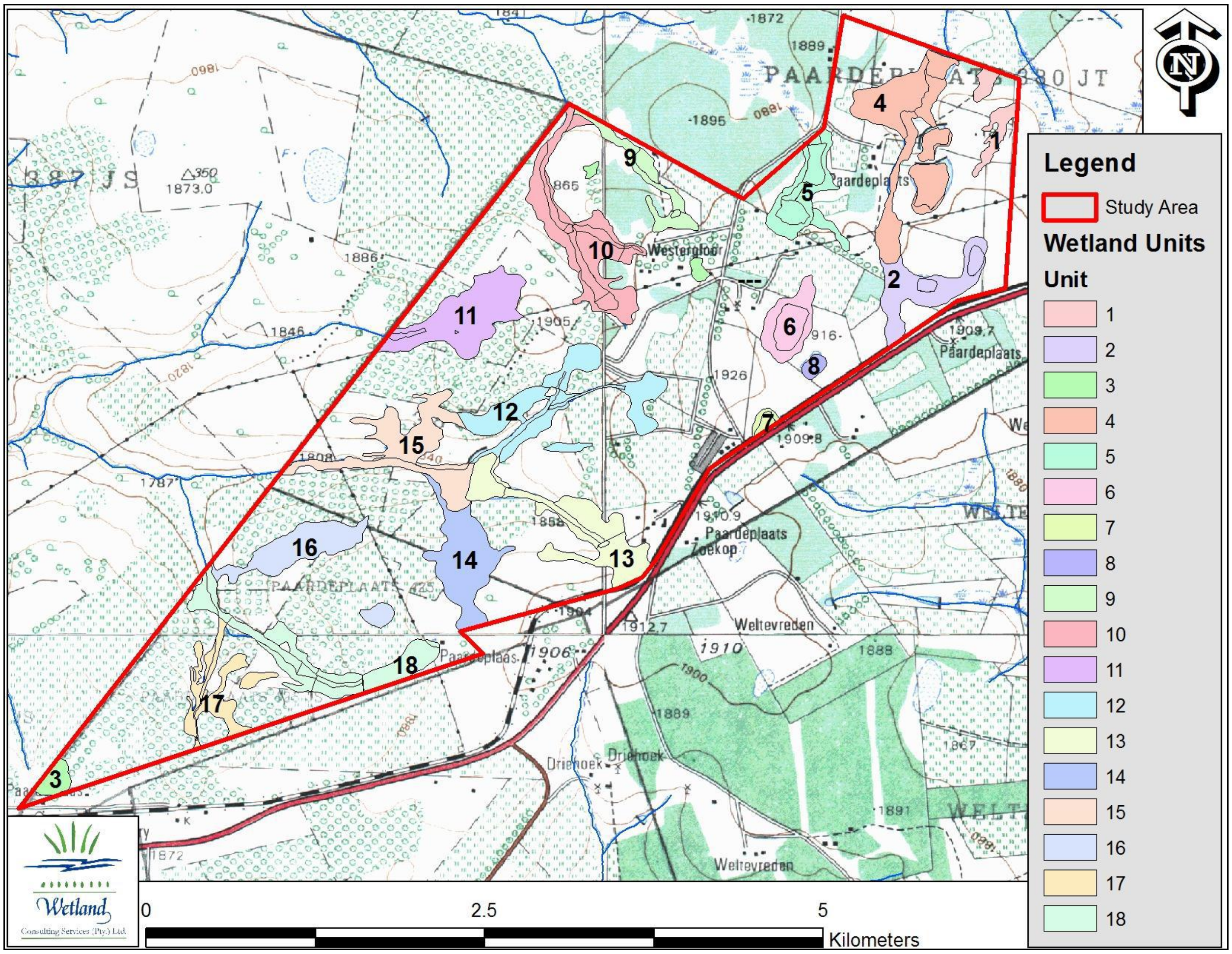


Figure 40: Wetland units as used for the functional assessment and PES and EIS assessments.

It is clear from the results in Table 29 that the wetlands on site play an important role in the maintenance of biodiversity. The wetlands represent the most extensive natural habitat remaining on site, and are thus likely to provide the main refuge for a number of species. In addition, the wetlands are located within a vegetation type listed as Vulnerable, and within an area classified as "Important & Necessary" in the Mpumalanga Biodiversity Conservation Plan. A number of the wetlands on site have however been impacted by anthropogenic activities mostly related to agriculture that have resulted in a loss of biodiversity associated with the affected wetlands. Most notably the central regions of the site are impacted by intensive agriculture, while large portions of the site also previously formed part of plantations.

The water quality enhancement functions also rated highly in terms of nitrate, phosphate and toxicant removal, as well as sediment trapping. Especially the hillslope seepage wetlands and the unchannelled valley bottom wetlands that are characterised by extended residence time of flows within the wetlands due to the slow, diffuse nature of flows through the wetland provide good opportunity for water quality enhancement. In this regard the wetlands located downslope of intensive agricultural areas, e.g. wetland units 5 and 13, are especially important in terms of water quality enhancement.

Table 29: Summarised results of the WET-EcoServices assessment

Function	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18	Average
Maintenance of biodiversity	3.00	3.50	1.75	3.25	2.80	1.06	1.75	1.63	3.25	3.25	3.50	3.75	3.8	2.00	3.75	2.19	3.50	3.50	**2.84**
Nitrate removal	2.75	2.95	2.80	2.90	2.95	1.85	2.15	2.25	2.00	2.10	2.85	2.70	2.7	2.55	2.65	2.50	2.50	2.85	**2.56**
Erosion control	2.88	2.96	2.25	3.08	2.92	2.21	2.08	2.46	2.54	2.38	2.38	2.25	2.3	2.17	2.58	2.08	2.42	2.50	**2.47**
Phosphate trapping	2.24	2.40	2.81	2.92	2.76	1.95	2.01	2.24	2.05	2.17	2.80	2.56	2.4	2.35	2.38	2.46	2.15	2.59	**2.40**
Toxicant removal	1.92	2.62	2.55	3.00	2.91	2.03	2.08	2.29	2.14	2.07	2.57	2.38	2.4	2.05	2.47	2.26	2.09	2.47	**2.35**
Sediment trapping	2.12	2.29	2.58	2.51	2.39	2.46	2.21	2.13	1.54	1.83	2.70	2.42	2.3	2.25	2.37	2.49	2.29	2.52	**2.30**
Streamflow regulation	2.33	2.67	1.67	2.67	2.83	1.33	1.50	1.50	2.00	2.00	2.50	2.67	2.7	2.50	2.67	1.83	2.67	2.67	**2.26**
Flood attenuation	2.17	2.37	2.40	2.26	2.09	2.03	2.03	2.03	2.07	1.90	1.87	2.20	2.2	1.80	2.07	2.24	2.07	2.21	**2.11**
Carbon storage	1.33	2.00	0.67	2.00	2.33	2.00	1.33	2.33	1.67	1.67	1.67	1.67	1.7	1.33	2.00	1.67	2.00	2.00	**1.74**
Tourism and recreation	1.14	1.86	1.00	2.43	2.71	1.86	0.71	1.00	1.43	2.00	1.43	1.57	2.4	1.43	2.14	0.71	1.71	2.00	**1.64**
Education and research	1.75	1.75	1.25	1.25	1.50	0.75	0.75	0.75	1.25	1.25	1.25	1.00	0.8	0.75	1.00	0.75	1.25	1.25	**1.13**
Water supply for human use	0.39	0.78	0.28	0.94	1.14	1.22	0.75	0.75	0.67	0.67	0.58	0.78	1.9	0.58	1.94	0.47	0.78	0.78	**0.86**
Natural resources	0.20	0.20	0.20	0.20	0.40	0.20	0.00	0.00	0.80	0.80	0.00	0.40	0.6	0.40	0.60	0.20	0.20	0.20	**0.31**
Cultivated foods	0.00	0.00	0.40	0.40	0.00	0.00	0.00	0.40	0.40	0.40	0.00	0.40	0.4	0.40	0.00	0.00	0.00	0.00	**0.18**
Cultural significance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	**0.00**

Hydrological functions performed by the wetlands include the functions of flood attenuation and streamflow augmentation. Wetlands are able to play an important role in flood attenuation given their location in the landscape were flows accumulate and slow down due to lower gradients. The surface roughness of the wetlands, due to increased plant cover and vigour, further aids in slowing down flood flows and attenuating floods. The extensive hillslope seepage wetlands on site are however expected to play only a minor role in flood attenuation; at the start of the wet season large volumes of water infiltrate the soils and the wetlands can play a role in flood attenuation. However, later in the rainy season when the soils in the seepage wetlands are already saturated, these areas encourage surface run-off and enhance floods rather than attenuate them. The main hydrological function of the hillslope seepage wetlands is the slow, diffuse release of water into downslope wetlands that extends from the wet season well into the dry season, highlighting the importance of these systems in stream flow augmentation.

3.3.6.2.1.1 Hillslope Seepage Wetlands

Hillslope seepage wetlands account for over 70% of the wetland area in the study site. They are predominantly associated with the sandstone derived soils in the catchment and typically reflect the presence of seasonal, shallow interflow. As is the case of the other wetland types, hillslope seepage wetlands support plants in particular, and associated insects, birds and small mammals adapted to the seasonal moisture regime. In addition hillslope seeps support conditions that facilitate both sulphate and nitrate reduction as interflow emerges through the organically rich wetland soil profile, and are thus thought to contribute to water quality improvement. They typically represent low energy environments where soil moisture conditions remain high throughout the year and can accumulate carbon. As hillslope seepage wetlands, for the most part, are dependent on the presence of an aquiclude, either a hard or soft plinthic horizon, they are not generally regarded as significant sites for groundwater recharge (Parsons, 2004). The presence of hillslope seepage wetlands indicates the emergence of water that is retained in the landscape but which is moving in the subsurface, with the rate of flow being a function of head, slope, soil depth and porosity. Because of this relationship between interflow and its emergence at the soil surface expressed as hillslope seeps, hillslope seepage wetlands are often linked with flow augmentation.

Given the extent of the hillslope seepage wetlands on site, the volume of water contributing to these wetlands is expected to be large. In addition, as this water is mostly derived from rainfall, it is expected to have a low total dissolved solids content. These two factors combined would suggest that one of the values of the seepage wetlands on site is their use as indicators of high quality water that finds its way into the Steenkoolspruit River, thus contributing to improving water quality.

3.3.6.2.1.2 Channelled valley bottom wetlands

Channelled valley bottom wetlands represent roughly 6% of the wetland area in the study site. Channelled valley bottom wetlands, through the erosion of a channel through the wetland, indicate that sediment loss and export is the dominant process, rather than sediment trapping. Erosion may be both vertical and/or lateral and reflect the attempts of the stream to reach equilibrium with the imposed hydrology. From a functional perspective channelled valley bottom wetlands can play a role in flood attenuation when flows over top the channel bank and spread out over a greater width, with the surface roughness provided by the vegetation further slowing down the flood flows. Some sediment trapping can occur during flood flows, though under intermediate flow conditions they contribute sediment to downstream reaches. These wetlands play only a minor role in the improvement of water quality given the short contact period between the water and the soil and vegetation within the wetland. Within the study area they also contribute to biodiversity support and provide movement corridors for wildlife through a landscape extensively transformed by cultivation.

3.3.6.2.1.3 Unchannelled valley bottom wetlands

Un-channelled valley bottom wetlands reflect conditions where surface flow velocities are such that they do not, under existing flow conditions, have sufficient energy to transport sediment to the extent that a channel is formed. In the study site, they account for almost 10% of the wetland area with only one unchannelled valley bottom located in the upper reaches of one of the small tributaries on site. In addition to the biodiversity associated with these systems it is expected that they play an important role in retaining water in the landscape as well as in contributing to influencing water quality through for example mineralisation of rain water. These wetlands could be seen to play an important role in nutrient removal, including ammonia through adsorption onto clay particles.

3.3.6.2.1.4 Pans/Depressions

Pans account for less than 2% of the wetland area in the study site. Given the position of most pans within the landscape, which is usually isolated from any stream channels, the opportunity for pans to attenuate floods is fairly limited, though some run-off is stored in pans. Pans are also not considered important for sediment trapping, as many pans are formed through the removal of sediment by wind when the pan basins are dry. Some precipitation of minerals and de-nitrification is expected to take place within pans, which contributes to improving water quality. Some of the accumulated salts and nutrients can however be exported out of the system and deposited on the surrounding slopes by wind during dry periods.

An important function usually performed by pans is the support of faunal and floral biodiversity, which is enhanced by the diversity in habitat types offered by different pans. Within the study area however, the small size of the pans, together with their seasonal nature and the disturbed vegetation, the biodiversity support of these pans is expected to be limited.

3.3.6.2.2 Present Ecological Status (PES) Assessment

The wetlands on site have been subjected to a range of anthropogenic activities, mostly related to agriculture and construction of infrastructure such as roads, which have resulted in the degradation of the wetland systems on site. This degradation is reflected in the results of the PES assessment, Table 30 and Figure 41.

Table 30: Table showing the results of the PES assessment (all figures are in hectares).

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Unit 12	Unit 13	Unit 14	Unit 15	Unit 16	Unit 17	Unit 18
Hydrologic																		
Flow modification	4	4	2	3	2	2	2	2	3	3	4	3	2	3	2	2	3	3
WATER QUALITY																		
Water quality modification	4	4	3	3	2	2	2	2	3	3	4	3	3	3	2	3	4	4
Sediment load modification	4	4	2	3	2	2	2	1	2	3	4	2	2	2	2	2	3	3
hydraulic/geomorphic/ physical																		
Canalization	5	4	3	3	3	4	4	4	3	3	4	2	2	4	3	3	3	3
Impounding	5	5	3	3	2	2	2	4	3	3	4	4	2	4	2	3	3	2
Topographic alteration	4	5	3	3	3	2	2	3	4	3	4	3	3	4	3	4	4	4
Modification of key driver or keypoint	4	4	3	3	2	2	2	2	3	3	4	3	3	3	2		3	3
Biota																		
Change in species composition and richness	3	3	2	3	3	2	2	2	3	3	3	3	2	2	3	2	2	3
Invasive plant encroachment	4	4	2	3	3	3	3	3	2	3	3	2	2	2	3	2	2	3
Over utilization of biota	3	3	2	3	3	3	3	2	3	3	4	3	3	2	3	2	3	3
Land-use modification	3	3	2	3	2	3	3	2	3	3	4	2	2	2	3	2	3	3
TOTAL	43	43	27	33	27	27	27	27	32	33	42	30	26	31	28	25	33	34
MEAN	**3.9**	**3.9**	**2.5**	**3.0**	**2.5**	**2.5**	**2.5**	**2.5**	**2.9**	**3.0**	**3.8**	**2.7**	**2.3**	**2.7**	**2.5**	**2.5**	**3.0**	**3.1**
PES	**B**	**B**	**D**	**C**	**D**	**D**	**D**	**E**	**C**	**C**	**B**	**C**	**D**	**D**	**C**	**D**	**C**	**B**

Table 31: Table showing the rating scale used for the PES assessment.

Mean*	Category	Explanation
Within generally acceptable range		
>4	A	Unmodified, or approximates natural condition
>3 and <=4	B	Largely natural with few modifications, but with some loss of natural habitats
>2.5 and <=3	C	Moderately modified, but with some loss of natural habitats
<=2.5 and >1.5	D	Largely modified. A large loss of natural habitat and basic ecosystem function has occurred.
Outside generally acceptable range		
>0 and <=1.5	E	Seriously modified. The losses of natural habitat and ecosystem functions are extensive
0	F	Critically modified. Modification has reached a critical level and the system has been modified completely with almost complete loss of natural habitat.

Table 32: Summary of the PES results by area.

PES	Area (ha)	% of wetland area
B	78.42	23.20%
C	149.99	44.37%
D	107.80	31.89%
E	1.84	0.54%
TOTAL	338.05	100.00%

The majority of the wetlands on site were classed as either Moderately Modified (44.4%) or Largely Modified (31.9%), though a significant proportion of the wetlands are still considered to be in a Largely Natural (23.2%) condition.

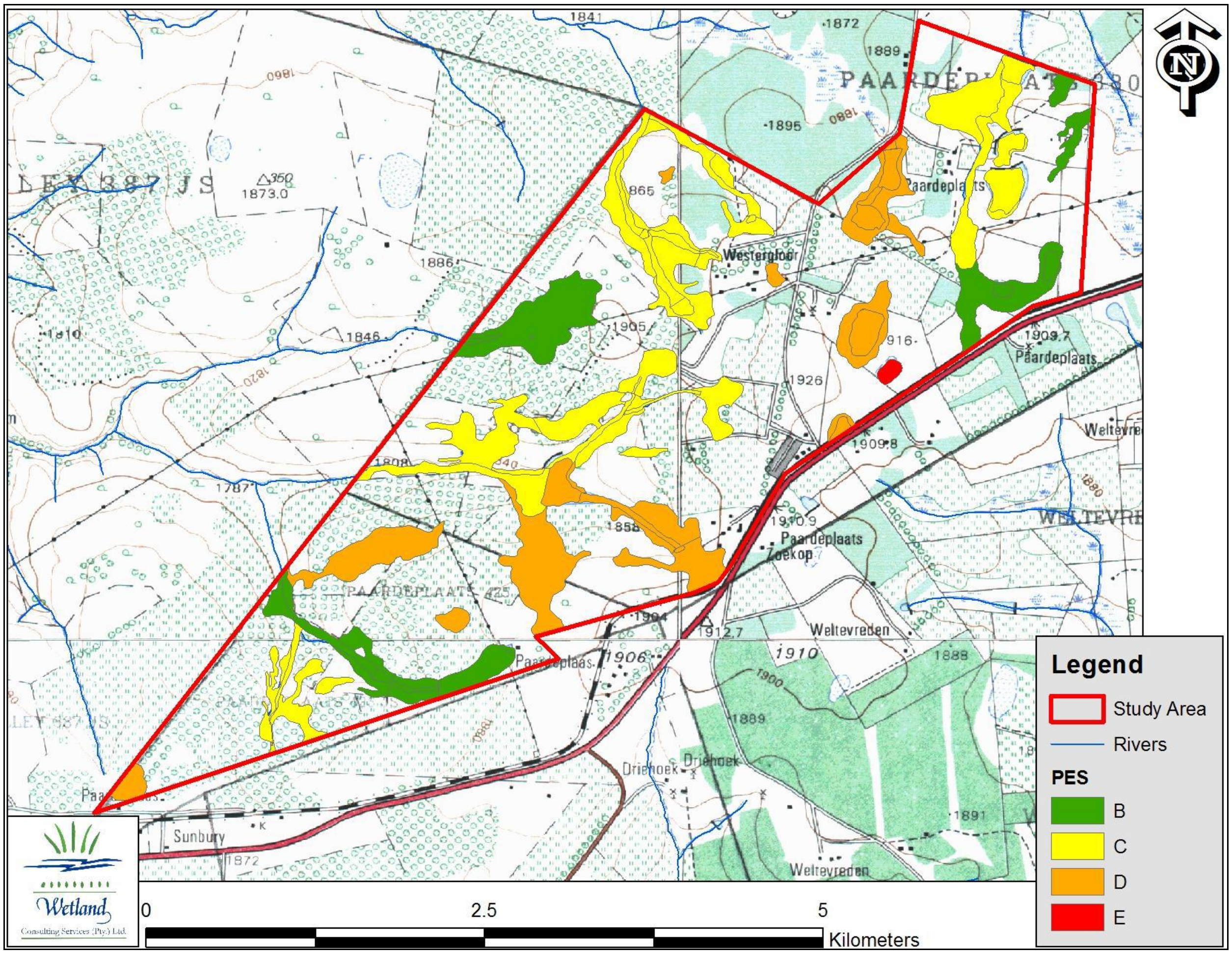


Figure 41: Map showing the results of the PES assessment.

3.3.6.2.3 Ecological Importance and Sensitivity (EIS) Assessment

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:

- Ecological Importance;
- Hydrological Functions; and
- Direct Human Benefits

These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services (the WET-EcoServices tool).

The results of the EIS assessment are summarised in Table 33 and 34. From Table 34 it is clear that the wetlands on site are mostly considered to be important from an ecological and hydrological perspective, and that the provision of direct human benefits generally is only of minor importance. An exception to this however is the provision of water for irrigation and also livestock watering purposes in the central regions of the study area, and the use of wetlands for tourism purposes in the north-east of the study area (dams have been built in the wetlands to provide opportunity for trout fishing).

Table 33: Summary of the EIS results by area.

EIS	Area (ha)	% of wetland area
B	144.51	42.75%
C	141.24	41.78%
D	52.30	15.47%
TOTAL	338.05	100.00%
EIS	**Area (ha)**	**% of wetland area**

Roughly an equal proportion of wetlands are considered of High (42.75%) and Moderate (41.78%) ecological importance and sensitivity, and only 15% of the wetlands on site are considered to be of Low importance and sensitivity – these are mostly hillslope seepage wetlands that have been cultivated in their entirety at some stage.

Table 34: Table showing the results of the EIS assessment

ECOLOGICAL IMPORTANCE AND SENSITIVITY:																		
Ecological Importance	Unit1	Unit2	Unit3	Unit4	Unit5	Unit6	Unit7	Unit8	Unit9	Unit10	Unit11	Unit12	Unit13	Unit14	Unit15	Unit16	Unit17	Unit18
Biodiversity support	1.00	1.83	0.83	2.17	2.00	1.00	1.00	0.67	2.17	1.55	2.00	1.67	1.83	0.50	1.83	0.50	1.67	2.17
Presence of Red Data species	1.50	2.00	0.50	2.50	2.00	0.50	1.00	0.50	3.00	2.50	2.50	2.00	2.00	0.50	2.00	0.50	2.00	2.00
Populations of unique species	1.00	1.00	1.50	1.50	1.50	0.50	0.50	0.50	2.00	0.15	2.50	1.50	1.50	0.50	1.50	0.50	1.50	2.00
Migration/breeding/feeding sites	0.50	2.50	0.50	2.50	2.50	2.00	1.50	1.00	1.50	2.00	1.00	1.50	2.00	0.50	2.00	0.50	1.50	2.50
Landscape scale	1.40	1.60	0.80	1.50	1.30	1.10	0.90	0.80	1.40	1.60	1.80	1.70	1.30	0.90	1.60	0.80	1.50	1.90
Protection status of the wetland	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Protection status of the vegetation type	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Regional context of the ecological integrity	3.00	3.00	1.00	2.00	1.00	1.00	1.00	0.50	2.00	2.00	3.00	2.00	0.50	0.50	2.00	1.00	2.00	3.00
Size and rareity of the wetland type/s present	1.00	1.50	0.50	1.50	1.50	1.00	0.50	0.50	1.50	2.00	2.50	2.00	2.00	1.00	2.00	0.50	1.50	2.00
Diversity of habitat types	1.00	1.50	0.50	2.00	2.00	1.50	1.00	1.00	1.50	2.00	1.50	2.50	2.00	1.00	2.00	0.50	2.00	2.50
Sensitivity of the wetland	1.67	1.83	0.83	2.00	1.17	1.00	0.83	0.83	1.67	1.83	1.83	1.50	1.17	1.00	2.00	1.00	1.50	2.00
Sensitivity to changes in floods	2.00	2.50	1.50	2.50	1.50	1.00	1.00	1.00	2.00	2.50	2.50	1.50	1.50	2.00	2.00	2.00	1.00	2.50
Sensitivity to changes in low flows/dry season	1.00	1.00	0.50	1.50	1.50	1.50	1.00	1.00	1.50	1.50	1.00	1.50	1.50	0.50	2.00	0.50	2.00	2.00
Sensitivity to changes in water quality	2.00	2.00	0.50	2.00	0.50	0.50	0.50	0.50	1.50	1.50	2.00	1.50	0.50	0.50	2.00	0.50	1.50	1.50
HYDROLOGICAL-FUNCTIONAL IMPORTANCE																		
Flood attenuation	1.00	1.50	0.50	2.50	2.50	1.50	1.00	1.00	1.50	2.00	1.00	1.50	2.00	1.00	2.00	0.50	1.50	2.50
Streamflow regulation	2.00	2.00	0.50	2.50	2.00	1.00	-	-	1.50	2.00	2.00	2.50	2.50	1.50	2.50	1.00	2.00	2.50
Sediment trapping	1.00	1.00	1.00	2.00	2.50	1.50	1.50	1.50	2.00	2.00	1.50	2.00	2.00	1.50	2.00	1.00	1.50	2.00
Phosphate assimilation	1.00	1.00	2.00	2.00	2.50	1.50	1.50	1.50	1.50	1.50	1.00	2.00	2.00	1.00	1.50	1.00	1.00	1.00
Nitrate assimilation	1.00	1.00	2.00	2.00	2.50	1.50	1.50	1.50	1.50	1.50	1.00	2.00	2.00	1.00	1.50	1.00	1.00	1.00
Toxicant assimilation	1.00	1.00	2.00	2.00	2.50	1.50	1.50	1.50	1.50	1.50	1.00	2.00	2.00	1.00	1.50	1.00	1.00	1.00
Erosion control	2.50	2.50	0.50	2.00	2.00	1.00	0.50	0.50	2.00	2.00	1.00	2.00	2.00	1.00	2.00	1.00	1.00	2.00
Carbon storage	0.50	1.00	0.50	1.50	1.50	1.50	1.00	1.00	1.00	1.00	0.50	1.00	1.00	0.50	1.00	0.50	1.00	1.50
IMPORTANCE OF DIRECT HUMAN BENEFITS																		
Water for human use	0.50	0.75	0.25	1.00	1.00	1.25	0.75	0.75	0.75	0.75	0.50	0.75	2.00	0.50	2.00	0.50	0.75	0.75
Harvestable resources	0.25	0.25	0.25	0.25	0.50	0.25	-	-	1.00	1.00	-	0.50	0.50	0.50	0.50	0.25	0.25	0.25
Cultivated foods	-	-	0.50	0.50	-	-	-	0.50	0.50	0.50	-	0.50	0.50	0.50	-	-	-	-
Cultural heritage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tourism and	1.00	1.50	1.00	2.50	2.50	1.50	0.50	1.00	1.50	2.00	1.50	1.50	2.50	1.50	2.00	0.50	1.50	2.00

recreation																		
Education and research	1.00	1.00	1.00	1.00	1.00	0.50	0.50	0.50	1.00	1.00	1.00	0.50	0.50	1.00	0.50	0.50	1.00	1.00
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1.67**	**1.83**	**0.83**	**2.17**	**2.00**	**1.10**	**1.00**	**0.83**	**2.17**	**1.83**	**2.00**	**1.70**	**1.83**	**1.00**	**2.00**	**1.00**	**1.67**	**2.17**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**1.25**	**1.38**	**1.13**	**2.06**	**2.25**	**1.38**	**1.06**	**1.06**	**1.56**	**1.69**	**1.13**	**1.88**	**1.94**	**1.06**	**1.75**	**0.88**	**1.25**	**1.69**
IMPORTANCE OF DIRECT HUMAN BENEFITS	**0.46**	**0.58**	**0.50**	**0.88**	**0.83**	**0.58**	**0.29**	**0.46**	**0.79**	**0.88**	**0.50**	**0.63**	**1.00**	**0.67**	**0.83**	**0.29**	**0.58**	**0.67**
OVERALL IMPORTANCE	**1.67**	**1.83**	**1.13**	**2.17**	**2.25**	**1.38**	**1.06**	**1.06**	**2.17**	**1.83**	**2.00**	**1.88**	**1.94**	**1.06**	**2.00**	**1.00**	**1.67**	**2.17**
	C	C	D	B	B	C	D	D	B	C	B	C	C	D	B	D	C	B

Table 35: Table explaining the scoring system used for the EIS assessment

Ecological Importance and Sensitivity categories	Range of Median	Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Wetland that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1.2 and <=2	C
Low/marginal Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1.2	D

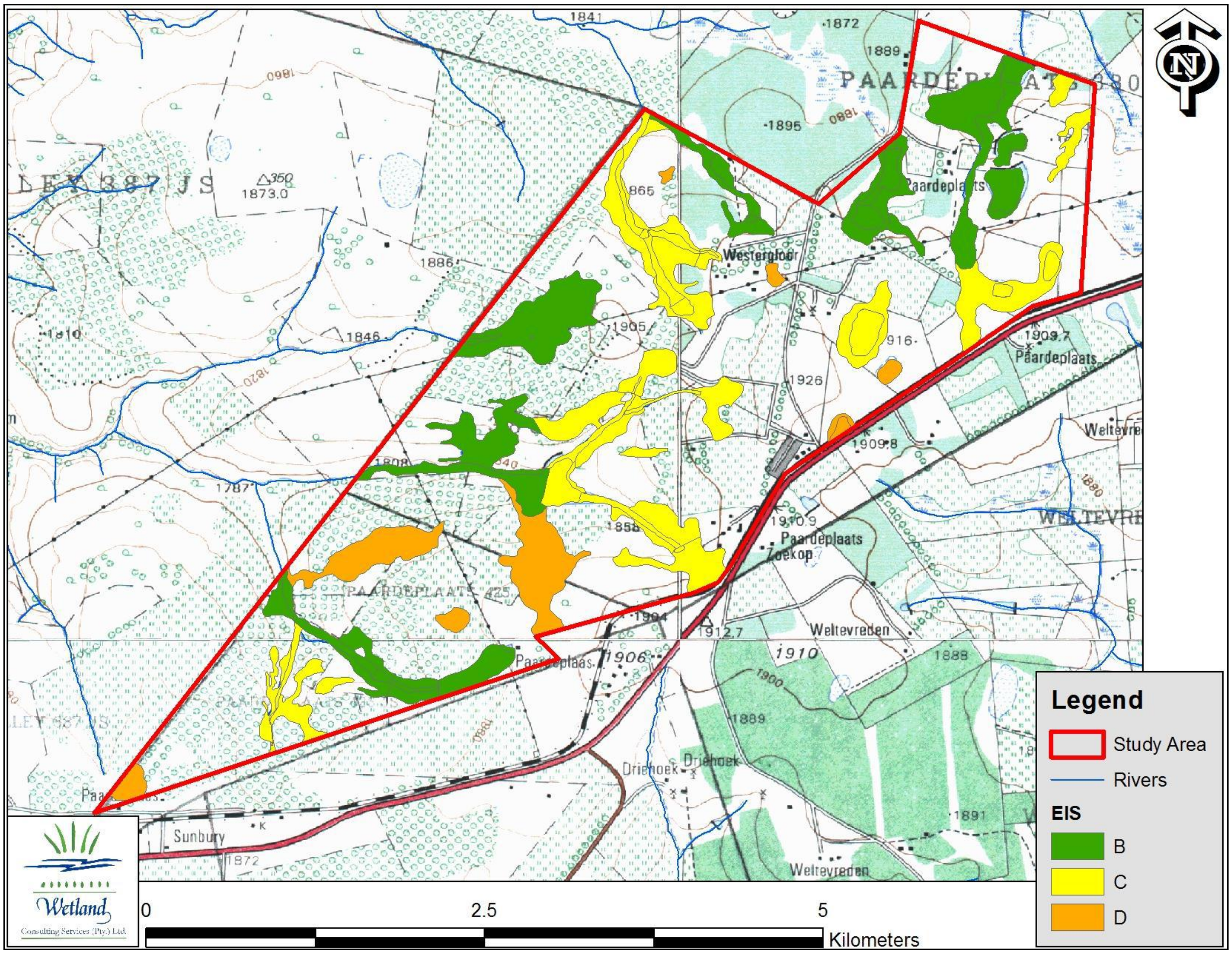


Figure 42: Map showing the results of the EIS assessment.

3.3.7 FLORA

The flora assessment made use of the Braun-Blanquet approach, which is the national standard for vegetation description and mapping in South Africa. Thirty (30) plots were sampled during February 2011, with a follow up winter survey to those plots with the most, least and average plots in July 2011. The thirty (30) plots were placed pro rata, randomly based on slope, aspect and wetness based on a Digital Terrain Model (DTM) derived from 5m contours.

Based on the summer survey (February 2011) results, it was possible to map five vegetation communities within the study area, of which four present primary vegetation communities and one secondary vegetation community. The main drivers of the distribution and extent of the five vegetation communities were altitude, soil conditions (wet/dry, sandy/clay, shallow/deep) and human influences (grazing, cultivation, forestry). Due to the absence of a detailed soil map and the change in species composition because of the exploitation of the area, it was difficult in spite of using GIS modelling and satellite imagery (Landsat 7 July 2005) to accurately and with high confidence map the extent and distribution of the vegetation communities in the remaining natural vegetation.

The most species rich community is community five associated with the outcrops, the species poorest community is community four, which represent the secondary grasslands (old fields, felled forerstry areas). No threatened Red Data flora was recorded within the study areas, but a number of provincially protected, medicinal and alien invasive plants were recorded. All of the plant communities have a high floral sensitivity, with the exception of the secondary grasslands (community four) which is moderately sensitive. Approximately 500 ha (37%) of the study area presents persistent grassland and these area should be given very high conservation priority, especially the area to the northeast (internal catchment 5) and the area adjacent to the Steelpoort river (internal catchment 10).

Should mining be allowed in the area, it is recommended that underground rather than open cast mining should be the preferred method, with the mining activities and infrastructure focused within internal catchment 6, which is close to an existing mining operation and of which most of the area had been historically transformed through intensive farming practices.

It should be noted that the remaining natural vegetation within the study area has high conservation status, with the following environmental liabilities being present:

- Alien invasive species;
- Erosion;
- Exploited vegetation;
- Provincially protected plants; and
- Wetlands.

The study area is located within the Mpumalanga Conservation Plan (C Plan) Area. The area has been highlighted by the Mpumalanga Parks and Tourism Agency as of high conservation value. The map below indicates the location of the study area in relation to the Mpumalanga C Plan.

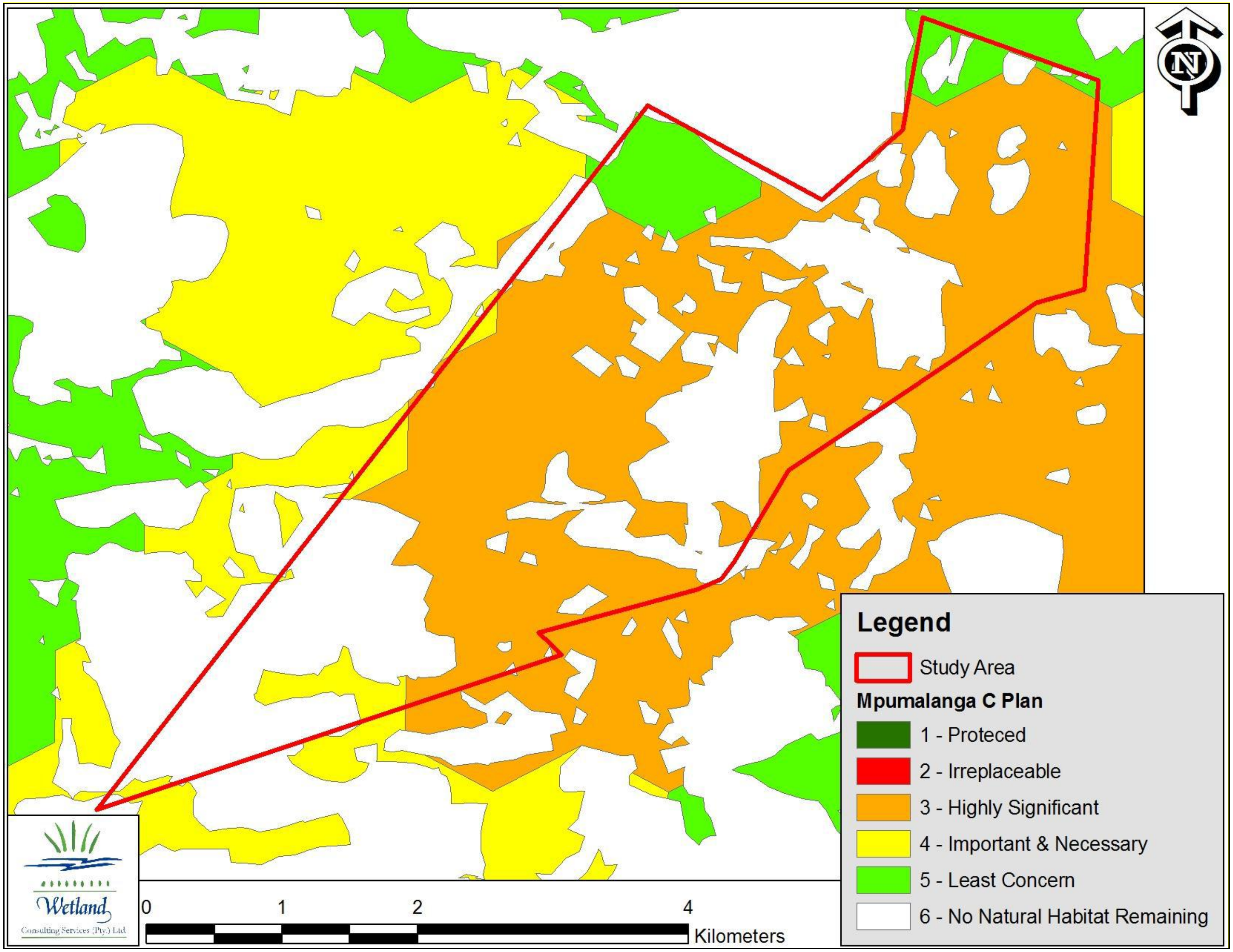


Figure 43: Paardeplaats study area in relation to the Mpumalanga Conservation Plan Area

3.3.7.1 Biomes

The study area is located the Grassland Biome of South Africa, is located across one regional vegetation unit, namely Eastern Highveld Grassland (Rutherford & Mucina 2006.) This regional vegetation unit is classified as Endangered.

Regionally according to the 2000 land cover classification, 74% of the landscape still represents natural vegetation (habitat), with only 26% being transformed. This implies that most of the landscape is still well connected and fragmentation is less of an issue (Turner, Gardner & O'Neill 2001, Wiens, Moss, Turner & Mladenoff 2006).

3.3.7.2 Vegetation Communities in the Study Area

According to “The Vegetation of South Africa, Lesotho and Swaziland” (Mucina and Rutherford, 2006) the study area falls within the Grassland Biome, Mesic Highveld Grassland Bioregion. At a finer level, the majority of the study area is classed as Eastern Highveld Grassland. A small extent of the lower lying areas along the western boundary of the study area is classed as Lydenburg Montane Grassland.

Eastern Highveld Grassland is mostly confined to Mpumalanga and western Swaziland, occurring marginally as well into Gauteng. The conservation status of this vegetation type is Endangered (Mucina & Rutherford, 2006), and whilst the conservation target is 24%, only a small fraction (<1%) is currently protected and 44% is considered to be transformed, mostly by cultivation, forestry, mines, dams and urbanisation (Mucina & Rutherford, 2006). Eastern Highveld Grassland is listed as Vulnerable in the Draft National List of Threatened Ecosystems (GN1477 as published in GG32689, 2009).

The wetlands on site, though not labelled as such by Mucina and Rutherford most probably due to an issue of scale, are considered to conform to the Eastern Temperate Freshwater Wetlands vegetation type. Eastern Temperate Freshwater Wetland vegetation occurs throughout South Africa except for the Western and Northern Cape Provinces. It is described as an intrazonal vegetation type occurring along water bodies with stagnant and slow flowing water and is embedded within the Grassland Biome of South Africa. It occurs on flat landscapes and within shallow depressions characterised by mostly temporary water bodies that support zoned systems of aquatic and hygrophilous vegetation.

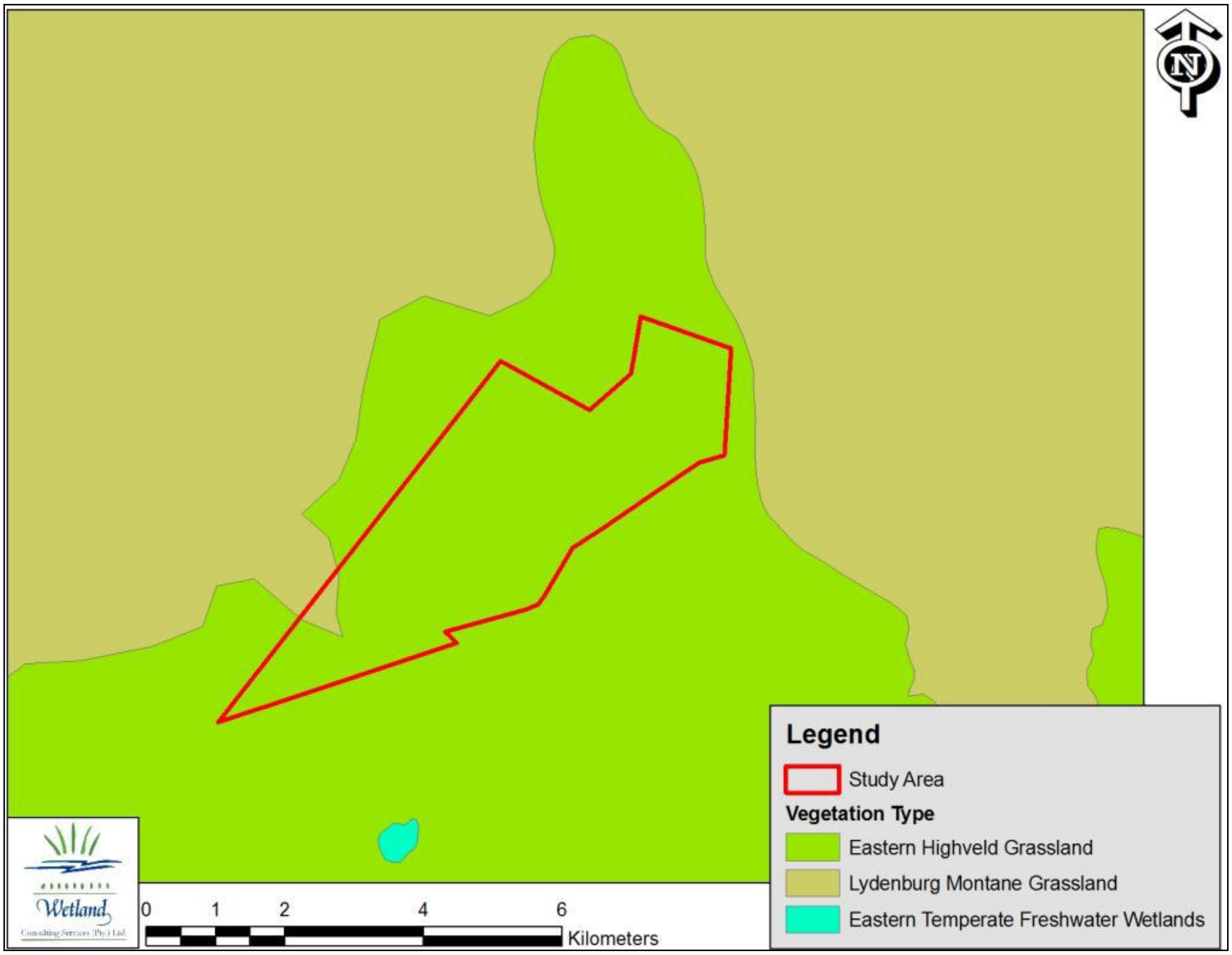


Figure 44: Map showing the vegetation types occurring within the study area, based on Mucina and Rutherford (2006).

3.3.7.3 Species Likely to Occur in the Study Area

Dominant species of the Eastern Highveld Grassland vegetation type listed by Mucina and Rutherford include the following:

> Graminoids: *Aristida aequiglumis, Aristida congesta, Aristida junciformis, Brachiaria serrata, Cynodon dactylon, Digitaria monodactyla, Digitaria tricholaenoides, Elionurus muticus, Eragrostis chloromelas, Eragrostis curvula, Eragrostis plana, Eragrostis racemosa, Eragrostis sclerantha, Heteropogon contortus, Loudetia simplex, Michrochloa caffra, Monocymbium ceresiiforme, Setaria sphacelata, Sporobolus africanus, Sporobolus pectinatus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix* and *T. rehmannii*.

Herbs: including *Berkheya setifera, Haplocarpha scaposa, Justicia anagalloides* and *Pelargonium luridum*.

Dominant species of the Eastern Temperate Freshwater Wetland vegetation type listed by Mucina and Rutherford include the following:

Megagraminoid: *Cyperus congestus, Phragmites australis, Schoenoplectus corymbosus, Typha capensis*.

Graminoids: *Agrostis lachnantha, Carex acutiformis, Eleocharis palustris, Eragrostis plana, E. planiculmis, Fuirena pubescens, Helictotrichon turgidulum, Hemarthria altissima, Imperata cylindrica, Leersia hexandra, Paspalum dilatatum, P. urvillei, Pennisetum thunbergii, Schoenoplectus decipiens, Scleria, dieterlenii* and *Setaria sphacelata*.

Herbs: *Centella asiatica, Ranunculus multifidus*.

A list of plant species recorded within the wetlands on site is provided in the table below. This list is by no means comprehensive and provides an indication of the more common plant species only. A number of the hillslope seepage wetlands on site had been previously cultivated or converted to plantations and are now characterised by secondary vegetation.

Table 36: List of plant species recorded within the wetlands on site.

Species Name	Seepage	Valley Bottom	Pan
Acacia mearnsi	Y		Y
Agrostis lachnantha	Y	Y	Y
Andropogon eucomis	Y		Y
Aristida congesta		Y	
Arundinella nepalensis	Y	Y	
Berkheya spp	Y		
Carex spp		Y	
Commelina africana	Y		
Conyza albida	Y		
Cymbopogon spp	Y		
Cynodon dactylon	Y	Y	Y
Cyperus denudatus	Y	Y	Y
Cyperus esculentus		Y	
Cyperus spp		Y	
Eleocharis dregeana	Y	Y	
Eragrostis curvula	Y	Y	Y
Eragrostis gummiflua	Y	Y	
Eragrostis montevidensis	Y		
Eragrostis plana	Y	Y	
Eragrostis racemosa	Y		
Eragrostis rigida	Y		
Eragrostis spp	Y	Y	
Erica woodii	Y		
Eucalyptus spp	Y		
Eucomis autumnalis	Y		

Eucomis pole-evansii		Y	
Fuirena pubescens	Y	Y	Y
Gladiolus grassifolius	Y		
Haplocarpa scaposa	Y		
Helichrysum aureonitens	Y		
Helichrysum spp	Y		
Helictotrichon turgidulum	Y		
Hemarthria altissima		Y	Y
Imperata cylindrica	Y	Y	
Juncus effusus		Y	
Juncus lomatophyllus		Y	
Juncus oxycarpus		Y	Y
Kyllinga erecta	Y	Y	Y
Leersia hexandra		Y	Y
Leonotis leonurus		Y	
Lobelia flaccida	Y		
Monopsis decipiens	Y		
Nidorella anomala	Y		
Paspalum dilatatum	Y	Y	
Paspalum urvillei	Y	Y	
Pennisetum clandestinum	Y	Y	
Phragmites australis		Y	
Pinus spp.	Y		
Populus canescens	Y	Y	
Pseudognaphalium luteo-album	Y		
Pycreus macranthus	Y		Y
Ranunculus multifidus	Y	Y	
Schoenoplectus corymbosus		Y	Y
Schoenoplectus decipiens	Y	Y	Y
Senecio consanguineus	Y		
Senecio spp.	Y		
Setaria palide-fusca	Y		
Setaria sphacelata	Y	Y	
Sporobolus africanus	Y	Y	
Stoebe vulgaris	Y		
Themeda triandra	Y	Y	
Typha capensis		Y	
Verbena bonariensis	Y	Y	
Verbena spp.	Y		

3.3.7.4 Potential Protected Species that may Occur in the Study Area

None of the threatened (Vulnerable, Endangered, Critical Endangered) species of Mpumalanga Province was recorded within the study area. The majority of the species recorded are least concern in terms of the latest Red Data flora publication of SANBI, with only the geophyte *Eucomis autumnalis* being flagged as declining, which was recorded within community two and three.

Six (6) species in terms of the Mpumalanga Conservation Act were recorded: *Agapanthus inapertus, Eucomis autumnalis, Gladiolus crassifolius, Habenaria epipactidea, Scilla nervosa,* *Zantedeschia albomaculata*. The majority of the protected species was recorded in community two, the transitional community between the moist and dry grassland. Please note that all species within either the family or genera are protected in terms of the Mpumalanga Nature Conservation Act, 1998 (Act No. 10 of 1998).

No listed protected species in terms of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) were recorded within the study area; however the eco-system, namely Eastern Higveld Grassland is listed as vulnerable under the NEMBA.

3.3.8 FAUNA

The study area falls within the Mpumalanga Conservation Plan (C Plan) Area and also falls on the boundary of the Steenkampsberg Iportant Bird Area (IBA). The site is therefore considered to be in a high conservation area.

3.3.8.1 Mammals

The following conclusions were reached during the survey regarding mammals in the study area:

- The Paardeplaats concession site exhibited a strong diversity of mammals, with 26 species being recorded. Of this assemblage, small mammals (8 species), meso carnivores (6 species), small carnivores (4 species) and small herbivores (4 species) were dominant. This represents a seemingly functional trophic system.
- The ridge and wetland habitats represent the most functional and sensitive mammalian systems within the site. Invasive flora zones also provide valuable refugia for mammalian species. Linear waterways such as rivers and spruits provide valuable linkages between habitats and regions.
- Four red-data species were located on site, namely serval, side-striped jackal, South African hedgehog and brown hyaena. Of these species, side-striped jackal and South African hedgehog are out of their normal distributions.
- The exceptional diversity of meso and small carnivores on the site, including species outside of their known distributions (side-striped jackal and African civet recorded at Glisa) warrant further investigations in the form of monitoring programs.
- A full, in season small mammal baseline should be redone prior to construction phase. This will provide adequate baseline data to be used for rehabilitation, as small mammals are excellent environmental indicators.

- Spoor tracking and camera trapping proved to be the most successful sampling techniques. It appears that prevailing sub-optimal weather patterns during the study period prevented expectedly strong small mammal results from manifesting.

3.3.8.1.1 Mammals Likely to Occur in the Study Area

The mammalian species most likely to occur in the study area based on the specialist study conducted by EkoInfo and Associates are listed in the table below.

Table 37: Mammalian species likely to occur in the study area

Biological Name	English Name	Likelihood
Acinonyx jubatus	Cheetah	Low
Amblysomus hottentotus	Hottentot's Golden Mole	Low
Ablysomus robustus	Robust Golden Mole	Low
Ambylosomus septentrionalis	Highveld Golden Mole	Medium
Aterix frontalis	South African Hedgehog	Confirmed
Canis adustus	Side-striped Jackal	Confirmed
Chrysospalax villosus	Rough-haired Golden Mole	Low
Crocidura cyanea	Reddish-grey Musk Shrew	Confirmed
Crocidura flavescens	Greater Musk Shrew	Medium
Crocidura fuscomurina	Tiny Musk Shrew	Medium
Crocidura hirta	Lesser Red Musk Shrew	Low
Crocidura maquassiensis	Maquassie Musk Shrew	Low
Cocidura mariquensis	Swamp Musk Shrew	Confirmed
Dasymys incomtus	Water Rat	High
Grammomys dolichurus	Woodland Mouse	Low

Graphiurus platyops	Rock Dormouse	Low
Hyaena brunnea	Brown Hyena	Confirmed
Lemniscomys rosalia	Single-striped Mouse	High
Leptailurus serval	Serval	Confirmed
Lutra maculicollis	Spotted-necked Otter	Medium
Manis temminckii	Pangolin	Low
Mellivora capensis	Honey Badger	High
Myosorex cafer	Dark-footed Forest Shrew	Low
Myosorex varius	Forest Shrew	Confirmed
Mystromys albicaudatus	White-tailed Rat	Low
Neamblysomus juliane	Juliana's Golden Mole	Low
Otomys slogetti	Stoggett's Rat	Low
Ourebia ourebi	Oribi	High
Peocilogale albunucha	African Weasel	High
Raphicerus sharpel	Sharp's Grysbok	Low
Suncus infinitesimus	Least Dwarf Shrew	Medium
Suncus lixus	Greater Dwarf Shrew	Medium
Suncus varilla,	Lesser Dwarf Shrew	Medium
Tatera leucogaster	Bushveld Gerbil	Confirmed

3.3.8.2 Avifauna

The proposed area falls within the Steenkampsberg Important Bird Area (IBA). The following map indicates the exact location of the study area in relation to the IBA.

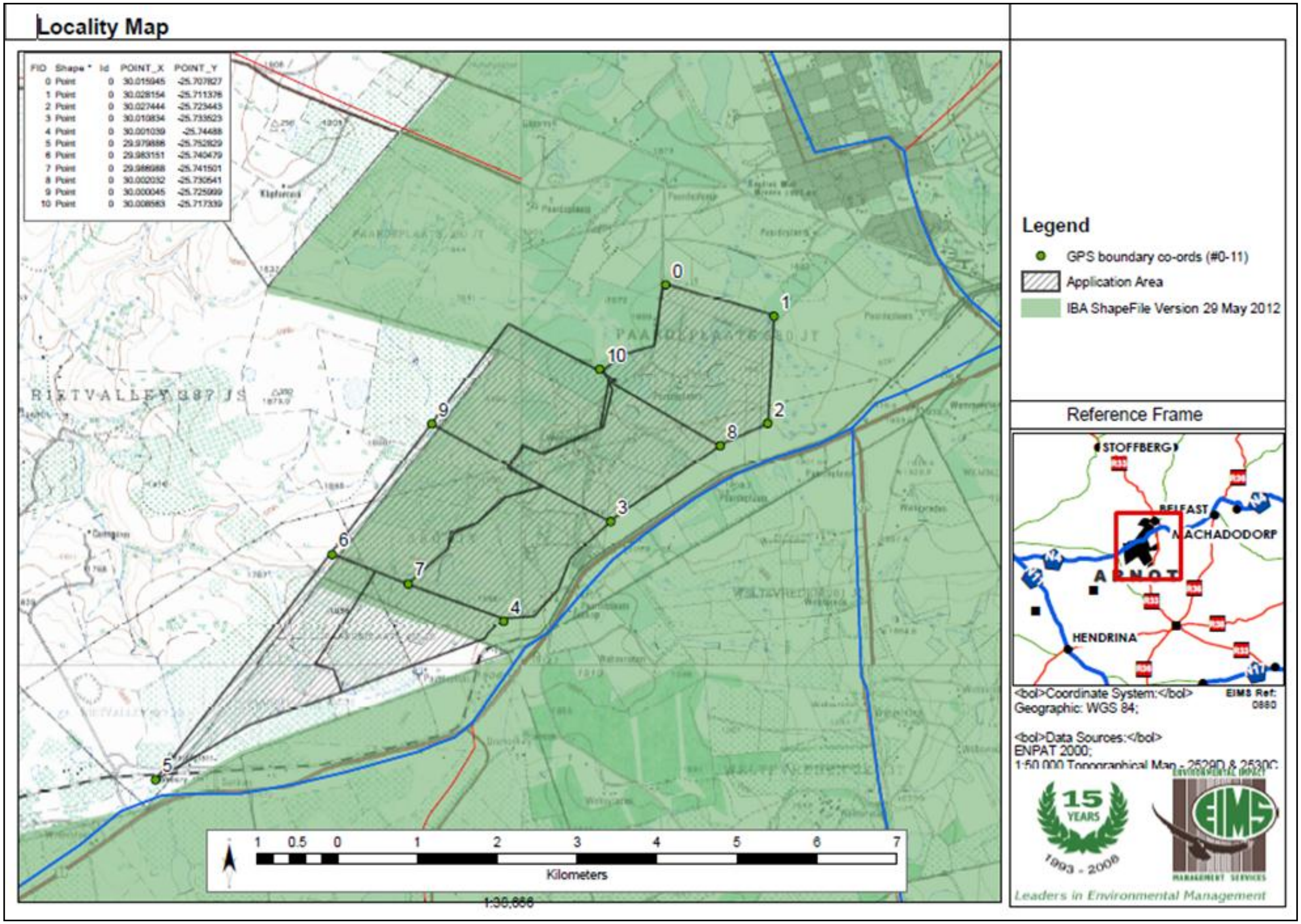


Figure 45: Steenkampsberg IBA and Paardeplaats area

Major conclusions reached during the survey include:

- Eight habitat types were identified, ranging from primary to secondary grasslands, exotic plantations and cultivated land. The *Tristachya leucothrix – Alloteropsis semialata* climax grassland, the seasonal and temporary moist grasslands and the various impoundments were found to be important habitat types since they sustain bird species of “conservation importance” or high invertebrate richness values;
- A total of 226 bird species are likely to occur on the study site and 156 species were confirmed during the survey;
- Six bird species of special conservation concern were recorded on the study site. These include the Blue Crane (*Anthropoides paradiseus*), Southern Bald Ibis (*Geronticus calvus*), Secretarybird (*Sagittarius serpentarius*), Lesser Kestrel (*Falco naumanni*), African Marsh Harrier (*Circus ranivorus*) and the Broad-tailed Warbler (*Schoenicola brevirostris*);
- The study site was represented by five avifaunal communities consisting of (1) a highveld community partial to exotic plantation species, (2) a species-poor community confined to high-altitude grassland, (3) a species-rich community restricted to areas of open surface water and associated shoreline habitat, (4) a community restricted to moist grassland and (5) an unspecified community representing highveld taxa with opportunistic life-histories;
- The ecological importance of the study site for bird species:
    - The hillslopes seeps, moist grassland units and Steelpoort River are linear in configuration and act as important dispersal corridors for many terrestrial bird species (especially skulking taxa such as rails, flufftails and crakes). These units are important daily flight routes for wading birds and waterfowl (mainly herons, cranes, cormorants, ibises, ducks and geese) between foraging and roosting sites. Some sections even provide potential breeding and foraging habitat for threatened bird species, in particular the African Grass Owl (*Tyto capensis*) and African Marsh Harrier (*Circus ranivorus*);
    - The impoundments, although artificial, conform to an interconnected system of dams and water features with high variability among each other in terms of depth and water levels. These systems are highly dynamic and experience frequent turnover of species. They often provide refuge for large congregations of waterfowl, especially during moulting; and
    - The grassland units on the central and northern section of the study site (mainly intact grasslands of large surface area) have the inherent potential to provide habitat for a number of threatened and conservation important bird species, in particular

terrestrial taxa such as the Blue Korhaan (*Eupodotis caerulescens*), Secretarybird (*Sagittarius serpentarius*) and Southern Bald Ibis (*Geronticus calvus*). These units are the preferred non-breeding foraging habitat for the “vulnerable” Lesser Kestrel (*Falco naumanni*);

3.3.8.2.1 Avifauna Likely to Occur In the Study Area

The ten most dominant avifaunal species likely to occur in the study area are listed in the table below.

Table 38: The ten most dominant bird species recorded on the study site.

Species	Consistency	Percentage Contribution
1. Cape Canary (*Serinus canicollis*)	0.49	24.54
2. African Pipit (*Anthus cinnamomeus*)	0.37	14.65
3. Levaillant's Cisticola (*Cisticola tinniens*)	0.43	10.25
4. Long-tailed Widowbird (*Euplectes progne*)	0.27	7.06
5. Wing-snapping Cisticola (*Cisticola ayresii*)	0.22	5.95
6. Cape Longclaw (*Macronyx capensis*)	0.25	5.92
7. Cape Wagtail (*Motacilla capensis*)	0.28	3.7
8. Cape Robin-chat (*Cossypha capensis*)	0.19	2.96
9. Redknobbed Coot (*Fulica cristata*)	0.23	2.86
10. Southern Masked Weaver (*Ploceus velatus*)	0.18	2.48

3.3.8.3 Herpetofauna

The herpetofauna survey conducted during summer (25-31 October 2011) was very successful; 60 reptiles (9 species) and >164 amphibians (10 species) were observed. This was partly due to the suitable climatic conditions experienced and partly due to the existence of relatively intact stretches of suitable habitat, especially grassland with rocky ridges and drainage lines. Three of the herpetofauna species expected to occur on the study area are of conservation concern namely *Acontias breviceps* (Short-headed legless skink), *Tetradactylus breyeri* (Breyer’s long-tailed seps) and *Pyxicephalus adspersus* (Giant bullfrog). A sensitivity map was generated in relation to the vegetation map showing the areas on the property that are of conservation value from a herpetofauna perspective. A number of potential threats to herpetofauna were briefly identified. In conclusion, the baseline situation on the property from a herpetofauna perspective is one of relatively natural conditions where high diversity and densities are observed. It is strongly recommended that a herpetologist be consulted to assist with the development of a comprehensive management plan if the area is intended for development.

3.3.8.3.1 Reptiles and Amphibians Likely to Occur in the Study Area

The reptile and amphibian species most likely to occur in the study area based on the specialist study conducted by EkoInfo and Associates are listed in the table below.

Table 39: Reptile and Amphibian species likely to occur in the study area

Biological Name	Likelihood
Acontias breviceps	Comfirmed
Acontias plumbeus	Expected
Afrotyphlops bibronii	Confirmed
Agama aculeata distanti	Expected
Agama atra,	Expected
Amplorhinus multimaculatus	Not expected
Aparallactus capensis	Expected
Bitis arietans arietans	Expected
Bitis atropos	Not expected
Causus rhombeatus	Expected
Chamaeleo dilepis	Not expected
Chamaesaura aenea	Expected
Cordylus vittifer	Expected
Crotaphopeltis hotamboeia	Expected
Dasypeltis scabra	Expected
Dispholidus typus typus	Not expected
Duberria lutrix	Expected

Gerrhosaurus flavigularis	Expected
Hemachatus haemachatus	Expected
Homoroselaps lacteus	Expected
Lamprophis capensis	Expected
Lamprophis inornatus	Expected
Lamprophis swazicus	Not expected
Leptotyphlops scutifrons	Confirmed
Lycodonomorphus rufulus	Confirmed
Lycophidion capense capense	Expected
Lygodactylus nigropunctatus	Expected
Lygodactylus ocellatus	Not expected
Naja annulifera	Expected
Nucras lalandii	Expected
Nucras ornate	Expected
Pachydactylus affinis	Expected
Pachydactylus capensis	Not expected
Pachydactylus vansoni	Expected
Panaspis walbergii	Expected
Pedioplanis lineoocellata	Expected
Philothamnus hoplogaster	Expected
Philothamnus natalensis occidentalis	Confirmed

Philothamnus semivariegatus	Expected
Platysaurus orientalis orientalis	Not expected
Psammophis crucifer	Expected
Psammophylax rhombeatus	Confirmed
Psammophylax tritaeniatus	Expected
Pseudaspis cana	Confirmed
Pseudocordylus melanotus	Not expected
Rhinotyphlops schlegelii schlegelii	Expected
Scelotes mirus	Expected
Tetradactylus breyeri	Expected
Trachylepis capensis	Expected
Trachylepis punctatissima	Confirmed
Trachylepis varia	Confirmed
Varanus niloticus	Expected
Amietia angolensis	Confirmed
Amietia fuscigula	Confirmed
Amietophrynus garmani	Expected
Amietophrynus gutturalis	Confirmed
Amietophrynus maculatus	Expected
Amietophrynus rangeri	Expected
Breviceps adspersus	Confirmed

Breviceps mossambicus	Expected
Cacosternum boettgeri	Confirmed
Hyperolius marmoratus	Not expected
Hyperolius semidiscus	Not expected
Kassina senegalensis	Confirmed
Phrynobatrachus natalensis	Expected
Ptychadena porosissima	Expected
Pyxicephalus adspersus	Expected
Schismaderma carens	Not expected
Semnodactylus wealii	Confirmed
Strongylopus fasciatus	Confirmed
Strongylopus grayii	Confirmed
Tomopterna cryptotis	Expected
Tomopterna natalensis	Expected
Tomopterna tandyi	Expected
Xenopus laevis	Confirmed

3.3.8.4 Invertebrates

Major conclusions reached during the survey include:

- A total of 20 butterfly species were recorded from the study site. The study site lacked in butterfly richness with an obvious absence of peculiar high-altitude species;
- A large depression located on the Hadeco property provides suitable habitat for the "Vulnerable" Marsh Sylph butterfly (*Metisella meninx*);

- The various sandstone outcrops provide habitat for the Ischnurid scorpion *Opistacanthus validus* – a protected species; and
- A definite predator (e.g. spiders and assassin bugs) and primitive group of phytophagous invertebrate taxa are prevalent on the primary grasslands, which were numerically less abundant on the secondary grasslands. The primary (natural) grassland units, based on their limited exposure to frequent disturbance events, have provided a platform for arthropod guild diversification (based on the high expected floristic richness in forb species).

3.3.8.5 Aquatic Ecology

3.3.8.5.1 Baseline assessment

3.3.8.5.1.1 Aquatic Macroinvertebrates

Aquatic macroinvertebrates were assessed using the SASS 5 (South African Scoring System) methodology. SASS5 is based on the presence or absence of sensitive aquatic macroinvertebrates collected and analysed according to the methods outlined in Dickens and Graham (2002). A high relative abundance and diversity of sensitive taxa present indicates a relatively healthy system with good water quality. Disturbance to water quality and habitat results in the loss of sensitive taxa. As this method was developed specifically for rivers, the methods of collection and analysis were modified for wetlands and pans. This meant sampling vegetation and substrate biotopes only, as no stone biotopes were available, and interpreting the PES for aquatic macroinvertebrates in terms of overall diversity and assemblage patterns, rather than according to guidelines derived from SASS5 scores in rivers (Dallas 2007). Table 40 summarises the categories used to classify sites according to both aquatic macroinvertebrates and fish.

3.3.8.5.1.2 Fish

The aquatic habitats form the template of the biological composition of any system. If the habitat components are undisturbed, and in good condition, the biological composition of the system can be expected to be normal and one can expect a high biodiversity within the system. If the habitat components are however degraded, due to human activities, the biota of the system will reflect this by a loss, firstly of the most intolerant species (Davies & Day, 1998). An evaluation of habitat quality and availability to biota is therefore critical to any assessment of ecological integrity and should be conducted at each site at the time of biological sampling. On site habitat assessments were conducted by using existing habitat evaluation indices.

The general characteristics of the site and its immediate surroundings were described. The composition and ability of the habitats to meet the requirements of different fish species was broadly based on the Habitat Cover Rating method (Kleynhans, 1997). This approach was developed to assess habitats according to different attributes that are surmised to satisfy the habitat requirements of various fish species (Kleynhans, 1997). At each site, the following velocity-depth classes were identified, namely:

- Slow (<0.3m/s), Shallow (<0.5m) (SS) - Shallow pools and backwaters.
- Slow, Deep (>0.5m) (SD) - Deep pools and backwaters.
- Fast (>0.3m/s), Shallow (FS) - Riffles, rapids and runs.
- Fast, Deep (FD) - Usually rapids and runs.

The relative contribution of each of the above mentioned classes at a site is estimated and indicated in the table that follows (adapted from Rankin, 1995).

Table 40: The estimated relative contribution of each of the above mentioned classes at each site (adapted from Rankin, 1995).

Descriptor	Relative ecological value/abundance score	Occurrence (% of area covered)
None	0	0
Rare	1	0-5
Sparse	2	5-25
Common	3	25-75
Abundant	4	75-90
Very abundant	5	90-100

For each depth-flow class, the following cover features, considered to provide fish with the necessary cover to utilise a particular flow and depth class, were investigated and similarly rated as described above:

- Overhanging vegetation
- Undercut banks and root wads
- Stream substrate
- Aquatic macrophytes

Most aquatic ecosystems assessed on the site were considered to be wetlands (including dams) and were thus assessed in the associated Wetland Assessment Report. The two sites with flowing water, downstream of the study area, were considered to be riparian in nature and were assessed in terms a simplified index of habitat integrity, namely Site Habitat Integrity (SHI), which describes the broad habitat integrity or condition, based on the extent of different human activities. This approach is based on the assessment of physical habitat disturbance (Kleynhans, 1997). The following impacts were investigated, namely:

- Water abstraction;

- Flow modification;
- Bed modification;
- Channel modification;
- Inundation;
- Exotic macrophytes;
- Solid waste disposal;
- Indigenous vegetation removal;
- Exotic vegetation encroachment; and
- Bank erosion.

The study area was visited in April 2011, and representative sites were selected in the primary aquatic ecosystems in the study area. Fish sampling of representative sites and habitats was performed using a SAMUS battery operated electro-fisher. All fish species were identified to species level and returned to their natural habitats. The latest version of the Fish Response Assessment Index (FRAI) (DWAF, 2008) was used to determine the present ecological status (PES) of the streams in the study area.

The determination and description of the present ecological status (PES) of the aquatic ecosystems according to fish were broadly done according to the methodology described for River EcoClassification during Reserve Determinations (Kleynhans & Louw, 2008). The PES in terms of the fish assemblage was determined using the Fish Response Assessment Index (FRAI). The results were then used to classify the present state of the fish assemblage into a specific descriptive category (A to F) (Table 41).

Table 41: Descriptive categories used to describe the present ecological status (PES) of biotic components (adapted from Kleynhans, 1999).

Category	Biotic Integrity	Description of generally accepted conditions
A	Excellent	Unmodified, or approximates natural conditions closely. The biotic assemblages compares 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 natural 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.

It must be emphasised that the A-F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson et al. 2004). These boundary categories are denoted as B/C, C/D, etc.

3.3.8.5.2 Aquatic Ecosystem Assessment

3.3.8.5.2.1 Sampling Sites

Sites sampled for aquatic macroinvertebrates, fish and diatoms are outlined in Figure 45. The stream draining to the west flows into the Skilferlaagtespruit, while the stream draining northwards flows into the Langspruit. The Skilferlaagtespruit flows into the Grootspruit (sub-quaternary B41A-01025) and, after its confluence with the Langspruit (sub-quaternary B41A-01002), it becomes the Steelpoort River.

Sites were selected to be representative of all the surface water ecosystems within the study area. Sites were also sampled downstream of the study area to provide a more accurate reflection of the aquatic health of receiving watercourses. Artificial aquatic ecosystems, such as dams, were excluded from the fish survey as they are usually stocked with alien fish species and do not contribute to the biodiversity of the area. They are, in fact, seen as a negative impact on the natural aquatic biodiversity of the area and discussed as such. Many of the other sites were also not suitable for fish (dry or lack of fish habitat). An abbreviated description of sampling sites is given in Table 42 below.

Figure 46: Aquatic sampling sites for the Paardeplaats baseline survey

Table 42: Aquatic sampling sites selected for the purpose of the baseline study.

Site Name	Coordinates	Description	Sampled for:
P1	25°42'51.03"S 30° 1'20.94"E	Farm dam in valley bottom wetland draining into the Langspruit	SASS5, diatoms, water quality
P1A	25°43'29.95"S 30° 1'29.46"E	Seasonal Depression	SASS5
P2	25°43'13.59"S 30° 0'49.60"E	Farm dam draining into Glisa Coal Mine surface rights area	SASS5, diatoms, water quality
P3	25°43'22.19"S 30° 0'43.36"E	Farm dam draining into Glisa Coal Mine surface rights area	Diatoms, water quality
P4	25°43'43.17"S 29°59'59.82"E	Farm dam in valley bottom wetland, draining into Glisa Coal Mine surface rights area	SASS5, diatoms, water quality
P5	25°43'49.23"S 30° 0'41.72"E	Seasonal pan modified into a permanent storage dam	SASS5, diatoms, water quality
P6	25°44'26.95"S 29°59'36.08"E	Channelised drainage line	Diatoms, water quality
P7	25°44'21.89"S 29°58'0.52"E	Unnamed tributary of the Steelpoort River, mdownstream of the study area	Fish, SASS5, diatoms, water quality
P8	25°41'35.14"S 30° 1'24.44"E	Channeled valley bottom wetland downstream of Paardeplaats as well as the road between Glisa Coal Mine and Belfast. Drains into the Langspruit.	Water quality, Diatoms, Fish

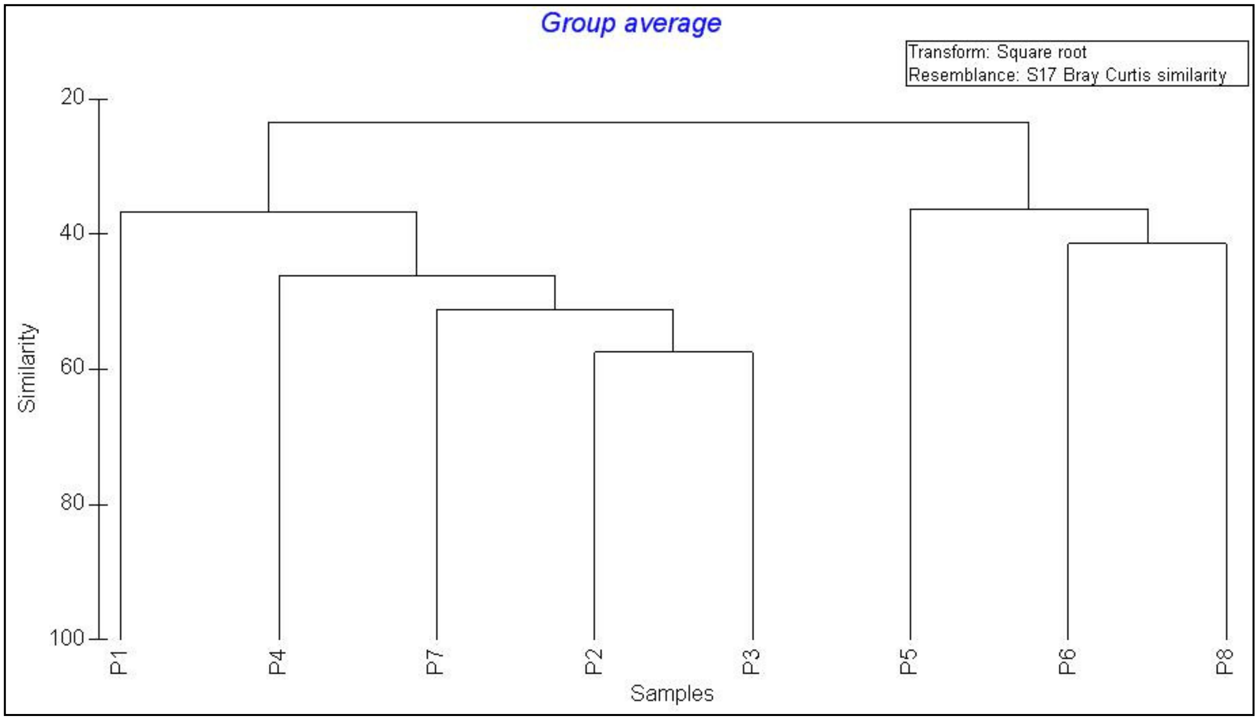
3.3.8.5.2.2 Diatoms

The diatom software programme OMNIDIA is a tool to assess the health of flowing rivers and is not applicable to standing water which sites P1-P6 and P8 represent. Analyses of diatoms were therefore based on measures of relative abundance and species composition (i.e. assemblage patterns) to infer baseline water quality conditions at these sites. Only site P7 was analysed according to OMNIDIA.

To visually represent assemblage patterns, a cluster analysis and MDS ordination (based on the Bray-Curtis similarity matrix of square root transformed species data) was generated using Primer 6 software. The results are displayed below (Figure 46), together with the most important species responsible for the differences between the two groups separated out during the cluster analysis (Table 43).

Table 43: Species primarily responsible for dissimilarities between sites (grouped according to the cluster analysis generated by Primer6 software). Species characteristic of each site are highlighted in grey

Taxa	P1	P2	P3	P4	P5	P6	P7	P8
Achnanthidium (including *A.minutissimum*)	60	240	311	205	7	20	234	2
Eolimna minima	0	0	0	0	105	0	0	11
Gomphonema parvulum var. *parvulum f. parvulum*	12	0	0	0	16	70	8	240
Nitzschia archibaldii	0	0	0	3	64	1	0	0
Nitzschia palea	23	7	11	4	36	78	0	10
Sellaphora seminulum	1	0	0	0	39	4	0	6
Fragilaria nanana	2	12	12	8	0	0	43	0



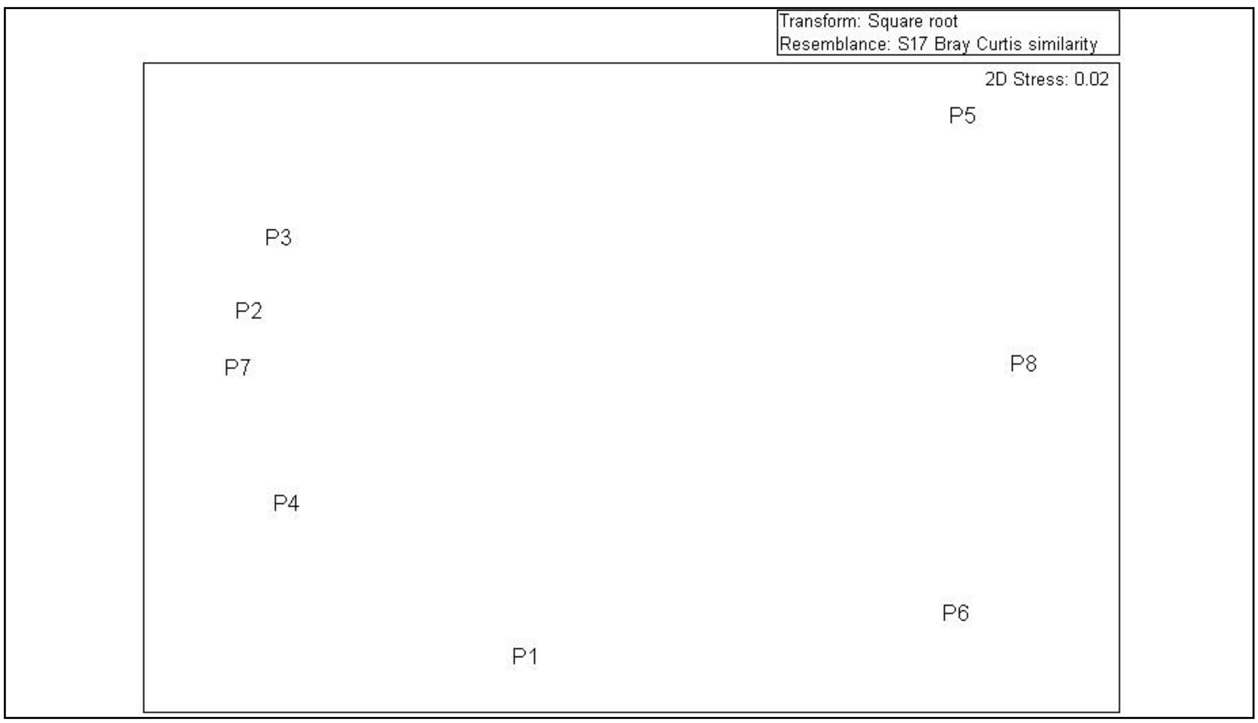


Figure 47: Cluster analysis and MDS ordination plot of Paardeplaats sites based on diatom relative abundance data

Diatom assemblage patterns at Paardeplaats sites (Figure 46 and Table 43) suggest the following (remembering that 'pollution indicators' used to determine anthropogenic stress in freshwater systems may be equally tolerant to the natural stressors that accompany healthy, eutrophic wetland systems):

- Sites P2, P3, P4 and P7 are most similar to each other because of the prevalence of *Acnanthidium* at these sites. This group of species is often associated with mesotrophic, high oxygenated water (Slàdecek, 1986; Leclercq and Maquet, 1987; Prygiel and Coste, 2000). Studies have however also revealed this group in particular *Achnanthidium minutissimum* to develop abundant populations at sites contaminated with different metals often associated with mining effluent (e.g. Pb, Cd, Zn, Cu) (Deniseger et al. (1986), Genter et al. (1987), Medley and Clements (1998), Ivorra et al. (1999), Gold et al. (2002, 2003), Cattaneo et al. (2004), Ferreira da Silva et al. (2009)). However it is important to be aware of the discrepancies surrounding *A.minutissimum* when inferring water quality based on diatom communities in a mine impacted area. Testing for heavy metals in the water would be a viable means to elucidate these differences.
- Site P5, P6 and P8 had lower relative abundances of *Achnanthidium* species, indicating lower levels of oxygen. Conversely, *Gomphonema parvulum* was more abundant at these sites. This species is common in heavily polluted, nutrient and organic enriched waters and strongly suggests there is significant disturbance of the system in terms of nutrient, electrolyte and organic inputs.
- Site P8, a site north of the road between Glisa Coal Mine and Belfast, and thus known to be impacted by Glisa Coal Mine activities as well as urban effluent from Belfast town, had a significantly higher relative abundance of *Gomphonema parvulum*. The *Achnanthidium* group of species was almost completely absent, indicating very low levels of oxygenation. In addition, the presence of *Fragilaria* biceps points to some inorganic nutrients in the system.
- Site P5 was characterised by a low prevalence of *Achnanthidium* species (i.e. low oxygen levels) and a relatively higher prevalence of *Eolimna minima* and *Sellaphora seminulum* which are both found in a range of conditions, including eutrophic, electrolyte rich water, and can indicate mining effluent or nutrient enrichment. The presence of sub-dominant *Nitzschia palea* suggests there is nutrient, electrolyte and some organic inputs. Other dominant species *Nitzschia archibaldii* is a taxon common in slight to moderately polluted waters with moderate electrolyte content.
- Site P6 was characterised by *Nitzschia palea* as well as *Gomphonema parvulum* common in heavily polluted, nutrient and organic enriched waters (This site may be receiving agricultural runoff as well as contaminated runoff from the N4 freeway).

In addition, the following observations were made:

- At site P2 sub-dominant *Encyonopsis subminuta* has an affinity for an oxygen rich environment but has also been reported in sulphate contaminated waters.
- At site P4 the presence of *Nitzschia acidoclinata* as well as taxa of the *Eunotia* group, such as *Eunotia incise*, are often found in oligotrophic electrolyte-poor, small water bodies.
- Site P7 – Diatoms were sampled from flowing water within this stream, hence OMNIDIA was applicable for interpretation of diatom data for this site. Diatom index values were calculated in OMNIDIA for epilithon data (Lecointe et al. 1993). The general water quality indices (integrating impacts from organic material, electrolytes, pH and nutrients) used in the assessment, were:
    - The Specific Pollution sensitivity Index (SPI) and
    - The percentage of (organic) pollution tolerant valves (%PTV)

The interpretation of the SPI scores is given in Table 44 below.

Table 44: Interpretation of the Specific Pollution sensitivity Index (SPI) scores

SPI Score	Class
>17	High quality
13 to 17	Good quality
9 to 13	Moderate quality
5 to 9	Poor quality
<5	Bad quality

The diatom species composition at P7 is indicative of circumneutral, fresh, oligo-mesotrophic waters with high oxygen content as reflected by dominant *Achnanthidium* taxa and subdominant *Fragilaria nanana* and *Eunotia* taxa. Overall the ecological water quality is of a category high quality (SPI score 17.4) with no organic impact to the system (%PTV of 2.3) as reflected by the likes of *Navicula radiosa*, a species very sensitive to organic pollution.

3.3.8.5.2.3 Habitat Integrity

One of the most significant impacts on the habitat integrity at site 7 was considered to be exotic vegetation encroachment, in particular by black wattle trees. The presence of alien vegetation results in decreased flows in the streams, altering the natural habitats through reduction of flow. In addition, alien invasive black wattle trees tend to shade out understory plants so that exposed stream banks become eroded. Bank erosion aggravated by alien vegetation encroachment result in sedimentation of instream substrates. Sedimentation and the resultant embeddedness of bottom substrates by fine sediment result in loss of habitat quality of fish with a preference or requirement for substrate with good quality. Alteration of the natural vegetation on stream banks results in a loss of overhanging vegetation, impacting negatively on fish and invertebrate assemblages that either shelter under the vegetation or use them as perch areas (e.g. dragonflies). Flow modification and channel modification at site 7 was also largely impacted by the upstream farm dam.

At site 8, downstream of the study area, mining and residential activities contribute to habitat deterioration. Flow modification was again highlighted as one of the most significant impacts, this being related to the presence of various small dams in the upper reaches of this stream. The channel was modified by dams and road crossings. Bed modification was again associated with bank and catchment erosion (especially related to dry land agriculture) as well as mining activities (at the adjacent Glisa Coal Mine).

Flow modification as a result of small dams in the upper catchment within the study area itself is estimated to have a large impact on fish habitats. Dams result in decreased flows, delays in small floods, reduced flushing of substrates and overall deterioration in aquatic habitat quality and availability. Bed modification as a result of sedimentation, associated with agricultural and mining activities is estimated to have a moderate impact in some areas. Channel modification as a result of damming, canalization and road crossings has had a large impact on aquatic habitats in many areas. Inundation, associated with dams and road crossings also impacted negatively on habitats. Indigenous vegetation removal (related to cultivated fields) and exotic vegetation encroachment were also identified as having a negative impact on aquatic habitats in many sections within the study area. The Present Ecological State of the wetlands on site is detailed in Section 3.3.6.2.2.

3.3.8.5.2.4 Fish

Site 7 provided three velocity-depth categories for fish, namely slow-deep and fast-shallow habitats, both occurring commonly, and slow-shallow habitats that were rare. The most significant cover feature available for fish was substrates (rocks) in the fast-shallow areas, while limited overhanging vegetation, undercut banks/root wads were also available.

Habitat diversity and availability for fish was generally very low with the stream at Site 8, with only fast-shallow and very limited slow-shallow habitats being present (Table 45). The most significant cover available for fish was in the form of substrates (rocks) and overhanging vegetation.

Table 45: Habitat composition and diversity for fish at different sampling sites

	Site 7	Site 8
SLOW-DEEP (>0.5m; <0.3m/s)		
Abundance	3	0
Overhanging vegetation	1	0
Undercut banks and Root-wads	1	0
Substrate	1	0
Macrophytes	0	0
Slow-shallow (<0.5m; <0.3m/s)		

Abundance	1	1
Overhanging vegetation	1	2
Undercut banks and Root-wads	0	0
Substrate	2	2
Macrophytes	0	0
Fast-deep (>0.3m; >0.3m/s)		
Abundance	0	0
Overhanging vegetation	0	0
Undercut banks and Root-wads	0	0
Substrate	0	0
Macrophytes	0	0
Fast-shallow (<0.3m; >0.3m/s)		
Abundance	3	5
Overhanging vegetation	1	1
Undercut banks and Root-wads	0	0
Substrate	3	2
Macrophytes	0	0

Abundance of velocity-depth classes and cover are estimated according to: 0 – absent; 1 – rare; 2 – sparse; 3 – common; 4 - abundant; 5 – very abundant

During the April 2011 baseline fish study performed in the study area no fish were sampled within the Paardeplaats boundary of the study area. The habitats within the streams of Paardeplaats were inadequate to sustain fish populations. No historic (pre-disturbance) information of the fish assemblage of the specific study area is available, and it is therefore not possible to determine the natural expected fish species composition of this area with high confidence. Based on all available information of fish species distribution, and an estimation of habitat conditions under natural conditions, it is estimated that at least one species, namely *Barbus anoplus* (Chubbyhead barb) may have occurred here under natural conditions. This species was sampled directly downstream of the Paardeplaats area during April 2011. The presence of dams and low water crossings presently create migration barriers and may limit the movement and recolonisation of this species during periods of higher flow (although flows are also reduced as a result of dams and other human activities in the catchment). Other fish species with a low probability of occurrence within the Paardeplaats area include the *Barbus neefi* (Sidespot barb), *Pseudocrenilabrus philander* (Southern mouthbrooder) and *Tilapia sparrmanii* (Banded tilapia).

Table 46: Fish species sampled during April 2011 in the Paardeplaats area.

Species		Sites	
Abbreviation	English Common Name	Site 7	Site 8
BANO	Chubbyhead barb	9	No fish

Table 47: Probability of occurrence of fish species under present conditions in the Paardeplaats study area and downstream receiving water bodies.

Abbreviation	English common name	Paardeplaats	Southern stream (Site 7)	Grootspruit (Site 8)	Northern stream	Langspruit
AURA	Stargazer (mountain catfish)	Absent	Low	Low	Moderate	High
BANO	Chubbyhead barb	Moderate/Low	Definite	High	Low/ absent	High
BNEE	Sidespot barb	Low	Low	Low	Low	Low
BPOL	Smallscale yellowfish	Absent	Low	Low	Low	Low
CGAR	Sharptooth catfish	Absent	Low	Low	Low	Low
CPRE	Shortspine suckermouth (or rock catlet)	Absent	Absent	Low	Absent	Absent
PPHI	Southern mouthbrooder	Low	Low	Low	Low	Low
TSPA	Banded tilapia	Low	Low	Low	Low	Low

Since rivers are continuum ecosystems, activities both up- and downstream of a specific area can have an impact on it. Dams downstream of a site can limit the natural movement of fish. Pollution incidences can also have a large spatial impact, depending on the extent, duration and type of pollution as well as the characteristics of the receiving stream. To enable an assessment of the potential impact of activities within the Paardeplaats area on the fish assemblages of the downstream receiving aquatic ecosystems, as well as the regional biodiversity in terms of fish, an assessment was also made of the expected fish species of the ecosystems directly downstream of the Paardeplaats area.

Only one fish species (*Barbus anoplus*) was sampled at site 1 in the southern stream during the baseline April 2011 survey (Table 46). Based on available information, there is a low probability that at least another seven fish species may also occur within the southern stream (lower reaches) and it’s receiving water body (Grootspruit) (Table 47). These include the Stargazer (*Amphilius uranoscopus*), Sidespot barb (*Barbus neefi*), Smallscale yellowfish (*Labeobarbus polylepis*), Sharptooth catfish (*Clarias gariepinus*), Shortspine suckermouth (*Chiloglanis pretoriae*), Southern mouthbrooder (*Pseudocrenilabrus philander*) and Banded tilapia (*Tilapia sparrmanii*) (Table 28).

These fish species differ in their preferences for different habitats types (Table 48). *Barbus anoplus*, sampled directly downstream of the Paardeplaats area, have a preference for slow habitats with overhanging vegetation and aquatic macrophytes (Table 48). It is therefore essential that especially these habitat features should not be altered by any future activities in the area. *Labeobarbus polylepis, Amphilius uranoscopus*, and *Chiloglanis pretoriae*, all species with low probability of occurrence within the study area, but not sampled during the current survey, have a preference for fast habitats with good substrates. Examples of activities often responsible for degradation in different fish habitat features are given in Table 49 and caution should therefore be taken with any of these activities, especially those that may influence the preferred habitats of the fish species known to occur in the study area.

Table 48: Habitat preferences (flow-depth and cover features) of the expected fish species (Kleynhans, 2003).

Abbrevi Ation	Scientific name	English common name	Slow deep (<0.3 M/s; >0.5 M)	Slow shallow (<0.3 m/s; <0.5 m)	Fast deep (>0.3 M/s; >0.3 M)	Fast shallow (>0.3 m/s; <0.3 m)	Overhanging Vegetation	Bank Undercut	Subs trate	Aquatic Macrop hytes	Water Colum n
AURA	Amphilius uranoscopus (pfeffer, 1889)	Stargazer (mountain Catfish)	0	0	4. 6	4. 6	0.1	0.4	5	0	0
BANO	Barbus anoplus weber, 1897	Chubbyhead barb	4.1	4.3	0.9	2.5	4	2.7	2.3	3.2	1.1
BNEE	Barbus neefi greenwood, 1962	Sidespot barb	3.3	4.7	1	1.7	3.9	3.3	4.4	0.5	0.2
BPOL	Labeobarbus polylepis Boulenger, 1907	Smallscale yellowfish	4.2	2.9	3.7	4.3	1	1.6	5	0	3.6
CGAR	Clarias gariepinus (burchell, 1822)	Sharptooth catfish	4.3	3.4	1.2	0.8	2.8	2.9	2.8	3	2.6
CPRE	Chiloglanis pretoriae van der horst, 1931	Shortspine suckermouth (or rock catlet)	0	0.6	4.3	4.9	0	0.1	4.9	0	0
PPHI	Pseudocrenila brus Philander (weber, 1897)	Southern mouthbrooder	2.6	4.3	0.5	0.9	4.5	3.2	1.9	2.9	0.3
TSPA	Tilapia sparrmanii smith, 1840	Banded tilapia	3	4.3	0.9	1.5	4.5	1.9	2.5	3.6	1.1

Table 49: Human activities that are often responsible for degradation in specific fish habitat features (important habitats for fish in study area in bold)

Velocity depth class or Habitat feature	General impacts and activities
Slow deep & slow shallow	Increased flows as result of regulation, water transfer schemes, irrigation releases. Sedimentation of pools as a result of catchment and bank erosion.
Fast deep and fast shallow	Decreased flows a result of water abstraction (for agriculture, domestic, mining or industry), flow modification as a result of dams, weirs and channelization.
Overhanging vegetation	Clearing of vegetation on stream banks for the purpose of stream crossings (conveyer belts, roads, haul roads), clearing of riparian zones for construction activities, exotic vegetation encroachment replacing natural vegetation and also causing increased bank erosion, and to a lesser extent water quality deterioration (increased toxins could result in decreased availability of vegetation while increased nutrients could result in excessive growth or domination by single or a few species).
Undercut banks	Alteration of natural water levels (through water abstraction, flow alterations, etc.). Physical disturbance of banks through construction or agricultural activities.
Substrate	Increased sedimentation (related to erosion), excessive algal growth (especially associated with irrigation return flows and WWTW effluents), sand mining, trampling by livestock, disturbance by bottom feeding alien species such as Common carp, etc.
Aquatic macrophytes	Altered flow regimes, use of herbicides, presence of alien Grass carp.
Water column	Decreased flows (through abstraction, constructions of dams, etc.)

The fish species of the study area also differ in their tolerance level to disturbance of the environment (Table 50). The fish species sampled within the Paardeplaats area (*Barbus anoplus*) are classified as being overall moderately tolerant to environmental change (Table 50). *Barbus neefi* is a moderately intolerant species, being moderately intolerant for all metrics assessed. The Smallscale yellowfish (*Labeobarbus polylepis*), a species not sampled during the current study and with low probability of occurring downstream of the Paardeplaats area is classified as being moderately intolerant to environmental changes. Another species not sampled during the current study but expected to have a low probability of occurrence downstream of Paardeplaats is the Stargazer (*Amphilius uranoscopus*). This species is classified as being overall intolerant to changes in the environment. Another intolerant species with low probability of occurrence in the area downstream of Paardeplaats is the Shortspine suckermouth (*Chiloglanis pretoriae*). Should *A. uranoscopus* and *C. pretoriae* still occur in the area downstream of Paardeplaats, they can be expected to be the first to react to environmental deterioration. *Labeobarbus polylepis*, a moderately intolerant species, can also be expected to react early to deterioration.

Table 50: Relative intolerance ratings of expected fish species (Kleynhans, 2003)

Abbreviation	Scientific name	English common name	Trophic Specialization	Habitat Specialization	Flow Requirement	Requirement: Unmodified Water Quality	Average Overall Intolerance Rating
AURA	Amphilius uranoscopus (pfeffer, 1889)	Stargazer (mountain Catfish)	4.7	4.9	4.8	4.8	4.8
BANO	Barbus anoplus weber, 1897	Chubbyhead barb	2.8	2.8	2.3	2.6	2.6
BNEE	Barbus neefi greenwood, 1962	Sidespot barb	3.3	3.4	3.4	3.4	3.4
BPOL	Labeobarbus polylepis Boulenger, 1907	Smallscale yellowfish	3	3.3	3.3	2.9	3.1
CGAR	Clarias gariepinus (burchell, 1822)	Sharptooth catfish	1	1.2	1.7	1	1.2
CPRE	Chiloglanis pretoriae Van der horst, 1931	Shortspine suckermouth (or rock catlet)	4.4	4.8	4.8	4.5	4.6
PPHI	Pseudocrenilabrus Philander (weber, 1897)	Southern mouthbrooder	1.3	1.4	1	1.4	1.3
TSPA	Tilapia sparrmanii smith, 1840	Banded tilapia	1.6	1.4	0.9	1.4	1.3

0-1.9 = TOLERANT; >2-2.9 = MODERATELY TOLERANT >3-3.9 = MODERATELY INTOLERANT >4-5.0 = INTOLERANT

None of the fish species expected or observed in the study area are classified as threatened on any scale (international, national or regional) (Table 51). The Chubbyhead barb, Sharptooth catfish, Southern mouthbrooder and Banded tilapia are all widespread and common species. The Sidespot barb is least concern, but is becoming scarcer in areas where it was previously common.

The current trend of this species in South Africa and Mpumalanga is uncertain due to data deficiency. The Smallscale yellowfish was classified as "least concern" by Wolhuter & Impson (2007). As for most yellowfish in South Africa, their natural distribution range is shrinking, but they are however still widely distributed and relatively abundant in many rivers (Roux, F: in Wolhuter & Impson, 2007).

Table 51: Conservation status of indigenous fish species expected within and directly downstream of the Paardeplaats study area

Abbreviation	Scientific name	English common name	Conservation status / general comments
AURA	Amphilius uranoscopus (Pfeffer, 1889)	Stargazer (mountain catfish)	Least concern (however intolerant and habitat specialist species)
BANO	Barbus anoplus (Weber, 1897)	Chubbyhead barb	Widespread and common
BNEE	Barbus neefi (Greenwood, 1962)	Sidespot barb	Least concern (Potentially more than one species).
BPOL	Labeobarbus polylepis (Boulenger, 1907)	Smallscale yellowfish	Least concern* (Natural distribution range however shrinking)
CGAR	Clarias gariepinus (Burchell, 1822)	Sharptooth catfish	Widespread and common
CPRE	Chiloglanis pretoriae (Van der Horst, 1931)	Shortspine Suckermouth (or rock catlet)	Least concern (however intolerant and habitat specialist species)
PPHI	Pseudocrenilabrus philander (Weber, 1897)	Southern Mouthbrooder	Widespread and common
TSPA	Tilapia sparrmanii (Smith, 1840)	Banded tilapia	Widespread and common

No alien fish species were sampled in the study area or directly downstream of the study area during the baseline study. Three alien fish species, the Common carp (*Cyprinus carpio*), Mosquito fish (*Gambussia affinis*) and Largemouth bass (*Micropterus salmoides*) are however known to occur in close proximity to the Paardeplaats study area. Common carp can be seen as equivocal, having a negative impact on the environment in which they occur, but being valued by certain interest groups such as sport fishermen. They are widely regarded as a pest, and are held responsible for the introduction of numerous fish parasites. They compete with other fish for food; they eat the spawn of other fish; and disrupt nest-building activities of some fish. Furthermore, they cause habitat degradation by their feeding behaviour of grubbing in the mud for food, which causes the destruction of vegetation, rooting up of marginal vegetation and disturbing of the bottom sediments which increases turbidity (de Moor & Bruton, 1988).

The potential presence of Largemouth bass is always alarming and the expected impact can be detrimental, as this aggressive predator can have a large impact on the indigenous fish species, especially small species and juveniles of larger species.

NB: The stocking of dams or streams within the Paardeplaats area with these or any other alien fish species should not be allowed as it is likely to result in loss of species.

Most of the fish species expected or observed in the study area are all classified as potadromous[1] in terms of migratory life history. *Labeobarbus polylepis, Barbus anoplus, Barbus neefi, Clarias gariepinus, Chiloglanis pretoriae* and *Tilapia sparrmanii* all require movement between reaches, while *Pseudocrenilabrus philander* and *Amphilius uranoscopus* primarily migrate within a reach.

[1] Potadromous: Truly migratory species whose entire life cycle is completed within freshwater and that undertake migrations within freshwater zones of rivers for a variety of reasons, such as for spawning, feeding, dispersion after spawning, colonisation after droughts, for over-wintering, etc.

Currently, migration of the fish in the study area is influenced by the presence of various existing dams and road crossings. It is recommended that all redundant dams should be removed from streams in the study area (and region where applicable) and no new instream dams should be constructed. The streams within the Paardeplaats area are source zones and therefore of low importance in terms of connectivity (including migration for fish).

No fish were sampled during the present baseline study within the Paardeplaats area, and since no long term data or historical data is available, it is not possible with any degree of confidence to estimate the pre-disturbance fish assemblage of this area. Based on the location of the study area, being at the source of these streams, there is a probability that fish may have been absent from this area even under natural conditions. Should it however be assumed that some species have occurred here under natural conditions, but have now disappeared (based on no fish sampled during the current study) as a result of human activities, then the biotic integrity of the Paardeplaats area, based on fish, can be described as critically modified from natural conditions (ecological category F). Based on the available information this would be a very low confidence assumption.

The biotic integrity, based on fish of the reaches downstream of the study area seems to also have been reduced from reference state. The absence of fish from site 2 in the northern stream may reflect poor biotic integrity (possibly also a category F) prevailing in this stream downstream of the Paardeplaats area. The presence of only a single fish species out of a possible seven other fish species that can possibly be expected in this stream, can also indicate largely modified biotic integrity prevailing at present (ecological category D/E). Due to the present (and possibly natural) absence of fish from the Paardeplaats area, as well as the scarcity of fish directly downstream of the Paardeplaats study area, it is estimated that fish are of limited use as indicators of biotic integrity of the streams of this area. More emphasis may have to be placed on other biota, such as aquatic macro-invertebrates and diatoms, to determine the present ecological status of these aquatic ecosystems.

3.3.8.5.2.5 Aquatic Macroinvertebrates

Compared with other pans and dams sampled in the Mpumalanga Highveld, the diversity of aquatic macroinvertebrates at Paardeplaats was relatively high. A total of 31 macroinvertebrate SASS5 taxa were sampled. It should be noted that, with the exception of site 7 which was a channelized drainage line, wetlands (including dams) cannot be interpreted according to SASS5 guidelines which are based on flowing water. However, the interpretation guidelines (Dallas 2007) for lower zones were used as an approximate guide for ecoclassification. The results are summarised in Table 52.

Assemblage patterns of aquatic macroinvertebrates reflect the geohydrological regime of the site. Dam sites all showed a similar macroinvertebrate assemblage with a high diversity of air-breathing hemipterans associated with marginal vegetation. Site 1A (a seasonal pan immediately south of Site 1) reflected seasonal conditions with a relatively low diversity of aquatic biota but a greater abundance of crustaceans adapted to seasonal waterbodies (cladocera, ostracods and copepods). Finally, the aquatic biota at site 7 reflected flowing waters with an abundance of rock and riffle habitats, thus having fewer air-breathing hemipterans but more crab, flatworms (Turbellaria), hydropsychiae and tipulid flies.

The wetland system draining to the north into the Langspruit and northwest towards Glisa Coal Mine had a high overall biodiversity with 23 taxa (collected from 3 sites). The seasonal depressions connected with this system increase the overall biodiversity within this area of the study area (although this site cannot be compared to the other sites in terms of diversity and sensitivity). This system was considered Largely Natural/Moderately Modified for aquatic macroinvertebrates (Category B/C). The dam at Site 1 had a relatively high diversity and ASS5 score compared to similar dams sampled within the Highveld, this indicating good water quality conditions (Category B/Largely Natural).

The dam at Site 4, draining towards Glisa Coal Mine, was considered Largely Natural (Category B) for macroinvertebrates. The taxon richness (diversity) was greatest at this site, and it had the highest number of taxa sensitive to water quality deterioration. This suggests that the site was relatively undisturbed in terms of water quality. Otter spoor and scats were observed at this site, as well as owl pellets.

Dam 5 had the lowest diversity and fewest sensitive taxa compared with other dams sampled. It was classified as Category D (Largely Modified) for aquatic macroinvertebrates. In addition to habitat changes, runoff from Hadeco cultivated fields may have compromised water quality. Site 7 was the only site with running water, albeit non-perennial under natural conditions, this necessitating judicious interpretation in terms of SASS5 guidelines. The ASPT of 5.13 for this site suggests a higher prevalence of taxa sensitive to changes in water quality. More than two species of baetid mayfly as well as leptophlebiid mayflies were present, indicating relatively good water quality. As such, the site was considered Largely Natural (Category B) for aquatic macroinvertebrates.

Table 52: Summary of aquatic macroinvertebrates sampled at Paardeplaats, using the SASS5 methodology.

SITE		1	1A	2	4	5	7
Sampling Date		April 2011					
Wetland type		Dam	Seasonal depression	Dam	Dam	Dam	Stream
pH:		7.33	-	7.87	7.57	7.83	7.30
Cond (mS/m):		16	-	48	13	42	11
Biotopes Sampled (Rated 1-5)	Stones	2	0	1	3	2	3
	Marginal vege	3	2	4	4	2	2
	Sediment	1	1	1	1	1	1
TOTAL No. SASS TAXA		18	10	15	20	15	16
SASS Score*		83	44	70	97	65	82
Average Score per Taxon		N/A	N/A	N/A	N/A	N/A	5.13

3.3.8.6 Potential Protected Species that may Occur in the Study Area

Protected bird and mammal species that may potentially occur in the study area are listed in the following tables (Tables 53-55).

Table 53: A list of biome-restricted and range-restricted bird species known from the Steenkampsberg Important Bird Area (according to Barnes, 1998).

Species	Common Name	Recorded in QDC 2529DB, 2530CA & 2529DD	Biome Affinity	Status
Geronticus calvus	Southern Bald Ibis	Yes	Afrotropical Highlands	Common
Sarothrura affinis	Striped Flufftail	No	Afrotropical Highlands	Rare
Heteromirafra ruddi	Rudd's Lark	No	Afrotropical Highlands	Rare
Turdus libonyanus	Kurrichane Thrush	Yes	Zambezian Affinity	Uncommon to common
Oenanthe bifasciata	Buff-streaked Chat	Yes	Afrotropical Highlands	Fairly common to common
Anthus chloris	Yellow-breasted Pipit	Yes	Afrotropical Highlands	Uncommon to common
Promerops gurneyi	Gurney's Sugarbird	No	Afrotropical Highlands	Fairly common
Cinnyris talatala	White-bellied Sunbird	Yes	Zambezian Affinity	Uncommon to fairly common

Table 54: Bird species of "special conservation concern" that could utilise the study site based on their known distribution range and the presence of suitable habitat. Species highlighted in grey were confirmed on the study site. * - denotes species that are restricted to the Afrotropical highlands (Barnes, 1998). Red list categories according to the IUCN (2011) and Barnes (2000)***.**

Species	Global Conservation Status**	National Conservation Status***	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
Alcedo semitorquata (Half-collared Kingfisher)	_	Near-threatened	Yes	No	Prefers fast-flowing and well-vegetated streams.	Unlikely to occur.
Anthropoides paradiseus (Blue Crane)	Vulnerable	Vulnerable	Yes	No	Prefers open pristine grasslands, as well as wetland habitats.	Regarded as an uncommon foraging visitor on the study site.
Balearica regulorum (Grey Crowned Crane)	Vulnerable	Vulnerable	Yes	Yes	Upland grassland in close association to wetland systems.	An uncommon foraging visitor on the study site. A regular visitor on the nearby Glisa Coal Mine.
Bugeranus carunculatus	Vulnerable	Critically Endangered	Yes	No	Restricted to extensive upland	A very rare foraging visitor – probably unlikely

Species	Global Conservation Status**	National Conservation Status***	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
(Wattled Crane)					sponges in montane grassland (at least in South Africa).	to occur.
Ciconia nigra (Black Stork)	-	Near-threatened	Yes	No	Forages in and around large permanent wetlands and roost and breeds in remote mountainous areas (cliffs).	Vagrant on the study site.
Circus ranivorus (African Marsh Harrier)	-	Vulnerable	Yes	No	Restricted to permanent wetlands with extensive reedbeds.	A regular non-breeding visitor on the study site – mainly confined to the upper catchment and source of the Steelpoort

Species	Global Conservation Status**	National Conservation Status***	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
						River.
Eupodotis senegalensis (White-bellied Korhaan)	-	Vulnerable	Yes	No	Prefers transitional habitat between grassland and savanna (e.g. Bankenveld).	Unlikely to occur.
Eupodotis caerulescens (Blue Korhaan)	Near-threatened	Near-threatened	Yes	No	Prefers extensive open short grassland and cultivated land.	An uncommon to fairly common foraging visitor on the central parts of the study site. Regularly observed from the pristine grasslands on the nearby Glisa Coal Mine.
Falco biarmicus (Lanner Falcon)	-	Near-threatened	Yes	Yes	Varied, but prefers to breed in mountainous	An occasional visitor on the study site.

Species	Global Conservation Status**	National Conservation Status***	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
					areas	
Falco naumanni (Lesser Kestrel)	Vulnerable	Vulnerable	Yes	Yes	The open grassland patches provide foraging habitat.	A fairly common summer visitor on the study site. Confined to the undulating grassland on the south-central section of the site.
Geronticus calvus (Southern Bald Ibis)*	Vulnerable	Vulnerable	Yes	Yes	A species restricted to montane grassland (especially when burned) and breed/nest on steep cliffs.	An occasional foraging visitor on the study site (especially in winter).
Hemimacronyx chloris	Vulnerable	Vulnerable	Yes	No	High-altitude	Unlikely to occur.

Species	Global Conservation Status**	National Conservation Status***	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
(Yellow-breasted Pipit)*					grassland rich in forb species.	
Lissotis melanogaster (Black-bellied Bustard)	-	Near-threatened	Yes	No	Tall grassland in open woodland.	Unlikely to occur.
Neotis denhami (Denham's Bustard)	Near-threatened	Vulnerable	Yes	No	Primary upland grassland, particularly on hilly terrain.	Unlikely to occur.
Phoenicopterus minor (Lesser Flamingo)	Near-threatened	Near-threatened	Yes	No	Restricted to large alkaline pans and other inland water bodies.	Vagrant on the study site.
Phoenicopterus ruber (Greater Flamingo)	Near-threatened	Near-threatened	Yes	No	Restricted to large saline pans and other inland water bodies.	Vagrant on the study site.

Species	Global Conservation Status**	National Conservation Status***	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
Sagittarius serpentarius (Secretarybird)	Vulnerable	Near-threatened	Yes	No	Prefers open grassland or lightly wooded habitat.	Regarded as an uncommon foraging visitor on the study site.
Sarothrura affinis (Striped Flufftail)*	-	Vulnerable	No	No	Moist upland grassland on slopes – partial to areas invaded by *Pteridium aquilinum.*	Vagrant on the study site.
Sarothrura ayresi (White-winged Flufftail)	Endangered	Critically Endangered	Yes	No	Upland cyperoid-dominated wetlands and seep (especially high altitude wetlands with a high frequency of peat).	Vagrant on the study site – a possible overlooked species during passage (southern part of the site).
Schoenicola	-	Near-threatened	Yes	No	Tall rank grassland	A rare and localised

Species	Global Conservation Status**	National Conservation Status***	Recorded during SABAP1	Recorded during SABAP2	Preferred Habitat	Potential Likelihood of Occurrence
brevirostris (Broad-tailed Warbler)					along vleis – mainly in upland areas.	resident.
Tyto capensis (African Grass Owl)	-	Vulnerable	Yes	No	Prefers rank moist grassland that borders drainage lines or wetlands.	Probably absent - historical resident but displaced by indiscriminate grazing and trampling by livestock.
Vanellus melanopterus (Black-winged Lapwing)	-	Near-threatened	Yes	No	Short undulating grassland, preferably in montane regions.	An uncommon foraging visitor.

Table 55: Likelihood of occurrence of red-data mammals for the study areas

Common name	Scientific name	IUCN	Likelihood	Notes
Serval	*Leptailurus serval*	NT	Confirmed	Strong local population
Side-striped Jackal	*Canis adustas*	NT	Confirmed	Out of distribution, requires investigation
Brown hyena	*Parahyaena brunnea*	NT	Confirmed	Transient species
South African Hedgehog	*Atererix frontalis*	NT	Confirmed	Confirmed
Cheetah	*Acinonyx jubatus*	VU	Low	Vagrant seen in 2010
Robust Golden Mole	*Ablysomus robustus*	EN	Low	Data deficient
Highveld Golden Mole	*Ambylosomus septentrionalis*	NT	Medium	Confirmed at neighbouring Glisa Coal Mine
Rough-haired Golden Mole	*Chrysospalax villosus*	CR	Low	Data deficient
Maquassie Musk Shrew	*Crocidura maquassiensis*	VU	Low	Out of distribution
Water Rat	*Dasymys incomtus*	NT	High	Confirmed at neighbouring Glisa Coal Mine
Spotted-necked Otter	*Lutra maculicollis*	NT	Medium	Confirmed on neighbouring areas
Pangolin	*Manis temminckii*	VU	Low	Sub-optimal habitat
Honey Badger	*Mellivora capensis*	NT	High	Confirmed on neighbouring areas
White-tailed Rat	*Mystromys albicaudatus*	EN	Low	Rare vagrant
Juliana’s Golden Mole	*Neamblysomus juliane*	VU	Low	Out of distribution
Oribi	*Ourebia ourebi*	EN	High	Confirmed on neighbouring areas
Sharp’s Grysbok	*Raphicerus sharpel*	NT	Low	Out of distribution

3.3.9 AIR QUALITY

3.3.9.1 Climate and Atmospheric Dispersion Potential

Meteorological mechanisms direct the dispersion, transformation and eventual removal of pollutants from the atmosphere. The extent to which pollution will accumulate or disperse in the atmosphere is dependent on the degree of thermal and mechanical turbulence within the earth’s boundary layer. This dispersion comprises vertical and horizontal components of motion. The stability of the atmosphere and the depth of the surface-mixing layer define the vertical component. The horizontal dispersion of pollution in the boundary layer is primarily a function of the wind field. The wind speed determines both the distance of downwind transport and the rate of dilution as a result of plume ‘stretching’. The generation of mechanical turbulence is similarly a function of the wind speed, in combination with the surface roughness. The wind direction, and the variability in wind direction, determines the general path pollutants will follow, and the extent of crosswind spreading. The pollution concentration levels therefore fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field (Tiwary and Colls, 2010).

The spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich and Tyson, 1988). The atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area. A qualitative description of the synoptic systems determining the macro-ventilation potential of the region may be provided based on the review of pertinent literature. These meso-scale systems may be investigated through the analysis of meteorological data observed for the region.

3.3.9.1.1 Synoptic-scale circulations and regional atmospheric dispersion potential

Situated in the subtropical high-pressure belt, southern Africa is influenced by several high-pressure cells, in addition to various circulation systems prevailing in the adjacent tropical and temperate latitudes. The mean circulation of the atmosphere over the subcontinent is anticyclonic throughout the year (except near the surface) due to the dominance of three high pressure cells, viz. the South Atlantic High Pressure (HP), the South Indian HP off the east coast, and the continental HP over the interior.

Seasonal variations in the positioning and intensity of the HP cells determine the extent to which the circumpolar westerlies impact on the atmosphere over the region. In winter, the high-pressure belt intensifies and moves northward and the upper level circumpolar westerlies are able to impact significantly on the region. The winter weather of the region is, therefore, largely dominated by perturbations in the westerly circulation. Such perturbations take the form of a succession of cyclones or ridging anticyclones moving eastwards around the South African coast or across the country. During summer months, the anticyclonic belt weakens and shifts southwards and the influence of the circumpolar westerlies diminishes. A weak heat low characterises the near surface summer circulation over the interior, replacing the strongly anticyclonic wintertime circulation (Preston-Whyte and Tyson, 1988).

The general circulation of the atmosphere over southern Africa as a whole is anticyclonic throughout the year above the 700 hPa level (i.e. altitude of ~3 000 m). Anticyclones are associated with convergence in the upper levels of the troposphere, strong subsidence throughout the troposphere, and divergence in the near-surface wind field. The subsidence inversions, fine conditions and little to no rainfall occur as a result of such airflow. The climatology of the Highveld region has been studied extensively in the past, where the frequency of anticyclonic conditions reaches a maximum in winter. The dominant effect of the winter subsidence is that, averaged over the year, the mean vertical motion is downward. The clear, dry air and light winds, often associated with anticyclonic circulation are ideal for surface radiation inversions of temperature, responsible for limited dispersion of especially low level pollution emissions (e.g. domestic coal fires). These surface inversions increase in frequency during night time and vary in depth between ~300 m to more than 500 m. The mean inversion strength during the winter is about 5°C – 6°C, whereas, in summer the strength is less than 2°C.

The circumpolar westerly waves are characterised by concomitant surface convergence and upper-level divergence that produce sustained uplift, cloud and the potential for precipitation. The cold fronts, which are associated with westerly waves, occur predominantly during winter when the amplitude of these disturbances is greatest. The passage of a cold front is characterised by distinctive cloud bands and pronounced variations in wind direction, wind speed, temperature, humidity, and surface pressure. The airflow ahead of a front passing over has a distinct north-north-easterly component and stable and generally cloud-free conditions prevail as a result of subsidence and low-level divergence. Following the passage of the cold front the north-easterly wind is replaced by winds with a distinct southerly component. The low-level convergence, in the south-westerly airflow to the rear of the front, produces favourable conditions for convection. The temperature decreases immediately after the passage of the front, with minimum temperatures being experienced on the first morning after the cloud associated with the front clears. The strong radiative cooling, due to the absence of cloud cover, and the advection of cold southerly air, combine to produce the lowest temperatures.

The tropical easterlies and the occurrence of easterly waves and lows affect most of southern Africa throughout the year, but occur almost exclusively during summer months. The easterly waves and lows are largely responsible for the summer rainfall pattern and the north-easterly wind component that occurs over the region (Schulze, 1986; Preston-Whyte and Tyson, 1988).

In contrast to anticyclonic circulation, convective activity associated with westerly and easterly wave disturbances hinders the persistence of inversions. Cyclonic disturbances, which are associated with strong winds and upward vertical air motion, destroy, weaken, or increase the altitude of elevated inversions. The easterly and westerly wave disturbances therefore facilitate the dispersion and dilution of accumulated atmospheric pollution.

3.3.9.1.2 Atmospheric Stability and Mixing Depth

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of flow due to the frictional drag of the earth's surface, or as result of the heat and moisture exchanges that take place at the surface. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated inversion. Radiative flux divergence during the night usually results in the establishment of ground-based inversions and the erosion of the mixing layer. The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about five to six hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and slower developing mixing layer. Night times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds, hence less dilution potential. During windy and/or cloudy conditions, the atmosphere is normally neutral.

The mixed layer (i.e. layer within which air pollutants are able to mix) therefore ranges in depth from a few metres during the evening and early morning to the base of the lowest-level elevated inversion during unstable, daytime conditions. Elevated inversions may occur for a variety of reasons and on some occasions as many as five may occur in the first 1000 m above the surface. The lowest-level elevated inversion is located at a mean height above ground of 1 550 m during winter months with a 78% frequency of occurrence. By contrast, the mean summer subsidence inversion occurs at 2 600 m with a 40% frequency.

For low level releases, such as due to vehicle entrainment from unpaved roads, the highest ground level concentrations will occur during weak wind speeds and stable (night-time) atmospheric conditions. Wind erosion, on the other hand, requires strong winds together with fairly stable conditions to result in high ground level concentrations i.e. neutral conditions. The highest ground level concentrations from stack releases will occur during unstable, daytime conditions.

The atmospheric boundary layer properties are therefore described by two parameters; the boundary layer depth and the Monin-Obukhov length, rather than in terms of the single parameter Pasquill Class. The Monin-Obukhov length (LMo) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation. The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and less dilution potential.

3.3.9.2 Pre-Mining Air Quality

The pre-mining air quality will be determined during the EIA Phase which us currently underway.

3.3.9.3 Contributors to Fall Out Dust

Power generation, mining activities, farming and residential land-uses occur in the vicinity of the proposed Paardeplaats project. These land-uses contribute baseline emission sources via vehicle tailpipe emissions, household fuel combustion, biomass burning and various fugitive dust sources. Long-range transport of particulates, emitted from remote tall stacks and from large-scale biomass burning in countries to the north of South Africa, has been found to contribute significantly to background fine particulate concentrations over the interior (Andreae et al., 1996; Garstang et al., 1996; Piketh et al., 1996).

3.3.9.3.1 Power Generation

Multiple operational power stations fall within the Mpumalanga Highveld region. The main emissions from such electricity generation are carbon dioxide (CO_2), sulphur dioxide (SO_2), nitrogen dioxides and ash (particulates). Fly-ash particles emitted comprise various trace elements such as arsenic, chromium, cadmium, lead, manganese, nickel, vanadium and zinc. Small quantities of volatile organic compounds are also released from such operations.

The power stations are large sources of SO_2, which will oxidise in the atmosphere to particulate sulphate at a rate of between 1 and 4% per hour. Fine particulate sulphate has been used to trace the transportation of power station plumes across the southern African sub-continent. The power stations, located mostly in a south-westerly direction from the proposed Paardeplaats project area, include Arnot (~28 km), Hendrina (~48 km), Komati (~62 km), Duvha (~68 km), Kriel (~96 km), Matla (~101 km) and Kendal (~107 km). Due to the elevated height at which these power stations emit, the potential exists for their emissions to impact on the air quality of the Witbank, Middelburg and eMakhazeni areas.

3.3.9.3.2 Mining Operations

There are numerous coal mines located to the west of Belfast. Some of the mines located close to the proposed Paardeplaats project include Arnot North Mine, Kopermyne Colliery, Klippan, Steelcoal Colliery, Arnot Coal Mine, Glisa Coal Mine, Optimum Colliery, Blackwattle Colliery, Middelburg Mine and Bank Colliery. Fugitive emissions from opencast and underground mining operations mainly comprise of land clearing operations (i.e. scraping, dozing and excavating), materials handling operations (i.e. tipping, off-loading and loading, conveyor transfer points), vehicle entrainment from haul roads, wind erosion from open areas and drilling and blasting. These activities mainly result in fugitive dust releases with small amounts of oxides of nitrogen (NO_x), carbon monoxide (CO), SO_2, methane and CO_2 being released during blasting operations.

3.3.9.3.2.1 Projected air quality at the neighbouring Glisa-North-Block complex

The Exxaro North-block / Glisa complex is located adjacent to the proposed Paardeplaats project. The current overall production rate of Glisa Coal Mine is approximately 7.0 million tonnes of coal per annum, consisting of 4.6 million tonnes from Blesbok and 2.4 million tonnes from Block B. The remainder of Blesbok and Block B reserves will be mined at the current mining rate for the next eight years. A recent air quality impact assessment of current and future mining operations (Kornelius and Bornman, 2011) concluded the following:

- Predicted incremental highest daily PM_{10} values due to unmitigated emissions exceed post-2015 South African standards at all the representative residential sensitive receptors and everywhere on the mine boundary for both the baseline and project scenarios. However, predicted annual average contributions result in exceedences only at Siyathuthuka and a farm house immediately adjacent to the mine on the eastern side. It is for this reason, and because considerable background values are also expected, that mitigation measures were proposed and modelled.
- In all cases, the projected mitigated annual average values due to mining operations meet the proposed South African post-2015 standard of 40 µg m^{-3}, except at the adjacent farm house, in the mining area itself (which is not subject to community exposure standards), and in limited areas immediately adjacent to the mining area.
- Predicted highest daily values exceed the proposed South African standard of 75 µg m^{-3} (from 2015 onwards) at some areas outside the mining area, even with the mitigation described. A small section of Siyathuthuka will experience PM_{10} concentrations in excess of the daily post-2015 standard on some days of the year.
- All mitigated predicted off-site values for dust fall-out are within the guideline values for residential areas.

3.3.9.3.3 Fugitive Dust Sources

These sources are termed fugitive because they are not discharged to the atmosphere in a confined flow stream. Sources of fugitive dust identified to potentially occur in the study area include paved and unpaved roads; agricultural tilling operations; and wind erosion of sparsely vegetated surfaces.

3.3.9.3.3.1 Unpaved and paved roads

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the South African context. The force of the wheels of a vehicle traveling on an unpaved road, results in the pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads vary in relation to the vehicle traffic (including average vehicle speed, mean vehicle weight, average number of wheels per vehicle) and the silt loading on the roads.

Emissions from paved roads are significantly less than those originating from unpaved roads; however, they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the re-suspension of loose material on the road surface.

3.3.9.3.3.2 Wind erosion of open areas

Emissions generated by wind erosion are dependent on the frequency of disturbance of the erodible surface. Every time a surface is disturbed, its erosion potential is restored. Erodible surfaces may occur as a result of agriculture and/or grazing activities.

3.3.9.3.4 Domestic Fuel Combustion

Domestic households are known to have the potential to be one the most important sources contributing to poor air quality within residential areas. Individual households are low volume emitters, but their cumulative impact is significant. It is likely that households within the local communities or settlements utilise coal, paraffin and/or wood for cooking and/or space heating (mainly during winter) purposes. Pollutants arising from the combustion of wood include respirable particulates, CO and SO_2 with trace amounts of polycyclic aromatic hydrocarbons (PAHs), in particular benzo(a)pyrene and formaldehyde. Particulate emissions from wood burning have been found to contain about 50% elemental carbon and about 50% condensed hydrocarbons.

Coal is relatively inexpensive in the Mpumalanga region and is easily accessible due to the proximity of the region to coal mines and the well-developed coal merchant industry. Coal burning emits a large amount of gaseous and particulate pollutants including SO_2, heavy metals, total and respirable particulates including heavy metals and inorganic ash, CO, PAHs (recognised carcinogens), NO_2 and various toxins. The main pollutants emitted from the combustion of paraffin are NO_2, particulates, CO and PAHs.

3.3.9.3.5 Biomass Burning

Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Within the project vicinity, crop-residue burning and wild fires (locally known as veld fires) may represent significant sources of combustion-related emissions. Within the project vicinity, wild fires (locally known as veld fires) may represent significant sources of combustion-related emissions (Maenhaut et al., 1996; Galpin and Turner, 1999,). The frequency of wildfires in the Highveld grasslands varies between annual and triennial (Tainton and Mentis, 1984).

Biomass burning is an incomplete combustion process (Cachier, 1992), with carbon monoxide, methane and nitrogen dioxide gases being emitted. Approximately 40% of the nitrogen in biomass is emitted as nitrogen, 10% is left in the ashes, and it may be assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds (Held et al., 1996). The visibility of the smoke plumes is attributed to the aerosol (particulate matter) content. In addition to the impact of biomass burning within the vicinity of the proposed mining activity, long-range transported emissions from this source can be expected to impact on the air quality between the months August to October. It is impossible to control this source of atmospheric pollution loading; however, it should be noted as part of the background or baseline condition before considering the impacts of other local sources.

3.3.9.3.6 Vehicle Tailpipe Emissions

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants form in the atmosphere as a result of chemical reactions. Significant primary pollutants emitted by internal combustion engines include CO_2, CO, carbon (C), SO_2, oxides of nitrogen (mainly NO), particulates and lead. Secondary pollutants include NO2, photochemical oxidants such as ozone, sulphur acid, sulphates, nitric acid, and nitrate aerosols (particulate matter). Vehicle (i.e. model-year, fuel delivery system), fuel (i.e. type, oxygen content), operating (i.e. vehicle speed, load), and environmental parameters (i.e. altitude, humidity) influence vehicle emission rates (Onursal and Gautam, 1997). The release of volatile organic compounds (VOCs) via vehicle emissions is likely to have localised impacts and be within ambient air quality standards and are considered to be a minor contributor to an emissions inventory.

3.3.9.3.7 Informal Refuse Burning

An additional source of emissions is the waste sector especially from informal refuse and tyre burning. The informal burning of refuse tips within former township areas and burning of waste at local municipal landfill sites represents a source of concern in all provinces. For example, refuse tip combustion has been found to contribute significantly to the total airborne particulate concentrations within Soweto in the Gauteng Province. This source was estimated during a source apportionment study conducted in Soweto during 1996-1997 to be responsible for between 10% and 25% of the $PM_{2.5}$ concentrations recorded (Annegarn and Grant, 1999).

3.3.9.3.8 Other Fugitive Dust Sources

The fugitive dust emissions may occur as a result of vehicle entrained dust from local paved and unpaved roads and wind erosion from open areas. The extent of particulate emissions from the main roads will depend on the number of vehicles using the roads and on the silt loading on the roadways.

3.3.9.4 Baseline Fall Out Dust Levels

Baseline fall out dust levels are still to be determined during the EIA Phase which is currently underway.

3.3.9.5 Air Quality Standards

The environmental regulations and guidelines governing the emissions and impact of the mining operations need to be considered prior to potential impacts and sensitive receptors are identified.

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality limits are intended to indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging periods. These averaging periods refer to the time-span over which the air concentration of the pollutant was monitored at a location. Generally, five averaging periods are applicable, namely an instantaneous peak, 1-hour average, 24-hour average, 1-month average, and annual average. The application of these standards varies, with some countries allowing a certain number of exceedances of each of the standards per year.

3.3.9.5.1 National Ambient Air Quality Standards

The South African Bureau of Standards (SABS) assisted the Department of Environmental Affairs (DEA) in the development of ambient air quality standards. National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for PM_{10}, SO2, NO2, ozone (O3), CO, lead (Pb) and benzene. The NAAQS were published in the Government Gazette (no. 32816) on 24 December 2009 (Table 56).

Draft $PM_{2.5}$ national ambient air quality standards were gazetted for comment on the 5 August 2010 (Table 57).

Table 56: South African national ambient air quality standards (Government Gazette 32816, 2009)

Substance	Molecular formula / notation	Averaging period	Concentration limit (µg m^{-3})	Frequency of exceedance[1]	Compliance date[2]
Sulfur dioxide	SO_2	10 minutes	500	526	Immediate
		1 hour	350	88	Immediate
		24 hours	125	4	Immediate
		1 year	50	0	Immediate
Nitrogen dioxide	NO_2	1 hour	200	88	Immediate
		1 year	40	0	Immediate
Particulate matter	PM_{10}	24 hour	120	4	Immediate – 31 Dec 2014
			75	4	1 Jan 2015
		1 year	50	0	Immediate – 31 Dec 2014
			40	0	1 Jan 2015
Ozone	O_3	8 hours (running)	120	11	Immediate
Benzene	C_6H_6	1 year	10	0	Immediate – 31 Dec 2014
			5	0	1 Jan 2015
Lead	Pb	1 year	0.5	0	Immediate
Carbon monoxide	CO	1 hour	30 000	88	Immediate
		8 hour (calculated on 1 hour averages)	10 000	11	Immediate

[1]The number of averaging periods where exceedance of limit is acceptable. [2]Date after which concentration limits become enforceable.

Table 57: Draft South African national ambient air quality standards for $PM_{2.5}$

Substance	Molecular formula / notation	Averaging period	Concentration limit (µg m^{-3})	Frequency of exceedance[1]	Compliance date[2]
Fine particulate matter	$PM_{2.5}$	24 hour	65	0	Immediate – 31 Dec 2015
			40	0	1 Jan 2016 – 31 Dec 2029
			25	0	1 Jan 2030
		1 year	25	0	Immediate – 31 Dec 2015
			20	0	1 Jan 2016 – 31 Dec

Substance	Molecular formula / notation	Averaging period	Concentration limit ($\mu g\ m^{-3}$)	Frequency of exceedance[1]	Compliance date[2]
					2029
			15	0	1 Jan 2030

3.3.9.5.2 National Regulations for Dust Deposition

No criteria for the evaluation of dust fallout levels are available for the United States Environmental Protection Agency (US-EPA), European Union (EU), World Health Organisation (WHO), or the World Bank (WB). Dust deposition may be gauged according to the criteria published by the South African Department of Environmental Affairs (DEA). In terms of these criteria dust deposition is classified as follows:

Table 58: National regulations for dust deposition

Classification	Volume
SLIGHT	less than 250 mg m^{-2} day^{-1}
MODERATE	250 to 500 mg m^{-2} day^{-1}
HEAVY	500 to 1 200 mg m^{-2} day^{-1}
VERY HEAVY	more than 1 200 mg m^{-2} day^{-1}

The South African Department of Minerals and Energy (DME) use the 1 200 mg m^{-2} day^{-1} threshold level as an action level. In the event that on-site dust-fall exceeds this threshold, the specific causes of high dust-fall should be investigated and remedial steps taken.

A perceived weakness in the current dust-fall guidelines is that they are purely descriptive, without giving any guidance for action or remediation (SLIGHT, MEDIUM, HEAVY, and VERY HEAVY). On the basis of the cumulative South African experience of dust-fall measurements, a modified set of dust-fall standards is proposed, within the overall framework of the new Clean Air Legislation. Dust-fall will be evaluated against a four-band scale as presented in Table 59 and Table 60.

A draft copy of the National Dust Regulation was published for comment on the 27 May 2011 which states no person may conduct any activity in such a way as to give rise to dust in such quantities and concentrations that:

- The dust or dust fall, has a detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage, or has contributed to the degradation of ambient air quality beyond the premises where it originates; or
- The dust remains visible in the ambient air beyond the premises where it originates; or
- The dust fall at the boundary or beyond the boundary of the premises where it originates exceeds:
  - 600 mg m^{-2} day^{-1} averaged over 30 days in residential and light commercial areas measured using reference method ASTM 01739; or
  - 1 200 mg m^{-2} day^{-1} averaged over 30 days in areas other than residential and light commercial areas measured using reference method ASTM 01739.

Table 59: Bands of dust-fall rates proposed for adoption

Band number	Band description label	Dust-fall rate (D) (mg m^{-2} day^{-1}, 30-day average)	Comment
1	Residential	D < 600	Permissible for residential and light commercial
2	Industrial	600 < D < 1 200	Permissible for heavy commercial and industrial
3	Action	1 200 < D < 2 400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2 400 < D	Immediate action and remediation required following the first exceedance. Incident report to be submitted to relevant authority.

Table 60: Target, action and alert thresholds for ambient dust-fall

Level	Dust-fall rate (D) (mg m^{-2} day^{-1}, 30-day average)	Averaging period	Permitted frequency of exceedances
Target	300	Annual	
Action residential	600	30 days	Three within any year, no two sequential months.
Action industrial	1 200	30 days	Three within any year, not sequential months.
Alert threshold	2 400	30 days	None. First exceedance requires remediation and compulsory report to authorities.

3.3.9.5.3 European Community Limit Values

In order to position the South African Air Quality standards, the European Community (EC) limit values for the protection of human health (as obtained from the EC Directive, 2008/50/EC have been provided (Table 61). In many cases the concentration limit values are similar however the frequency of exceedance or margin for tolerance, vary slightly between the sets of standards.

Table 61: European Commission Limit Values for the protection of human health

Pollutant	Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
Sulfur dioxide	1 hour	350 µg m^{-3}, not to be exceeded more than 24 times a calendar year	150 µg m^{-3} (43%)	1 January 2005
	24 hours	125 µg m^{-3}, not to be exceeded more than 3 times a calendar year	None	1 January 2005
Nitrogen dioxide	1 hour	200 µg m^{-3}, not to be exceeded more than 18 times a calendar year	50% on 19 July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010	1 January 2010
	1 year	40 µg m^{-3}		1 January 2010
PM_{10}	24 hours	50 µg m^{-3}, not to be exceeded more than 35 times a calendar year		1 January 2005
	1 year	40 µg m^{-3}	20%	1 January 2005
Benzene	1 year	5 µg m^{-3}	5 µg m^{-3} (100%) on 13 December 2000, decreasing on 1 January 2006 and every 12 months thereafter by 1 µg/m³ to reach 0% by 1 January 2010	1 January 2010
Lead	1 year	0.5 µg m^{-3}	100%	1 January 2005
Carbon	Maximum	10 000 µg m^{-3}	60%	1 January 2005

Pollutant	Averaging period	Limit value	Margin of tolerance	Date by which limit value is to be met
monoxide	daily 8 hour mean			

3.3.9.5.4 Highveld Priority Area

The Highveld Airshed Priority Area (HPA) was declared the second national air quality priority area (after the Vaal Triangle Airshed Priority Area) by the Minister of Environmental Affairs at the end of 2007 (HPA, 2011). This required that an Air Quality Management Plan for the area be developed. The plan includes the establishment of an emissions reduction strategies and intervention programmes based on the findings of a baseline characterisation of the area. The implication of this is that all contributing sources in the area will be assessed to determine the emission reduction targets to be achieved over the following few years.

The DEA published the management plan for the Highveld Priority Area in September 2011. Included in this management plan are 7 goals, each of which has a further list of objectives that has to be met. The 7 goals for the Highveld Priority area are as follows:

- **Goal 1:** By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards.
- **Goal 2:** By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dust fallout limit values.
- **Goal 3:** By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards.
- **Goal 4:** By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy.
- **Goal 5:** By 2020, a measurable increase in awareness and knowledge of air quality exists.
- **Goal 6:** By 2020, biomass burning and agricultural emissions will be 30% less than current.
- **Goal 7:** By 2020, emissions from waste management are 40% less than current.

Although the proposed Paardeplaats Project falls outside of the HPA footprint it may, however, contribute to the pollution within the Highveld airshed due to its close proximity to the HPA boundary. Emission reduction strategies and associated specific targets are called for in the HPA including for the numerous coal mines in the area. Refer to the HPA (2011) Highveld Priority Management Plan for further details.

3.3.9.6 Sensitive Receptors

The National Ambient Air Quality Standards (NAAQS) and Dust Deposition Guidelines (detailed in Section 3.1) are based on human exposure to specific criteria pollutants and as such, possible sensitive receptors were identified where the public is likely to be unwittingly exposed. NAAQS are enforceable outside of mine boundaries and therefore the sensitive receptors identified (Figure 47) include the nearest residential areas in the region; eMakhazeni (~2 km north-east) and Siyathuthuka (~3 km north). The town hospital and three schools are located within 3 km of the north-east corner of the proposed mining operations. Individual residences (i.e. farm houses) are also within the area of proposed operations as well as the Hadeco tulip nursery and associated village. The modelled ground-level concentrations of total suspended particulates (TSP) and PM_{10} will be compared to National Standards and Guidelines at these sensitive receptors during the EIA phase.

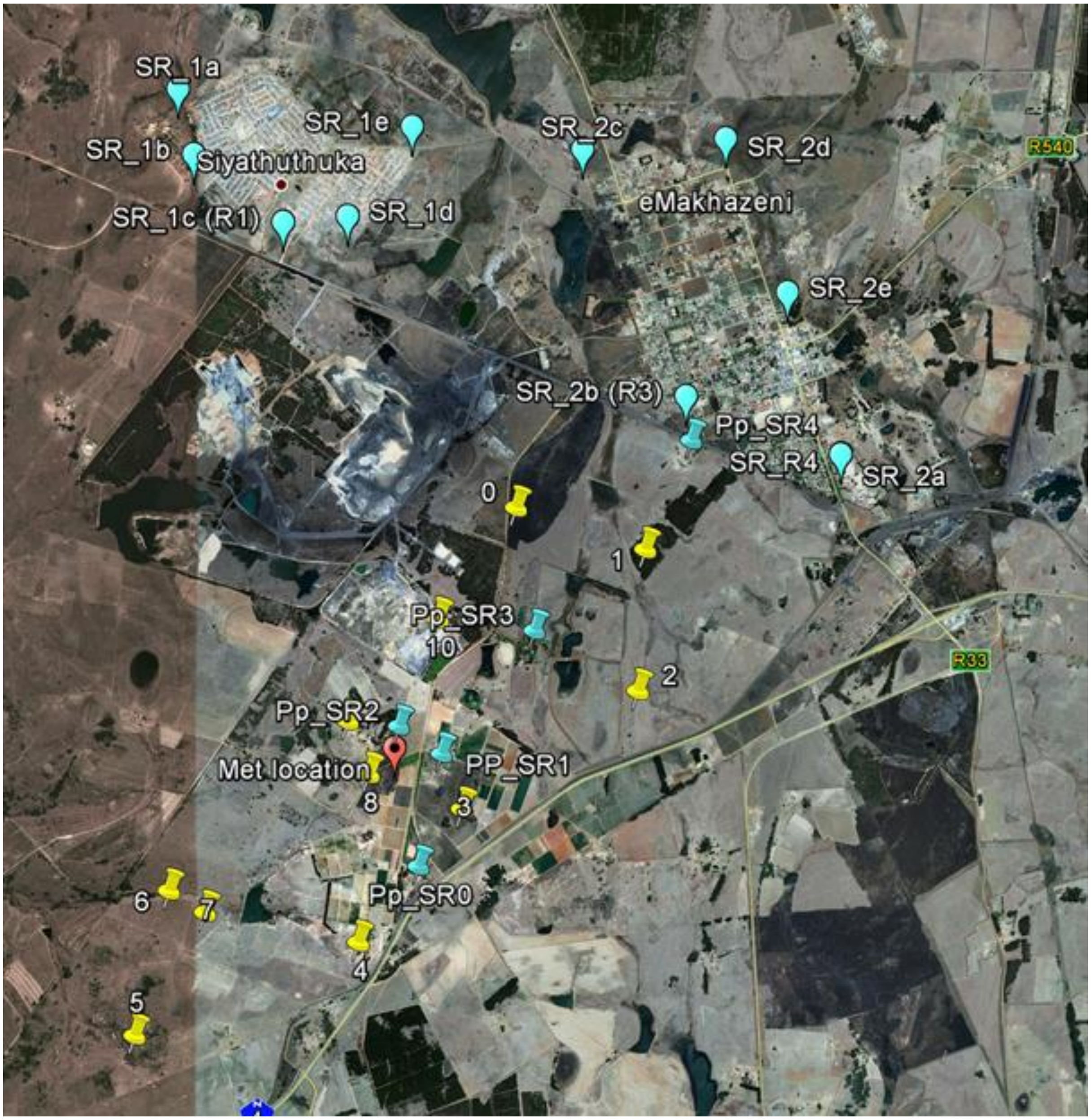


Figure 48: Aerial map of the Proposed Paardeplaats project, indicating mine boundary (yellow markers 0 to 10) and possible sensitive receptors (light blue markers).

3.3.10 NOISE

3.3.10.1 Pre-Mining Ambient Noise Levels

The determination of the residual (existing) noise climate in the study area is based on the measurements and observations made in the area, and where relevant also from the calculation of the noise from the traffic on the main roads.

The areas remote from the main roads are quiet and are typical of a rural/agricultural noise environment. In the residential areas of eMakhazeni and Siyathuthuka, the existing residual noise climate is typical of a suburban environment. The noise climate in areas close to the main roads is degraded. There is a noise nuisance factor in areas close to the railway line when trains pass.

3.3.10.2 Noise Standards

From the findings and observations on site it was considered appropriate to apply the following noise standards and impact criteria to the study area:

- Rural residential: the noise impact on the farmhouse sites and residences and guesthouses on farms in the area has been determined on the basis of rural residential district standards (SANS 10103), namely the daytime period ambient noise level should not exceed 45dBA and that for the night-time period should not exceed 35dBA. Measured levels indicate that parts of the (rural) study area are already severely degraded close to the main sources of noise.
- Suburban residential: the noise impact on the residences in eMakhazeni and Siyathuthuka has been determined on the basis of suburban residential district standards (SANS 10103), namely the daytime period ambient noise level should not exceed 50dBA and that for the night-time period should not exceed 40dBA.
- Educational: the noise impact on the schools in the area has been determined on the basis that the daytime period ambient noise level should not exceed 50dBA.

The above indicates the ideal situation, where noise sensitive receptors are not already degraded by the existing (residual) noise climate. However, it is likely that the residual noise level at some of the noise sensitive receptors already exceeds the recommended maximum (e.g. next to major roads and the railway line). In order to assess the actual noise impact at any particular site, therefore, the residual noise climate has to be taken into account when determining impact. Where the noise level for a particular site is presently lower than the maximum ambient allowed (as indicated in SANS 10103) the recommended maximum shall not be exceeded by the introduction of the intruding noise. Where the noise level for the site is presently at or exceeds the maximum level allowed, the existing level shall not be increased by more than that indicated as acceptable in SANS 10103.

3.3.10.3 Sensitive Receptors

The residential, educational and institutional land uses are considered to be noise sensitive receptors (NSR).

For this study, the position of houses/dwellings on the farms was taken off 1:50 000 topographical cadastral maps and verified as far as possible using Google Earth. Even though the latest edition was used, the relevant maps are 26 years out of date and there may be new dwellings and/or some of the existing shown buildings may be derelict. During the field survey for the noise measurement survey, such aspects were noted where possible. The following 1:50 000 topographical cadastral maps were used:

- SOUTH AFRICA 1:50 000 Sheet 2529DB, LANGUITSIG Second Edition 1986.
- SOUTH AFRICA 1:50 000 Sheet 2529DD, Arnot Second Edition 1986.
- SOUTH AFRICA 1:50 000 Sheet 2530CA, BELFAST Second Edition 1988.
- SOUTH AFRICA 1:50 000 Sheet 2530CC, MOEDIG Second Edition 1988.

The noise sensitive sites/areas in the study area that are potentially affected by the development of the mine on this site are the residential areas of eMakhazeni, Siyathuthuka township, farm houses, farm labourer residences, schools, crèches, clinics, and hospitals.

3.3.11 VISUAL IMPACT

3.3.11.1 Landscape Quality

Landscape character, landscape quality (Warnock & Brown, 1998) and "sense of place" (Lynch, 1992) are used to evaluate the visual resource i.e. the receiving environment. Subjectively, the landscape is pastoral and peaceable with grassland and agricultural fields, small homes and farmsteads and small dams amidst stands of tall woody trees near water and residential development. The landscape character does however have a dual character – it is also interspersed with activity at mine sites, contributing to the sense of place of this particular region. The landscape offers long, panoramic views to the extended horizon over rolling hills and fields with wetlands and greater visual variety in depressions, valleys and rises. The foreground is textured, while the far-middle to background is often obscured due to atmospheric haze.

The area has a low to moderate visual complexity, as it includes scenes with water and topographic interest. The landscape also has a moderate visual complexity as there is an amount of natural landscape within the long views of this area, punctuated at intervals by agricultural development and mining development.

The landscape contains no especially vivid, distinguished, uncommon or rare visual features or abstract attributes; although the wide open spaces and the ability of the landscape to attract nature lovers and other tourists renders the landscape more than able to elicit evocative responses from the viewer. The landscape's Aesthetic Value comprises the landscape meanings

(Anglo-Boer war historic sites, Highlands Meander Tourist Route), landscape character and sense of place, and the landmark quality (Belfast dam, Berg-en-Dal monument).

3.3.11.2 Landscape Character

Landscape character types are landscape units refined from the regional physiographic and cultural data derived from 1:50 000 topographical maps, aerial photographs and information gathered during the site visit. Dominant landform and land use features (e.g., hills, rolling plains, valleys and urban areas) of similar physiographic and visual characteristics, typically define landscape character types. The landscape types identifies on site are the following: Agricultural lands; rocky outcrops and grassland; less-disturbed and fallowing land; stands of exotic trees; dams and bodies of still water; residential stands and built-up areas; mining, disturbed soils and infrastructure; Wetlands, pans, drainage lines and seepage zones.

Refer to the views in images 3 – 8 of Figure 48, which illustrate the nature and character of the study area. The viewpoint locations are indicated in Figure 49.

The area has a rolling topography with grasslands and cultivated land that is intersected by streams, wetlands and dams (approximately 27 % of the Paardeplaats study area is considered to be covered by wetlands, making up a combined wetland extent of over 338 ha (Scoping Level Report: Ecological Assessment Of The Proposed Paardeplaats Mining Area)). Most of the disturbed areas are used for the cultivation of maize, potatoes and timber as well as for grazing fields. There are clusters of exotic trees spread throughout this area - some of the clusters appear to have previously formed part of plantations. According to the Scoping Level Ecological Assessment Report (EkoInfo CC & Associates) the regional 2000 land cover classification states that 74% of the landscape still represents natural vegetation (habitat), with only 26% being transformed. On the study site itself, 651 ha (46%) of the study area represents natural vegetation.

The vegetation of the area is characterised by the Eastern Highveld Grassland as described by Mucina & Rutherford (2006). This vegetation type is classified as Endangered and mainly consists of short dense Highveld grassland. There are also small, scattered rocky outcrops with wiry, sour grasses and some woody species, these outcrops are the most species rich community on site according to the Scoping Level Ecological Assessment Report (EkoInfo CC & Associates) while the poorest community in terms of specie richness is the type representing secondary grasslands (old fields, felled forestry areas etc.). The landscape character as described by Munich & Rutherford (2006) is moderately to undulating plains and includes some hills and pan depressions. The preceding description applies to the conditions on site.

The man-made landscape types that occurs on the study area includes the grazing areas, cultivated fields, built-up areas (residences), infrastructure such as dirt roads, power lines and the existing mining activities. Although there is currently no mining activity on site, the Landscape Character types include grazing areas, cultivated fields, built-up areas (residences), infrastructure such as dirt roads and power lines, natural hilly grassland and wetland / pan depressions as well as stands of exotic trees. Figure 50, illustrates the spatial distribution of the various landscape character types.

Figure 3: A small seepage area alongside the N4; a typical sight in the area.

Figure 4: Railway and telecommunication infrastructure.

Figure 5: Stands of exotic trees, grassland and agricultural land.

Figure 6: Rocky outcrops and natural grassland.

Figure 7: View from the North towards the Belfast Dam in view in the middle ground. This figure demonstrates the pastoral quality of the landscape.

Figure 8: Agricultural land, maize farming and stands of exotic trees. This figure demonstrates the pastoral quality of the landscape.

Figure 49: Landscape Character

3.3.11.3 Sense of Place

Central to the concept of “sense of place” is that the landscape requires uniqueness and distinctiveness. The primary informant of these qualities is the spatial form and character of the natural landscape taken together with the cultural transformations and traditions associated with the historic use and habitation of the area. According to Lynch (1992), sense of place “is the extent to which a person can recognize or recall a place as being distinct from other places – as having a vivid, unique, or at least particular, character of its own”. Sense of place is the unique value that is allocated to a specific place or area through the cognitive experience of the user or viewer. In some cases these values allocated to the place are similar for a wide spectrum of users or viewers, giving the place a universally recognized and therefore, strong sense of place.

Because the sense of place of the study area is derived from the emotional, aesthetic and visual response to the environment, it cannot be experienced in isolation. The landscape context must be considered. With this in mind, the combination of the natural landscape (mountains, streams and the vegetation) together with the manmade structures (residential areas, roads, mining activities and power lines) contribute to the sense of place for the study area. It is these land-uses, which define the area and establish its identity.

According to Lynch (1992) sense of place "is the extent to which a person can recognize or recall a place as being distinct from other places - as having a vivid, or unique, or at least particular, character of its own". The Project site and its surrounds have a moderately strong sense of place. The general landscape type however s recognisable and indeed marketed for tourism as unique to the Mpumalanga highlands: rolling hills, dams and streams contribute to the unique character of the area as well as the typical haziness of the air. However, the views are not pristine although remaining natural vegetation within the study area has high conservation status. Contributing to the sense of place of the study area is the presence of numerous mines and mining development as well as environmental liabilities such as alien invasive species, erosion and exploited vegetation. This supports the moderate classification as these developments and alterations are prominent in the landscape and tend to compromise the original natural/rural quality of the landscape.

3.3.11.4 Visual Resources

The spatial distribution of the landscape types discussed in Section 3.3.11.2 is illustrated in Figure 50. Scenic quality ratings were assigned to each of the landscape types defined in Figure 50.

A summary of the visual resource values, within the context of the sub-region is tabulated in Table 62 below.

Table 62: Value of the Visual Resource (after The Landscape Institute with the Institute of Environmental Management and Assessment (2002))

High **Rocky outcrops or natural grassland. Pans, depressions, water and streams**	**Moderate** **Stands of exotic trees, Farmsteads and other built-up areas, Agricultural Activities and fallowing land.**	**Low** **Transport and mining infrastructure and disturbed land.**
This landscape type is considered to have a high value because it is a: Distinct landscape that exhibits a very positive character with valued features that combine to give the experience of unity, richness and harmony. It is a landscape that may be considered to be of particular importance to conserve and which has a strong sense of place.	This landscape type is considered to have a moderate value because it is a: Common landscape that exhibits some positive character but which has evidence of alteration /degradation/erosion of features resulting in areas of more mixed character.	This landscape type is considered to have a low value because it is a: Minimal landscape generally negative in character with few, if any, valued features.
Sensitivity:		

It is sensitive to change in general and will be detrimentally affected if change is inappropriately dealt with	It is potentially sensitive to change in general and change may be detrimental if inappropriately dealt with	It is not sensitive to change in general and change will not cause a great measure of detriment.

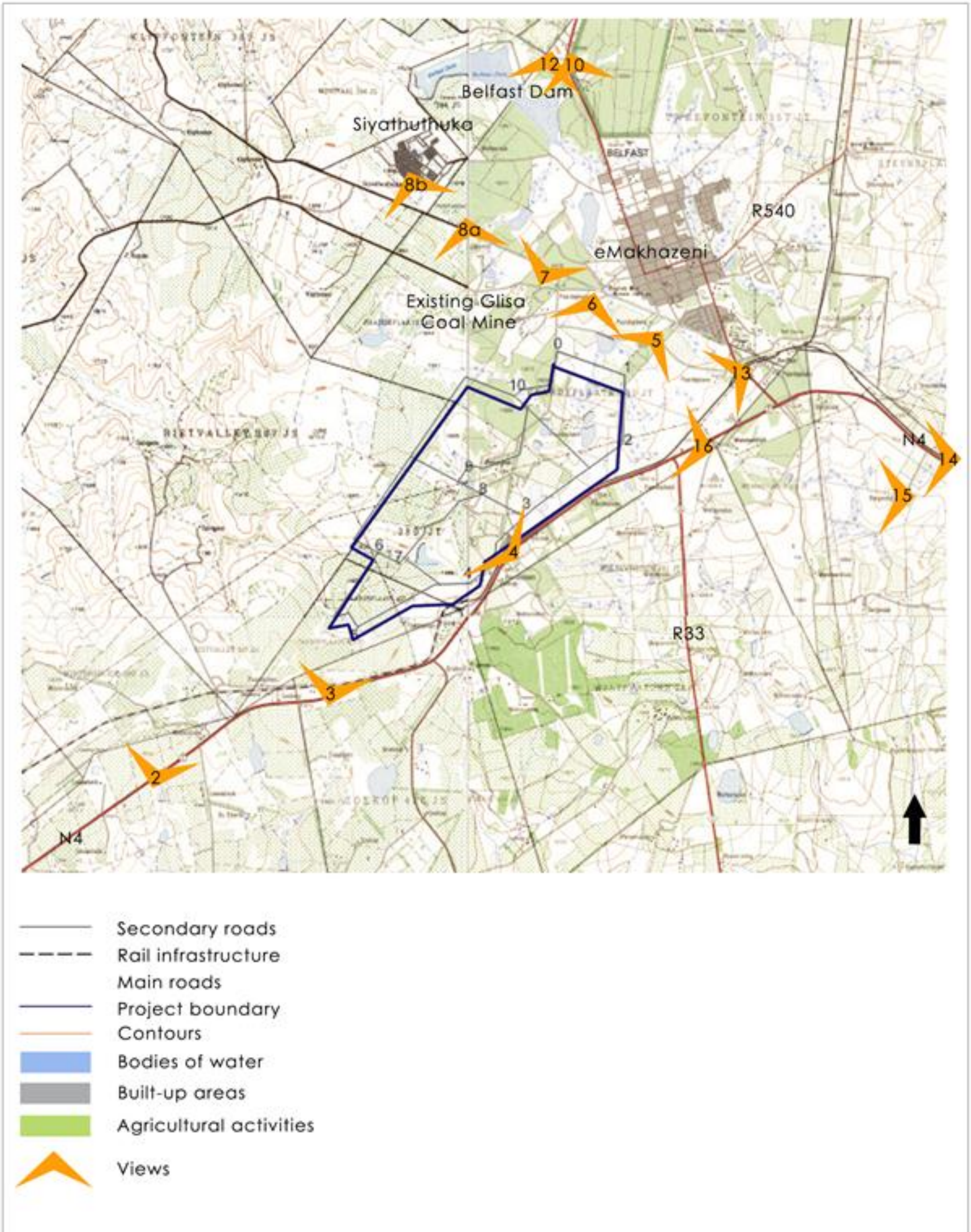


Figure 50: Locality and Views

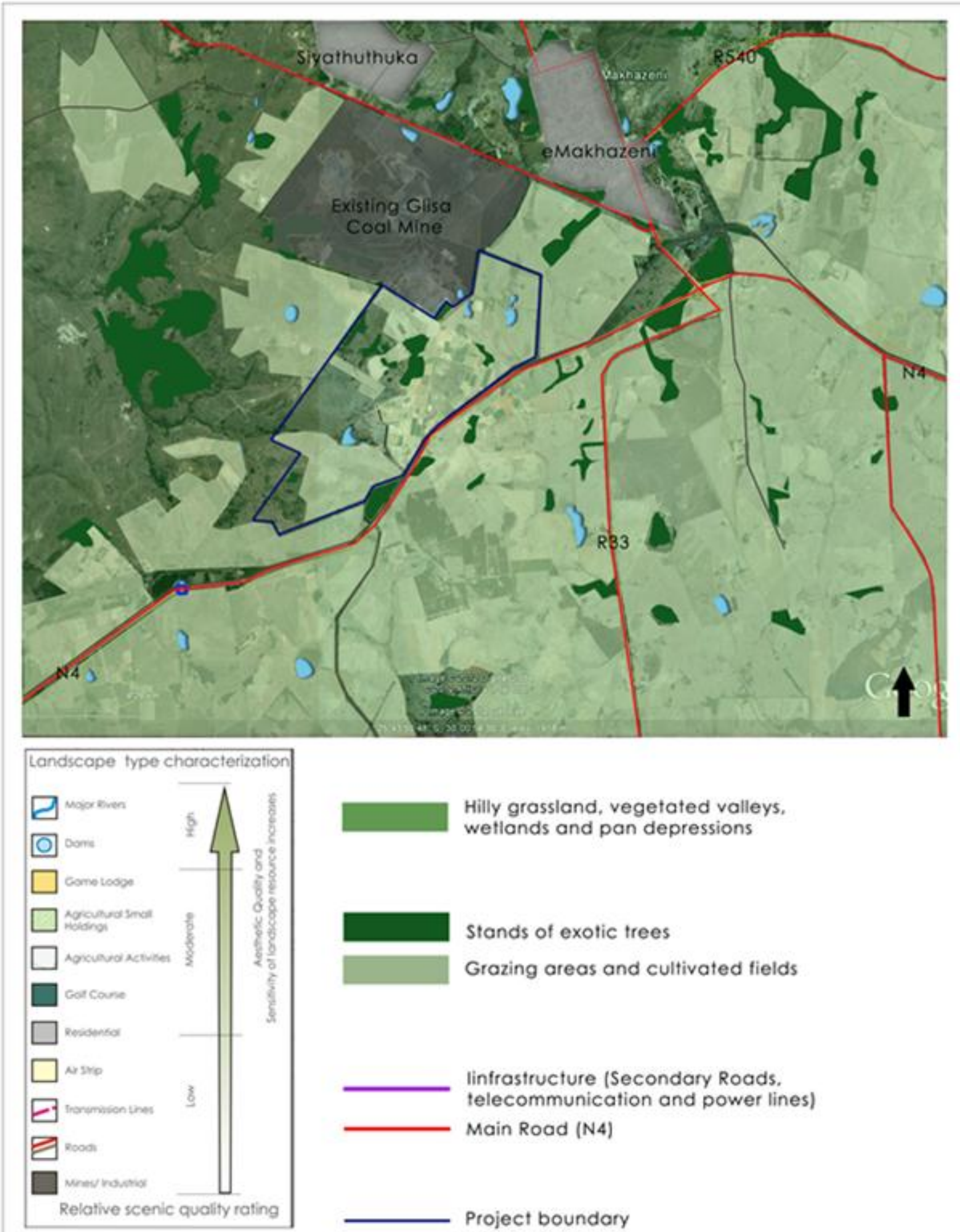


Figure 51: Visual Resource

Landscape character, landscape quality (Warnock, S. & Brown, N., 1998) and "sense of place" (Lynch, K., 1992) are used to evaluate the visual resource i.e. the receiving environment. A qualitative evaluation of the landscape is essentially a subjective matter. In this study the aesthetic evaluation of the study area is determined by the professional opinion of the author based on site observations and the results of contemporary research in perceptual psychology.

Aesthetic value is the emotional response derived from the experience of the environment with its particular natural and cultural attributes. The response is usually to both visual and non-visual elements and can embrace sound, smell and any other factor having a strong impact on human thoughts, feelings and attitudes (Ramsay, 1993). Thus aesthetic value is more than the combined factors of the seen view, visual quality or scenery. It includes atmosphere, landscape character and sense of place (Schapper, 1993).

Studies for perceptual psychology have shown human preference for landscapes with higher visual complexity, for instance scenes with water or topographic interest. On the basis of contemporary research (Crawford, 1994), landscape quality increases where:

- Topographic ruggedness and relative relief increase;
- Water forms are present;
- Diverse patterns of grassland and trees occur;
- Natural landscape increases and man-made landscape decreases;
- Where land use compatibility increases (Crawford, 1994).

Aesthetic appeal (value) is therefore considered high when the following are present (Ramsay, 1993):

- Abstract qualities: such as the presence of vivid, distinguished, uncommon or rare features or abstract attributes;
- Evocative responses: the ability of the landscape to evoke particularly strong responses in community members or visitors;
- Meanings: the existence of a long-standing special meaning to a particular group of people or the ability of the landscape to convey special meanings to viewers in general;
- Landmark quality: a particular feature that stands out and is recognized by the broader community.

And conversely, it would be low where:

- Limited patterns of grasslands and trees occur;
- Natural landscape decreases and man-made landscape increases;

- And where land use compatibility decreases (after Crawford, 1994).

In determining the quality of the visual resource, both the objective and the subjective or aesthetic factors associated with the landscape are considered. Many landscapes can be said to have a strong sense of place, regardless of whether they are considered to be scenically beautiful but where landscape quality, aesthetic value and a strong sense of place coincide - the visual resource or perceived value of the landscape is considered to be very high.

3.3.11.5 Sensitive Viewer Locations

The sensitivity of visual receptors and views are dependent on the location and context of the viewpoint, the expectations and occupation or activity of the receptor or the importance of the view. This may be determined with respect to its popularity or numbers of people affected its appearance in guidebooks, on tourist maps, and in the facilities provided for its enjoyment and references to it in literature or art.

The following sensitive viewer groups have been identified based on the above considerations, on 1:50000 Topographical maps, aerial photographs and observations from the site visit:

- The residents of the town of eMakhazeni (Belfast);
- The residents of the town of Siyathuthuka;
- The employees of the Exxaro Glisa Coal Mine;
- The travellers and tourists driving on the N4 and staying in guesthouses within a 10km radius;
- The local population and workforce driving on local roads and the N4;
- The residents and workforce of the outlying farms in a 10km radius; and
- Visitors to, and employees of, the Hadeco Nursery.

The most important views onto the site identified during the site visit are the following:

- From the N4 along the 3.5 km boundary closest to the road reserve and train commuters;
- The view from the homes of the residents on the southern boundaries of the towns of eMakhazeni (Belfast) and Siyathuthuka;
- The views from residential properties, homesteads and guesthouses in a 10km radius;
- The views from local roads; and

- Users of outdoor recreational or sport facilities including the Belfast Dam and various other tourist destinations, especially those whose intent it may be to admire the natural beauty of the area.

Views from residences and tourist facilities/routes such as the Highlands Meander route are typically more sensitive, since views from these are considered to be frequent and of long duration.

Table 63: Potential Sensitivity of Visual Receptors

High	Moderate	Low
The residents of the town of eMakhazeni (Belfast) and Siyathuthuka where the development results in changes in the landscape setting or valued views enjoyed by the community; Visitors of Tourist facilities/destinations travelling along local and national routes, whose intention or interest may be focused on the landscape; Occupiers of residential properties with views affected by the development.	People engaged in outdoor sport or recreation (other than appreciation of the landscape, as in landscapes of acknowledged importance or value); People travelling through or past the affected landscape in cars, on trains or other transport routes without the intention or interest focused on the landscape	Visitors and people working in mining / prospecting activities and travelling along local mining roads whose attention may be focused on their work or activity and who therefore may be potentially less susceptible to changes in the view.

3.3.11.6 Sensitive Landscapes

The sensitivity of a landscape or visual resource is the degree to which a particular landscape type or area can accommodate change arising from a particular development without detrimental effects on its character. Its determination is based upon an evaluation of each key element or characteristic of the landscape likely to be affected. The evaluation will reflect such factors such as its quality, value, contribution to landscape character, and the degree to which the particular element or characteristic can be replaced or substituted (Institute of Environmental Assessment & The Landscape Institute, 1996:87).

3.4 BUILT ENVIRONMENT

3.4.1 BLASTING AND VIBRATION

3.4.1.1 Blasting Methods

Blast designs current applied by the contractor employed by Exxaro and used for drilling and blasting is summarised in Table 64. Exxaro will utilise the same contractor and configurations present at Glisa Coal Mine for the proposed Paardeplaats Coal Mine. Three basic configurations are to be used: coal, interburden and overburden blasts.

Table 64: Information on blast designs used

Technical Aspect	Bench Coal	Interburden	Overburden
B/H Diameter (mm)	141	127	171
Explosive Density (g/cm3)	1.15	1.15	1.15
Burden (m)	5	5	5
Spacing (m)	5	5	7
Bench Height (m)	3.3	3.42	22.6
Min Depth (m)	3.3	3.42	22.6
Average Depth (m)	3.3	3.42	22.6
Linear Charge Mass (kg)	17.96	14.57	26.41
P/F Blasthole (kg/m3)	0.26	0.28	0.64
Stemming Length (m)(30BHDia)	2.12	1.79	3.33
Column Length (incl. Subdrill.)	1.2	1.63	19.3
Explosives Per B/H (incl. Subdrill+airgap) (kg)	21	24	509
Include SubDrill (Yes/No)	No	No	No

3.4.1.2 Sensitive Receptors

The possible effects that will be considered to contribute toward potential to damage of structures/installations or features in the area cannot be determined at this stage. The specific areas to be drilled and blasted will be required to determine extent of impact. The expected drilling and blasting operations to be done will be considered to determine possible impacts with regards to structure damage and considering human perceptions of ground vibration and air blast. Humans are sensitive to even very low level effects of ground vibration and air blast. In order to take this into consideration an area of 3500m is identified as an area that could observe influence. This is in view that people will experience ground vibration at levels as low as 0.75mm/s.

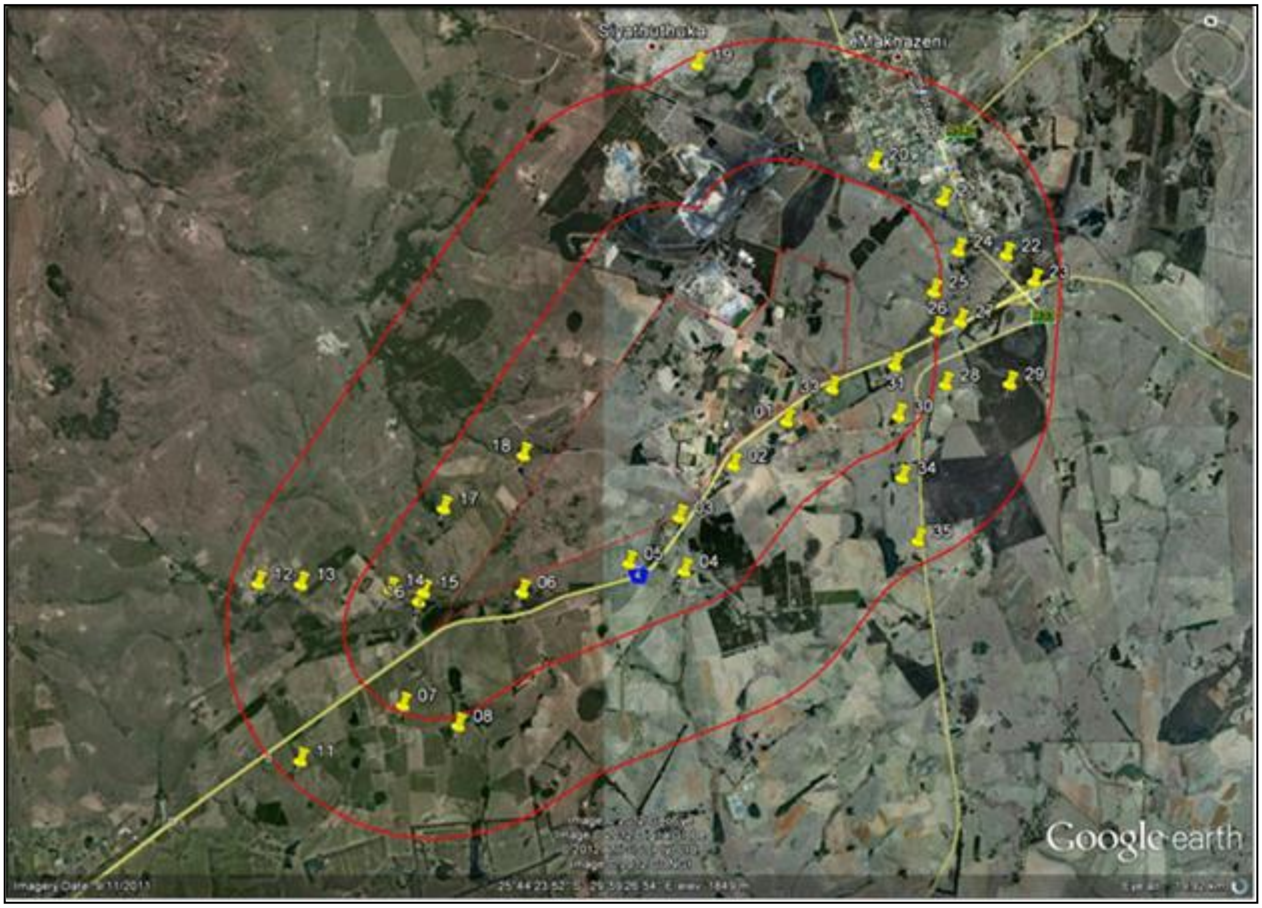


Figure 52: Potential blasting zone of influence

3.4.2 TRAFFIC

The weekday AM and PM peak hours have been selected as the critical peak period for this assessment. This is the time when background traffic will be at its highest levels.

For a mine it is likely that they will operate a shift pattern and that the changeover period will occur outside of the peak hours, but this has not been confirmed by Exxaro. Although the mine will operate a shift system vehicles will still arrive and depart during the peak hour so these hours will be assessed as the background traffic on the road network will be at its highest. For the proposed Paardeplaats Coal mining development it is anticipated that the critical peaks occur during the weekday morning peak and afternoon peak hour.

The traffic counts that were undertaken for this study, and as discussed in Section 3.4.2.3 below, were used to determine the times when the background traffic is at its peak. The AM peak hour was between 06:45 and 07:45 and the PM peak was between 16:30 and 17:30.

To determine the road improvements if any, which are necessary to accommodate the new development traffic, the following scenarios were analysed:

- Scenario 1 – 2022 background traffic no development
- Scenario 2 – 2022 with the Glisa Coa Mine traffic included; and
- Scenario 3 – 2022 with the Glisa Coal Mine and Paardeplaats, therefore total development.

3.4.2.1 Existing Road Network

Figure 53 below shows the N4 at the entrance to the Paardeplaats study area. The N4 is a north-south undivided two lane national road. The N4 is a major corridor between Pretoria and the Komatipoort border post.

Figure 53: N4 at the Intersection with Sunbury

Figure 54 shows the gravel road running through the Paardeplaats site. The Paardeplaats Road is an east-west gravel road and links with the N4 west of the site.

Figure 54: Paardeplaats Road Looking North towards Belfast

Figure 55 below shows the Spitskop Road. Spitskop Road is an east-west undivided two lane rural road and links with Vermooten Street (R33) at Belfast, east of the site.

Figure 55: Spitskop Road

3.4.2.2 Existing Traffic Operations

The existing traffic volumes on the surrounding road network were determined from traffic counts that were carried out over a three hour period on the 22 February 2012 during the AM and PM peak hours at the following intersections in the vicinity of the site:

- Vermooten Street (R33) / Spitskop Road;
- Spitskop Road / Van Kraayenburg Street; and
- Spitskop Road / Site Access.

Only peak hour counts were undertaken as this is generally deemed acceptable by local municipalities in order to provide a picture with regards to traffic flows at particular intersections. It is always stated with commissioning surveys that any incidences that occur during the survey are recorded so that the effect of these can be considered when reviewing the surveys.

The main route to the site is Spitkskop Road and the results from the traffic counts can be summarised as follows:

- During the AM peak hour approximately 114 vehicles are travelling on the road to the east and 70 to the west of the site;
- Of the 114 vehicles to the east, 40% are heavy vehicles and this decreases to 18% west of the site;
- During the PM peak hour approximately 78 vehicles are travelling to the east of the site and 41 vehicles to the west; and
- Approximately 41% are heavy vehicles.

The major road in the area is Vermooten Street (R33) and traffic flows on this road can be summarised as follows:

- Approximately 400 vehicles travel on this road during the AM peak hour in both directions with the flow evenly split between northbound and southbound traffic;
- In the PM peak hour approximately 530 vehicles travel in both directions with the heaviest flow being northbound.

The N4 Road carries approximately 1,060 vph during the AM peak hour in both directions of which the majority is eastbound. During the afternoon peak, the N4 Road carries approximately 1,020 vph in both directions. The peak direction in the afternoon is in a westerly direction.

3.4.2.3 Future Traffic Volumes

The Manual for Traffic Impact Studies (Department of Transport, 1995) suggests a five year design horizon is used i.e. 2017. But, at this point the mine will not be fully operational so the decision has been made to use 2022 as the design horizon. The predicted future (2022) traffic flows have been determined by using the growth method. The growth method is the simplest form of increasing the traffic between the base year, the year in which the traffic counts were undertaken, and the assessment year. The growth method assumes that the current traffic growth rate will continue on a year by year basis until the assessment year.

There are two main reasons for traffic growth to occur. The first is economic prosperity and an increase in car ownership. The second is that between the time the assessment is carried out and the opening of the development a number of developments may have been constructed in the area that would generate and attract additional vehicles.

A growth rate of 2% per annum has been applied to the existing traffic volumes over a 10 year period.

Due to the close proximity of the Glisa Coal Mine the decision has been taken to include the additional traffic generated by this mine into consideration when assessing the potential impact of the Paardeplaats Coal Mine. The guidance for traffic impact studies suggest a five year design horizon is used i.e. 2017. But, at this point the mine will not be fully operational so the decision has been made to use 2022 as the design horizon. The predicted future (2022) traffic flows have been determined by using the growth method. A growth rate of 2% per annum has been applied to the existing traffic volumes over a 10 year period.

4 DETAILED PROJECT DESCRIPTION

4.1 MINING OPERATIONS

4.1.1 ACTIVITY DESCRIPTION

The proposed Paardeplaats Coal Mine is essentially an extension of the existing Glisa NBC Coal Mine. As an extension of Glisa Coal Mine, all mineral processing and waste disposal will be undertaken at Glisa Coal Mine. Paardeplaats will be an opencast mining operation targeting a RoM production rate of between 4.2 – 4.4 mtpa from an availbale reserve of approximatelt 76.65 million tonnes, equating to a life of mine of approximately 20 years.

All RoM for the Paardeplaats project will be transported to the Glisa Coal Mine beneficiation plant at a rate of 4.2 – 4.4 mtpa. The mining method will be a hybrid between roll-over mining as well as bench/box cut mining. The roll-over mining will be used where only one seam is present, as well as where the overburden has a thickness less than 20m. The bench mining will be used where two or more seams are present and where the overburden has a thickness of more than 20m. This hybrid mining method will allow for the extraction of coal from both shallow and deeper seams. The proposed Paardeplaats Coal mining and surface infrastructure is limited due to all mineral processing occurring on the adjacent Exxaro owned and operated Glisa Coal Mine. As such the mining and surface infrastructure on approval of the Paardeplaats project will consist of the following:

- Mining Activities (opencast pits);
- Pollution control and return water dams;
- Storm water management including clean and dirty water separation systems;
- Access and haul roads;
- Pipelines;
- RoM Stockpiles;
- Diesel storage;
- Mobile office and ablution block; and
- Temporary general waste storage area.

4.1.2 OPENCAST MINE DESIGN AND MINE SCHEDULE

The proposed mining method for the Paardeplaats Coal Mine will be a hybrid between roll-over mining as well as bench mining. The roll-over mining will be used where only one seam is present as well as where the overburden has a thickness less than 20m. The bench mining will be used where two or more seams are present and where the overburden has a thickness of more than 20m.

The stripping operation removes the topsoil and exposes the overburden of the next cut. The continuity of this process is essential in order to ensure that sufficient workroom is maintained. The initial topsoil will be hauled to a designated area and be used for rehabilitation later on. Topsoil, subsoil, and wetland soil will be stockpiled separately. No mixing of stockpiled soils will occur. When steady state is reached, topsoil is replaced in a continuous operation. The overburden will be drilled and blasted. The operation will be done in two phases. The top portion will be loaded and hauled; the lower portion will be done via a dozing process. This will ensure that the rehabilitation is adequately addressed by means of a backfilling process. Once the overburden has been removed, the coal (RoM) is transferred to the plant by means of a load and hauls operation.

The accompanying figures, numbered 1 to 12 are a schematic representation of the mining process after the first 4 cuts, at which a steady state will be reached.

The following generic actions are involved in the operation and are classified sequentially as follows:

a) Strip topsoil, subsoil, and wetland soils;

b) Separate stockpiling of topsoil, subsoil, and wetland soils;

c) Drill and blast overburden;

d) Load and Haul the top off;

e) Doze the roll over;

f) Clean the top of the coal;

g) Dig trench to prevent contamination;

h) Drill and blast coal;

i) Load and haul coal; and

j) Start with next cut.

The schematic layout below (Figures 55 – 58) describes the mining method in more detail and depicts the following:

1. A section through the general straitgraphic sequence. The mining direction is from left to right;
2. The box cut is now excavated after removal of the topsoil and subsoil;
3. Coal is removed from the box cut, subsoil from cut 2 and topsoil from cut 3;
4. The overburden from cut 2 is blasted;
5. The top most part of the overburden is hauled to a stockpile as there is not enough pit room availbale;
6. The bottom part is dozed over and the coal face cleaned;
7. Coal is removed from cut 2 and subsoil from cut 3;
8. Cut 3 overburden is blasted;
9. The top part of blasted overburden is hauled and placed at the beginning of the low wall;
10. The bottom part of cut 3 is dozed over and the coal face cleaned;
11. Coal is removed from cut 3 and subsoil from cut 4; and
12. Overburden from cut 4 is blasted. The pit is now in a ready state and no more material is stockpiled as it can be accomdated in the pit. Rehabilitation can now logically follow as soon as the subsoil gets stripped in the front and replaced in the back. The same is true for the topsoil which gets placed over the subsoil in a continuous process. Wetland soil will be replaced in the original location in the correct sequence.

Mining Method

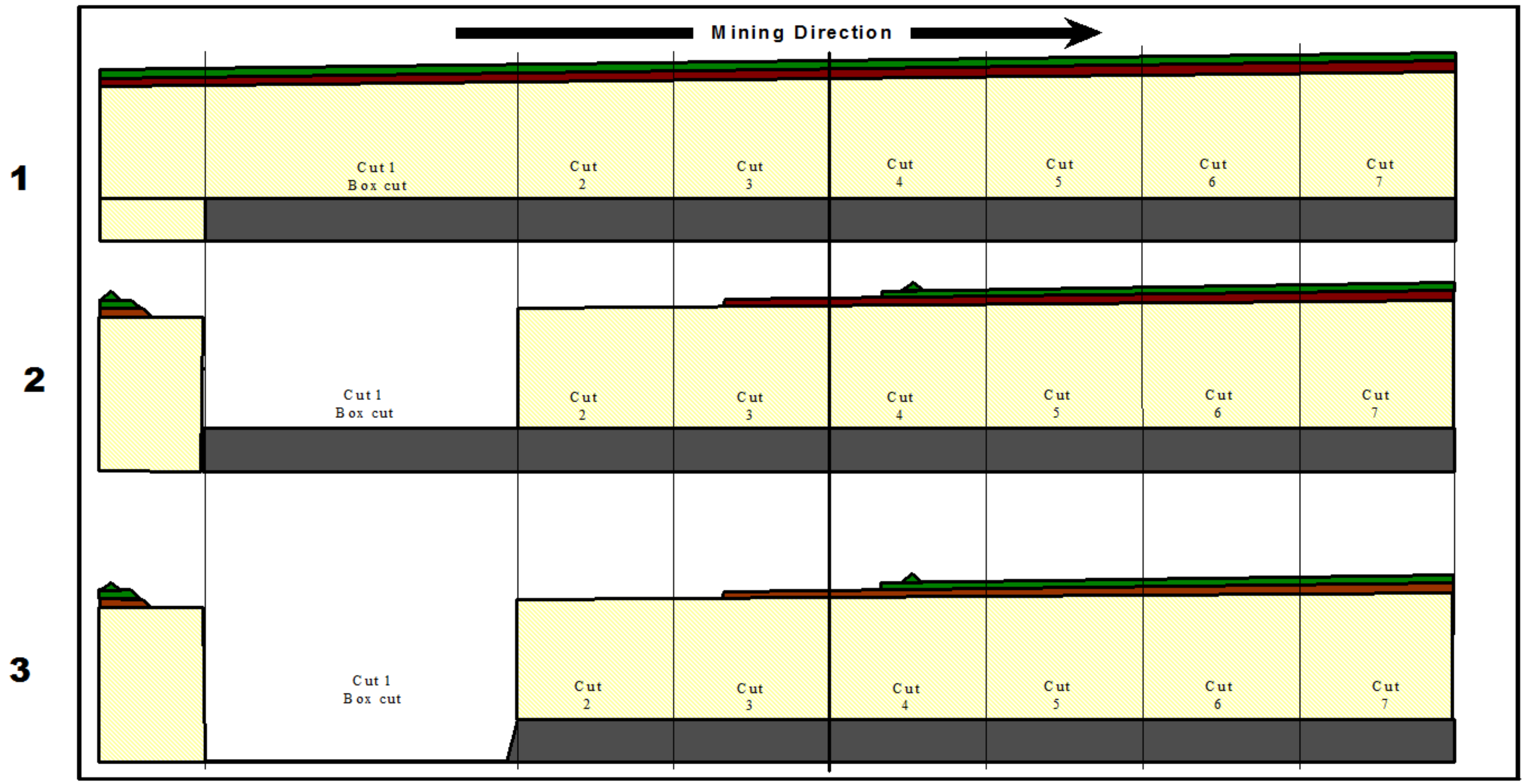


Figure 56: Mining method – Steps 1-3

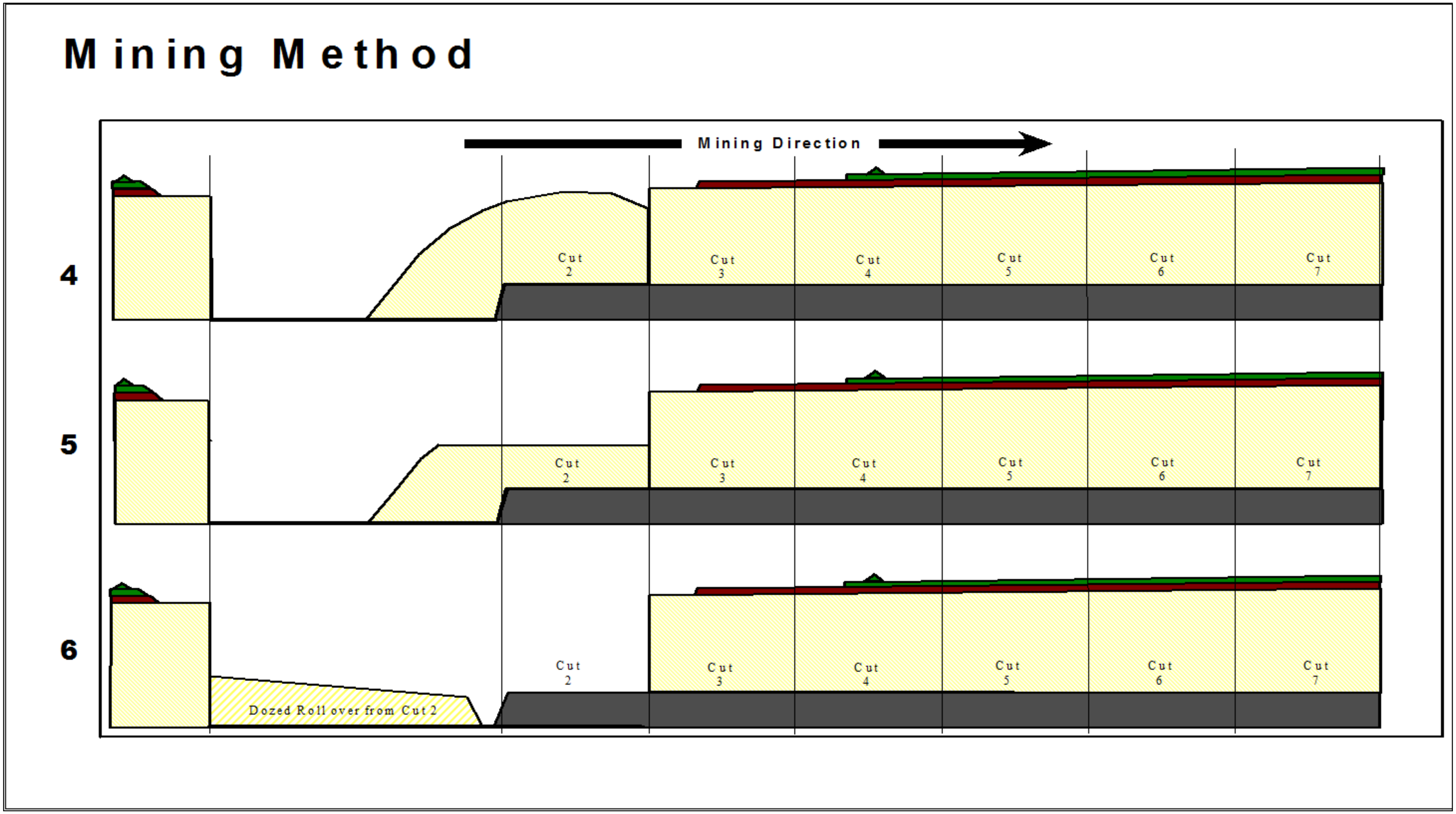


Figure 57: Mining method – Steps 4-6

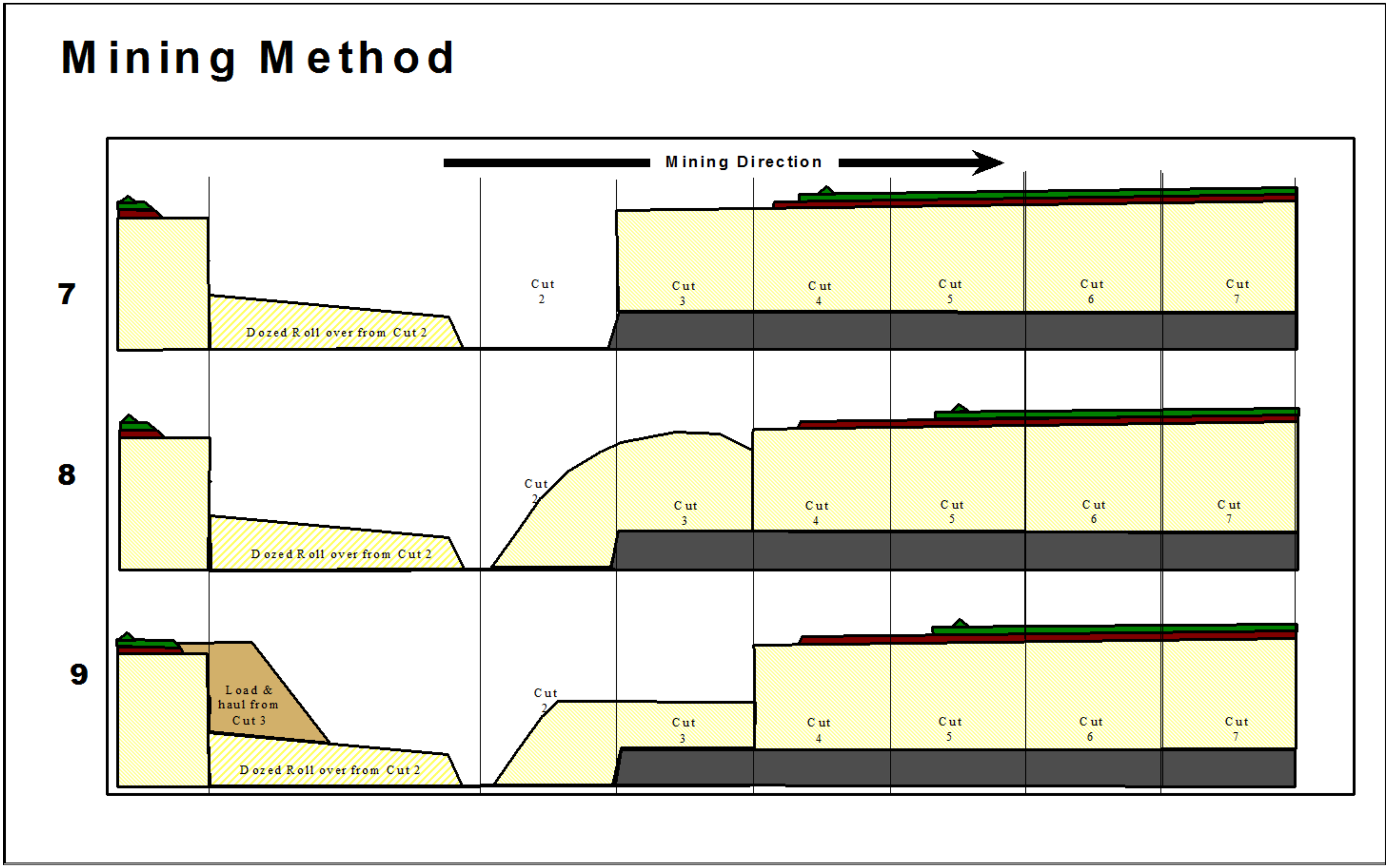


Figure 58: Mining method – Steps 7-9

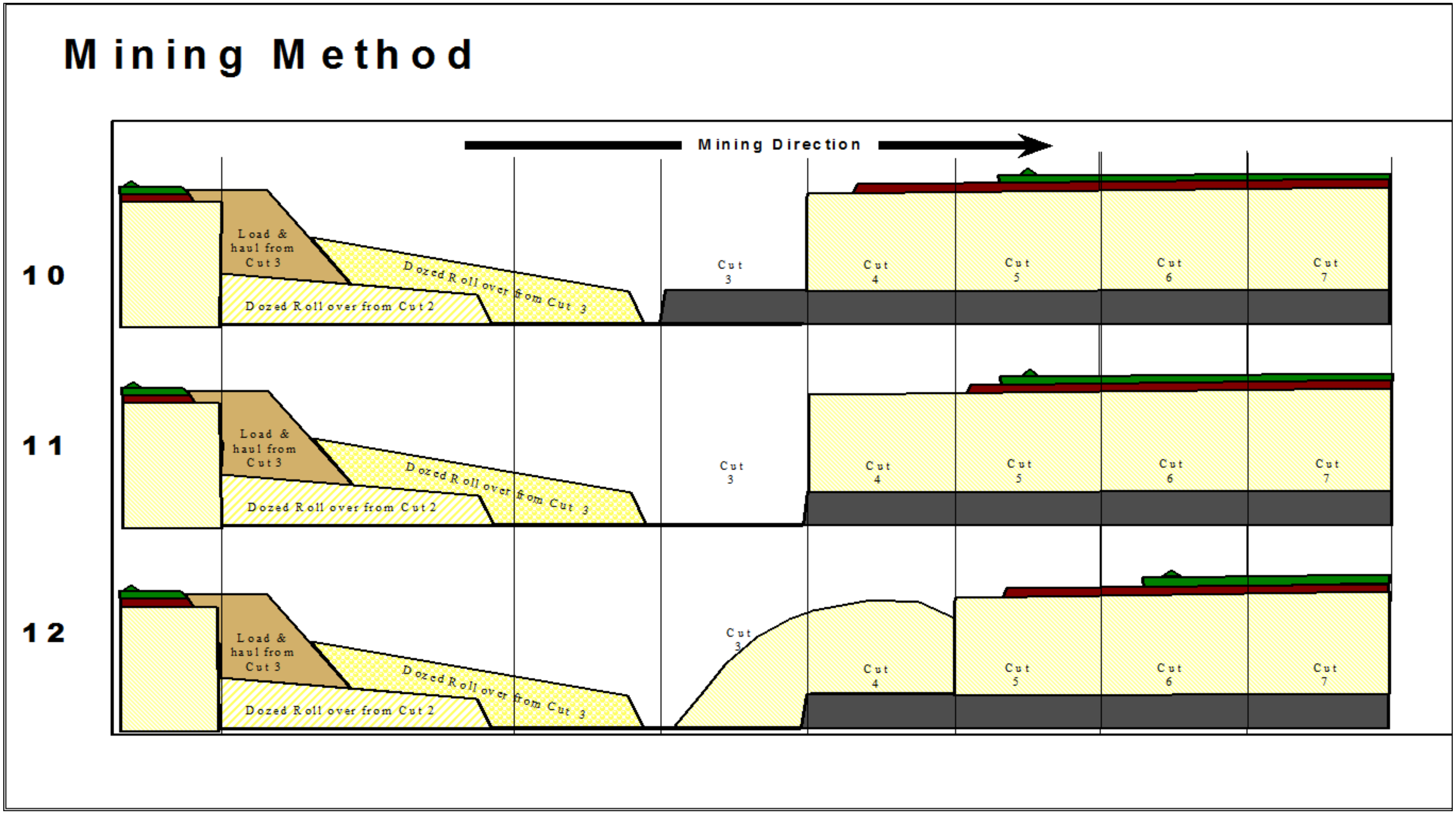


Figure 59: Mining Method – Steps 10-12

4.2 COAL PROCESSING

4.2.1 PROCESS DESCRIPTION

All RoM processing will take place at Glisa Coal Mine. A flow diagram of the existing Glisa Coal Mine plant is represented below and will be utilised by the proposed Paardeplaats Coal Mine.

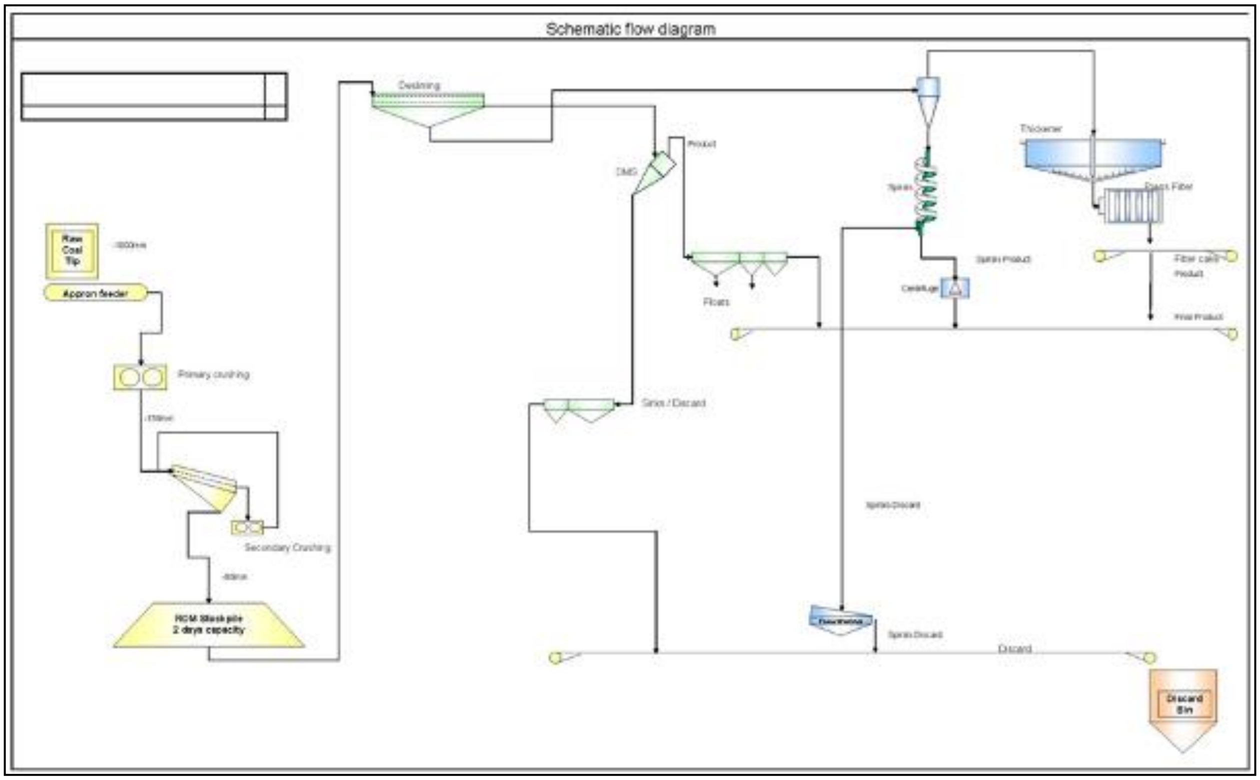


Figure 60: Flow diagram showing existing glisa plant

The plant will consist of the following systems:

- ROM Crushing and Screening system;
- DMS section;
- Fines Treatment System;
- Thickening;
- Filtration;
- Products and Discard Handling and Load-Out Systems; and
- Services (Water, Air, Flocculent and Magnetite).

The plant will be designed to treat 5 million tons per annum (t/yr) of ROM material. The ROM material at a top size of 1200mm will be received from the mining operation. The coal will be crushed to -50mm through a crushing and screening section. This material will then be fed to the washing plant for beneficiation. The material will be processed in the DMS in order to produce a product. The fines (-1mm) will be processed in the fines plant. The slimes (approximately – 200 microns) will be thickened and then sent to the filter plant where the filter cake will be produced. The waste from the plant will be discarded.

4.3 SURFACE INFRASTRUCTURE

4.3.1 DESIGN PHILOSOPHIES

4.3.1.1 Environmental Consideration

The proposed Paardeplaats Coal Mine is located in a relatively sensitive environmental area and due consideration will be given to the placement, location and orientation of mine required infrastructure. The following factors will be considered during the EIA investigation:

- Energy efficiency;
- Prevailing environmental conditions and site sensitivities; and
- Water recycling and re-use.

4.3.2 ON-SITE INFRASTRUCTURE

The following on site infrastructure is required for the proposed Paardeplaats Coal Mine:

- Pollution control and return water dams;
- Topsoil, subsoil, and wetland soil stockpiles;
- Overburden stockpiles;
- Storm water management including clean and dirty water separation systems;
- Access and haul roads;
- Pipelines;
- RoM Stockpiles;
- Diesel storage;
- Mobile office and ablution block; and
- Temporary general waste storage area.

4.4 BULK POWER SUPPLY

4.4.1 POWER SUPPLY

No electrical power supply is planned or required for the proposed Paardeplaats Coal Mine. All equipment and infrastructure required will instead be diesel powered.

4.5 WATER MANAGEMENT

4.5.1 BULK WATER REQUIREMENTS

The proposed Paardeplaats Coal Mine will require bulk water for its mining operations as well as domestic water for drinking and ablutions purposes. Bulk water is required for dust suppression and any other mining operations that may require large volumes of water. Possible water supply options will be identified and their suitability evaluated during the detailed EIA investigation.

A preliminary water balance will be designed for the proposed Paardeplaats Coal Mine to determine bulk water requirements during peak production and a mine safety factor (to be determined) will be applied to ensure adequate water supply to the mine.

4.5.2 WATER MANAGEMENT

Water is a valuable resource and a water management strategy will be developed during the EIA investigation.

4.5.2.1 Run-Off Water

The water management strategy will be designed to address the following significant issues at the proposed Paardeplaats Coal Mine:

- Water use and users with a focus on water concumption rates;
- Engineering design basis for the water reticulation and distribution systems required to provide water to the mining operation;
- Engineering design basis for clean water diversion system; and
- Engineering design basis for the dirty water collection and management systems, including flood protection.

4.5.2.2 Water Management Infrastructure

The following water management infrastructure is envisaged for the proposed Paardeplaats Coal Mine:

- Network of dirty water collection drains – concrete lined
  - Cut Off drains to collect water which came into contact with contaminants on site.
- Pollution Control Dams – HDPE lined
  - Collection dams to collect water which came into contact with contaminants on site.
- Newtork of water control berms
  - Berms to prevent off-site run-off water which came into contact with contaminants on site.
- Network of clean water collection drains – concrete lined
  - Cut Off drains to collect clean water and prevent contact with contaminated water.
- Pit dewatering dam – Zinc construction and HDPE lined
  - Dam to collect ground and rain water collected from the pit and pumped back into the Pollution Control Dam; and
- Dirty water channels
  - A network of concrete channels to contain water which came into contact with contaminants on site.

The detailed design requirements for water management infrastructure are currently underway and will be included in the detailed EIA investigation and report.

4.6 LOGISTICS

The proposed Paardeplaats Coal Mine intends to supply coal to Eskom and its nearby coal fired power stations. A detailed Traffic Impact Assessment (TIA) is underway and will be concluded during the EIA level investigation.

4.7 DISCARD AND WASTE MANAGEMENT

4.7.1 TOPSOIL STOCKPILES

Locations for topsoil berms and stockpiles will be identified and evaluated during the detailed EIA investigation. As a minimum requirements topsoil berms and stockpiles will be designed and located to as to reduce compaction and outside of natural drainage patterns to prevent erosion from both water and wind. Wetland soils will be identified and stockpiled sepereately during mining operations. Soil stockpiles will be designed and located in the same manner as topsoil.

4.7.2 NON-CARBONACEOUS STOCKPILES

All non-carboncaeous stockpiles will be placed in predetermined areas at Glisa Coal Mine.

4.7.3 CARBONACEOUS STOCKPILES AND DISCARD DUMPS

All carbonaceous stockpiles will be placed in predetermined areas at Glisa Coal Mine.

4.7.4 SLURRY

All slurry deposits will be placed in predetermined area at Glisa Coal Mine.

4.7.5 WASTE MANAGEMENT

The following types of waste will be generated by the proposed Paardeplats Coal Mine:

- Domestic waste;
- Scrap metal;
- Used oil, diesel and lubircants; and
- Building rubble.

The proposed Paardeplaats Coal Mine will utlise a temporary waste storage facility and all waste will be collected by an approved, registered waste contractor for removal and final disposal. No landfill will be established on the proposed Paardeplaats Coal Mine site.

4.7.6 WASTE MANAGEMENT DESIGN PROGRESS

The detailed design requirements for the temporary general waste storage area and waste management protocols are currelty underway and will be included in the detailed EIA investigation and report.

5 DESCRIPTION OF POTENTIAL IMPACTS ASSOCIATED WITH ACTIVITY

5.1 CULTURAL AND HERITAGE RESOURCES

5.1.1 PALAEONTOLOGICAL IMPACTS AND MITIGATION MEASURES

5.1.1.1 Impacts

The fossil coal floras of South Africa are of international interest, and represent an important part of our local heritage. Any loss of this heritage due to mining or construction activities is permanent, and should be regarded as a highly significant negative impact.

Alternatively, discovery of fossils during excavation, followed by effective mitigation in collaboration with a palaeontologist, would result in the curation of new and important fossil material – therefore the development could potentially have a positive, beneficial impact on South Africa's palaeontological heritage.

Table 65: Impact significance rating table*

Criteria		Status	Comments
Temporal Scale		Permanent	Destruction of a fossil represents loss of an irreplaceable heritage resource
Spatial Scale		study area	• physical effects limited to development footprint; • destruction of fossil heritage registers at the national or international level • depending on the type and quality of fossil destroyed
Frequency		ongoing, cumulative	The potential to impact negatively on fossil floras will remain as long as mining continues to expose and destroy fossiliferous strata
Severity	**without mitigation**	high; unpredictable	• destruction of well-preserved coal floras during construction and mining activities represents a high negative impact; • the occurrence of these floras is patchy,making the likelihood and extent of the impact difficult to define
	with mitigation	beneficial	Monitoring by a trained ECO and recording and collecting of fossil material by a professional palaeontologist could result in a high positive impact.
Likelihood		probable	Since these deposits are by definition coal-

		associated, there is a strong possibility of encountering well-preserved plant fossils
Confidence	high	Coal floras in the Vryheid Formation are known from other areas in this province.
Reversibility	irreversible	• destruction of fossil heritage is permanent; • destruction of rare fossil forms could mean a significant loss to our scientific knowledge base.
Significance	high negative	• mitigation measures are required to reduce high negative impact of fossil heritage destruction; • specialist intervention could make a significant contribution to the understanding of South Africa's coal floras.

* format and categories modified from Almond (2012)

Impact significance and duration	In palaeontological terms any destruction of fossils is a **permanent negative impact** and must be regarded as potentially a **high impact significance**. New taxa are fairly regularly encountered in plant fossil studies, and destruction of well-preserved, undescribed fossil beds could represent a heavy loss in terms of our understanding of historical biodiversity.	
Certainty	Definite	More than 90% sure of a particular fact. Substantial supportive data exist to verify the assessment.
	Probable	Over 70% sure of a particular fact, or of the likelihood of impact occurring.
	Possible	Only over 40% sure of a particular fact or of the likelihood of an impact occurring.
	Unsure	Less than 40% sure of a particular fact or likelihood of an impact occurring.

5.1.2 POTENTIAL FATAL FLAWS

Fatal flaws would constitute environmental characteristics which cannot or may not interact with the proposed development. From a heritage point of view, fatal flaws can be seen as a heritage resource/s present on the site that will halt the project and that cannot be mitigated due to site constraints such as limited space to implement buffer or no-go zones. In most case the implementation of buffer zones and extensive conservation management plans can change possible fatal flaws as noted in Table 66.

Table 66: Below indicates broad heritage resources that could constitute a fatal flaw on a development site where buffer zones and exclusion zones are impossible to implement

Heritage Resource	Example
Rock Art	Rock Art, paintings or engravings situated within a development area – Seen as immovable resources and can only be moved under

	exceptional circumstances.
National or Provincial Heritage Sites	Site specific monuments like battles or major sites or structures with considerable significance.
Sacred Sites	Immovable sites associated with religion or cultural groupings, such as sacred pools, historic initiation school sites, etc.
Archaeological sites of National Significance	Sites such as Mapungubwe Hill or an archaeological landscape such as the Limpopo Valley or The Cradle of Humankind.
Cultural Landscapes of significance	Landscapes such as valleys and vistas held as being of national or international importance.

5.1.3 IDENTIFIED POTENTIAL IMPACTS

The desktop evaluation of the study area and surrounds has shown that the possibility exists of finding various heritage resources in the proposed study area. This includes archaeological sites or material, historical structures and graves or cemeteries. This desktop evaluation however, does not exclude the need for proper field verification and survey which will be undertaken during the EIA phase of the project.

- Within the study area, the main heritage sites identified at the desk top level are various built structures, some of which are likely to be of historical date. However, the significance of these built structures can only be assessed at the ground verification stage. A heritage architect would probably need to be appointed to provide specialist input on these structures. It is also important to note that the presence of historical structures is often associated with individual graves or cemeteries. The possible presence of graves can only be verified at the ground verification stage.
- The various kraals, ruins and built structures, which may be archaeological and/or historical sites, and which have been identified at the desktop level as occurring outside the immediate study area will probably not be directly impacted by the proposed development and therefore, would probably not require further specialist investigation.

5.1.3.1 Impact on Archaeological Sites

- As seen from the archival work and discussion, the possibility of archaeological finds has been identified and thus further fieldwork is required to develop a comprehensive Heritage Management Plan for the construction activities;
- No existing impacts are known; and
- Predicted Impact during construction of haul roads, pipelines or pollution control dams:

    - Unidentified archaeological sites can seriously hamper construction and development activities and timelines. Destruction or damage of such sites requires a permit from the responsible heritage authority (NHRA, section 35); and
    - Fieldwork can provide valuable information on such sites in the study area and provide timeous management of such sites through various mitigation measures, including the realignment of the construction activities, if necessary.

5.1.3.2 Impact on Historical Sites

- As seen from the archival work and discussion, the possible presence of historical structures has been identified as being high and thus fieldwork is required to develop a comprehensive Heritage Management Plan for the development;
- No existing impacts are known;
- Predicted Impacts:
    - During construction of haul roads, pipelines or pollution control dams;
        - Destruction or damage during construction of haul roads, pipelines or pollution control dams;
    - During the mining operations in most cases as direct result of blasting. This type of impact on historical structures can extend beyond the mining boundary;
        - Damage/destruction by blasting (vibration) and other mining activities e.g. bench box cut mining (direct impacts), on historical structures. Destruction or damage of such sites requires a permit from the responsible heritage authority (NHRA, section 34).

5.1.3.3 Impact on graves and cemeteries sites

- The existence of graves and cemeteries has not been verified during the archival research. It has however, been found that such sites are rarely noted in maps and documents and can only be identified during field work;
- No existing impacts are known;
- Predicted Impacts:
    - Destruction or damage during construction of haul roads, pipelines or pollution control dams and during the operational phase of the mine, the mining direction and subsequent box cutting and earth works can possibly impact on graveyards and cemeteries in the way of the mining activities.

- Unidentified graves and cemeteries and the discovery of such sites can seriously hamper construction and development timelines. Damage, destruction or removal of such sites requires a permit from various responsible authorities, including the Heritage Authority (NHRA, section 36), Provincial Health Department and the SA Police Service. Such a process can take up to 12 months to finalise;
- Fieldwork can provide valuable information on the presence of such sites in the study area and provide timeous management of such sites, which may include the realignment of the proposed development activities;
- In the event that identified graves and cemeteries cannot be avoided, a grave relocation process needs to be initiated, bearing in mind that such a process impacts on the spiritual and social fabric of the next of kin; and
- Archaeological field survey of selected areas will identify possible impacted sites.

5.1.3.4 Impact on palaeontological resources

- The existence of palaeontological will be addressed during the HIA phase through a desktop study completed by a palaeontologist;
- No existing impacts are known;
- Predicted Impacts:
    - Destruction or damage during construction of haul roads, pipelines or pollution control dams and during the operational phase of the mine, the mining direction and subsequent box cutting and earth works can possibly impact on palaeontological resources.
        - Unidentified palaeontological resources and the discovery of such resources can seriously hamper construction and development timelines. Damage, destruction or removal of such sites requires a permit from the responsible heritage authority (NHRA, section 35);
        - The desktop assessment would provide valuable information on the study area and provide timeous management of identified resources, which may include the realignment of the proposed construction footprints; and
        - In the event that such resources cannot be avoided, the necessary mitigation measures, that could include initial sampling, followed-up with the excavation and collection of representative specimens. This can however only be done with a permit issued by SAHRA under Section 35 of the NHRA.

5.1.4 IDENTIFICATION OF AREAS FOR FURTHER SPECIFIC FIELD WORK STUDY

As noted in sections 3.1.2.3 and 3.1.2.4 various structures and areas have been identified within the study area from the map and aerial photographic analysis. The structures and sites will be evaluated during the field verification stage and incorporated into the HIA during the detailed EIA investigation.

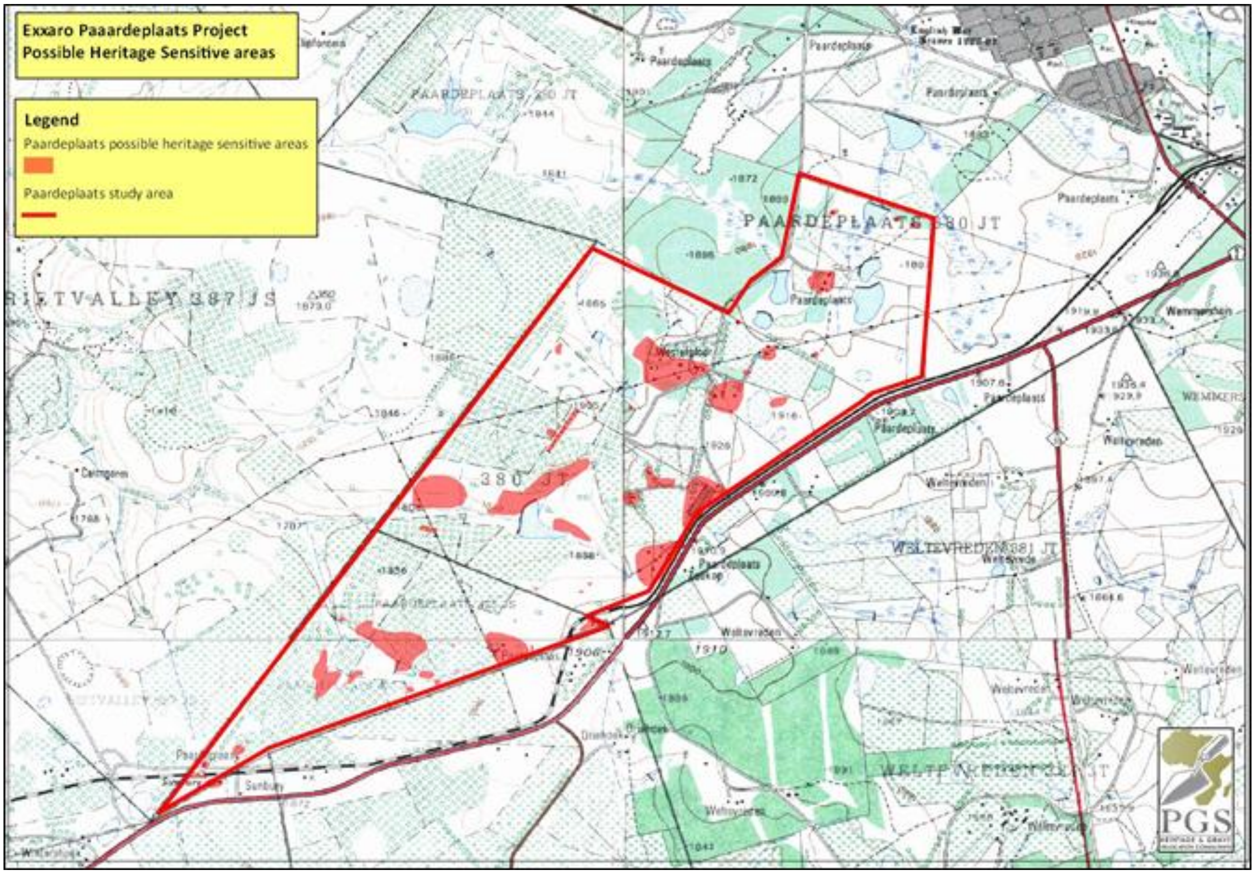


Figure 61: Heritage sensitivity map

5.2 SOCIO-ECONOMIC ENVIRONMENT

Sources of social impacts are often not as clear-cut as those in the biophysical environment. Social impacts are not site-specific, but occur in the communities surrounding the proposed site – where the people are. The following is a list of some of the possible impacts that may occur as a result of the project. It must be stated that the list is not exhaustive and should be expanded on in the EIA phase when consultation with stakeholders will take place. Mitigation measures are context specific and the mitigation measures in this report should be viewed as guidelines and may change once consultation with stakeholders took place. These impacts should be investigated further in the Environmental Impact Assessment phase of the project.

5.2.1 PRE-CONSTRUCTION PHASE

- Possible Impacts:
    - **Expectations** regarding social and economic benefits; and
    - **Expectations** regarding creation of opportunities (Jobs etc.)

5.2.2 CONSTRUCTION PHASE

- Possible impacts:
    - Impacts of **traffic** on people – dust, noise, safety – from a social and nuisance perspective;
    - **Safety** of community – possible increase in crime due to increased number of strangers in community;
    - Negative **community relations** due to conduct of contractors / representatives from mine;
    - Impacts of **construction camp** – HIV/AIDS, movement of people etc. (This impact would only occur if there is a construction camp);
    - **Influx of people** – also possible social disintegration and cultural differentiation;
    - **Creation of jobs** and other economic opportunities;
    - For some stakeholders their **sense of place** may change; and
    - **Visual** – the landscape will look different.

5.2.3 OPERATIONS PHASE

- Possible impacts:
    - Impacts of **traffic** on people – dust, noise, safety – from a social and nuisance perspective;
    - **Noise and vibrations** resulting from blasting may damage surrounding properties;
    - Concerns that **quality** and **quanitity** of underground **water** impacted on by mine will affect livelihoods (Especially since water is a scarce commodity in the area);
    - Negative **community relations** due to conduct of contractors / representatives from mine;
    - **Creation of jobs** and other economic opportunities;
    - Additional **social infrastructure;**

    - For some stakeholders the **sense of place** will change;
    - **Visual** – the landscape will look different; and
    - Historical grievances with Glisa Coal Mine.

5.2.4 ECONOMIC IMPACTS

- Possible impacts:
    - Construction Impacts;
    - GDP and Income;
    - Supply Chain;
    - Labour;
    - Government Income; and
    - Tourism, Recreation and Heritage.

5.3 BIOPHYSICAL ENVIRONMENT

5.3.1 AIR QUALITY

Although there are a number of ambient air pollutants in the vicinity of the proposed Paardeplaats Project, the pollutants of concern due to the mining activities will consist of particulate matter.

5.3.1.1 Identification of Possible Environmental Impacts

The proposed operations at the Paardeplaats Project will comprise opencast mining operation, road transportation and materials handling. Atmospheric emissions represent the environmental aspects of concern for the baseline assessment of the proposed Paardeplaats Project. The sources of these emissions were determined by first identifying the inputs and outputs to the various processes and secondly considering the disturbance to the environment by the proposed operations. All aspects associated with the proposed operations of relevance in terms of air quality impacts are listed in Table 67. Particulates present the main pollutant of concern from mining operations. Fugitive dust from materials handling operations, wind erosion, crushing and screening and vehicle entrainment on paved and unpaved roads are classified as routine emissions and are fairly constant throughout the year.

Table 67: Possible activities and aspects identified due to proposed operations at Paardeplaats Project

Operational phase		
Aspects	**Source**	**Activities**
Vehicle Entrainment		
Increase in gaseous and particulate emissions (including VOCs)	Vehicle activity on paved and unpaved roads	Transportation of ore from open pit to processing plant
Mining operations		
Increase in fugitive dust emissions	Mining operations within open pit and underground; Vehicle activity on paved and unpaved roads; Materials handling operations; Wind erosion	Topsoil removal Drilling and blasting of overburden and ore Overburden removal by truck and shovel Ore removal by truck and shovel Tipping of ore onto storage piles Loading of ore at storage piles and tipping at crusher plant Crushing of the ore material Windblown dust from topsoil storage piles Windblown dust from ore storage piles Windblown dust from crushed ore storage piles Windblown dust from leach residue
Increase in fallout dust	Mining activities; Traffic	
Possible PM_{10} molecule generation	Materials handling operations	
Health concerns for sensitive receptors	Mining activities	

5.3.1.1.1 Effect of Dust on Vegetation, Animals and Susceptible Human Receptors

5.3.1.1.1.1 Effects of particular matter on vegetation

Suspended particulate matter can produce a wide variety of effects on the physiology of vegetation that in many cases depend on the chemical composition of the particle. Heavy metals and other toxic particles have been shown to cause damage and death of some species as a result of both the phytotoxicity and the abrasive action during turbulent deposition (Harmens *et. al.*, 2005). Heavy particle loads can also result in reduced light transmission to the chloroplasts and the occlusion of stomata (Ricks and Williams, 1974, Hirano *et. al*., 1995; Naidoo and Chirkoot; 2004; Harmens *et. al*., 2005), decreasing the efficiency of gaseous exchange (Ernst, 1981; Naidoo and Chirkoot, 2004; Harmens *et. al*., 2005) and hence water loss (Harmens et al., 2005). Disruption of other physiological processes such as budbreak, pollination and light absorption/reflectance may also result under heavy particulate loads (Harmens *et. al*., 2005). The chemical composition of the dust particles can also affect exposed plant tissue and have indirect effects on the soil pH (Spencer, 2001).

To determine the impact of dust deposition on vegetation, two factors are of importance:

- Does dust accumulate on vegetation surfaces and if it does, what are the factors influencing the rate of deposition; and
- Once the dust has been deposited, what is the impact of the dust on the vegetation?

Regarding the first question, there is adequate evidence that dust does accumulate on all types of vegetation. Any type of vegetation causes a change in the local wind fields, increasing turbulence and enhancing the collection efficiency. Vegetation structure alters the rate of dust deposition such that the larger the “collecting elements” (branches and leaves), the lower the impaction efficiency per element. Therefore, for the same volume of tree/shrub canopy, finer leaves will have better collection efficiencies. However, the roughness of the leaves themselves, in particularly the presence of hairs on the leaves and stems, plays a significant role, with venous surfaces increasing deposition of 1-5 µm particles by up to seven-times compared to smooth surfaces. Collection efficiency rises rapidly with particle size; wind tunnel studies show a relationship of deposition velocity on the fourth power of particle size for moderate wind speeds (Tiwary and Colls, 2010). In wind tunnel studies also show that windbreaks or “shelter belts” of three rows of trees has shown a decrease of between 35 and 56% of the downwind mass transport of inorganic particles.

After deposition onto vegetation, the effect of particulate matter depends on the composition of the dust. South African ambient standards are set in terms of PM_{10} (particulate matter smaller than 10 µm aerodynamic diameter) but internationally it is recognised that there are major differences in the chemical composition of the fine PM (the fraction between 0 and 2.5 µm in aerodynamic diameter) and coarse PM (the fraction between 2.5 µm and 10 µm in aerodynamic diameter). The former is often the result of chemical reactions in the atmosphere and may have a high proportion of black carbon, sulphate and nitrate; whereas the latter often consists of primary particles as a result of abrasion, crushing, soil disturbances and wind erosion (Grantz *et. al*., 2003). Sulphate is however often hygroscopic and may exist in significant fractions in coarse PM. This has been shown at the Elandsfontein, Eskom air quality monitoring station where the PM_{10} has been shown to vary between 15% (winter) and 49% (spring) sulphate (Alade, 2010). Grantz *et. al*. (op. cit.) however indicate that sulphate is much less phototoxic than gaseous sulphur dioxide and that “it is unusual for injurious levels of particular sulphate to be deposited upon vegetation”.

Naidoo and Chirkoot (2004) conducted a study to investigate the effects of coal dust on mangrove trees at two sites in the Richards Bay harbour. Mature fully-exposed sun leaves of 10 trees (*Avicennia marina*) were tagged as being covered or uncovered with coal dust and photosynthetic rates were measured. It was concluded that coal dust significantly reduced photosynthesis of upper and lower leaf surfaces and reduction in growth and productivity was expected. In addition, trees in close proximity to the coal stockpiles were in poorer health than those further away. Coal dust particles, which are composed predominantly of carbon, were not toxic to the leaves; neither did they occlude stomata as they were larger than fully open stomatal apertures (Naidoo and Chirkoot, 2004).

According to the Canadian Environmental Protection Agency (CEPA), generally air pollution adversely affects plants in one of two ways. Either the quantity of output or yield is reduced or the quality of the product is lowered. The former (invisible) injury results from pollutant impacts on plant physiological or biochemical processes and can lead to significant loss of growth or yield in nutritional quality (e.g. protein content). The latter (visible) may take the form of discolouration of the leaf surface caused by internal cellular damage. Such injury can reduce the market value of agricultural crops for which visual appearance is important (e.g. lettuce and spinach). Visible injury tends to be associated with acute exposures at high pollutant concentrations whilst invisible injury is generally a consequence of chronic exposures to moderately elevated pollutant concentrations. However given the limited information available, specifically the lack of quantitative dose-effect information, it is not possible to define a reference level for vegetation and particulate matter (CEPA, 1998).

Exposure to a given concentration of airborne PM may therefore lead to widely differing phytotoxic responses, depending on the mix of the deposited particles. The majority of documented toxic effects indicate responses to the chemical composition of the particles. Direct effects have most often been observed around heavily industrialised point sources, but even there, effects are often associated with the chemistry of the particulate rather than with the mass of particulate.

A review of European studies has shown the potential for reduced growth and photosynthetic activity in sunflower and cotton plants exposed to dust fall rates greater than 400 mg m^{-2} day^{-1}. Little direct evidence of the effects of dust-fall on South African vegetation, including crops, exists.

5.3.1.1.1.2 Effects of particulate matter on animals

As presented by the Canadian Environmental Protection Agency (CEPA, 1998) studies using experimental animals have not provided convincing evidence of particle toxicity at ambient levels. Acute exposures (4-6 hour single exposures) of laboratory animals to a variety of types of particles, almost always at concentrations well above those occurring in the environment have been shown to cause:

- Decreases in ventilatory lung function;
- Changes in mucociliary clearance of particles from the lower respiratory tract (front line of defence in the conducting airways);

- Increased number of alveolar macrophages and polymorphonuclear leukocytes in the alveoli (primary line of defence of the alveolar region against inhaled particles);
- Alterations in immunologic responses (particle composition a factor, since particles with known cytotoxic properties, such as metals, affect the immune system to a significantly greater degree);
- Changes in airway defence mechanisms against microbial infections (appears to be related to particle composition and not strictly a particle effect);
- Increase or decrease in the ability of macrophages to phagocytize particles (also related to particle composition);
- A range of histologic, cellular and biochemical disturbances, including the production of proinflammatory cytokines and other mediators by the lungs alveolar macrophages (may be related to particle size, with greater effects occurring with ultrafine particles);
- Increased electrocardiographic abnormalities (an indication of cardiovascular disturbance); and
- Increased mortality.

Bronchial hypersensitivity to non-specific stimuli, and increased morbidity and mortality from cardio-respiratory symptoms, are most likely to occur in animals with pre-existing cardio-respiratory diseases. Sub-chronic and chronic exposure tests involved repeated exposures for at least half the lifetime of the test species. Particle mass concentrations to which test animals were exposed were very high (> 1 mg m^{-3}), greatly exceeding levels reported in the ambient environment. Exposure resulted in significant compromises in various lung functions similar to those seen in the acute studies, but including also:

- Reductions in lung clearance;
- Induction of histopathologic and cytologic changes (regardless of particle types, mass, concentration, duration of exposure or species examined);
- Development of chronic alveolitis and fibrosis; and
- Development of lung cancer (a particle and/or chemical effect).

The epidemiological finding of an association between 24-hour ambient particle levels below 100 µg m^{-3} and mortality has not been substantiated by animal studies as far as PM_{10} and $PM_{2.5}$ are concerned. At ambient concentrations, none of the other particle types and sizes used in animal inhalation studies result in acute effects, including high mortality, with exception of ultrafine particles (0.1 µm). The lowest concentration of $PM_{2.5}$ reported that caused acute death in rats with acute pulmonary inflammation or chronic bronchitis was 250 g m^{-3} (3 days, 6 hour day^{-1}), using continuous exposure to concentrated ambient particles.

Most of the literature regarding air quality impacts on cattle refers to the impacts from feedlots on the surrounding environment, hence where the feedlot is seen as the source of pollution. This mainly pertains to odours and dust generation. The US-EPA recently focussed on the control of air pollution from feed yards and dairies, primarily regulating coarse particulate matter. However, the link between particulates and public health is considered to be understudied (Sneeringer, 2009).

A study was conducted by the State University of Iowa on the effects of air contaminants and emissions on animal health in swine facilities. Air pollutants included gases, particulates, bioaerosols, and toxic microbial by-products. The main findings were that ammonia is associated with lowered average number of pigs weaned, arthritis, porcine stress syndrome, muscle lesions, abscesses, and liver ascarid scars. Particulates are associated with the reduction in growth and turbine pathology, and bioaerosols could lower feed efficiency, decrease growth, and increase morbidity and mortality. The authors highlighted the general lack of information on the health effects and productivity-problems of air contaminants on cattle and other livestock. Ammonia and hydrogen sulphide are regarded the two most important inorganic gases affecting the respiratory system of cattle raised in confinement facilities, affecting the mucociliary transport and alveolar macrophage functions. Holland *et. al*., (2002) found that the fine inhalable particulate fraction is mainly derived from dried faecal dust.

Inhalation of confinement-house dust and gases produces a complex set of respiratory responses. An individual's response depends on characteristics of the inhaled components (such as composition, particle size and antigenicity) and of the individual's susceptibility, which is tempered by extant respiratory conditions (Davidson *et. al*., 2005). Most studies concurred that the main implication of dusty environments is the stress caused to animals which is detrimental to their general health. However, no threshold levels exist to indicate at what levels these are having a negative effect. In this light it was decided to use the same screening criteria applied to human health, i.e. the South African Standards and SANS limit values.

5.3.1.1.1.3 Effect of particulate matter on susceptible human receptors

The impact of particles on human health is largely depended on:

- Particle characteristics, particularly particle size and chemical composition, and
- The duration, frequency and magnitude of exposure.

The potential of particles to be inhaled and deposited in the lung is a function of the aerodynamic characteristics of particles in flow streams. The aerodynamic properties of particles are related to their size, shape and density. The deposition of particles in different regions of the respiratory system depends on their size.

The nasal openings permit very large dust particles to enter the nasal region, along with much finer airborne particulates. These larger particles are deposited in the nasal region by impaction on the hairs of the nose or at the bends of the nasal passages. The smaller particles (PM_{10}) pass through the nasal region and are deposited in the tracheobronchial and pulmonary regions. Then particles are removed by impacting with the wall of the bronchi when they are unable to follow the gaseous streamline flow through subsequent bifurcations of the bronchial tree. As the airflow decreases near the terminal bronchi, the smallest particles are removed by Brownian motion, which pushes them to the alveolar membrane (CEPA, 1998; Dockery and Pope, 1994).

The air quality guidelines for particulates are given for various particle size fractions, including total suspended particulates (TSP), thoracic particulates or PM_{10} (i.e. particulates with an aerodynamic diameter of less than 10 µm), and respirable particulates or $PM_{2.5}$ (i.e. particulates with an aerodynamic diameter of less than 2.5 µm). Although TSP is defined as all particulates with an aerodynamic diameter of less than 100 µm, and effective upper limit of 30 µm aerodynamic diameter is frequently assigned. The PM_{10} and $PM_{2.5}$ are of concern due to their health impact potentials. As indicated previously, such fine particles are able to be deposited in, and damaging to, the lower airways and gas-exchanging portions of the lung.

The World Health Organization states that the evidence on airborne particulates and public health consistently shows adverse health effects at exposures experienced by urban populations throughout the world. The range of effects is broad, affecting the respiratory and cardiovascular systems and extending from children to adults including a number of large, susceptible groups within the general population. Long-term exposure to particulate matter has been found to have adverse effects on human respiratory health (Abbey *et. al*., 1995). Respiratory symptoms in children resident in an industrialised city were found not to be associated with long-term exposure to particulate matter; however non-asthmatic symptoms and hospitalizations did increase with increased total suspended particulate concentrations (Hruba *et. al*., 2001). The epidemiological evidence shows adverse effects of particles after both short-term and long-term exposures. However, current scientific evidence indicates that guidelines cannot be proposed that will lead to complete protection against adverse health effects as thresholds have not been identified.

Many scientific studies have linked inhaled particulate matter to a series of significant health problems, including:

- Aggravated asthma;
- Increases in respiratory symptoms like coughing and difficult or painful breathing;
- Chronic bronchitis;

- Decreased lung function; and,
- Premature death.

PM_{10} is the standard measure of particulate air pollution used worldwide and studies suggest that asthma symptoms can be worsened by increases in the levels of PM_{10}, which is a complex mixture of particle types. PM_{10} has many components and there is no general agreement regarding which component(s) could exacerbate asthma. However, pro-inflammatory effects of transition metals, hydrocarbons, ultrafine particles (due to combustion processes) and endotoxins - all present to varying degrees in PM_{10} - could be important.

Exposure to motor traffic emissions can have a significant effect on respiratory function in children and adults. Studies show that children living near heavily travelled roadways have significantly higher rates of wheezing and diagnosed asthma. Epidemiologic studies suggest that children may be particularly susceptible to diesel exhaust. The adverse health effects from particulate matter exposure and susceptible populations is summarised in Table 68.

Table 68: Summary of adverse health effects from particulate matter exposure and susceptible populations

Health Effects	Susceptible Groups	Notes
Acute (short-term) exposure		
Mortality	Elderly, infants, persons with chronic cardiopulmonary disease, influenza or asthma	Uncertainty regarding how much life shortening is involved and how much is due to short-term mortality displacement.
Hospitalisation / other health care visits	Elderly, infants, persons with chronic cardiopulmonary disease, pneumonia, influenza or asthma	Reflects substantive health impacts in terms of illness, discomfort, treatment costs, work or school time lost, etc.
Increased respiratory symptoms	Most consistently observed in people with asthma, and children	Mostly transient with minimal overall health consequences, although for a few there may be short-term absence from work or school due to illness.
Decreased lung function	Observed in both children and adults	For most, effects seem to be small and transient. For a few, lung function losses may be clinically relevant.
Chronic (long-term) exposure		
Increased mortality rates, reduced survival times, chronic cardiopulmonary disease, reduced lung function, lung cancer	Observed in broad-based cohorts or samples of adults and children (including infants). All chronically exposed are potentially affected.	Long-term repeated exposure appears to increase the risk of cardiopulmonary disease and mortality. May result in lower lung function. Average loss of life expectancy in highly polluted cities may be as much as a few years.

Source: Adopted from Pope (2000) and Pope *et. al*., (2002)

5.3.2 ECOLOGY

Based on the results of the study it is concluded that 651 ha (46%) of the study area represents natural vegetation. This remaining vegetation is under serve pressure from grazing which is changing the species composition, to the detriment of decreaser (climax, palatable) species and the benefit of increaser (pioneer, successional) species. The vegetation community associated with the outcrops (community five) contains the highest species richness, but in the context of study area all the remaining natural vegetation has a high sensitivity and therefore an high conservation significance. In terms of persistent grassland with the study area to two areas are of very high conservation significance, the area to the northeast associated with internal catchment 5 and the area along the Steelpoort River (internal catchment 10).

It should be noted that in terms of South Africa's environmental legislation, the study area contains the following liabilities:

- Declared alien invasive species;
- Erosion;
- Exploitated vegetation;
- Wetlands; and
- National and Provincially protected plants.

The study site sustains a remarkably high diversity of bird species including many with strong highveld affinities. However, anecdotal evidence suggests that the long-term effect of the current grazing regime in the region will be detrimental for the persistence of conservation-dependant bird species on the site.

During the invertebrate taxa survey, it was noticed that the primary grassland seres were moribund or structurally dense, a condition which will invariably discourage the colonisation of ground-dwelling epigaeic taxa. However, apterous predators, mainly caraboid taxa (*Anthia thoracica* – Two Spotted Ground Beetle and *Lophyra spp* – Tiger Beetles.) associated with high trophic levels were observed on the study site in low numbers. These species are important apex predators and their occurrence is often linked to "healthy" systems. These species, being apterous (wingless and thus showing limited dispersal abilities), are often the first taxa to disappear when environmental conditions change.

While a very similar herpetofauna community was expected during this study compared to that for Glisa Coal Mine, the lesser degree of habitat degradation and fragmentation lead to a greater observed species diversity and abundance. In fact, several species were added to the expected herpetofauna list due to the great success of the summer survey and the consequently improved understanding of the herpetofauna of the region.

The strong presence of carnivores within the study area suggests that the area is exhibiting an overall sound system health. Preliminary evidence suggests that up to eight servals (IUCN Near Threatened) are resident on the study area and in the neighbouring Glisa Coal Mine.

The figures below indicate the floral, faunal, and combined ecological sensitivity of the Paardeplaats site.

Figure 62: Ecological Status of Vegetation on the site

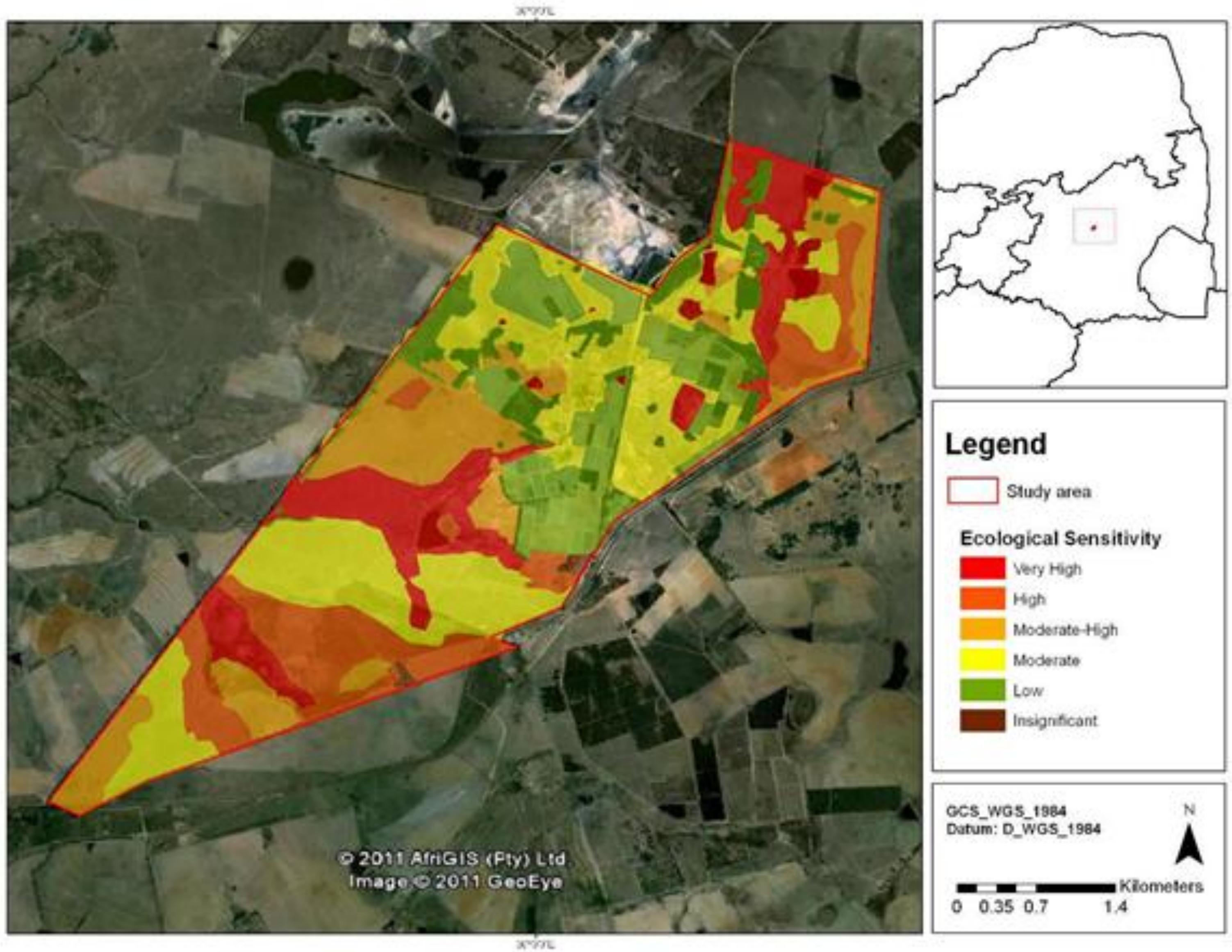


Figure 63: Avifaunal sensitivity of the study area

Figure 64: Simplified herpetofauna sensitivity map showing areas of conservation value

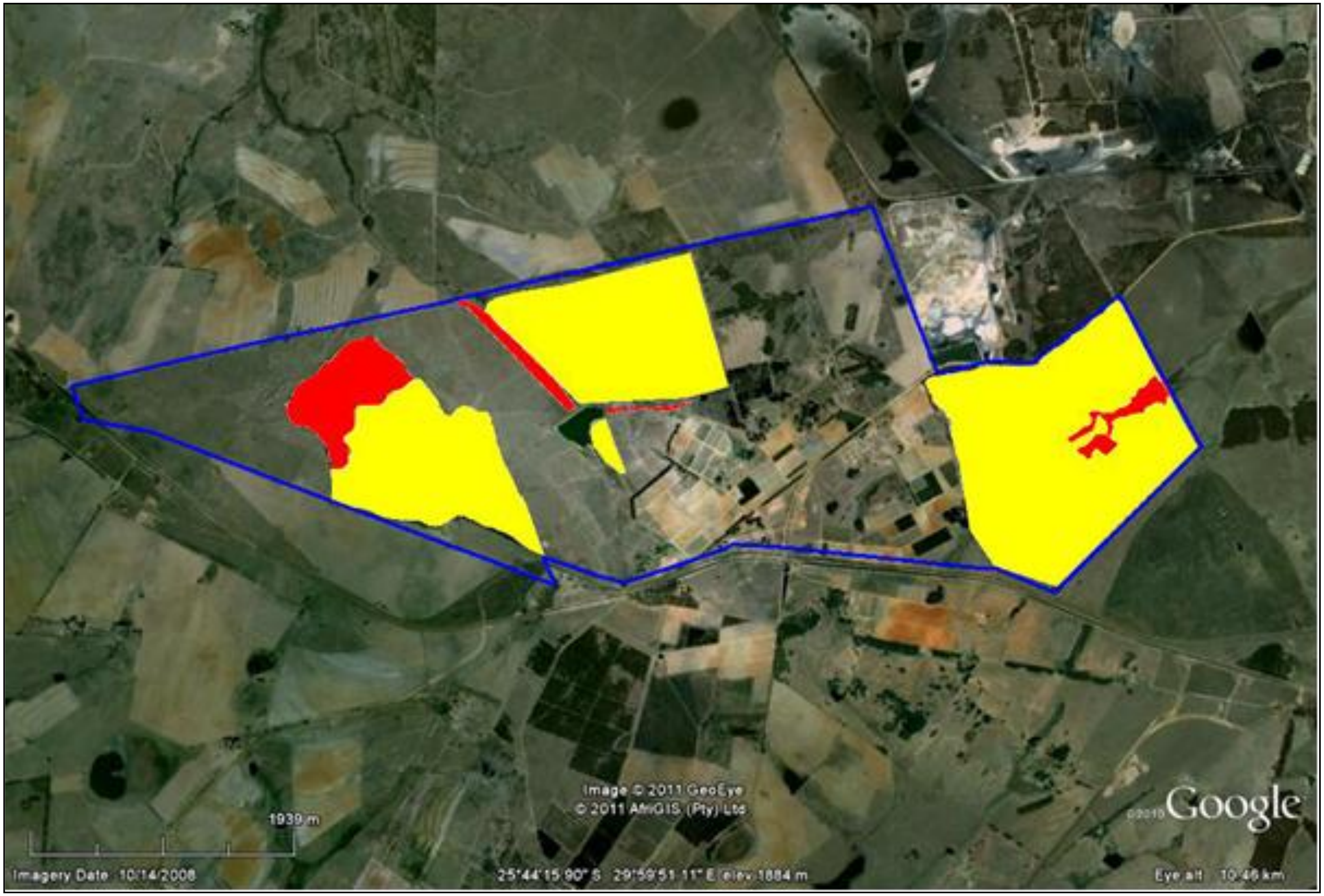


Figure 65: Mammalian sensitivity of the study area

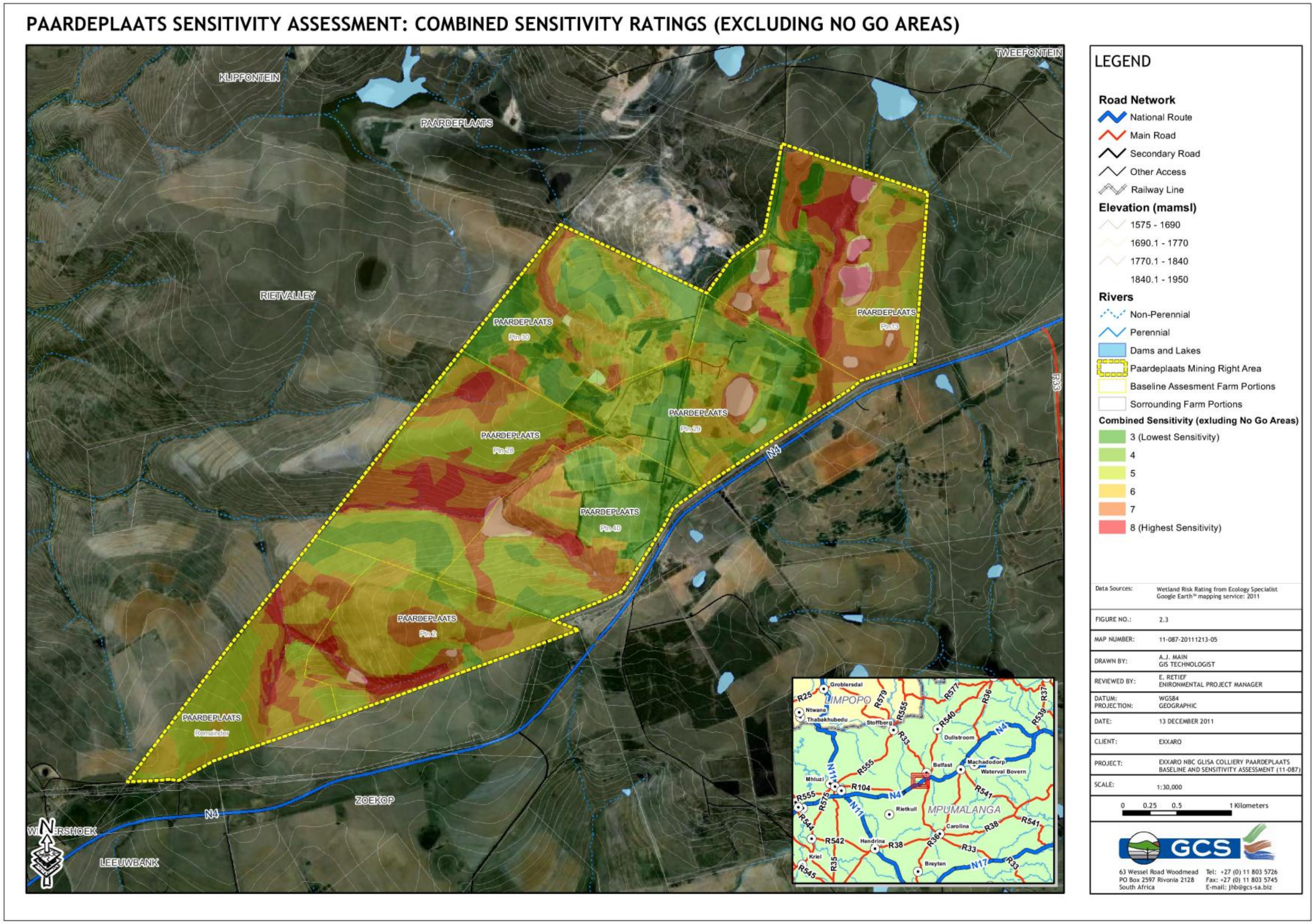


Figure 66: Combined Sensitivity Rating

5.3.2.1 List of Impacts

The following is a list of the potential impacts of the proposed mining activity on the ecology of the area.

- Ecosystem fragmentation;
- Damage to sensitive and conservation important vegetation types/habitats;
- Death/disturbance of fauna and flora;
- Disruption of habitat range for sensitive and conservation I,portant species;
- Loss of available habitat for Red Data and conservation important species;
- General loss of biodiversity; and
- Introduction or spread of alien invasive vegetation.

5.3.3 HYDROLOGY (GROUND AND SURFACE WATER)

Potential impacts from the proposed mining activities on the hydrology of the study area include:

- Alteration of current groundwater regime and levels;
- Increase in total dissolved solids in the ground water;
- Potential acidification of ground water due to oxidation of pyrite;
- Contaminats from the mine (including backfilled opencast pits and return water dams) can seep through the unsaturated zone into the ground water system;
- If groundwater ffeds surface water bodies such as wetlands and stream, these can also be polluted;
- Alteration/destruction/damage to surface water bodies such as streams due to mining operations; and
- Changes in surface water quality and quantity.

5.3.4 NOISE

5.3.4.1 Pre-Construction Phase

Activities during the planning and design phase that normally have possible noise impact implications are those related to field surveys (such as seismic testing and geological test borehole drilling for prospecting purposes and/or investigation of founding conditions for large buildings/plant/equipment). As these activities are usually of short duration and take place during the day, they are unlikely to cause any major noise disturbance or nuisance in most adjacent areas.

5.3.4.2 Construction Phase

The noise impact from construction activities are predicted to be as follows:

- Source noise levels from many of the construction activities will be high. Noise levels from all work areas will vary constantly and in many instances significantly over short periods during any day working period;
- Exact daytime period and night-time period continuous equivalent sound pressure levels are not possible to calculate with certainty at this stage as the final construction site layout, work programme for the various components, work modus operandi and type of equipment have not been finalised. Working on a worst case scenario basis, it is estimated that the ambient noise level from general construction activities could negatively affect noise sensitive sites within a distance of 1400 metres of the construction site. Night-time construction could have a significant impact on noise sensitive sites within a radius of 3000 metres of the construction site; and
- There are likely to be some noise nuisance effects during the day from intermittent loud noises on people living in the area. If there is any night-time construction, fairly significant impacts will be experienced.

5.3.4.3 Operational Phase

With the development of the mine the noise climates on the properties adjacent to the mine will alter significantly. The main noise sources at the mine will be from mining activitiessuch as drilling, blasting, construction of dumps, activity at the stockpiles, and the ore haul trucks. The processing of ore will take place at the beneficiation plant at the Glisa Coal Mine. It is predicted that the noise from the various operations at the mine could be of the following order at the given offsets from the source:

Table 69: Noise levels from various operations at the mine at given offsets

Offset distance (m)	Noise from Source (dBA)	
	Opencast Pits	Stockpiles and Dumps
500	64.0	54.9
1000	57.1	48.0
2000	49.6	40.3
3000	44.7	35.5
4000	41.0	<35
5000	37.9	
6000	35.5	

Where relevant the cumulative effects of noise sources will be addressed during the EIA Level Investigation.

5.3.4.4 Mine Generated Traffic

The total volume of traffic generated by the mine onto the adjacent main roads will be relatively small in comparison to the total volume of traffic on Road N4 and Road R33 and will hardly raise the noise climates along these routes. However, this traffic to and from the Glisa Coal Mine beneficiation plant is likely to raise the noise ambient climate along Spitskop Road by at least 3dBA, as calculated according to SANS 10210: Calculating and Predicting Road Traffic Noise.

5.3.5 SOILS, LAND USE AND CAPABILITY

The major potential impacst that would occur as a result of coal mining and related activities would include:

- Change in future land use options;
- Contamination/pollution of soil resource:
- Loss of agricultural land;
- Erosion;
- Damage to natural drainage systems; and
- Damage to prevailing topography.

Where storage facilities (discard dumps etc.) are established, the loss of agricultural land is virtually permanent, while for the open-cast area, spoil and topsoil can be replaced and rehabilitated to a certain degree, although a reduction of agricultural potential often occurs.

The prevailing water erodibility of the soils occurring is not high; due mainly to the clay content and stable mineralogy, but some erosion could occur if preventative measures are not taken.

The natural pre-mining topography of the area shows several stream beds and other depressions in the landscape, with dams occurring in several places. If the topsoil is removed and replaced in or close to these areas, it will be critical to try and ensure that the prevailing topography, with associated drainage aspects, is retained, so that the natural soil drainage patterns are disturbed as little as possible.

5.3.6 VISUAL

To evaluate the impacts of the proposed Paardeplaats Coal Mine it is assumed that the landscape has some inherent scenic value. The existing visual condition of the landscape that would be affected by the proposed mine has been described. Its scenic quality has been rated and highly sensitive viewing areas identified. The next phase is to assess and rate the significance of impacts on the visual resource and sensitive receptors, as well as including comments and concerns raised by I&APs during a detailed public participation process which is to be followed. This will occur in the assessment phase of the project.

It is most likely that visual impacts would result from the construction, operation, and maintenance of the proposed mine. Impacts to views are the highest when viewers are identified as being sensitive to change in the landscape, and their views are focused on and dominated by the change. Visual impacts occur when changes in the landscape are noticeable to viewers looking at the landscape from their homes or from tourism/conservation areas, travel routes, and important cultural features and historic sites, especially in foreground views. Specifically, impacts would result from the mine being seen from nearby public roads, residential properties and from effects to the scenic qualities of the existing landscape. These impacts include:

- Loss of landscape value; and
- Change in sense of place.

5.3.7 WETLANDS AND AQUATIC ECOLOGY

The main impacts to aquatic habitat integrity within the study area include farm dams (causing, channel, bed and flow modifications), cultivated fields and mining (affecting water quality) and invasion by alien black wattle (*Acacia mearnsii)* trees (affecting marginal vegetation and bank stability). Potential impacts from the proposed mining activities include:

- Damage to or destruction of wetlands;
- Changes to water quality of wetlands;
- Changes to wetland function;
- Changes to available water quantity for wetlands; and
- Alteration/damage/disturbance to aquatic ecology.

A wetland risk assessment was undertaken to inform decision making with regards to the location of proposed developments on site. In order to provide data which is comparable to the data obtained from other specialist fields investigated, a standardized rating scale was used. The rating scale proposed for this project is reproduced below. The scale ranges from 1 to 9, with a value of 1 indicating an area highly suitable for the proposed mining activities and a value of 9 indicating a restricted area.

1 = Highly Suitable;

2 = Suitable;

3 = Medium Suitable;

4 = Low Suitability;

5 = Low Sensitivity;

6 = Sensitive;

7 = Medium Sensitive;

8 = Highly Sensitive; and

9 = Restricted.

The following factors were considered in assigning risk values:

- The ecological importance and sensitivity of the wetlands; and
- The requirement of GN704 that no potentially polluting mining activities take place within 100m of any wetlands.

From a water quality and quantity perspective, all of the wetlands on site are considered highly sensitive. However, the wetlands are merely an expression of water moving through the landscape and are dependent on landscape, or rather catchment, scale processes. As such, if the wetlands are considered sensitive, the entire wetland catchment should in effect also be considered sensitive. This is captured in part by the inclusion of the 100m and 500m buffer in the sensitivity mapping, though catchment boundaries extend beyond the 500m buffer in some instances. From a biodiversity perspective, those wetlands that are characterised by natural vegetation and are considered important from a biodiversity support perspective are considered sensitive, while those wetlands that have been completely cultivated are considered less sensitive; though still being sensitive as the water discharging from these wetlands supports downstream ecosystems.

From the map (below) it is clear that all wetlands on site are considered sensitive and, as a result of this, most of the site is considered to be, at best, of low suitability for mining development. This is based on the value of the water that the wetlands represent as well as the requirements of legislation (National Water Act, NEMA, GN704, GN1199 etc.) and other guideline documents (e.g. Mpumalanga Biodiversity Conservation Plan) which require that all wetlands are considered as sensitive and that any activity within a wetland or within 500m of a wetland requires authorisation. The varying sensitivities ascribed to the wetlands on site, ranging from Restricted to Low Sensitivity, are based on the varying degrees of degradation of the wetlands on site.

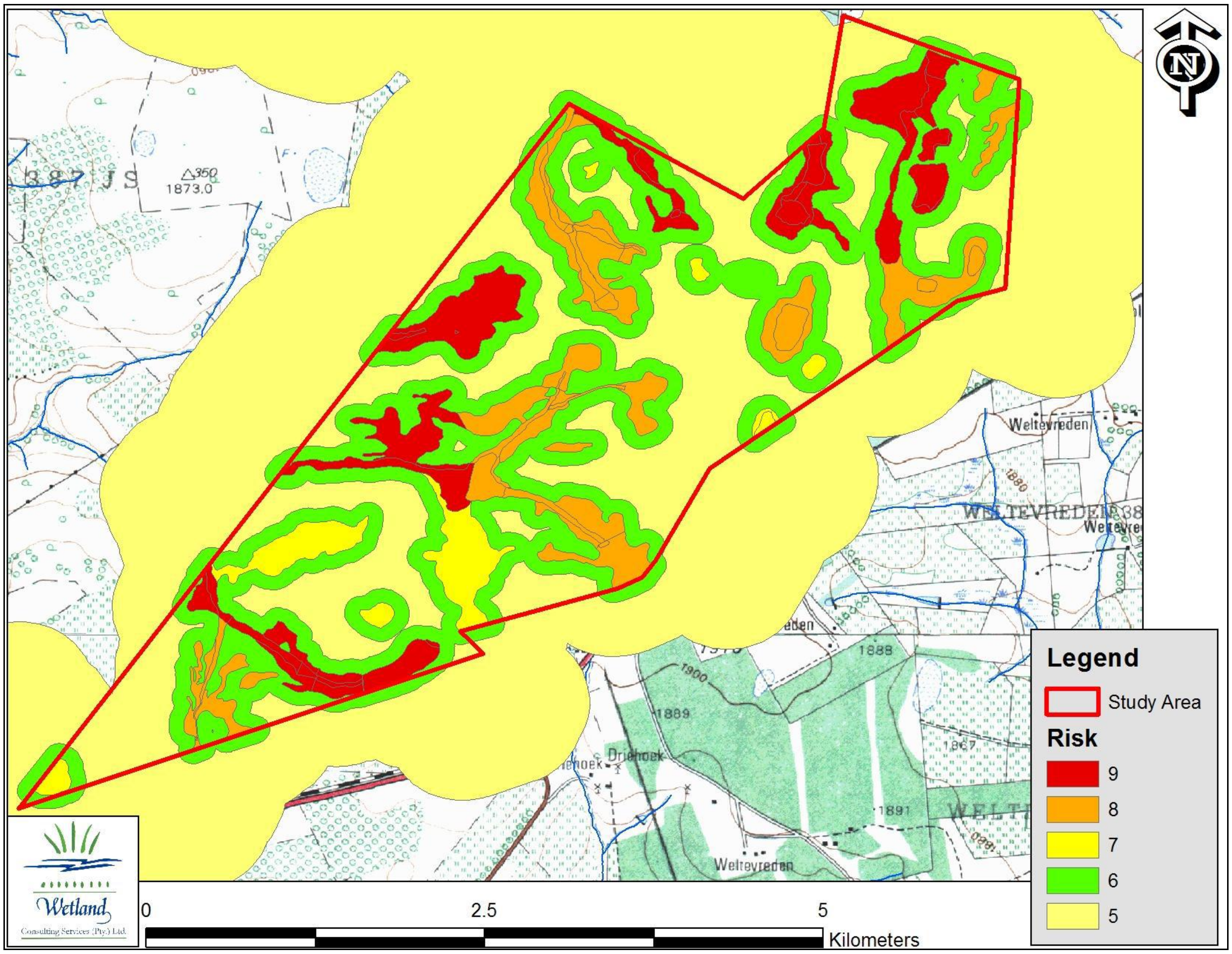


Figure 67: Results of the wetland risk assessment.

5.4 BUILT ENVIRONMENT

5.4.1 BLASTING AND VIBRATION

As indicated it is expected that there will be impact due to blasting operations. These include:

- Increased noise and vibration nuisance;
- Damage to structures;
- Loss of prodctivity of farm animals due to vibration;
- Damage to roads;
- Damage to boreholes;
- Air blast;
- Pollution of borehole water;

- Fly rock; and
- Noxious fumes.

The prediction outcomes will determine the extent and if mitigation will be required.

The figure below shows estimated influence areas including an area that is expected to be influenced and area expected where influence is expected to be of a lesser degree.

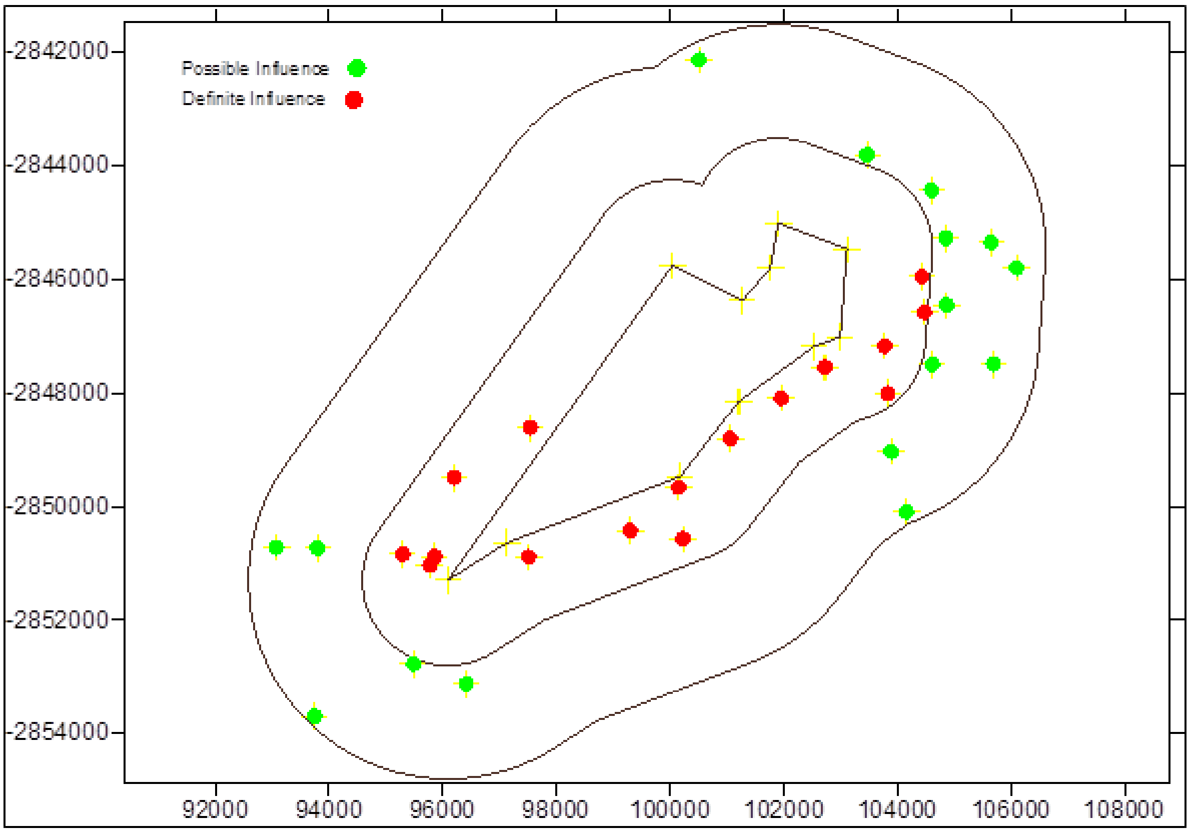


Figure 68: Map indicating influence

5.4.2 TRAFFIC

No intersection analysis has been carried due to existing low traffic flows and little risk of intersections operating near capacity. A link analysis for the AM and PM peak hour (shows that the additional traffic from the Glisa Coal Mine and Paardeplaats Project result in no change to the LOS for the links. The additional development traffic is expected not to cause capacity issues. No road upgrades are therefore proposed to increase road capacity. However, road upgrades should be considered to accommodate access for the heavy vehicles, in particular the abnormal loads that may be required during construction.

An assessment of the additional traffic on the road network will be carried out to determine the potential environmental impact of the development during a detailed EIA Phase Investigation.

5.5 CUMULATIVE IMPACTS

Due to the close proximity of the Glisa NBC Coal Mine and the presence of other large mining operations in the area, cumulative impacts and their assessment is of importance. The identification and assessment of cumulative impacts will be identified, evaluated and mitigation measures suggested during the detailed EIA level investigation. The impact identification and calculation methodology employed by all specialists' incorpates cumulative impacts in a quantitative manner to determine the final impact score and corresponding rating. Please refer to Section 8.2 for information on the methodology utilised.

6 LAND USE OR DEVELOPMENT ALTERNATIVES

The current land uses on site comprises of a mixture of commercial agriculture (arable and grazing), irrigation in the south-west for the Hadeco tulip nursery and farm homesteads for workers. Most of the commercial agriculture on site involves the farming of maize monoculture as well as grazing for livestock such as cattle, sheep, springbok, and blesbok. Some dams are present and used for trout fishing on a small commercial scale and recreationally by surface rights holders.

6.1 LAND USE ALTERNATIVES

6.1.1 MINING

Mining is the predominant activity within the area. Several active mines, predominantly coal mines, are located within the surrounding project area. The mining operations within the area are numerous and can be categorised as opencast operations and underground operations with surface access nodes. Additional supporting mining infrastructure is also present and includes slurry and co-disposal facilities, conveyor routes, haul roads, offices, pipelines, and power lines, most notably at Glisa NBC Coal Mine.

The Paardeplaats Coal Mine project will serve to ensure that Exxaro is able to make optimum usage of the mineral resources within the project area and supply coal, essential for Eskom, to meet the growing energy demand of South Africa, making it both necessary and desirable.

6.1.2 CULTIVATED LAND AND GRAZING

Farming is the second largest land use occurring within the area. The mining right area is surrounded by farms to the east, west, and south. Farms within the area are predominantly used for monocultures such as maize as well as grazing land for cattle and sheep. Within the

Paardeplaats study area, this trend is also observable as it is dominated by maize farming and grazing land for cattle, sheep, blesbok, and springbok. The study area also contains irrigated land used by Hadeco for their tulip bulb nursery.

Other than the Hadeco nursery, most farming practices within the area take place on a very limited scale and many of the farms in the surrounding area are owned by mining companies and leased to farmers for utilisation. As such, and based on the close proximity of the existing Glisa NBC Coal Mine, it is not envisaged that large scale farming activities can be considered a feasible alternative to mining activities within the study area and the surrounding area in general.

6.1.3 RESIDENTIAL DEVELOPMENT

Belfast is the nearest town to the proposed Paardeplaats Coal Mine. The character of Belfast is of a rural nature, in which farming and mining are the predominant economic activities. Residential development is not suitable for the Paardeplaats project area due to the close proximity of the Glisa NBC Coal Mine and other surrounding mining operations. This alternative is not considered feasible and will therefore not be considered and assessed further in the EIA Phase.

6.1.4 TOURISM

The proposed Paardeplaats Coal Mine is located close to the town of Belfast, which is part of the Highlands Meander and a well-known fly-fishing destination. The Hadeco tulip bulb nursery located within the proposed project area is a popular tourist destination in spring when the tulips are in bloom. The prevalent mining character of the area does limit the probability of further tourism success in the immediate area. As such, tourism potential and development in the immediate area is possible, but unlikely to be highly successful as an alternative land use at present. This alternative is not considered feasible and will therefore not be considered and assessed further in the EIA Phase.

6.2 DEVELOPMENT ALTERNATIVES

The identification and assessment of alternatives is a key aspect to the success of an EIA process. Typically the Scoping process will identify available feasible alternatives and then the EIA provides an in-depth assessment and comparison of these alternatives. The development alternatives that will be considered for the proposed Paardeplaats Coal Mine will be assessed during the detailed EIA investigation and will include the following:

6.2.1 ALTERNATIVE 1 – NO GO ALTERNATIVE

This alternative will imply that no development takes place and that the environment remains unchanged and unaltered. The proposed development site for the Paardeplaats Coal Mine comprises a mixture of commercial agriculture (arable and grazing), irrigation, homesteads, and “undisturbed” natural vegetation surrounded by predominantly mining activities. The biodiversity within the proposed project area is relatively high and of a sensitive nature. It is worth noting that whilst the proposed Paardeplaats study area is located in a relatively pristine environment, the continued operation of mines in the surrounding area represent a risk of eventually impacting negatively on the area making it less than ideal from an environmental perspective regardless of whether or not the Paardeplaats Coal Mine is to be developed.

If the development should not take place, no additional socio-economic benefits would be created in the area, the mineral resource will be lost, and secure supply of coal to Eskom will be compromised. In addition, the continued operation of Glisa NBC Coal Mine is likely to be halted and the study area is likely to be negatively impacted by adjacent mining operations. Further implications of the No-Go option include:

- Loss of employment options at the Glisa NBC Coal Mine (Paardeplaats is essentialy an extension of Glisa NBC);
- Loss of economic input into the area; and
- Loss of regional socio-economic benefit.

6.2.2 ALTERNATIVE 2 – SENSITIVITY PLANNING APPROACH

This alternative will emphasise resource protection and use stringent mitigation measures to minimise identified adverse impacts. This alternative will use specialist planning and evaluation of the following in order to avoid consolidated sensitive environmental features such as:

- Mining footprint alteration;
- Mining methodology (opencast vs. underground);
- Pipeline placement;
- Pollution control dam and return water dam placement;
- Storm water management including clean and dirty water separation systems;
- Bulk water supply requirements;
- Transport; and
- General infrastructure placement.

This alternative will allow for the proposed development of the Paardeplaats Coal Mine whilst protecting identified consolidated high sensitive environmental features which will be identified during the specialist EIA investigation. The concept of in-situ conservation and biodiversity off-sets to account for significant residual impacts may also be explored.

Within this alternative, there are two options. Firstly mining the entire area as per the mining schedule and using the sensitivity planning approach to place limited infrastrucure, and secondly, mining only Portion 30 which is the least sensitive portion and the area with the highest grade coal.

If only Portion 30 is mined the other Exxaro owned Portions (28, 2, and RE) can be used in an offset program due to the presence of high quality wetlands and high ecological sensitivity.

6.2.3 ALTERNATIVE 3 – MAXIMUM MINE PRODUCTION

In this alternative, the mining and production of coal is emphasised. Less restrictive mitigation measures will be used to protect the environmental features, thus allowing for maximum coal production. This approach will increase the financial viability of the proposed Paardeplaats coal mine at the potential cost of impacting on more environmental features than the sensitivity planning approach. This alternative is likely to increase landscape character changes and impact on hydrology and biodiversity, as mining operations will likely move through sensitive environmental features.

6.3 MOST APPROPRIATE ALTERNATIVE GOING FORWARD

The most appropriate development alternative at this stage is mining using the second sensitivity planning approach described above. The sensitivity planning approach is also likely to have further implications in terms of mine design as well as economic viability of the proposed project, all of which will be evaluated in the EIA investigation. All viable alternatives described above will also be comparatively assessed and evaluated during the EIA to determine the most appropriate alternative going forward.

7 STAKEHOLDER ENGAGEMENT

The Public Participation Process (PPP) is a requirement of several pieces of South African Legislation and aims to ensure that all relevant Interested and Affected Parties (I&AP's) are consulted, involved and their opinions are taken into account. The process ensures that all stakeholders are provided this opportunity as part of a transparent process which allows for a robust and comprehensive environmental study. The proposed Paardeplaats Coal Mine is located in a complex stakeholder environment that needs to be managed sensitively and according to best practises in order to ensure and promote:

- Compliance with international best practise options;
- Compliance with national legislation;
- Establish and manage relationships with key stakeholder groups; and
- Encourage involvement and participation in the environmental study and authorisation/approval process.

As such, the purpose of the PPP and stakeholder engagement process is to:

- Introduce the proposed Paardeplaats project;
- Explain the environmental authorisations required;
- Explain the environmental studies already completed and yet to be undertaken;
- Determine and record issues, concerns, suggestions, and objections to the project;
- Provide opportunity for input and gathering of local knowledge;
- Establish and formalise lines of communication between the I&AP's and the project team;
- Identify all significant issues for the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent environmental impacts associated with the project.

7.1 LEGAL COMPLIANCE

The Public Participation Process must comply with the three important sets of legislation that require public participation as part of an application for authorisation or approval; namely:

- The Mineral and Petroleum Resources Development Act (Act No. 28 of 2002);
- The National Environmental Management Act (Act No. 107 of 1998); and
- The National Water Act (Act No. 36 of 1998).

Adherence to the requirements of the above mentioned Acts will allow for an Integrated Public Participation Process to be conducted, and in so doing, satisfy the requirement for public participation referenced in the Acts. The details of the Integrated Public Participation Process are provided below.

7.2 GENERAL APPROACH TO SCOPING AND PUBLIC PARTICIPATION

The PPP for the proposed Paardeplaats project will be undertaken in accordance with the requirements of the MPRDA, NEMA, and NWA, in line with the principles of Integrated Environmental Management (IEM). IEM implies an open and transparent participatory process, whereby stakeholders and other I&AP's are afforded an opportunity to comment on the project.

7.3 ANNOUNCEMENT OF THE PROJECT

On submission of the NEMA Scoping and EIA Application form to the Mpumalanga Department of Economic Development, Environment and Tourins (MDEDET) the Integrated PPP was initiated on 1 August 2012 and entailed the following activities.

7.3.1 COMPILATION OF INITIAL LIST OF INTERESTED AND AFFECTED PARTIES

An initial I&AP list was compiled using the existing Glisa NBC Coal Mine I&AP database as well as WinDeed searches, to determine the registered landowners of the project affected land parcels. The I&AP list was compiled containing the following categories of stakeholders:

- National Government;
- Provincial Government;
- Local Government;
- Agricultural Sector;
- Organised Business;
- Host and Adjacent Communities;
- Land Claimants;
- Other organisations, clubs, communities, and unions; and
- Various NGO's.

7.3.2 NOTICES TO INTERESTED AND AFFECTED PARTIES

From the above mentioned list of I&AP's and stakeholders, notification documents were drafted and sent via registered post, facsimile, and e-mail on 31 July 2012. The notification document included a Background Information Document (BID), the details of which are provided below. A copy of the scoping report was made available in the Belfast Library and on the EIMs website on

1 August 2012. Site notices and posters were placed in Blefast and around the study area on 1 August 2012.

7.3.3 COMPILATION AND DISTRIBUTION OF BACKGROUND INFORMATION DOCUMENT

Included in the I&AP notification letters, facsimiles, and e-mail was a BID. The BID includes the following information:

- Project introduction;
- Aim of the BID;
- Project description;
- Location and extent of the project;
- Legislative requirements;
- Summary of the PPP;
- Information on document review;
- A questionnaire;
- I&AP registration form; and
- Details on the first public open day to be held for the project.

7.3.4 ADVERTISEMENTS

Two advertisements were placed. An advertisement was placed in the legal section of the Beeld national newspaper on 1 August 2012. A second newspaper adverstiment was place in the Middleburg Herald on 28 September 2012 in order to remind I&AP's of the project and requests their continued involvement. The newspaper adverts include the following information:

- Project name;
- Applicant name;
- Project location;
- Closest town;
- Mine description;
- Project description;
- Legislative requirements;
- Details of the first public open day to be held for the project (in the Beeld only); and

- Relevant EIMS contact person for the project.

The Afrikaans advertisement appeared in the Beeld on 1 August 2012. Proof of the placement of this advertisement is included in Appendix N. A follow up advertisement has been placed in the Middleburg Herald in Engish to run on 28 September 2012 to remind I&AP's of the project.

7.3.5 ON SITE NOTICES

Site notices as well as posters were placed along and within the perimeter of the proposed project area, as well as in locations frequented by local and surrounding area inhabitants, such as schools, grocery stores, and garages on 1 Agust 2012. The on-site notices included the following information:

- Project name;
- Applicant name;
- Project location;
- Map of proposed project area;
- Closest town;
- Mine description;
- Project description;
- Legislative requirements;
- Details of the first public open day to be held for the project; and
- Relevant EIMS contact person for the project.

7.4 CONSULTATION MEETINGS

This section briefly outlines the consultation meetings that have been and will be scheduled to be held for the project.

7.4.1 AUTHORITY MEETINGS

The MDEDET reference number has been received and an Authority meeting will be scheduled with the Department of Mineral Resources (DMR), Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET), Department of Water Affairs (DWA), and Department of Agriculture, Forestry and Fisheries (DAFF). The purpose of the Authority meeting is to explain the project in detail to authorities and clarify the process going forward. The date, time, and venue of the meeting will be scheduled post dissemination of the project notification documents and submission of the Integrated Scoping Report.

An Authority meeting was held on site on 29 August 2012 with representatives from the DWA Regional office, the Nkomati Catchment Agency, and the Olifants Catchment Agency were present. The purpose of the meeting was to discuss the WULA and provide the DWA with project background. The result of the site meeting concluded with DWA requesting that the IWULA be lodged post submission of and inclusion of comment by the Department on the EIA/EMP and EMPR.

7.4.2 FOCUS GROUP MEETINGS

Focus group meetings will also be scheduled if neccesary post dissemination of the notification documents. Focus group meetings are aimed at providing information and consulting with groups such as farmers unions, NGO's, or any Traditional Authorities.

7.4.3 PUBLIC OPEN DAYS

Two Public Open Days will also be scheduled. The focus of the first Public Open Day was to introduce I&AP's to the proposed project, explain the process going forward and provide them opportunity to comment on the Draft Scoping Report. I&AP's were notified of the Public Open Day, availability of the Draft Scoping Report for review and given from 31 August 2012 to 15 September 2012. The first Public Open Day was held at the Belfast Golf Club on 31 August 2012. The attendance register is attached in Appendix S.

The second Public Open Day will be held at a date to be determined to discuss the findings of the EIA investigation and to solicit further comment, concerns, suggestions or objections from I&AP's for inclusion into the EIA. I&AP's will also be provided a period in which to comment on the EIA/EMP Report prior to submission.

7.5 ISSUES AND RESPONSES BY I&AP'S

The Integrated public participation process was initiated on 1 August 2012. The first public open day was held on 31 August 2012. IAP's were given until the 15th September 2012 for initial notification, registration, and comment on the draft scoping report. Attempts were made to contact Mr. Themba Nkosi the Community Liaison. Mr. Nkosi stated that he would provide details of the Community Forum Meetings to be held so that EIMS could arrange to be present, but this information has not been forthcoming. The correspondence with Mr Nkosi is attached in Appendix N.

Comment was received from 22 I&AP's. The majority of I&AP's, including those present at the Open Day were concerned with blasting, socio-economic impacts, noise, rehabilitation, and the effect of mining activities on the current receiving environment.

- The effect of blasting on the the surrounding environment was raised by 64% of the I&AP's (14);
- The effect of the proposed project on the current receiving environment on was raised by 59% of the I&AP's (13);
- The socio-economic impacts of the mining activities, rehabilitation of the area, and the impact of noise on the surrounding environment were each raised by 50% of the I&AP's (11);
- The impacts of dust, vibration, air quality, and run-off management were each raised by 45% of the I&AP's (10); and
- Historical grievances with Glisa Coal Mine, the extent of the mining area, and the impact on drainage were each raised by 41% of the I&AP's (9).

Two objections were recorded from Birdlife SA and Hadeco respectively who object to the project. Birdlife SA's objection is based on the project area falling within the Steenkampsberg Important Bird Area (IBA) and is considered important in terms of avifauna conservation and Hadecos objection is based on the potential impact mining may have on their current tulip farming operations.

8 PLAN OF STUDY

8.1 SPECIALIST STUDIES

8.1.1 AIR QUALITY

The main findings from the scoping level assessment were as follows:

- The main sources likely to contribute to cumulative PM_{10} impact are windblown dust from exposed areas, vehicle entrainment on unpaved road surfaces and biomass burning.
- The flow field is dominated by winds from the north-west and east sectors. During day-time conditions, wind from the north-western sector increases in frequency with winds from the south-eastern sector increasing at night.

- Residential areas in the region include eMakhazeni (~2 km north-east), Siyathuthuka (~3 km north). Individual residences (i.e. farm houses) are also within the area of proposed operations.

The main aim of this investigation was to provide the basis for the air quality impact assessment plan to be conducted for the proposed Paardeplaats Project. The following will be included in the impact assessment study:

- Compilation of an emissions inventory, comprising the identification and quantification of potential sources of emissions due to the proposed mining operations;
- Dispersion simulations of ambient thoracic (PM_{10}), respirable ($PM_{2.5}$) particulate concentrations and dust fallout from all the operations at the mine for selected averaging periods;
- Evaluation of potential for human health and environmental impacts;
- Determination of environmental risk according to stipulated Impact Assessment methodology and,
- Recommendation of mitigation and management measures.

The modelling of air quality impacts requires information regarding the operation of the mine, including the number of blasting-holes drilled daily, the blast frequency, the stripping ratio of coal to overburden, the capacity of vehicles used for haulage and physical properties of the material transported. The identification and evaluation of impacts may be hampered should default values be applied, or assumptions made, during the modelling process. Recent ambient air quality data from the vicinity, if available, will help verify the model projected air quality for baseline conditions.

8.1.2 BLASTING AND VIBRATION

The methodology consists of modelling the expected impact based on expected drilling and blasting information for the project.

Various accepted mathematical equations are applied to determine the attenuation of ground vibration, air blast and fly rock. These values are then calculated over distance investigated from site and shown as amplitude level contours. Overlay of these contours with the location of the various receptors then give indication of the possible impact and expected result of potential impact. Evaluation of each receptor according to the predicted levels will then give indication of possible mitigation measures to be done or not. The possible environmental or social impacts are then addressed in the detailed EIA phase investigation.

The possible environmental or social impacts are then addressed in the final report with the following chapters.

- Ground vibration expected from future blasting operations;
- Ground Vibration and human perception;
- Vibration impacts on productivity of farm animals (cattle, chickens, pigs, etc.);
- Vibration impact on national and provincial roads;
- Vibration to communication towers and equipment in the area sensitive to vibration;
- Vibration that may impact on adjacent communities;
- Damage of houses and consequent devaluation;
- Potential borehole collapse;
- Muddying and pollution of borehole water;
- Air blast expected from future blasting operations;
- Fly-rock expected; and
- Noxious fumes.

8.1.3 ECOLOGY

A detailed site survey has already been conducted. During the EIA phase, the consultant will calculate the impacts of the proposed mining operation on the ecology of the study area based on the results of the site survey. Appropriate mitigation and monitoring measures will be suggested in the EIA/EMP.

8.1.4 HERITAGE

The following will be required to develop a final HIA to manage the heritage resources within the proposed mining area.

8.1.4.1 Physical Surveying

The fieldwork component will consist of a selective walk through/site visit of the proposed mining area and is aimed at locating heritage resources falling within (and directly adjacent to) the proposed study area. The locations of all heritage resources that are recorded during the survey will be documented using a hand-held GPS. Furthermore, the documentation will reflect a brief qualitative description and statement of significance for each site and include a photographic record of all the sites.

It is important to also note that informal social consultation (i.e. with local community members, residents and knowledgeable individuals) will be undertaken during the fieldwork component. The aim of social consultation is to identify any tangible and intangible resources (i.e. sacred places, myths and indigenous knowledge resources) that may exist.

A desktop palaeontological impact assessment (PIA) report is to be included in the final HIA report. The NHRA defines 'palaeontological', as "any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace;". Palaeontological sites and material are protected under section 35 of the NHRA from destruction, damage, excavation, or other disturbance without a permit from the responsible heritage resources authority (NHRA, section 35(4)). The PIA will identify any specific rock types underlying the study area which are known to contain fossilised remains or trace of plants or animals and which could be negatively impacted by the proposed coal mining activities.

8.1.4.2 Deliverable

A report will be written which would include the following components:

- The identification and mapping of all heritage resources in the affected area;
- An assessment of the significance of such resources in terms of the heritage assessment criteria;
- An assessment of the impact of the development of such heritage resources;
- If heritage resources will be adversely affected by the proposed development, consideration of the alternatives; and
- Proposed mitigation of any adverse effects during and after the completion of the proposed development.

8.1.5 HYDROLOGY – GROUND WATER

8.1.5.1 General Approach

The information presented in this scoping report was largely gathered through a desk study of available data. No direct field data for the area is available to support these interpretations. The purpose of the detailed plan and field investigations is, therefore, to generate sufficient new data to build on the existing understanding of the hydrogeological regime and the impact of mining infrastructure on the groundwater regime.

The overall phases of the detailed plan are as follows:

- Phase 1 – Field Work
- Phase 2 - Data Analysis and Evaluation (including groundwater modelling)

- Phase 3 - Reporting

Phase 1 (fieldwork) will comprise of the following tasks:

- Task 1 - Inception Phase
- Site Familiarisation
- Hydrocensus and water sampling
- Geophysical Surveys
- Preliminary Reporting
- Task 2 - Main Field Work Phase
- Borehole drilling
- Pumping tests

Below is an outline of the activities to be carried out under each specific task:

8.1.5.2 Task 1 - Inception Phase

This phase will initiate all fieldwork by the team undertaking a site visit to familiarise themselves with the environment and ground conditions. A hydrocensus will be carried out to identify existing groundwater sources. Geophysical surveys will target areas identified by studying of geological maps and aerial photography.

8.1.5.2.1 Site Familiarisation

The objectives of this activity are to:

- Provide an overview of site geology, geography and hydrology;
- Confirm findings of the remote sensing study;
- Allow for an assessment of the distribution of potential aquifer zones and related impermeable zones;
- Assist in selecting areas for geophysical surveys; and
- Collect any additional/outstanding data.

This activity will entail liaison and discussions with local personnel, the gathering of additional data as available, and a detailed reconnaissance of the proposed mining operations and surrounding area.

It is expected that five working days will be required to allow sufficient time to become adequately familiar with the site access and geology across the study area.

8.1.5.2.2 Hydrocensus

The objectives of the hydrocensus are:

- Identify the distribution of existing groundwater facilities (boreholes, springs.);
- Develop a baseline of knowledge of groundwater use in the area;
- Measure groundwater level depths from surface; and
- Collect groundwater samples for chemical analysis.

At each of the groundwater sites visited the following information will be collected and recorded:

- GPS co-ordinates (using a handheld GPS unit),
- Owner and date of installation,
- Existing equipment and condition of equipment,
- Current use and abstraction volumes,
- Reported or measured yield,
- Reported or measured depth,
- The static water level, and
- Field water quality testing (temperature, dissolved oxygen, pH/Eh, electrical conductivity and turbidity).

The hydrocensus will be undertaken at the same time as the site familiarisation and will require approximately five to ten days, depending on the accessibility of certain areas.

8.1.5.2.2.1 Deliverables:

- Tabulation of water sources;
- A regional piezometric surface map, indicating groundwater contours, groundwater flow directions, hydraulic gradients, groundwater recharge and discharge areas.
- Water quality data.

8.1.5.2.3 Geophysical Survey

The objectives of the geophysical survey are to:

- Confirm the presence of major geological features and their orientation;
- Delineate site suitable for the drilling of monitoring boreholes;
- Provide information to assist in the delineation of the various aquifer units.

The geophysical survey will be carried out concentrating on the target areas identified by this desk study and remote sensing as well as any other areas where the site familiarisation indicates additional information is required. The survey will comprise electromagnetic and magnetic traversing methods to identify structural zones, intrusives and areas of deep weathering that can impact on groundwater occurrence and movement. Monitoring holes will be sited on the basis of the geology, site familiarisation, hydrocensus and geophysical survey results.

Each of the monitoring boreholes will serve as a long term monitoring borehole and will be tested to obtain aquifer parameters needed to develop a conceptual groundwater model and subsequently, to provide the necessary input to a numerical groundwater model.

8.1.5.2.3.1 Deliverables

- A location map showing target drill sites;
- A map indicating the major geological/structural features, prepared by integrating the existing geological information, remote sensing interpretation and geophysical results
- Preliminary hydrogeological map, indicating the main aquifer units, which will include the piezometric and water quality data.

8.1.5.2.4 Preliminary Report

The data gathered and the findings will be presented in the form of an inception report. The report will provide an overview of the hydrogeological environment, existing groundwater use and groundwater quality.

Data collected from the initial phase and the subsequent findings will be used to direct the subsequent main field work phase, and also provide important background information to the EIA. A piezometric map showing groundwater level information, flow directions, any compartmentalisation, and discharge area to the surface drainage will be prepared.

8.1.5.3 Task 2 - Main Field Work Phase

The objectives of the main fieldwork phase are as follows:

- Set up the basis for the assessment of prevailing groundwater conditions and data for a future impacts assessment, by:

  - Confirming the nature and extent of the main aquifer units in the area;
  - Confirming the hydraulic properties of the identified aquifers;
  - Assessing the life of mine sustainability of the groundwater resources;
  - Assessing the need for dewatering when mining progresses to large depths; and
  - Providing baseline information for an impact assessment by integrating the hydrogeological and water quality information to be used in the development of a numerical flow model.

Task 2 will comprise the following activities:

- Drilling of monitoring boreholes; and
- Pumping tests on the monitoring boreholes.

Each activity is outlined below.

8.1.5.3.1 Drilling Technique

The drilling technique will be determined by the geological and structural conditions of the area. Specifications for the drilling design and construction of the exploratory/test/monitoring boreholes will be prepared, together with specifications for the controlled test pumping of the boreholes to obtain aquifer hydraulic parameters

All the boreholes will be developed until clean silt free water is obtained and completed with a cement block and cap. The technical specifications will be incorporated into tender documents and contractors will be invited to tender for the works.

8.1.5.3.2 Drilling

The objectives of the drilling programme are to:

- Provide a control to the geophysical data;
- Collect geological and hydrogeological information;
- Provide boreholes for test pumping; and
- Provide long term monitoring locations.

The programme will comprise the drilling of monitoring boreholes as necessary to satisfy the project requirements.

The depth of the boreholes will be dictated by the geological and hydrogeological conditions. It is important that they are drilled deep enough to fully penetrate the aquifer horizons, which could be 60 m or more.

During drilling strata samples will be collected at 1m intervals and analysed. These will be used to prepare a detailed log of the lithologies intersected, fracture zones, water strike depths, blowing yields, groundwater bearing zones, etc. All drilling will be undertaken under the direct supervision and control of our field hydrogeologist.

8.1.5.3.2.1 Deliverables

- Borehole logs, showing geology, water strikes, air lift yields, etc
- Borehole construction diagrams, showing borehole diameter, casings, screens, etc.

8.1.5.3.3 Pumping Tests

The main objective of carrying out pumping tests is to determine aquifer parameters of transmissivity, storage and well performance (specific capacity);

All testing will be carried out under the direct supervision of our site hydrogeologist. Two tier pumping tests are planned: step tests to determine well performance (specific capacity and well losses); and constant rate tests to determine large scale aquifer parameters and boundary conditions.

A four hour step test will be carried out at each borehole to determine the optimum pumping rate for the constant rate test. A 24 constant rate pumping test at rates of up to 10 l/s will be run on each of the monitoring boreholes.

Any drawdown and fluctuation in water levels will be recorded in any nearby observation boreholes as well as in the pumped boreholes.

8.1.5.3.3.1 Deliverables

- Pumping test data;
- Pumping test hydrographs;
- Aquifer parameters and well performance parameters.

8.1.5.4 Task 3 – On-going Monitoring

The objectives of this task are to:

- Establish and implement a long-term groundwater level monitoring network;

- Establish and implement a long-term water quality monitoring network;
- Undertake QA/QC checks on the groundwater level and water quality data;
- Set up a database and capture the data for future evaluation and interpretation.

The details of the programme will be determined in conjunction with the findings and in accordance with the EIA requirements scoped.

8.1.5.4.1 Deliverables

- Baseline groundwater and surface water chemistry data.
- Report describing the monitoring network, sampling procedures, frequency, sample handling, etc.
- Annual monitoring report of results and interpretation thereof.

8.1.5.5 Phase 2 – Data Analysis and Evaluation

8.1.5.5.1 Analysis and Interpretation of Pumping Tests

The objectives of this task are to:

- Determine the hydraulic properties of the identified aquifer units (transmissivity, hydraulic conductivity and storativity);
- Determine the hydraulic characteristics of each monitoring borehole (well losses);
- Determine the boundary conditions for the hydrogeological area; and
- Determine the role that the geology and associated structures play in the spatial distribution of aquifer properties and groundwater flow;

Drawdown data collected during each pumping test will be analysed using standard interpretation software. The approach will be as follows:

- Compile the groundwater level data from before, during and after the pumping test, plot as a hydrograph;
- Evaluate the step test data to determine well performance parameters – linear and non-linear well losses;
- Evaluate the corrected time drawdown data from the constant rate pumping tests using appropriate analytical methods consistent with the aquifer conditions – confined, unconfined, leaky, boundary conditions;

- Evaluate time recovery data and distance drawdown data using appropriate analytical models of aquifer conditions;

8.1.5.5.2 Numerical Groundwater Flow Modelling

The objectives of numerical modelling are to:

- Determine the potential groundwater inflows into the mine;
- Determine the need for dewatering at the proposed mine pit or underground tunnels, in the long term;
- Assess the impact of dewatering on the local groundwater and surface water flows;
- Assess and simulate the impact of mine dewatering on existing groundwater users and the local rivers and associated wetlands during operations and post closure;
- Assess and simulate the impact on the groundwater regime (quantity and quality) from the proposed mine infrastructure (tailings dam, waste rock dump, etc) during operations and closure; and
- Assess the need for mitigation measures to minimise adverse impacts from mine infrastructure;

The deliverables for this task will include the development of a conceptual hydrogeological model for the site, followed by the construction of a numerical model.

8.1.5.5.3 Modelling Scope

The evaluation will be carried out through the following steps:

- Collation and evaluation of data collected from the initial and field investigations.
- Development of a conceptual hydrogeological model for the site.
- Identification of issues to be evaluated using modelling.
- Modelling code selection – to ensure that the conceptual model is represented appropriately by the numerical model. MODFLOW will be used for this project since it offers the greatest flexibility for evaluating mining hydrogeology issues.
- Model construction. This entails selecting the model domain, discretising the model domain, discretising data in space and time, defining boundary and initial conditions, and assembling and preparing model input data.
- Calibration of the model(s) for steady state and transient state groundwater flow conditions.

- Sensitivity analysis demonstrating model sensitivity to input parameters.
- Conducting model predictions and addressing study objectives.
- Predictive modelling.

8.1.5.6 Phase 3 – Final Report

The final report will describe the baseline hydrogeological environment, outlining groundwater use and quality. It will also include the delineation of aquifers and the groundwater flow direction. Major topics within the report will include:

- Geology and hydrogeology;
- Conceptual hydrogeological model including:
  - Hydrostratigraphic units;
  - Nature, extent and thickness of units;
  - Aquifer parameters and boundary conditions;
  - Piezometer surface for aquifers;
  - Groundwater flow directions and rates;
  - Groundwater recharge and discharge;
  - Groundwater level fluctuations;
  - Groundwater quality.
- Location of existing boreholes, wellfields and zones of current abstraction; and
- Groundwater quality, with particular emphasis on the impact that the mining operations could have on the prevailing groundwater regime.

The information collected during the inception and main field phase, together with the results of the numerical flow and solute transport modelling, will be used to confirm the occurrence and status of the aquifer(s) in the study area, define the areal extent of these aquifers and assess the groundwater resources associated with the identified aquifers. The need for dewatering to maintain dry working conditions in the proposed mine will be assessed.

An impact assessment on the prevailing groundwater regime from the dewatering, mine infrastructure, during operational and post closure of the mine will be made. Our scope of work does not include the design of a dewatering wellfield, unless this is found to be warranted, in which case this will be communicated to EIMS and costed separately.

The report will contain:

- The characterisation of the groundwater regime.
- A discussion of the hydrostratigraphy including permeability characteristics and hydraulic conductivity values.
- A water table map indicating groundwater flow directions in the uppermost aquifer and maps of the piezometric surface in confined aquifers.
- A water level map indicating the depth below surface of the water table.
- A discussion of groundwater quality.
- An assessment of groundwater impacts.
- An assessment of likely groundwater inflows into the open pits.
- Recommendations for mitigation measures to limit the impacts on existing users, as necessary.
- Recommendations and design for the implementation of a production wellfield, as appropriate.
- Production borehole design.
- The development programme required.
- An estimate of the cost of the implementation.
- Recommendations for the implementation of an aquifer monitoring system.

The report will detail:

- The number of production and standby boreholes required to satisfy the estimated water demand.
- Details of and production wellfield configurations.
- Details of the monitoring programme.

8.1.6 HYDROLOGY – SURFACE WATER

8.1.6.1 Methodology

The following methodology will be used to conduct the EIA Level Investigation for surface water hydrology:

- Desktop study – collecting existing information (DWA database & existing monitoring report etc.);

- Hydrocensus study to locate surface water monitoring points (within 2 km radius from the study area);
- Collect surface water samples from dams and nearby river or stream and submitting samples to accredited laboratory for analyses;
- Topographical map showing location of surface water points and catchment boundaries;
- Position of existing and planning facilities of mine;
- Identification of rivers within 100m from mine. Desktop study of channel of rivers taking into account the topography, total volume of storm water, rainfall and runoff;
- Collect information from Mine EMP; and
- Sensitivity survey of surface water.

8.1.6.2 Deliverables

The following are the EIA Level Investigation deliverables:

- Compiling and evaluating the existing information;
- Providing recommendations regarding surface monitoring points;
- Providing information regarding the surface water quality in and around the mine and propose a long term water quality monitoring plan;
- Provide storm water management plant with locations of dirty and clean water;
- Provide catchment map indicating catchment boundaries, water bodies, slope and drainage etc;
- Provide maps indicating river channels (within 100m), 1:50 year flood lines;
- Provide recommendations on the contamination impacts and provide mitigation measures;
- Provided detailed sensitive map indicating areas of high and low sensitivity.

8.1.7 NOISE

8.1.7.1 General

The general procedure used to determine the noise impact assessment for the EIA Phase will be guided by the requirements of the Code of Practice SANS 10328:2008: Methods for Environmental Noise Impact Assessments. A comprehensive assessment of all noise impact descriptors (standards) will be undertaken. The noise impact criteria that will be used specifically take into account those as specified in the South African National Standard SANS 10103:2008, The Measurement and Rating of Environmental Noise with Respect to Annoyance and Speech Communication as well as those in the National Noise Control Regulations. The investigation will comprise the following:

- Determination of the existing situation (prior to the planned development).
- Determination of the situation during and after development.
- Assessment of the change in noise climate and impact.

Note that some preliminary work has been undertaken in this Scoping phase.

8.1.7.2 Determination of the Existing Conditions

This phase will comprise the following:

- The relevant technical details of the planned mine (as known at this stage), the existing traffic patterns and the existing and planned land use in the study area will be reviewed in order to establish a comprehensive understanding of all aspects of the project that will influence the future noise climate in the study area.
- Using these data, the limits of the study area will be determined and the potential noise sensitive areas, other major noise sources and potential problems in these areas will be identified.
- Applicable noise standards will be identified. The National Noise Control Regulations and the SANS 10103:2008 standards will be applied.
- The Noise Impact Assessment Study for the Glisa Coal Mine which was undertaken in 2010 will be reviewed.

8.1.7.3 Assessment of Planning/Design Phase and Construction Phase Impacts

Aspects of the pre-design field surveys and construction activities that potentially will have a noise impact will be identified.

8.1.7.4 Assessment of Operational Phase Impacts

The main focus of the operational phase assessment (at EIA level) will be to establish the nature, magnitude and extent of the potential change in noise climate in the study area directly related to and within the area of influence of the development site. The modelling of the noise propagation from a multi-noise source site such as the proposed Paardeplaats Coal Mine is extremely complex and requires the careful consideration and input of many diverse parameters. Once the layout of the surface infrastructure of the planned mine, the details of the component plant/equipment and the operational details are finalized, the appropriate noise generation and noise propagation models (based on SANS 10357) will be loaded with these data and then run to establish the noise profile of the mine. The likely noise that will be generated by the mining operations will be established and used to determine the footprint of impact. The projected operational noise climate will then be compared with the baseline noise climate in order to determine the nature, magnitude, extent and implications of the noise impact. A preliminary estimate has been made in the Scoping Phase.

8.1.7.5 Impact Significance Rating Methodology

The impact significance rating methodology, as provided by EIMS, is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

8.1.8 SOCIAL AND ECONOMIC

The Social and Economic Impact Assessment would assist the client to:

- Predict the social and economic effects caused by the proposed project and prioritise key effects.
- Provide a report that lists the best potential for enterprise development opportunities in the Paardeplaats area for HDSA’s.
- Provide a management tool for managing the positive and negative social and economic consequences of the project and social economic change.
- Know who the key stakeholders are, create a positive environment with them and identify possible partnerships.
- Collect data for the development of indicators to report on in the future.

The Sustainable Development Investigation will be done by means of an economic comparative analysis.

The detailed methodology for the Social and Economic components of the study is described under the next two headings.

8.1.8.1 Plan of Study for Social Impact Assessment

In terms of the way forward, it is believed that a participatory approach is the best way to approach social impact assessment in the South African context. The World Bank Social Standards, Equator Principles and International Principles for Social Impact Assessment will be applied in the study. It must be noted that international standards and principles will be adapted to ensure that it can be applied in the local social context. Apart from obtaining environmental permits as required by law, any proposed project would also require “social license to operate” from the community where it will be situated. This is seen to be a crucial element to ensure the successful implementation of any Environmental Management Plan (requested by law) resulting from the environmental studies. Social license to operate is also an important consideration in the compilation and execution of a Social and Labour Plan (SLP) required for all mining applications. Without the buy-in of the affected public, the chance of successful implementing these plans will be slim. The methodology proposed will therefore focus on involving the affected public in the research and planning where it is realistically possible and executable. Different methodologies will be utilised to ensure the affected communities are consulted in the way that is most appropriate to the community.

The following activities will form part of the process forward:

- Compilation of a baseline study that should include an in-depth literature review of the available literature. This should include relevant legislation and existing provincial and municipal documents and studies, as well as any additional literature that is deemed to be applicable to the study. This study should focus on the local, regional and provincial level. This has already been done for this report.
- Necessary demographic data should be obtained from Statistics South Africa and Municipal Integrated Development Plans. This has already been done for this report.
- A scoping exercise consisting of an initial site visit and information search will be conducted. Stakeholders will include town councils, tribal councils, landowners, the relevant farmer’s associations, community representatives, forums and political leaders, amongst others.
- The initial site visit will be followed up with a longer period of field work to obtain additional information and communicate with key stakeholders. A preliminary report listing issues identified during this process will be submitted after the fieldwork is completed. Key stakeholders identified by the client include:

  - Authorities: local municipality where in the project operates.
  - Affected parties: communities that will be affected by the project, farm labourers, farmers, current employees of the mine who will have to go and work at Belfast mine and their families.
  - Interested parties: local business in the area, community-based organisations and non-governmental organisations within the affected communities, trade unions, political groups.
- All public meetings arranged by the stakeholder engagement team should be attended by the social scientists.
- Information will be obtained via methods such as focus groups, formal and informal interviews, participatory rural appraisal, observation, the internet and literature reviews. Field notes will be kept of all interviews and focus groups. Initial meetings have been conducted.
- An interview schedule might be utilised instead of formal questionnaires. An interview schedule consists of a list of topics to be covered, but it is not as structured as an interview. It provides respondents with more freedom to elaborate on their views. The interview schedule will include, but not be limited to, the following topics:
  - Employment;
  - Taxes and royalties;
  - Natural resources/ assets/environment;
  - Capacity and quality of existing infrastructure and services;
  - Safety;
  - In and out-migration;
  - Resettlement if applicable;
  - Community relations and power structures, social structures;
  - Awareness of health;
  - Deterioration in health status;
  - Crime;
  - Labour relations;
  - Education/skills;
  - Recreation;

  - Social investment;
  - Economic growth; and
  - Impact on local economy.
- The final report will focus on current conditions, providing baseline data. Each category will discuss the current state of affairs, but also investigate the possible impacts that might occur in future. Recommendations for mitigation will be made at the end of the report.
- The SIA process will have a participatory focus. This implies that the SIA process will focus strongly on including the local community and key stakeholders.
- The public consultation process needs to feed into the SIA.
- The following will be included in the SIA:
  - Skills gap analysis;
  - Needs indicated by different stakeholders which could be addressed as part of the Social and Labour Plan (IDP, existing projects within the community).
- Impacts will be rated according to significance (severity), probability, duration, spatial extent and stakeholder sensitivity.
- Where applicable, a distinction will be made between subjective and objective impacts.

Information obtained through the public processes will inform the writing of the final SIA and associated documents.

8.1.8.2 Plan of Study for Economic Impact Assessment

The plan of study for the economic impact assessment is set out below:

We will focus on the objective socio-economic impacts in the study and in essence will express a view on:

- The direct and total economic and employment impacts of the development on the regional and provincial economies;
- The net economic value added between coal mining and agriculture.

We will provide an economic impact assessment based on the standard environmental impact assessment tool as developed by the IAIA and used in standard practice.

- Enhancement strategies to assist with future economic development needs of the region will also be highlighted.

We are subscribers to the Quantec Economic database and will use all the available economic sector information in this database. Further down the RFP indicates that the project team is familiar with this database and hence it is assumed that this database is generally understood.

- This database has economic information per economic sector, per year, per local, district, provincial and national region. Information is generally up to 2010, except on a ward level, where it is still 2001.
- Our task is to download this data, analyse it for public consumptions and convert it into understandable graphs with explanatory notes.

It is important to understand that the study area is an open economic system with strong linkages with surrounding economies, representing interaction across boundaries and therefore spillover effects across regional economic boundaries.

This brings to the fore the following concepts:

- Leakages: Net outflow of buying power, i.e. households residing within the study area but purchasing goods and services outside the study area; and
- Injections: Refer to the reverse of leakages, i.e. businesses located outside the study area but purchasing inputs / products inside the study area.

Our analysis of leakages will take two forms:

- Applying a theoretical understanding of leakages as calculated by Quantec. This analysis is a spreadsheet calculation based on derived quantities.
- A desk-top analysis of leakages from the region, augmented by interviews. In this regard, we expect Exxaro to provide us with a downloaded database of all procurement from a similar operation. We categorise the procurement and then interview local business people to determine whether the local, district and provincial economies have the capacity to provide products and services. From this analysis, we determine what % of the GDP is likely to “leak” out of the economy. This also often indicates import substitution opportunities for the new project.

The analysis for injections would be done on a very similar basis.

- This analysis will be limited to a reasonably high level as the intermediary supply and demand of products could explode into a wide array of permutations.

Economic comparative analysis refers to the effects on the level of economic activity in a given area, as a result of interventions in the economy. In this case two separate interventions need to be investigated namely:

- Coal mining; and
- Farming.

On account of the nature of the problem and therefore the large number of variables to be accounted for within the study, it is important to create a tool/mechanism, which could undertake simulation modelling of economic structural changes and the resultant impact from the afore-mentioned interventions.

This analysis is similar to an alternative economic land-use analysis for the project in terms of the Department of Mineral Resources Regulations recently promulgated.

(We refer to these guidelines as “Regulation 50” guidelines.)

- Regulation 50 has two distinct components, the first being a straight analysis of the economic value of land between a mining project and the predominant alternative land-use, and the second being an opinion on the sustainable development quality of the project relative to the alternative land-use.
- The latter requires the integration of all the social, environmental and economic impacts on a cost-benefit basis. The wording of this requirement is ambiguous and we interpret this as an assessment of the better land-use alternative for this generation without compromising the needs of the next generation.
- Based on Regulation 50, the first task required in terms of this analysis is to report on the property values that would potentially be lost and gained in the continuation of the mining project. We assume the logical reason for this (not stated in Regulation 50) is that at any given time a country has capital stock with which it produces income and a reduction of one type of asset (say farming land), needs to be replaced by another (in this case mining land assets). This calculation is incorporated in the findings below.
- The second task with respect to the alternative land use valuation is the calculation of the Net Present Value of future income streams to determine which alternative land-use yields the most positive economic results for this generation. Our approach in this regard is to obtain the budgeted economic value added from the mine for the duration of its life (which is its Investments, EBITDA, Salaries and Wages less its mine closure costs). The economic value opportunity cost is the economic value lost in agricultural produce of impacted farms. The land use with the highest value is then rated as the better economic alternative land-use.
- Although not stated in Regulation 50 as a requirement to analyse, we deem the net employment gain and lost as an important factor and have considered this analysis as well.

Inception and delineation of study area is required. For the purpose of economic analysis, a delineation of the study area is required. The study area and areas of impact should be delineated into primary (local), secondary (surrounding area of impact) and tertiary area of investigation (broader area). The primary area refers to farm areas and settlements directly affected by the mine and related infrastructure. The surrounding areas and communities/villages refer to the secondary area of investigation and the tertiary area of investigation refers to the broader area, major towns, municipal areas and District that will be economically impacted.

We will make a wide array of socio-economic baseline data available to the project team as downloaded by Quantec Database. This information is not just limited to economic data, but also social and infrastructure development data. The data does not cover health and educational data sufficiently and hence only some data series will be provided.

- A discussion of the economic structure will be provided and the insights and data from the local and district IDP's and LED's will also be integrated (assuming this is up to date and available).

Once all of the background data has been scrutinised it will also be important to develop and cost four scenarios, namely:

- Scenario 1: Farming for the next 25 years
- Scenario 2: Farming for the next 50 years
- Scenario 3: Farming for the next 100 years
- Scenario 4; Farming, followed by coal mining for the life of the mine, rehabilitation, and back to farming for the remainder of the three scenarios as stated above.

The different scenarios will be calculated in excel spreadsheet format using goal seek functions and will be presented in Word Format.

Generally the rule of thumb is to use an economic generation given that GDP income streams are discounted at Risk Free Rate of 8% which means effectively after 50 years an income stream is likely to be close to zero, thus negating the need for a 100 years analysis. However, we will calculate as requested.

The following information regarding costing of the coal mine will be made available by the client:

- Number of persons under full time employment during the operation phase, and employment breakdown and salaries;
- Total cost of salaries/wages (labour);
- Tonnage from proposed mine and timing;

- Lifespan of proposed mine;
- Proposed starting date of construction;
- Type, cost and location of additional secondary developments or expansions proposed;
- Infrastructure development: both mine and non-mine (social development/investments) related;
- Capital expenditure during construction and operation phase;
- Annual income and expenditure breakdown, i.e. annual operating costs and annual turnover;
- Procurement policy (mining operations related), what bought (which sectors), and from where;
- Breakdown of expenses;
- Expected loans required;
- Total annual operational costs; and
- Total cost of materials required during construction and operation phases.

It would also be important to undertake costing for the farming scenario by using the specialist studies regarding soil, land use and land capability. It is however anticipated that additional data not covered by the specialist study would need to be obtained, regarding inter alia:

- Potential development based on demand and supply analysis;
- Farming spin-offs with respect to the tourism market;
- Capital requirements for development;
- Carrying capacity;
- Potential revenue; and
- Employment potential.

The above information needs to be obtained from surrounding farming activities in the area and detailed economic data.

Our approach to this analysis will be as follows (in order to undertake this analysis cost-effectively):

- Interview immediate and indirect farmer on a sample basis.

- Determine the current farming mix as well as land-use (e.g. many farmers have game farming and tourism make up big component of this income).
- Apply the best GGP rate per hectare or employee for both farming and tourism and calculate thus the total potential GDP lost. The GGP per agricultural hectare and GGP per Tourist employee are derived from credible publically available data.

In this manner, the best scenario for agricultural and tourist income lost is obtained.

A critical input from the environmentalists is the potentially fatally impacted farm and tourist land in the area.

Impact modelling per development scenario is required. The purpose of this step is to determine the economic comparative impacts by means of the input-output technique. In terms of quantifying the comparative impacts on the economy an input output model should be utilised for both of the scenarios and scenario components.

An input-output model has various analytical applications that can be used to determine the direct, indirect and induced impact of the proposed transformation process on the economy. The approach takes into account the interdependence between different sectors (i.e. agriculture, mining, manufacturing, government, etc.) in the local economy as well as economic flows of goods and services to and from the economy.

The quantification of the following impacts on the economy for the four scenarios for construction cost and operation should be carried out:

- New business sales: refers to the value of all inter- and intrasectoral business sales generated in the economy as a consequence of the introduction of an exogenous change in the economy. Explained more simply, new business sales equates to additional business turnover as a result of the introduction of an exogenous change in the economy:
- Total employment generation: reflects the number of jobs created or lost as a result of the exogenous change in the economy. A job is defined as one person employed for one year;
- Change in Gross Domestic Product: This measure essentially reflects the sum of wage income and corporate profit generated in the study area as a result of an exogenous change in the economy. The exogenous change in the economy will impact different sectors in different ways, with some sectors benefiting more than others;
- The objective of this task is to determine both the direct, indirect and induced ‘costs’ and potential economic comparative impact in the implementation of the four scenarios; and

- The current values of the impacts should be calculated as well as the exact timing of the impacts. The values should also be discounted over 100 years to arrive at the present benefit.

For this purpose it is important to make a distinction between direct growth elements and indirect impacts.

This analysis refers to previous work steps as well and will be undertaken. The most regional multipliers available are on a provincial level and these will be used. Imputations will be made based on the procurement analysis above.

In order to determine the direct growth possibilities of the various economic sectors of the local economy and to make relative projections, the most appropriate economic techniques should be utilised. The growth potential of each of the economic sectors should be quantified.

The growth analyses should focus on structural changes pertaining to the following:

- Macro-economic trends: These include: Inter-regional strengths and weaknesses, GGP growth (structural changes), Income and expenditure (household level).
- Spatial-sectoral trends: These trends focus on the integration of the economic and spatial dimensions and should, in the main, address the following: Movement patterns (interaction between work and home), Impact of population and activity distribution, density levels, spatial development initiatives, irrigation sector growth: Quantification of growth expectations due to new agriculture projects.
- Indirect Impact Analysis: The impacts of any structural changes in the local economy can be most effectively measured by means of the application of multipliers and the utilization of the input-output technique. An input-output matrix of the broader region should be utilised to capture linkages (forward and backward) and to undertake a multiplier impact assessment that should measure the generated spin-offs and agglomeration impacts to other sectors of the economy.

These results will be drawn together in a memorandum containing the various development scenarios expressed in economic variables.

Upon completion of the comparative impact analysis, the cumulative results of the four scenarios can be compared, e.g. return on investment.

In other words, a final report will be compiled, tabulating the economic comparative impact of the four scenarios and analysing the comparative long-term impacts on the economy taking into account the start-up costs as well as the financial impacts on the economy (both direct and indirect). This should ultimately determine which scenario over the 100 years should have the highest impact on the economy and be the most sustainable and viable option from an economic point of view.

8.1.9 SOILS, LAND USE AND CAPABILITY

The EIA phase of the project will involve a detailed (150 x 150 m grid of observation) survey of the soils occurring, as well as their distribution. Samples of representative topsoil and subsoil horizons will be collected for analysis and the soils will be grouped into homogenous units, with the distribution shown on a map.

All relevant soil information and characteristics will be recorded, including agricultural potential, erodibility, natural drainage and effective depth. The latter is important in establishing the volume of useable (non-plinthic and non-gleyed) soil available for stockpiling and rehabilitation purposes within each mapping unit, and cumulatively within the study area as a whole.

The potential impacts will be assessed using the relevant methodology, so that their significance can be determined.

The prevailing land use will also be noted and shown on a map.

8.1.10 TRAFFIC

As part of the EIA/EMP the extent of the road upgrades will be examined in more detail. Attention will be paid towards the following:

- Areas that are environmentally sensitive;
- Culturally sensitive;
- Have an important water course in close proximity; and
- Housing, schools or hospitals are in close proximity.

These areas will be examined in more detail during the EIA stage as traffic could have an indirect impact on these if upgrades to the road network are required and are in close proximity to these. The traffic could result in having an impact on these areas and as a result of this this needs to be determined and assessed.

In particular the attention will be paid towards areas that are environmentally or culturally sensitive, have a water course running in close vicinity, housing, schools or hospitals in close proximity.

The EIA will also examine other areas in which transport is part of the overall impact. These additional impacts are:

- Noise;

- Air Quality; and
- Vibration.

In order to carry out the EIA/EMP additional information for the transport work would be required in order to provide a more accurate assessment of the impact of transport and for the impact of transport to be more accurately assessed in other areas. The additional information required would consist of the following:

- Details regarding the shift pattern and the times of shifts;
- Number of staff per shift;
- Hours of work for the administrative and managerial staff;
- The amount of coal Exarro expect to transport from the site each day
- Whether waste material generated during the mining process is to be removed from site;
- The internal layout with regards to location of building, the mine pit and the location of internal roads

Following on from this scoping study the EIA should examine the following traffic areas in more detail:

- Geometric design of intersections and roads,;
- Impact with regards to noise, air, vibration;
- Potential impacts on the environment, cultural environment and water courses;
- The internal road network and the impact this will have on the environment

From the various environmental studies carried out, a number of sensitive areas in relation to wetlands and ecology have been determined. It is recommended that these areas are avoided, but that in some circumstances transport infrastructure may have to infringe these areas. If this is the case then the EIA will study the impact that haul roads will have on these areas.

8.1.11 VISUAL

The cumulative visual impacts (taken together with other proposed industrial and mining uses in the study) that would result from the construction and operation of mine would be direct, adverse, and long-term and must be addressed in the assessment phase of the project. The following plan is laid out for the Assessment Phase along with the issues noted here to be addressed:

- A detailed Impact Assessment report will be submitted in response to the proposed activities both mining and supplementary);

- The project will be divided into different phases namely the construction, operation and decommissioning phases of which the significance of the visual impacts will be assessed for each phase.
- Establish/confirm public and Authorities concern for scenic quality of the study area and their perception of what constitutes a sensitive viewing site;
- Determine/confirm the visibility of the mine by conducting a viewshed analysis;
- Determine visual intrusion (contrast) of the proposed mine by simulating its physical appearance from sensitive viewing areas;
- Rate the impact of the mine on sensitive viewing areas: identified potential impacts (cumulative, direct and indirect) will be quantified (where possible) and fully described for each feasible alternative;
- Rate the impact on the scenic quality and sense of place of the study area: identified potential impacts will be evaluated in accordance with the agreed methodology to determine significance. Significance will be determined by considering and quantifying where possible, the nature, extent, duration, intensity and probability of each potential impact.
- Establish management measures (mitigation) to reduce the impact of the proposed activities which will include a detailed description of implementation and means of measuring their success.
- Residual impacts after mitigation will be evaluated (in accordance with the assessment methodology mentioned before) so that actual implemented results can be measured against those predicted;
- Mitigation measures will be suggested for inclusion into the EMP; anticipated costs to implement mitigation measures and recommendations will be suggested.

8.1.12 WETLAND AND AQUATIC

A functional assessment of the wetlands on site will be undertaken using the level 2 assessment as described in “Wet-EcoServices” (Kotze *et. al*., 2005). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions

8.1.13 REHAB, FINAL LAND USE AND CLOSURE

A final land use plan will be compiled based on the current baseline information in terms of the biophysical information gathered during the specialist investigations. It will incorporate the following:

- Baseline situation including the following:
    - Description of the mining activity;
    - Climate;
    - Water;
    - Geology;
    - Soils;
    - Air;
    - Fauna and flora;
    - Hazardous substances;
    - Visual resources and character
    - Land capability and land use
    - Socio-economy aspects;
    - Social framework and demographics; and
    - Infrastructure and services
- Analysis and development, incorporating the following:
    - Site context and sensitivity;
    - Opportunities and constraints;
    - Land suitability for development;
    - Land use schedule and inventory;
    - Access and bulk services;
    - Layout alternatives; and
    - Candidate land use
- Community and stakeholder consultation and engagement
- Final zonation and layout;

- Control and intervention; and
- Implementation

Once the final land use plan has been identified and suitable long-term land use objectives formulated, a rehabilitation plan will be compiled. This will focus on the following:

- Rehabilitation aspects/topics, including reclamation objectives and associated measures for attainment of long-term:
    - Physical stability of surface reclamation, high wall, subsidence areas etc;
    - Environmental quality, especially in terms of possible contaminated water decant and contamination of local groundwater;
    - Land use/land capability from the work under the Land use plan;
    - Health and safety considerations posed by reclaimed pit and related areas;
    - Biodiversity;
    - Aesthetic quality; and
    - Social issues
- Progressive rehabilitation options" where possible, areas/portions of the open pits, subsidence areas that can be rehabilitated in conjunction with operational activities and the alignment of this with the overall mine planning;
- Statutory requirements, both at local and national level; and
- Performance and monitoring

It is important to use the following supporting information, gathered during baseline studies in order to develop the above rehabilitation plan:

- Local groundwater situation and the possible influence on the long-term water balance;
- Long term water balance indicating the period to possible decant as well as the anticipated rate and quality;
- Geochemical analysis of spoils material to be used for pit infilling and/or to be used for ongoing / concurrent rehabilitation. This also includes the requirements for possible selective spoils handling;
- Soil survey of the disturbed (pits/subsidence areas) and adjacent areas not only to inform the possible land capability but also the nature of the material which could be applied to reduce possible ingress through in-filled areas;

- Vegetation of the surrounding areas and the application of this information with rehabilitation and alignment with the overall biodiversity requirements for the mine; and
- The local surface water situation and the re-instatement of local drainage lines and/or possible rerouting of these to reduce possible (pit) discharge.

A closure liability assessment in line with the proposed mining and mining related infrastructure development is required in order to determine the financial provision for closure.

8.2 IMPACT ASSESSMENT METHODOLOGY

The impact significance rating methodology, as provided by EIMS, is guided by the requirements of the NEMA EIA Regulations (2010). The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/ likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$\frac{\underline{C = (E+D+M+R) \times N}}{4}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 70:

Table 70: Criteria for determination of impact consequence

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),

	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table 71.

Table 71: Probability scoring

Probability	1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
	2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
	3	Medium probability (the impact may occur; >50% and <75%),
	4	High probability (it is most likely that the impact will occur- > 75% probability), or
	5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

ER= C x P

Table 72: Determination of environmental risk

Consequence	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 73.

Table 73: Significance classes

Environmental Risk Score	
Value	Description
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥ 9; < 17	Medium (i.e. where the impact could have a significant environmental risk),
≥ 17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/ mitigated.

In accordance with the requirements of Regulation 31 (2)(l) of the EIA Regulations (GNR 543), and further to the assessment criteria presented above it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision making process.

In an effort to ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority / significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/ mitigation impacts are implemented.

Table 74: Criteria for the determination of prioritisation

Public response (PR)	Low (1)	Issue not raised in public response.
	Medium (2)	Issue has received a meaningful and justifiable public response.
	High (3)	Issue has received an intense meaningful and justifiable public response.
Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable loss of resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 74. The impact priority is therefore determined as follows:

$$\textbf{Priority = PR + CI + LR}$$

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (refer to Table 75).

Table 75: Determination of prioritisation factor

Priority	Ranking	Prioritisation Factor
3	Low	1
4	Medium	1.17
5	Medium	1.33
6	Medium	1.5
7	Medium	1.67
8	Medium	1.83
9	High	2

In order to determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

Table 76: Environmental Significance Rating

Environmental Significance Rating	
Value	**Description**
< 9	Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
≥ 9; < 17	Medium (i.e. where the impact could influence the decision to develop in the area),
≥ 17	High (i.e. where the impact must have an influence on the decision process to develop in the area).

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

8.3 TIME FRAME

The dates provided in the following sections are a forecast only and may change as the project progresses.

8.3.1 OVERVIEW OF THE PROCESS TO BE FOLLOWED

An overview of the integrated environmental impact assessment approach is provided below. Forecast dates for submission provided below may change as the project progresses but Authority submission deadlines will be strictly adhered to.

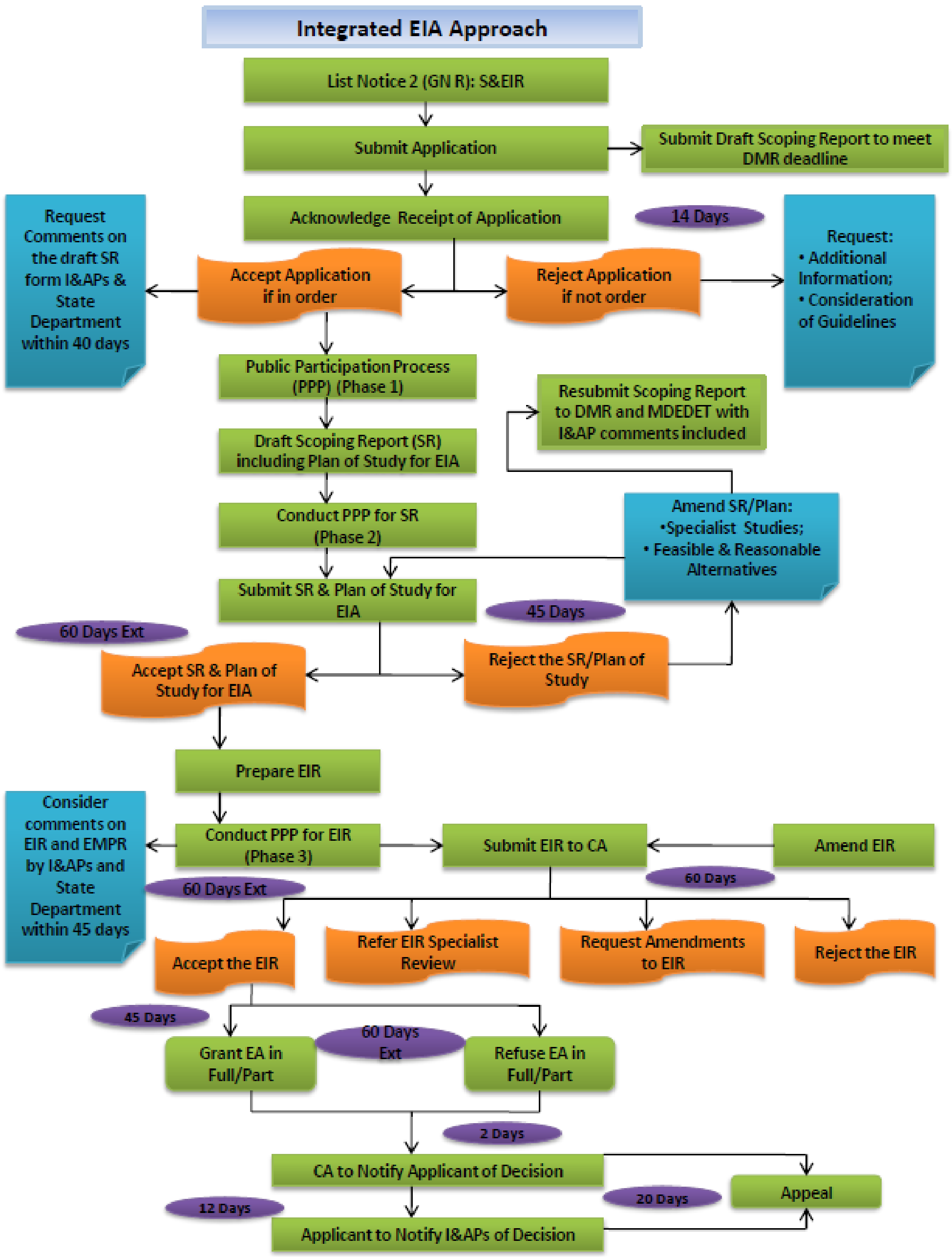


Figure 69: Overview of the integrated environmental impact assessment approach

8.3.2 COMMENTING PERIODS ON PROJECT REPORTS

The commenting periods that will be provided to I&AP's will be forty-five (45) days long. Two commenting periods will be provided for the:

- Scoping Report; and
- EIA/EMP

The 45 day notification, registration, commenting and review of the Draft Scoping Report is complete and began on 1 August 2012 and run until 15 September 2012.

8.3.2.1 Integrated Scoping Report

This document constitutes the integrated scoping report as required by the Regulations stipulated in both the MPRDA and NEMA respectively. This document includes comment from I&AP's and will be submitted to both the DMR and MDEDET for decision making.

8.3.2.2 Draft Environmental Impact Assessment

The draft Environmental Impact Assessment and Environmental Management Programme (including EMPR) is due on 19 December 2012. However, the due date of 19 December 2012 as stipulated by the DMR is indirect conflict with regulations of the NEMA which relate to Public Particpation, as such an extension is formally requested from the DMR in order to adhere to the requirements of the NEMA and to provide I&AP's with a second 45 dau period in which to review the completed EIA/EMP and EMPR. As such Exxaro wish to apply for extension for the submission of the EMPR and EIA/EMP to authorities for decision making at the end of January 2013. The EIA/EMP and EMPR will also entail an Integrated EMPR and will comply with the requirments of the relevant regulations promulgated under both the NEMA and the MPRDA.

8.3.3 RESPONSES TO COMMENTS/ISSUES RAISED

The Integrated public participation process was initiated on 1 August 2012. The first public open day was held on 31 August 2012. IAP's were given until the 15th September 2012 for initial notification, registration, and comment on the draft scoping report. A comments and responses register can be found in Appendix Q and copies of all the returned Registration forms are in Appendix P.

The table below provides a summary of the issues, concerns or comments raised by the I&AP's during the Public Participation Process followed to date.

Table 77: Summary of I&AP Issues

Issue	Raised by
SASS5 and Diatoms	Chris Foster
Public Participation	Chris Foster
Cumulative impacts	Chris Foster
Rehabilitation	David Hepworth
Effect on current receiving environment	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Hadeco (Stuart Barnhoorn and JMD Law) Francois Krige (MPTA) Ursula Franke (EWT) Carolyn Ah-Shene (BirdLifeSA)
Blasting	Maria Wilkie Marguerite Wilkie Minette Eiselen

Issue	Raised by
	Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Amanda Botha (ELM) Ernst van de Berg (ELM) Verne Lello (ELM) John Stevens (ELM) Janet Hendriks
Historical grievances with Glisa Coal Mine	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha

Issue	Raised by
Extent of mining area	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha
Socio-economic	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Hadeco (Stuart Barnhoorn and JDM Law) Francois Krige (MPTA)

Issue	Raised by
Drainage	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha
Noise	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Catherina Visagie Janet Hendriks

Issue	Raised by
Dust	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Catherina Visagie
Vibration	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Catherina Visagie

Issue	Raised by
Run-off management	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Janet hendriks
Air quality	Maria Wilkie Marguerite Wilkie Minette Eiselen Petro Wilkie Sue Sabbagha Corne Wilkie Neville Wilkie Erich Eiselen Con Sabbagha Hadeco (Stuart Barnhoorn and JMD Law)

Issue	Raised by
Railway servitude	Tshilidzi Masalesa (Transnet)
Topsoil	Hadeco (Stuart Barnhoorn and JMD Law)
Current land uses	Hadeco (Stuart Barnhoorn and JMD Law) Ursula Franke (EWT)
Water pollution	Hadeco (Stuart Barnhoorn and JMD Law) Catherina Visagie
Traffic	Catherina Visagie Janet Hendriks
Accommodation	Janet Hendriks
Pollution	Janet Hendriks
Tourism	Janet Hendriks
Fly-Fishing	Janet Hendriks
Wetlands	Francois Krige (MPTA) Carolyn Ah-Shene (BirdLifeSA)
Objections	Hadeco (Stuart Barnhoorn and JMD Law) Carolyn Ah-Shene (BirdLifeSA)

8.3.4 FEEDBACK TO REGISTERED INTERESTED AND AFFECTED PARTIES

Feed back from I&AP's has been solicited through the following means:

- Public Open Days;
- Focus Group Meetings;

- Advertisements;
- Site Notices and Posters;
- Registered Letters;Faxes; E-mails;
- Completion of the questionnairs provided; and
- Any other communication with EIMS

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