THE DUEL COAL PROJECT

Baseline Environmental Report

October 2015

Compiled by:
Jacana Environmentals cc

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

GLOSSARY OF TERMS

TERM / ABBREVIATION	MEANING
AMD	Acid Mine Drainage
AQA	National Environmental Management: Air Quality Act 39 of 2004
Biome	A broad ecological unit representing major life zones of large natural areas – defined mainly by vegetation structure and climate
CARA	Conservation of Agricultural Resources Act 43 of 1983
CBA	Cost Benefit Analysis
CRR	Comment and Response Report
DAFF	Department of Agriculture, Forestry and Fisheries
dBA	Decibels
DEA	Department of Environmental Affairs
DEMC	Desired Ecological Management Class
DMR	Department of Mineral Resources
DM	Dense Medium
DMS	Dense Medium Separator
DWS	Department of Water and Sanitation
Ecological integrity	Overall functioning of the ecological system as a whole
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EIS	Ecological Importance and Sensitivity Classification
EMC	Ecological Management Class
EMPr	Environmental Management Programme
ESA	Earlier Stone Age
ESP	Exchangeable sodium percentage
FAII	Fish Assemblage Integrity Index
GDP	Gross Domestic Product
GPS	Global Positioning system
HIA	Heritage Impact Assessment
IAPs	Interested and Affected Parties
IDPs	Integrated Development Plans
IHAS	Invertebrate Habitat Assessment System
IHIA	Intermediate Habitat Integrity Assessment
ISP	Internal Strategic Perspective

TERM / ABBREVIATION	MEANING
IUCN	International Union for Conservation of Nature and Natural Resources
IWUL	Integrated Water Use Licence
IWWMP	Integrated Water and Waste Management Plan
LCC	Land Claims Commissioner
LEDET	Limpopo Department of Economic Development, Evrironment and Tourism
LIHRA	Limpopo Heritage Resources Agency
LM	Local Municipality
LOM	Life of Mine
LSA	Late Stone Age
Mamsl	Meters above mean sea level
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Run-off
MPRDA	Mineral and Petroleum Resources Development Act 28 of 2002
MRA	Mining Right Application
MSA	Middle Stone Age
Mtpa	Million Tonnes Per Annum
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act 107 of 1998
NEMBA	National Environmental Management: Biodiversity Act 10 of 2004
NEMWA	National Environmental Management: Waste Act 59 of 2008
NFA	National Forest Act 84 of 1998
NFEPA	National Freshwater Ecosystem Priority Areas
NHRA	National Heritage Resources Act 25 of 1999
NWA	National Water Act 36 of 2008
NWCS	National Wetland Classification System
PEMC	Present Ecological Management Class
PES	Present Ecological State
PFD	Process Flow Diagram
PRECIS	Pretoria Computer Information Systems
QDS	Quarter Degree Square
RDL	Red Data List
RDM	Resource Directed Measures
RE	Risk estimation

TERM / ABBREVIATION	MEANING
REC	Recommended Ecological Category
RHP	River Health Programme
ROM	Run of Mine
SAM	Social Accounting Matrix
SANBI	South African National Biodiversity Institute
SAR	Sodium Absorption Ration
SASS5	South African Scoring System version 5
SDF	Spatial Development Framework
SEIA	Socio-Economic Impact Assessment
SIA	Social Impact Assessment
SSC	Species of Special Concern
SUR	Strict Unemployment Rate
TDS	Total Dissolved Solids
TOPS	Threatened or Protected Species
TWQR	Target Water Quality Range
UNESCO	United Nations Education, Science and Cultural Organizations
VIA	Visual Impact Assessment
WHS	World Heritage Site
WMA	Water Management Area
WQO	Water Quality Objective
WQT	Water Quality Threshold
WZ	Weathered Zone

1 CONSERVATION CHARACTERISTICS OF THE DUEL PROJECT

1.1 FORMAL AND INFORMAL PROTECTED AREAS

The recently completed National Biodiversity Assessment (NBA), 2011 provides an assessment of South Africa's biodiversity and ecosystems, including headline indicators and national maps for the terrestrial, freshwater, estuarine and marine environments. The NBA 2011 was led by the South African National Biodiversity Institute (SANBI) in partnership with a range of organisations. It follows on from the National Spatial Biodiversity Assessment 2004, broadening the scope of the assessment to include key thematic issues as well as a spatial assessment. The NBA 2011 includes a summary of spatial biodiversity priority areas that have been identified through systematic biodiversity plans at national, provincial and local levels (SANBI BGIS).

According to the NBA (2011), The Duel Coal Project is not located within a formally or informally protected area. It does however fall within the boundaries of the Vhembe Biosphere Reserve as shown in Figure 2.

Protected areas in the vicinity of the site include:

- Nzhelele Nature Reserve directly to the east
- Honnett Nature Reserve to the north-east

Informal protected areas include the Kuduland Conservancy to the north-east and Ekland Safaris to the west.

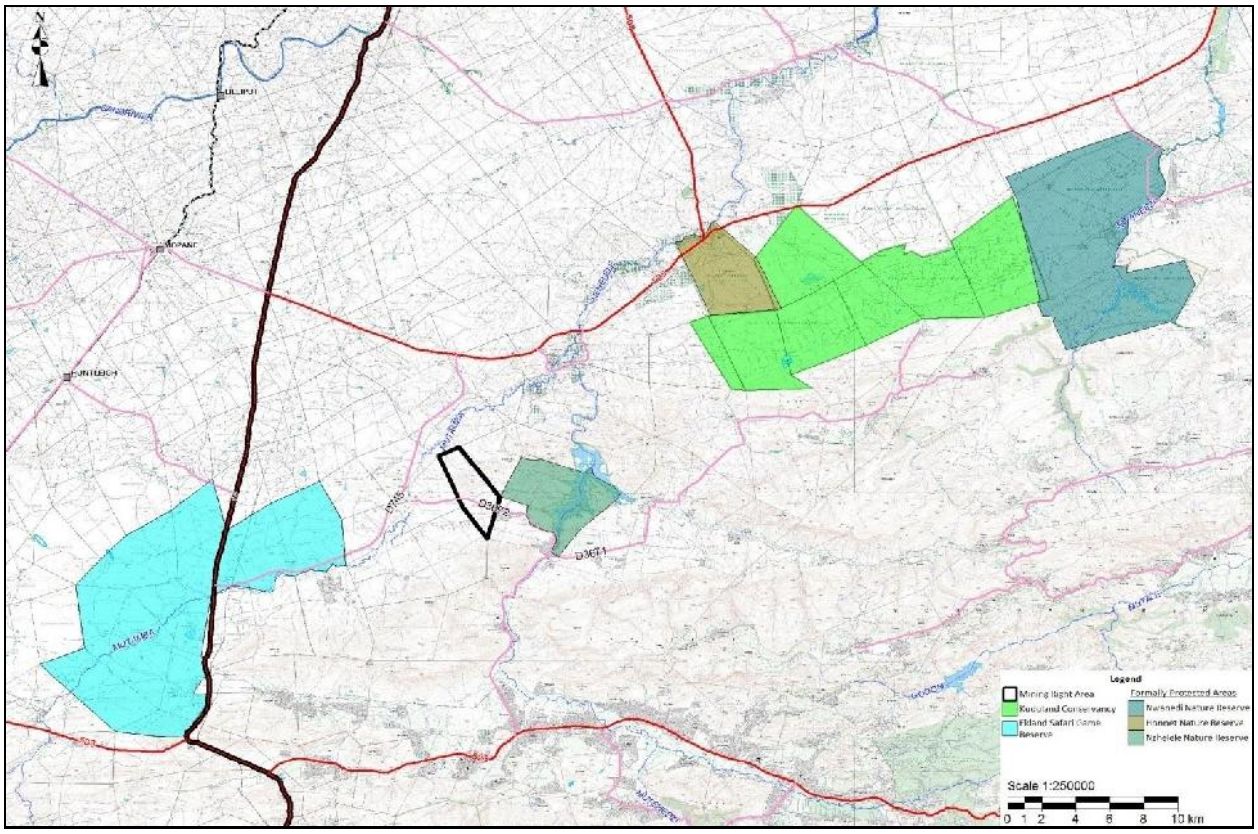


Figure 1: The Duel Coal Project area in relation to the formal and informal protected areas

1.2 NATIONAL LIST OF THREATENED TERRESTRIAL ECOSYSTEMS FOR SOUTH AFRICA (2011)

The NEMBA provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered, endangered, vulnerable or protected. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to conserve sites of exceptionally high conservation value (SANBI, BGIS).

According to the National List of Threatened Terrestrial Ecosystems (2011) the MRA area does not fall into any threatened ecosystems.

1.3 NPAES FOCUS AREAS FOR PROTECTED AREA EXPANSION

The goal of the National Protected Area Expansion Strategy (NPAES) is to achieve cost effective protected area expansion for ecological sustainability and adaptation to climate change. The NPAES sets targets for protected area expansion, provides maps of the most important areas for protected area expansion, and makes recommendations on mechanisms for protected area expansion. It deals with land-based and marine protected areas across all of South Africa's territory (SANBI BGIS).

According to the NPAES database, the MRA area is not affected by areas earmarked as part of the NPAES.

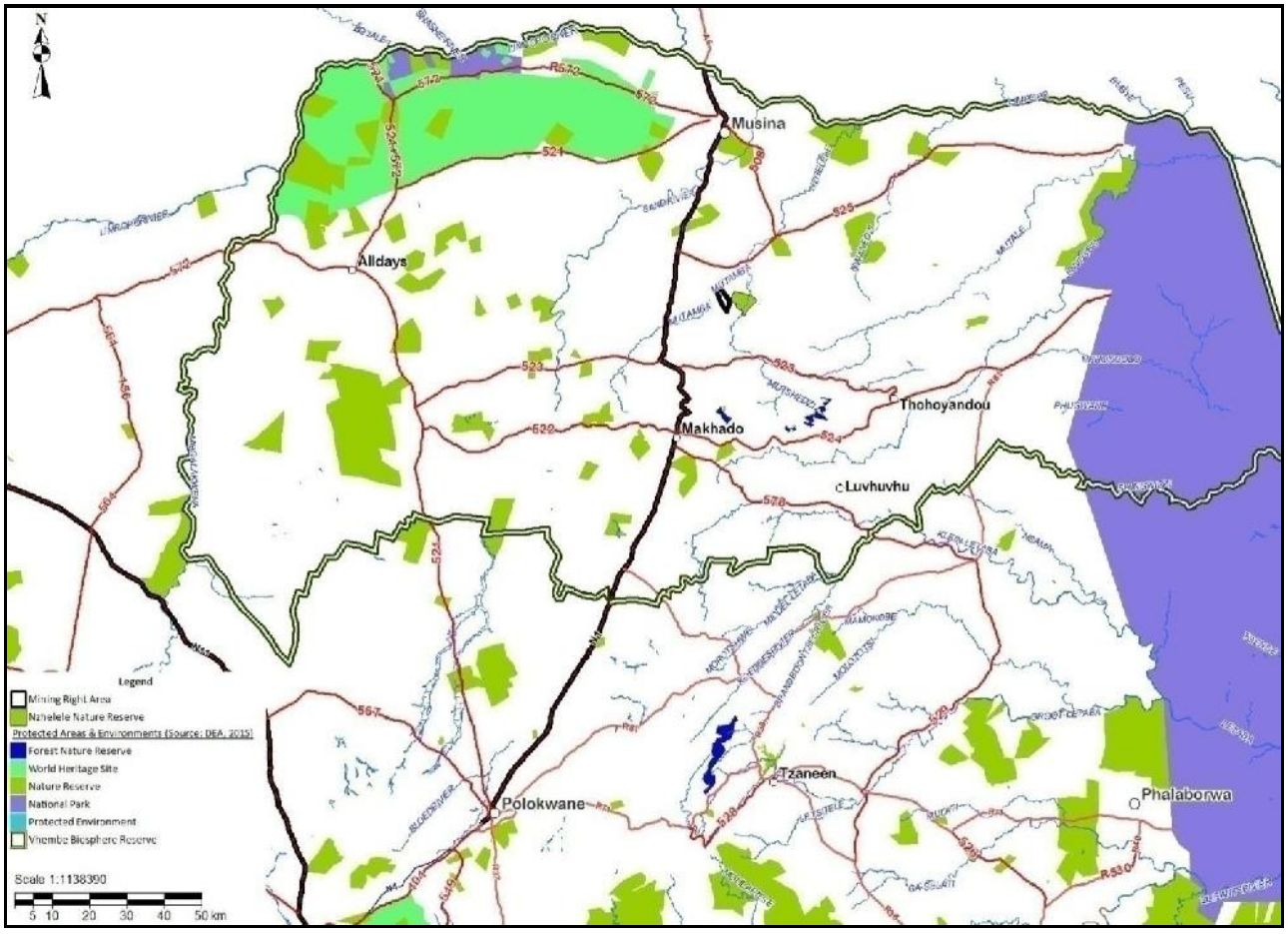


Figure 2: The Duel Coal Project in relation to the VBR and protected areas

1.4 IMPORTANT BIRD AREAS (IBA)

The MRA area falls within the Soutpansberg IBA (IBA 003), which is presented in Figure 3. The Soutpansberg supports a *Gyps coprotheres* (Cape Vulture) colony, which has been fragmented and is located on three separate adjacent cliffs. The thick forest vegetation in the valleys and basins supports a small population of *Poicephalus robustus* (Cape Parrot), as well as *Stephanoaetus coronatus* (Crowned Eagle), *Buteo trizonatus* (Forest Buzzard), *Tauraco corythaix* (Knysna Lourie), *Cossypha dichroa* (Chorister Robin-Chat), *Apaloderma narina* (Narina Trogon), *Coracina caesia* (Grey Cuckooshrike), *Chlorophoneus olivaceus* (Olive Bush-Shrike), *Chlorophoneus nigrifrons* (Black-fronted Bush Shrike), *Mandingoa nitidula* (Green Twinspot) and *Crithagra scotops* (Forest Canary). The bushveld on the slopes holds *Chlorophoneus viridis* (Gorgeous Bush-Shrike), *Cossypha humeralis* (White-throated Robin-Chat) and *Eremomela usticollis* (Burnt-necked Eremomela). The grasslands at the summit of the Soutpansberg hold Protea woodland suitable for *Promerops gurneyi* (Gurney's Sugarbird). The rivers, which run off this catchment area towards the lowveld, are known to hold small populations of *Podica senegalensis* (African Finfoot), *Gorsachius leuconotus* (White-backed Night Heron) and *Scotopelia peli* (Pel's Fishing Owl). Owing to the unique nature of these mountains, and the taxa exclusive to them, it is recommended that additional land be considered for formal protection. The Soutpansberg's river catchments require particular conservation attention (BirdLife South Africa, 2013).

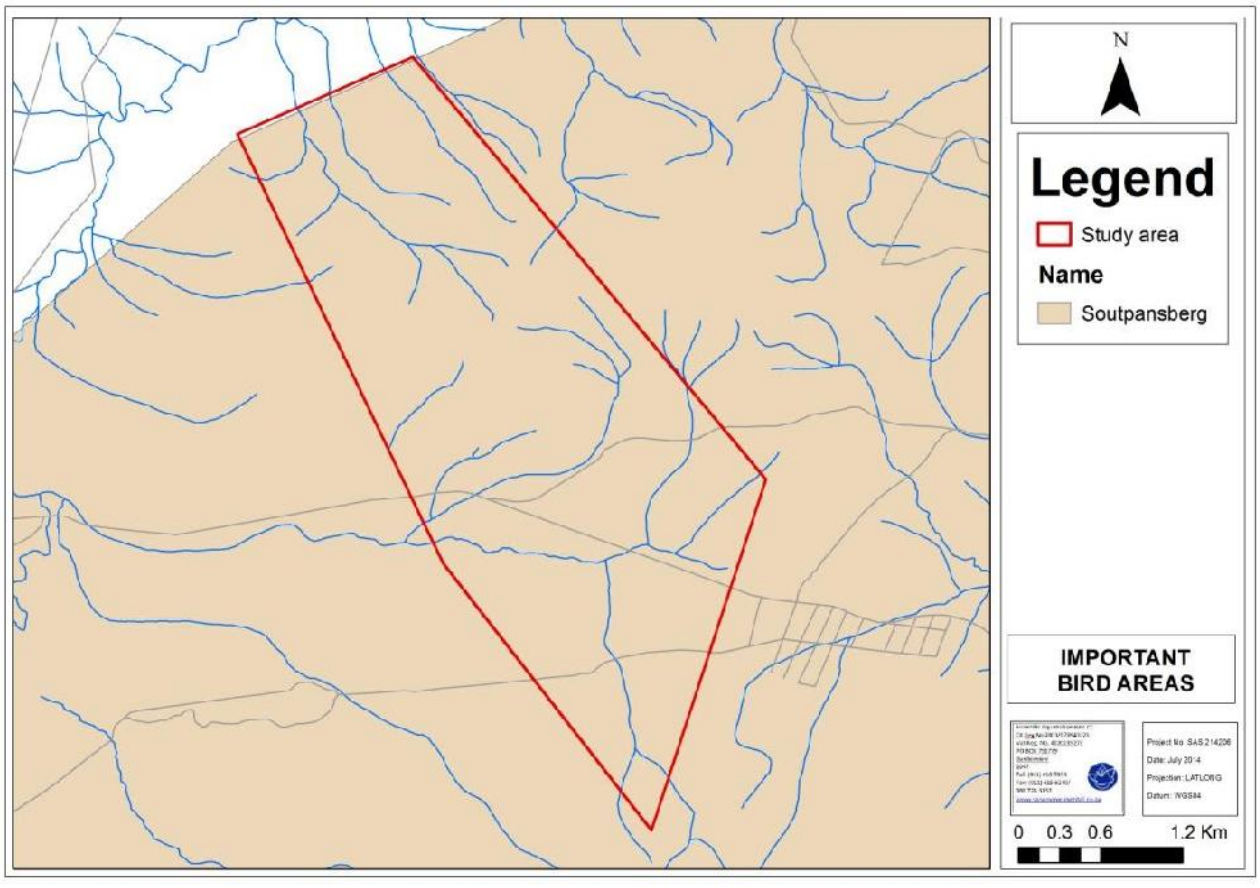


Figure 3: Important Bird Areas

1.5 IMPORTANCE ACCORDING TO THE MINING AND BIODIVERSITY GUIDELINE (2012)

The Mining and Biodiversity Guideline (2012) provides explicit direction in terms of where mining-related impacts are legally prohibited, where biodiversity priority areas may present high risks for mining projects, and where biodiversity may limit the potential for mining. The Guideline distinguishes between four categories of biodiversity priority areas in relation to their importance from a biodiversity and ecosystem service point of view as well as the implications for mining. These categories include: Legally Protected Areas, Highest Biodiversity Importance, High Biodiversity Importance and Moderate Biodiversity Importance.

According to the Mining and Biodiversity Guideline the majority of the study area is located within an area considered to be of Highest Biodiversity Importance (Figure 4). Highest Biodiversity Importance areas include areas where mining is not legally prohibited, but where there is a very high risk that due to their potential biodiversity significance and importance to ecosystem services (e.g. water flow regulation and water provisioning) that mining projects will be significantly constrained or may not receive necessary authorisations.

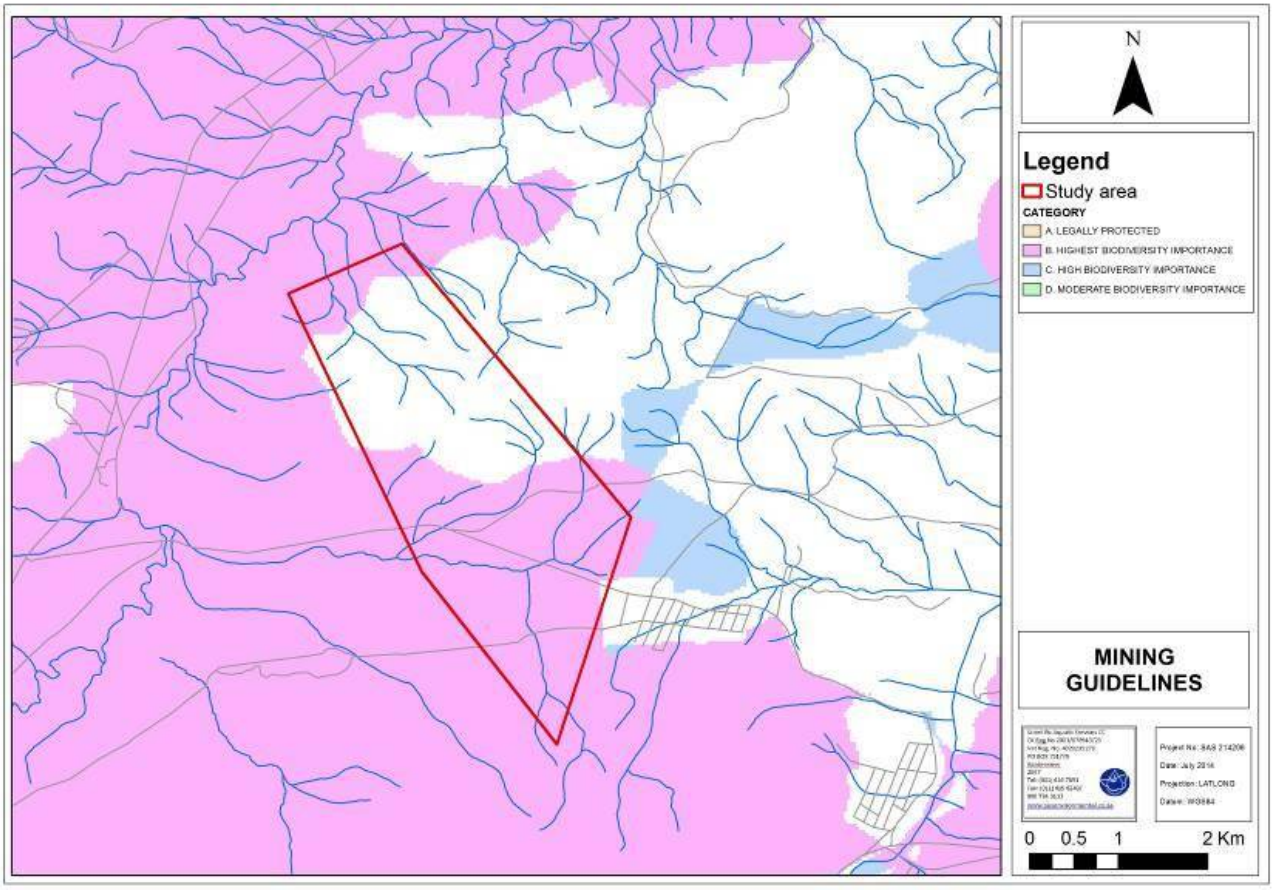


Figure 4: Importance in accordance with the Mining and Biodiversity Guideline (2012)

1.6 IMPORTANCE ACCORDING TO THE LIMPOPO CONSERVATION PLAN VERSION 2

The Limpopo Conservation plan is one of a range of tools provided for in the NEMBA that can be used to facilitate biodiversity conservation in priority areas outside the protected area network. The purpose of this plan is to inform land use planning, environmental assessment and authorisations, and natural resource management, by a range of sectors whose policies and decisions impact on biodiversity (SANBI, BGIS).

The Limpopo Conservation Plan V2 was consulted in order to determine whether the study area falls within any areas of conservation importance. From Figure 5, it is evident that the study area falls within a Critical Biodiversity Area (CBA) 1 and 2. The following land-use guidelines and compatible land uses are proposed for CBA 1 and 2 areas:

- CBA 1:
    - Conservation and associated activities;
    - Extensive game farming and eco-tourism operations with strict control on environmental impacts and carrying capacities, where overall there is a net biodiversity gain;
    - Extensive livestock production with strict control on environmental impacts and carrying capacities;
    - Required support infrastructure for the above activities; and
    - Urban Open Space Systems.
- CBA 2:
    - Current agricultural practices including arable agriculture, intensive and extensive animal production, as well as game and ecotourism operations, so long as these are managed in a way to ensure populations of threatened species are maintained and the ecological processes which support them are not impacted.
    - Any activities compatible with CBA1.

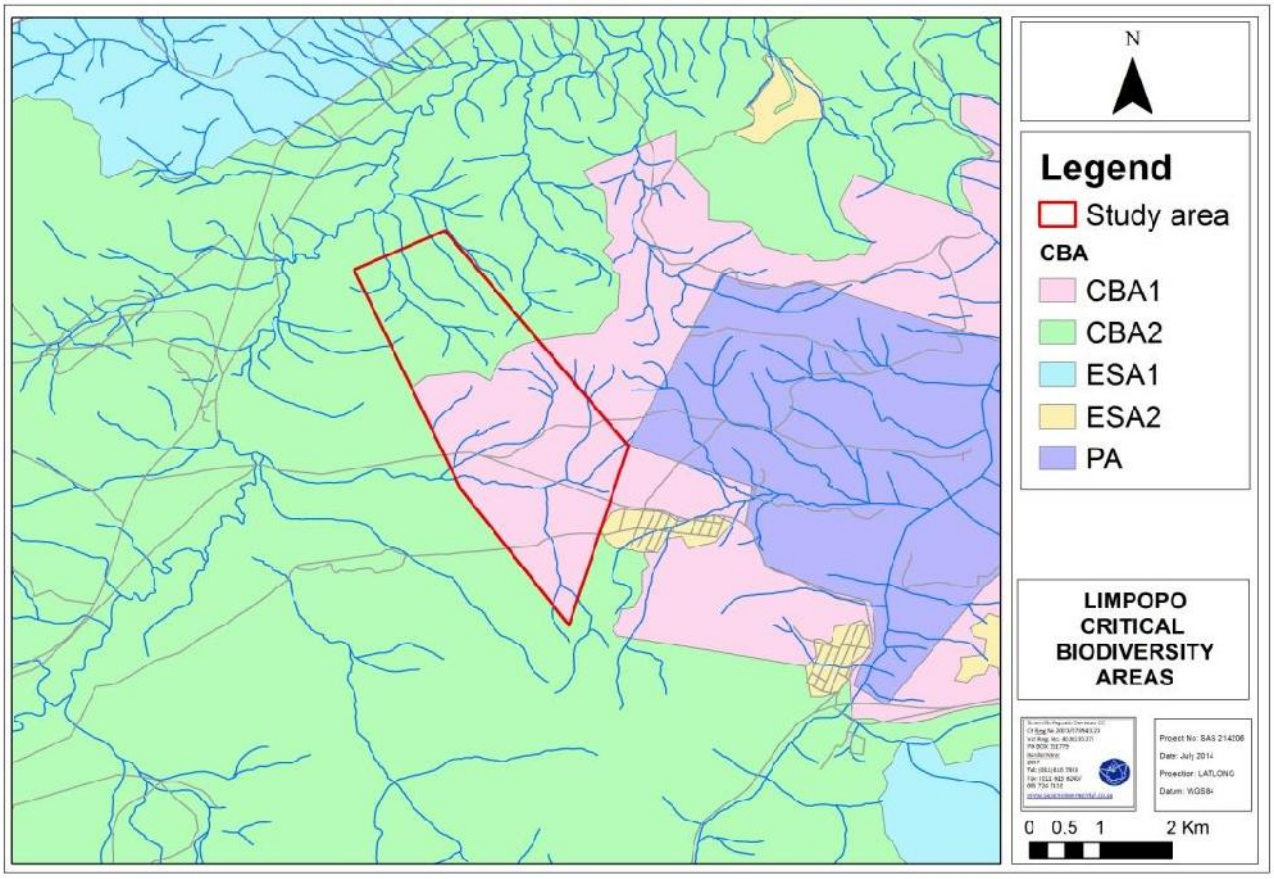


Figure 5: Limpopo Critical Biodiversity Areas

2 BIOPHYSICAL ENVIRONMENT

2.1 TOPOGRAPHY

The study area is also located at the foot of the Soutpansberg Mountains in a low-gradient, plateau-like surface, cut by irregular valleys and hills.

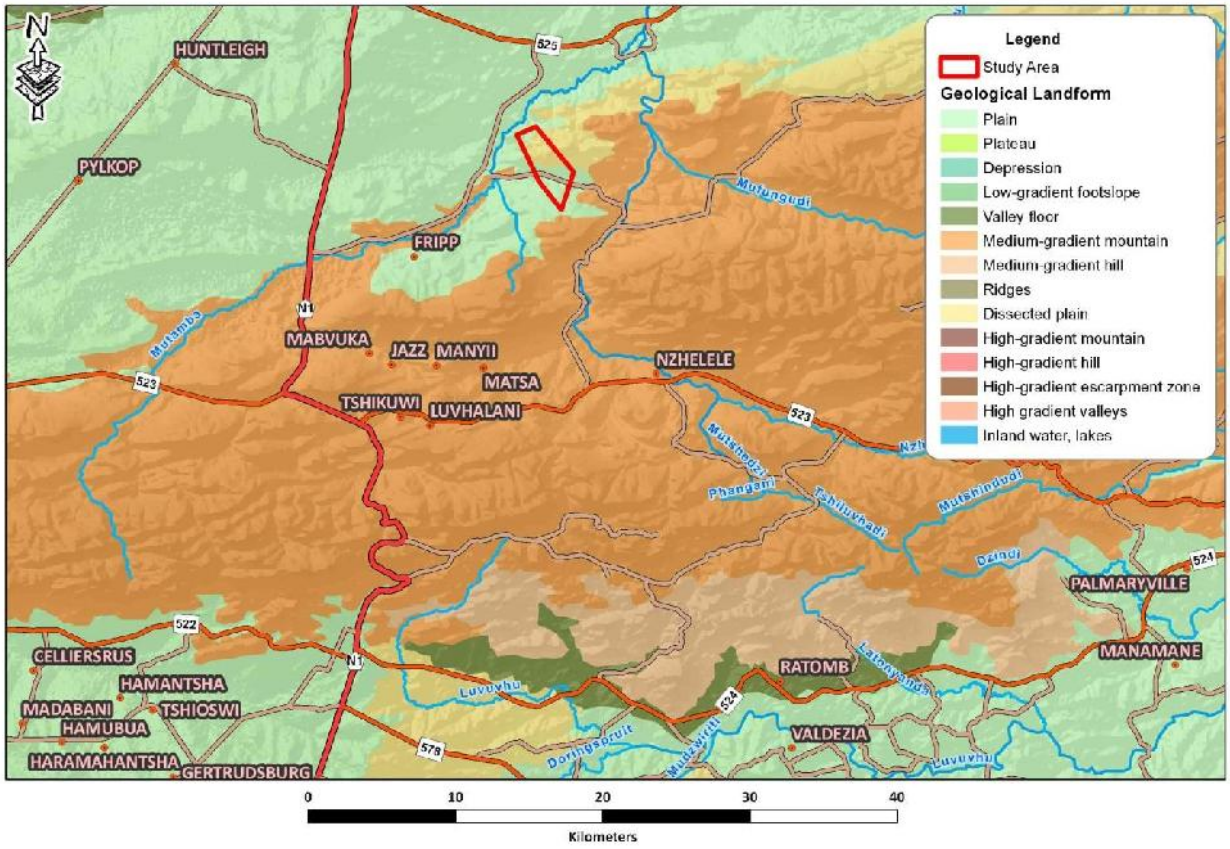


Figure 6: Geological landform

2.2 GEOLOGY

2.2.1 GENERAL GEOLOGY OF THE AREA

The Duel Project is located in the Soutpansberg Coalfield which is situated north of the Soutpansberg Mountain Range. This coalfield extends along the northern parts of South Africa but south of Zimbabwe. It has a strike length of about 200 km and extends from Waterpoort in the west to the Kruger National Park in the east. The Soutpansberg Coalfield is situated north of the Soutpansberg Mountain Range in the Limpopo Province and stretches for ± 190km from Waterpoort in the west to the Kruger National Park in the east. The Soutpansberg Coalfield can be divided into 3 separate coal fields i.e. the Mopane Coalfield, the Tshipise Coalfield and the Pafuri Coalfield (Figure 7).

- The Pafuri Coalfield terminates at the northern limit of the Kruger National Park in the east.
- The Mopane Coalfield lies between the towns of Mopane and Waterpoort in the west.
- The Tshipise Coalfield stretches fromthe town of Mopaneto Tshipise. The Duel is located within this coal field.

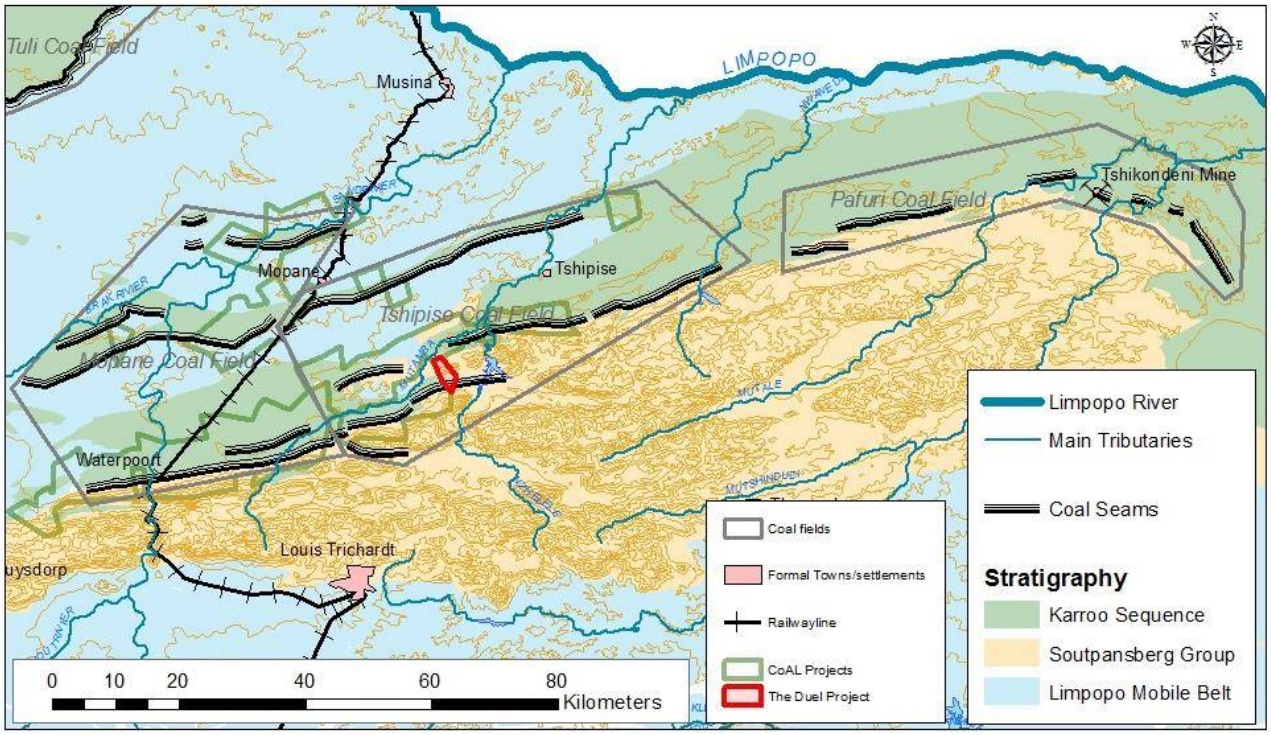


Figure 7: Regional Geology of the Soutpansberg Coalfield

The regional geology consists of 3 main lithological groups, i.e. the Limpopo Mobile Belt, the Soutpansberg Group and the Karoo Sequence rocks:

- The Limpopo Mobile Belt (LMB) forms the gneissic basement on which the overlying strata (Soutpansberg Group and the Karoo Sequence) were deposited. The LMB rocks are the metamorphic expression of the collision and welding together of the Kaapvaalcraton and the Zimbabwe craton. The LMB has a long and complex history of deformation occurring from 3200Ma (million years) to 2000Ma. The LMB gneisses are made up of intra-cratonicsediments andvolcanics, deformed and metamorphosed to granulite facies and intruded by granite bodies which have themselves been metamorphosed to varying degrees. The rift fault systems controlling the various basins, in which the Soutpansberg and Karoo strata have been preserved, are major zones of crustal weakness preferentially re-activated during periods of tectonic instability over time.
- The Soutpansberg/Waterberg Group strata were deposited into rift basins controlled by these major fault systems between 1900 Ma and 1600 Ma. The strata consist of basaltic lavas, arenites and shales attaining a maximum preserved thickness of 5000m. Dipdiection is to the north and can vary from 20° to 80°.
- The Karoo Sequence strata were deposited on LMB basement and/or Soutpansberg Group strata between 300 – 180 Ma. Karoo deposits are preserved in the same reactivated rift basins and are

often terminated against major east-west trending faults on their northern margins. The dips are between 3° and 20° to the north with coal located at the base of the sequence. The nature of the coal deposits changes from a multi-seam coal-mudstone association (7 seams) approximately 40m thick in the west (Mopane Coalfield), to two thick seams in the east (PafuriCoalfield in the Tshikondeni area).

2.2.2 THE DUEL PROJECT GEOLOGY

The full Karoo sequence occurs on the project area and was intersected in several boreholes with the lower most part of the Karoo succession, the Tshidzi Formation deposited on the Nzhelele Formation of the Soutpansberg Supergroup. The grits pass upwards into laminated shale of the Madzaringwe Formation with intermittent lenses of red and yellowish grit in its lower part and containing the coal zones. The succeeding Mikambeni Formation comprises about 15 m of grey (sometimes carbonaceous) or yellowish shales and siltstones with occasional coal seams and is overlain by the Fripp Formation, comprising of 5 to 10 m of clean, well sorted, and medium to coarse-grained, white arkosic sandstone, together with gritty layers and conglomerate lenses. The Solitude Formation consists of siltstones and very fine sandstones with subordinate mudstones while the Klopperfontein and Bosbokpoort Formation is only present in the central part of the basin. At the top sits the Clarens Formation which is subdivided into two members namely, the Lower Red Rocks Member and an Upper Tshipise Member. Several fossilised leaf imprints were observed in the southernmost contact of the Karoo sequence. These occur at the contact between the Tshidzi and the Mazaringwe Formations and are indicative of the sub-outcrops of the lower coal formation.

The Duel Coal Project area is underlain by Karoo sediments deposited unconformably on Soutpansberg strata as seen in the core drilling. The Karoo sediments terminate along its northern limit against a normal faulted contact with Soutpansberg strata and forming an on-lapping sedimentary contact along the southern margin. For purposes of representation the Karoo Sequence is divided into Lower Karoo, Middle Karoo, the Clarens Formation and the Letaba basalts. See Figure 8 and Figure 9 for the project specific geological map and cross-section.

The Lower Karoo consists of a basal glacial deposit overlain by carbonaceous and coaliferous mudstones. From oldest to youngest the stratigraphy is as follows:

- Tshidzi Formation, a 10m thick basal conglomerate/diamictite and can be correlated to glacial Dwyka Tillite in the main Karoo basin. These strata are not always present.
- The Madzoringwe Formation, a succession of alternating black shale, micaceous sandstone, siltstones and inter-bedded coal seams attaining a thickness of 190m. The coals seams are of economic potential.
- The Mikambeni Formation overlying the above consists of dark grey mudstone and shale with subordinate sandstone attaining an approximate thickness of 140m. The Madzoringwe and Mikambeni Formations can be correlated with the Ecca Group of the main Karoo basin.

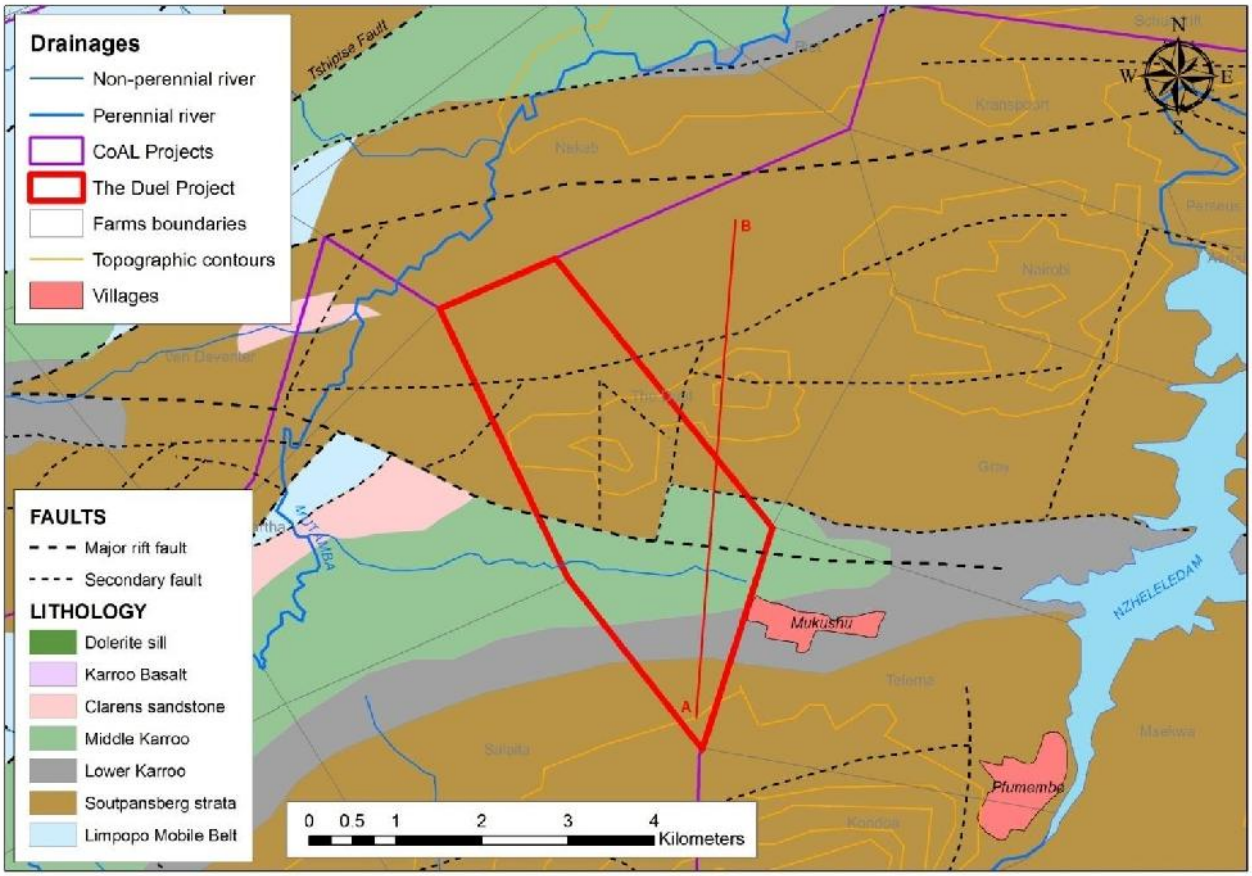


Figure 8: The Duel Coal Project geology

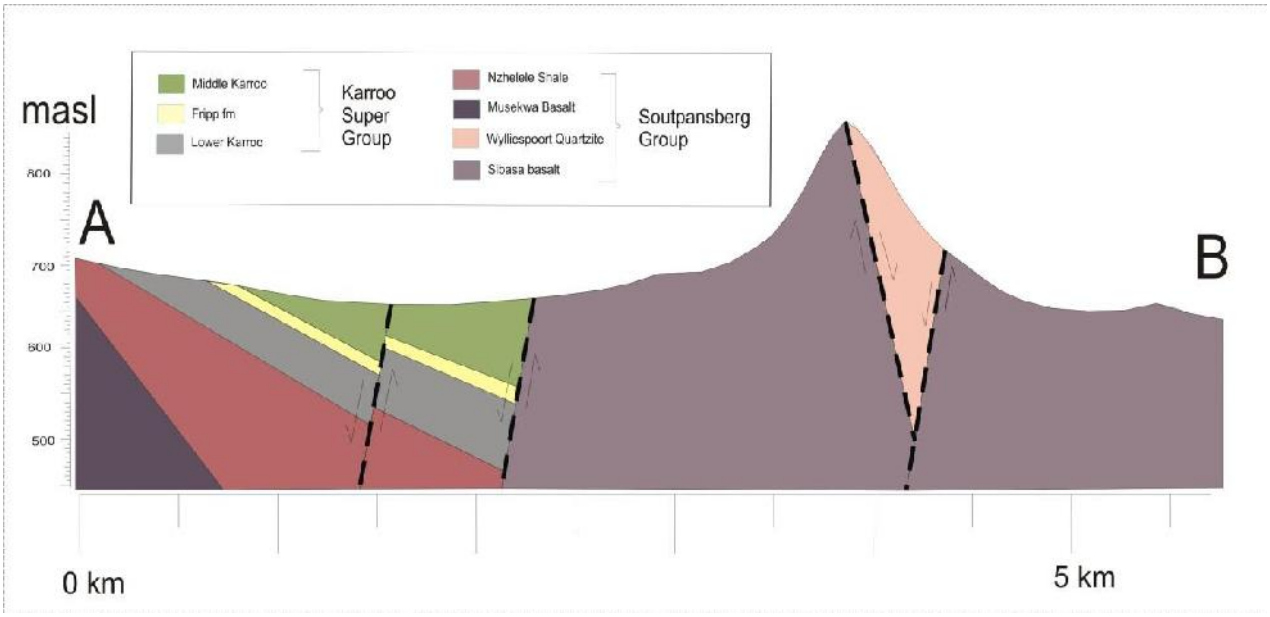


Figure 9: Geological cross section

The Middle Karoo consists of overlying fluvial deposits made up of sandstones and grey, purple and red mudstones. The stratigraphy is as follows:

- The Fripp Sandstone Formation consists (10 – 20 m) of coarse feldspathic sandstone or “grit” and often forms a ridge on outcrop and marks a change from a mature meandering river depositional environment to a braided stream environment. The Fripp is an easily identifiable marker in the core separating the middle Karoo sediments from the carbonaceous lower Karoo.
- The Solitude Formation is a110m thick inter-layered grey and purple shale with minor sandstone and grit intercalations.
- The Klopperfontein Formation (10 – 20 m) resembles the Fripp Sandstone Formation as coarse, feldspathic “gritty” sandstone.
- The overlying Bosbokpoort consists of red very fine sandstone and dark red silty mudstone.
- The fluviatile Red Rocks Member (150 m) of the overlying Clarens fm. For the purposes of this explanation is grouped with the Middle Karoo strata.

The Tshipise Member (150 m) of the Clarens Formation caps the underlying fluvial sediments with aeolian sands as the final expressionof sedimentary deposition in an ever increasingly arid environment.

The Letaba basalt ends Karoo Sequence deposition with widespread outpouring of continental lavas, heralding a period of tectonic instability and the start of the break-up of Gondwanaland. Dolerite sills and dykes served as feeders to the basalt lava and are the hyperbyssal component of this event. There is no basalt in the study area, but dykes and sills of the same age were intersected in the exploration drilling. Dolerite dykes and sill cause disruption of the host rock and can act as aquifers.

2.2.3 STRUCTURE

The structure on the property consists of horst and graben featurestypical of a rift environment with Karoo sediments preserved in down faulted troughs. The faults trend in an east west direction causing some duplication in both Karoo and Soutpansberg strata. The faults intersected with brittle horizons such as the coal layers and the sandstone layers will host water.

2.3 CLIMATIC DATA

2.3.1 CLIMATE ZONE

The northern part of the Limpopo Province is situated in a dry savannah sub region, characterized by open grasslands with scattered trees and bushes. The Soutpansberg mountain range is a major regional topographic feature and it extends in an east-west direction for a distance of approximately 130 km. The regional climate is strongly influenced by the east-west orientated mountain range which represents an effective barrier between the south- easterly maritime climate influences from the Indian Ocean and the continental climate influences (predominantly the Inter-Tropical Convergence Zone and the Congo Air Mass) coming from the north.

The region is characterized by Warm Temperate to AridClimate conditions as classified by the 2012 CSIR Köppen-Geiger map for South Africa (Conradie and Kumirai, 2012).

The climate for the region varies from warm summers with dry winters (Cwa) in the south and in close proximity to the Soutpansberg Mountains to Hot Semi-Arid and Arid (Bsh & Bwh) conditions north of the mountains. The regional climate conditions are shown in Figure 10.

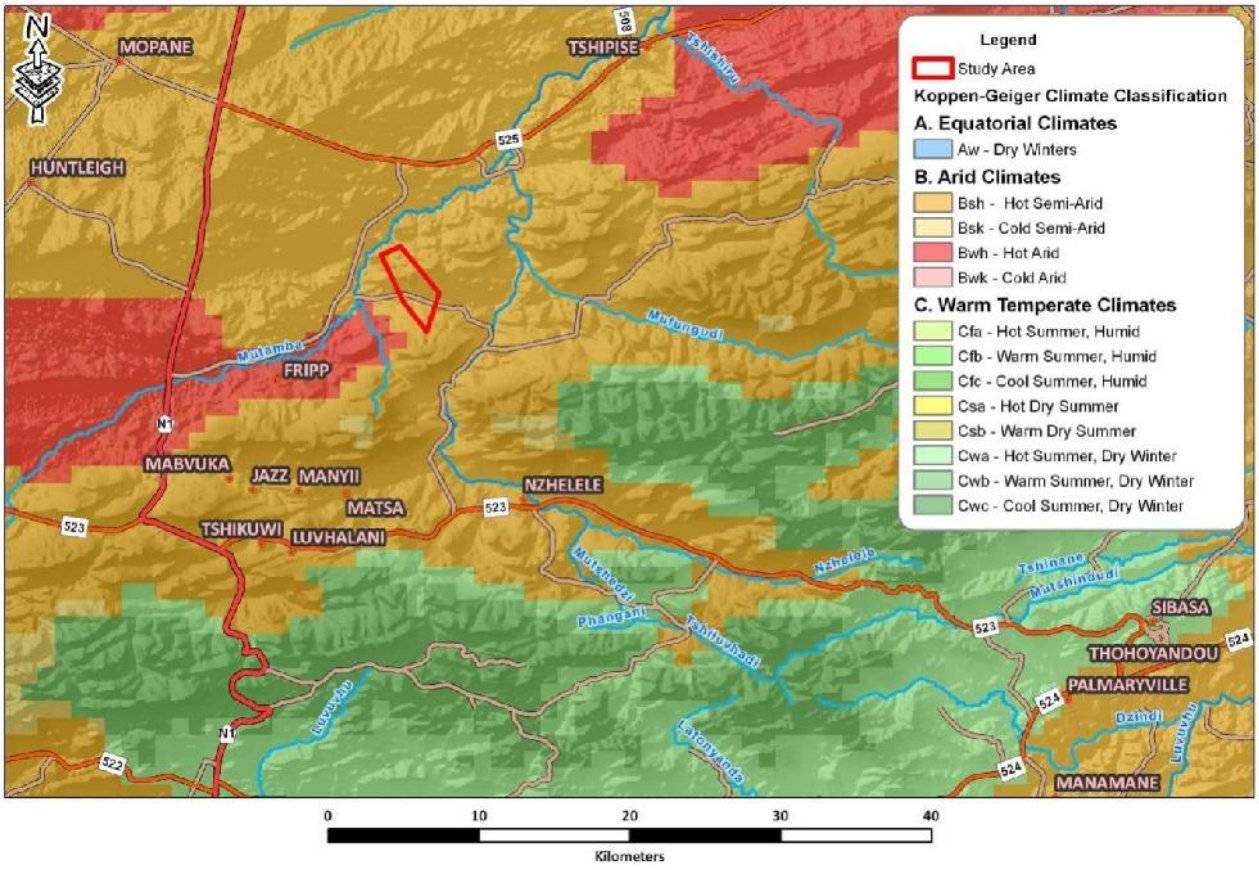


Figure 10: Regional climate conditions

2.3.2 TEMPERATURE

Average monthly minimum and maximum temperatures for the Tshipise weather station (No. 0766277 1) some 5 km north-east of The Duel Project area is shown in Table 1. Note that this station is the closest station with long term available climate data. Average daily maximum and minimum summer temperatures (November to February) at the weather station range between ~33°C and ~20°C, while winter temperatures (May to August) range between ~28°C and ~7°C respectively. The high average temperatures are reflected by the fact that the minimum average daily summer temperature is a high 20°C and the minimum average daily winter temperature does not dip below 7°C.

Table 1: Temperature data for Tshipise for the period from 1994 to 2006

Month		Temperature (° C)		
	Highest Recorded	Average Daily Maximum	Average Daily Minimum	Lowest Recorded
January	42.2	32.8	21.5	12.6
February	41.4	32.3	21.5	14.9
March	42.9	31.5	20.1	13.0
April	40.9	30.1	16.3	5.7
May	42.3	27.9	11.2	1.7
June	34.3	25.6	8.2	-0.4
July	34.1	25.0	7.3	-1.2
August	37.4	27.8	10.3	1.7
September	41.2	27.7	12.9	3.6
October	41.4	29.1	16.5	8.0
November	42.5	32.2	20.1	11.1
December	43.4	33.1	21.0	13.8
Year	43.4	29.6	15.6	-1.2

Source: Weather SA (Station No 0766277 1)

The Department of Agriculture's Agricultural Geo-referenced Information System (AGIS) hosts a wide spectrum of spatial information maps for public use. Figure 11 and Figure 12 indicate the maximum and minimum annual temperature for the region that was obtained from their natural resources atlas on climate.

The area is characterized by cool, dry winters (May to August) and warm, wet summers (October to March), with April and September being transition months. Temperature ranges from 0.9°C to 39.9°C and the area is generally frost free.

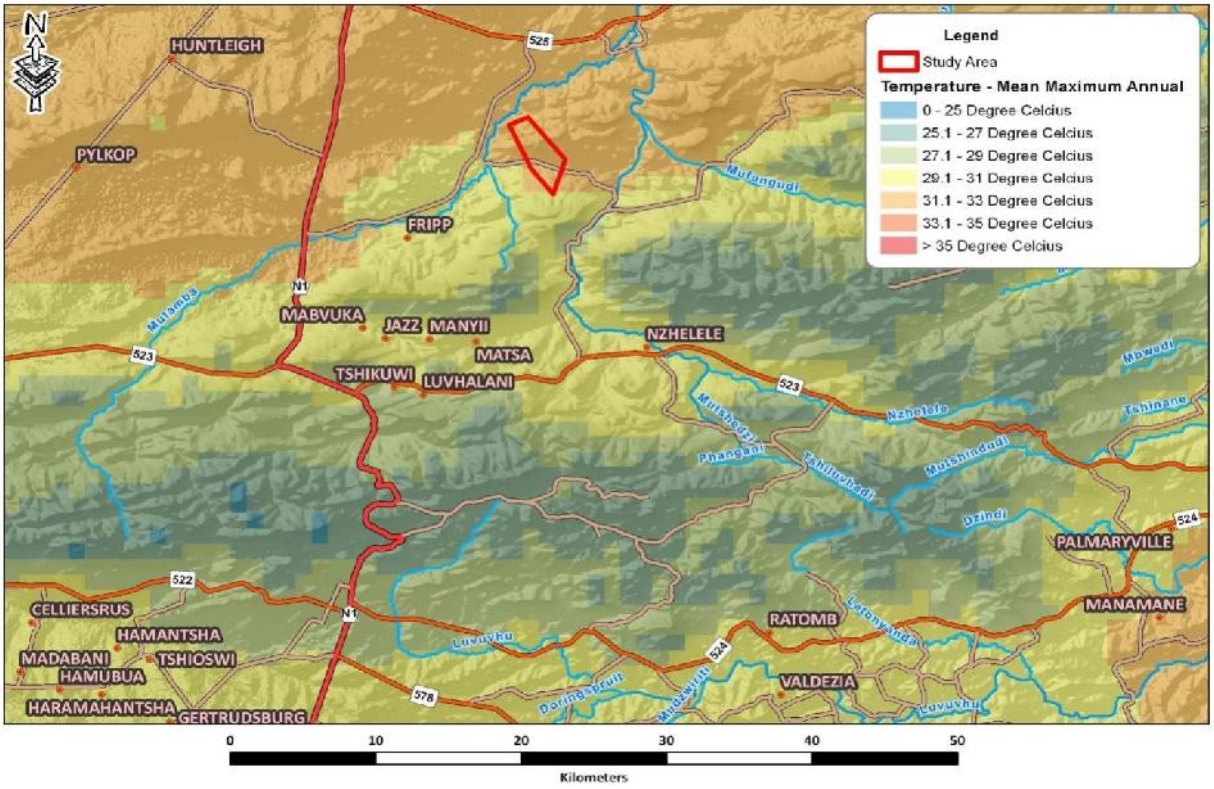


Figure 11: Mean annual maximum temperature

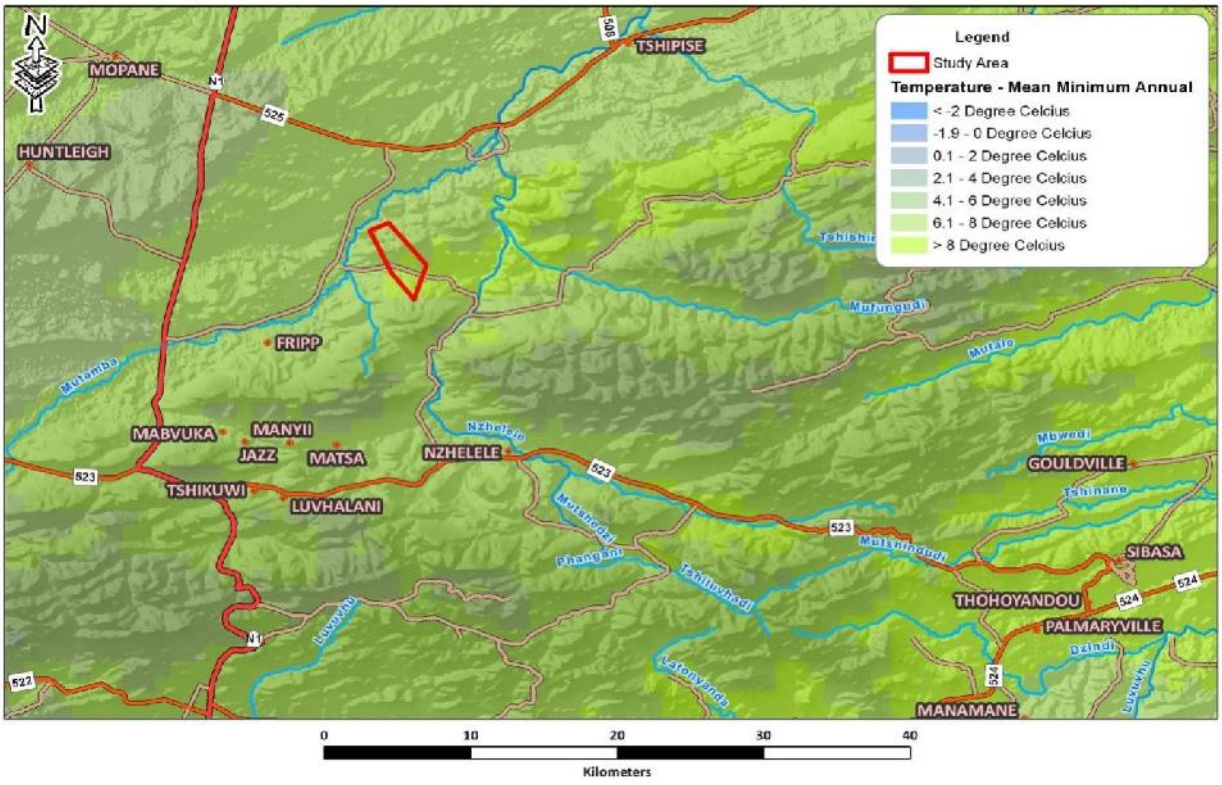


Figure 12: Mean annual minimum temperature

2.3.3 MEAN ANNUAL PRECIPITATION AND MEAN MONTHLY RAINFALL

The mean annual precipitation (MAP) distribution for the region is shown in Figure 13 and varies from 1600-1700mm south of the Soutpansberg Mountains to 200-300mm north of the mountains near Mopane.

The Duel Coal Project is located in the hot-arid zone to the north of the Soutpansberg where the rainfall is in the order of 300-500 mm per annum. The area experiences summer rainfall which occurs in the form of heavy thunderstorms or soft rain. It is characterised as being hot and dry resulting in high evaporation rates.

Note that the region is also within the impact zone of tropical cyclones occurring in the Indian Ocean which may cause high-intensity rainfalls leading to peak run-off events. These events occurred here for example in 1958 (Astrid), 1976 (Danae), 1977 (Emily) and 2000 (Eline) (Van Bladeren and Van der Spuy, 2000).

The Duel Coal Project area span across the quaternary catchment A80F as defined in the WR2005 Study (Middleton and Bailey, 2009) which is located in Rainfall Zone A8A. The mean monthly precipitation values are given in Table 2. The maximum monthly rainfall occurs in January and the lowest in August. The monthly distribution pattern of rainfall in the quaternary catchment is shown in Table 3.

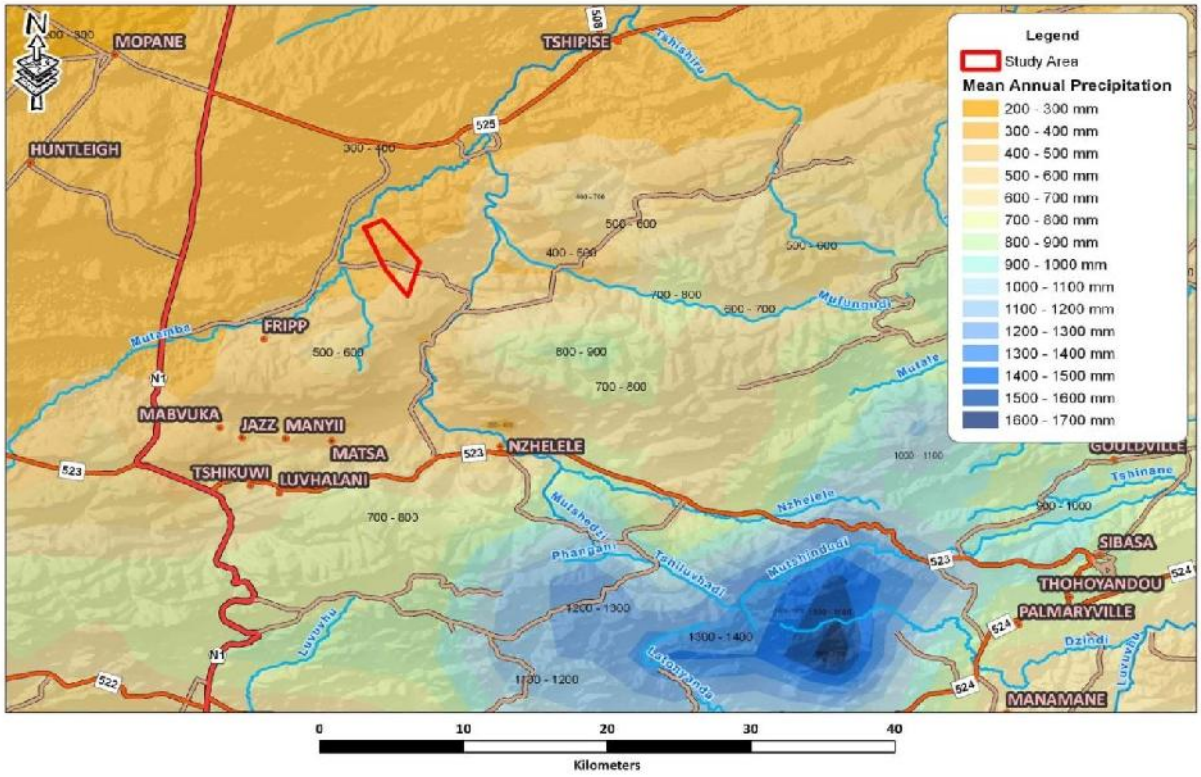


Figure 13: Mean annual precipitation

Table 2: Mean monthly rainfall distribution of site rainfall zone A8A

Rainfall Zone	Mean Monthly Precipitation (%Distribution)											
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
A8A	6.46	11.81	15.17	20.17	18.66	13.16	5.40	2.29	1.63	1.66	1.15	2.43

(Source: Middleton, B.J. and A.K. Bailey (2009). Water Resources of South Africa, 252005 Study. WRC Rep No TT381. Pretoria)

The absolute monthly rainfall (% distribution x MAP) in the site's quaternary catchmentsare shown in Table 3. The average rainfall for the catchment has been determined and the maximum rainfall of 78mm occurs in January and the lowest of 4mm in August. The data in the table is shown in the bar chart below (Figure 14).

Table 3: Mean monthly quaternary rainfall (mm)

Quaternary Catchment	MeanAnnual Precipitation (mm)	Rainfall Zone	Mean Monthly Precipitation (mm)											
			OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
A80F	388	A8A	25	46	59	78	72	51	21	9	6	6	4	9

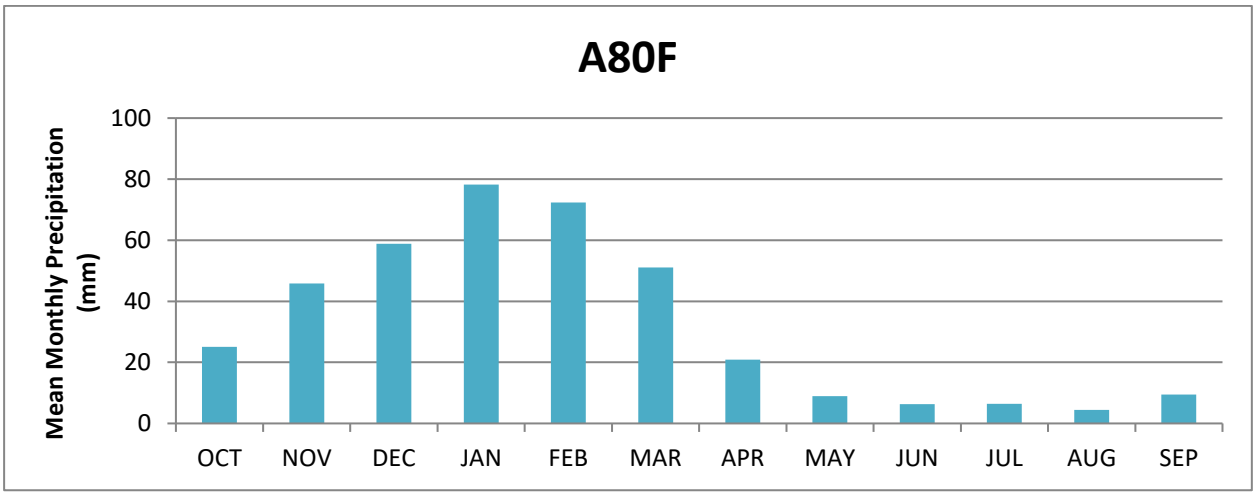


Figure 14: Distribution of mean monthly precipitation (mm)

2.3.4 RUNOFF AND EVAPORATION

2.3.4.1 Mutamba River basin runoff

The DWS has delineated the country's river systems into 22 major drainage basins, referred to as 'Primary' catchment areas. Each basin has subsequently been subdivided into secondary, tertiary and quaternary catchment areas. The Limpopo River Basin was designated as river basin 'A' and the proposed development is located within this basin. It is situated mainly within the Nzhelele River Sub-Basin, which is a tributary of the Limpopo River. The upper reaches of the Nzhelele River, including its tributary the Mutamba River, originate from the Soutpansberg Mountain range in the vicinity of Makhado, approximately 50 km south of The Duel Coal Project Area. The Mutamba River drains a substantial dry bushveld area, an area north of the mountains which is drier than the feeder areas of the Nzhelele River.

The Mutamba River flows into the Nzhelele River downstream of the Nzhelele Dam, at the outlet of catchment A80F. The unit runoff in the Mutamba River is shown in Table 4. The catchment hydrological data of this summer rainfall region are summarized in Table 5. The Mean Annual Runoff (MAR) value is based on the net catchment area shown in the table.

Run-off data were generated on a quaternary catchment area scale in the WRSM2000model, an enhanced version of the original Pitman rainfall-run-off model, since there are no reliable long term measured flow data for most of the catchment. Note that the present day MAR is not reflected in the table since it shows the naturalized run-off generated within the catchment. To obtain the present run-off, all surface water uses in the catchment area must be subtracted.

Table 4: Catchment data (from WR2005) of the Mutamba River basin

Quaternary catchment	Net area (km^2)	Mean Annual Precipitation (mm) MAP	Mean Annual Run-off (mcm) MAR	Mean Annual (gross) Evaporation (mm) MAE (Zone1B)	Irrigation area (km^2)	Forest area (ha)
A80F	491	388	3.37	1750	0	0

The naturalized run-off in the Mutamba River upstream of the outlet of quaternary catchment A80F has been compiled from data in WR2005 and the resultant MAR is 84.34 million m^3/a as shown in Table 5.

Table 5: Mutamba River naturalized run-off at the exit of quaternary catchment A80F (mcm = million cubic metres)

Quaternary Catchment	River	Mean Monthly Natural Runoff (mcm)												Mean Annual Natural Runoff (mcm)
		OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
A80F	Mutamba& Nzhelele	1.33	2.05	3.64	14.41	24.70	18.16	7.86	4.18	2.91	2.16	1.64	1.27	84.34

The spatial representation of the regional MAR as defined in the WR2005 Study (Middleton and Bailey, 2009) is shown in Figure 15.

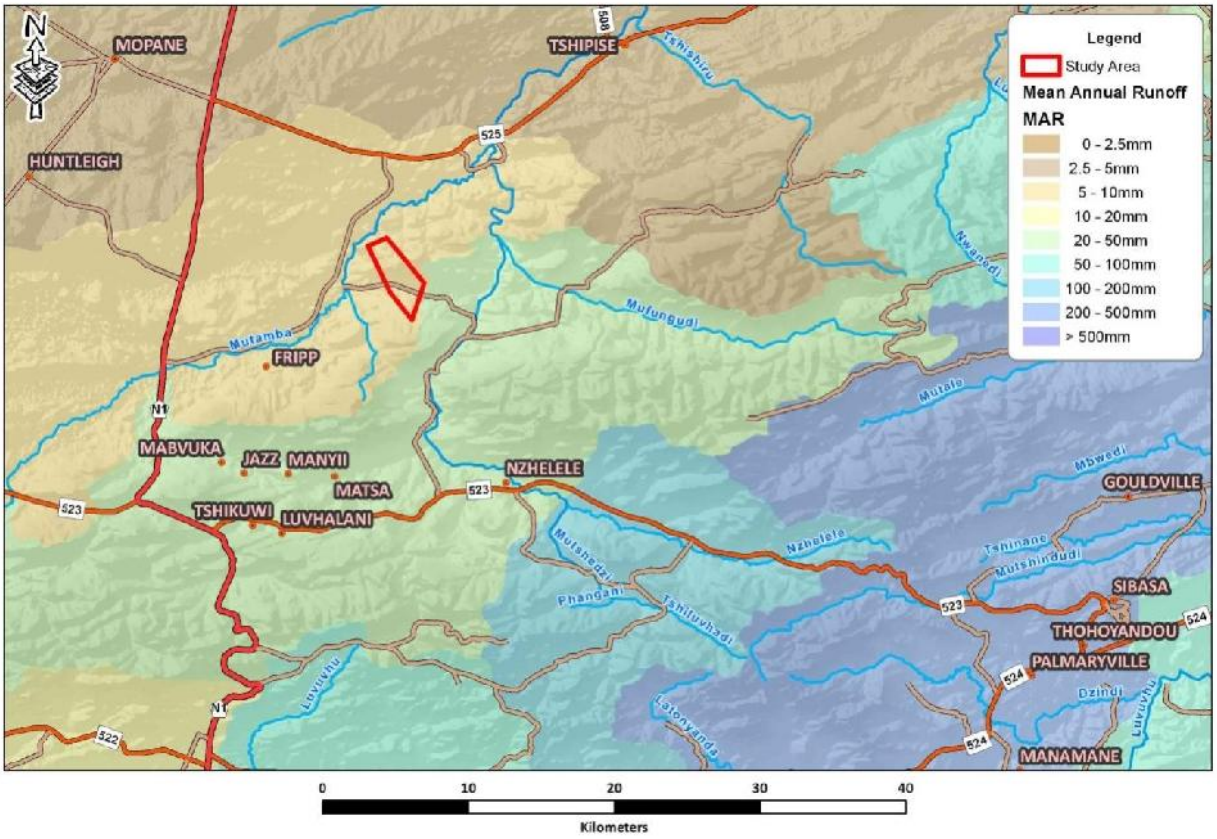


Figure 15: Regional MAR (mm)

2.3.4.2 Evaporation

Mean Annual Evaporation data is given in Table 4, while the monthly evaporation pattern (as percentages of the total) is given in Table 6. The spatial representation of the regional Mean Annual Evaporation as defined in the WR2005 Study (Middleton and Bailey, 2009) is shown in Figure 16 below.

Table 6: Monthly evaporation distribution

Month	Evaporation (%)
October	10.46
November	10.03
December	10.68
January	10.43
February	8.49
March	8.49
April	6.94
May	6.55
June	5.40
July	6.08
August	7.42
September	9.03

Source:WR90,evaporationzone1B,basedondatafromAlbasiniDam

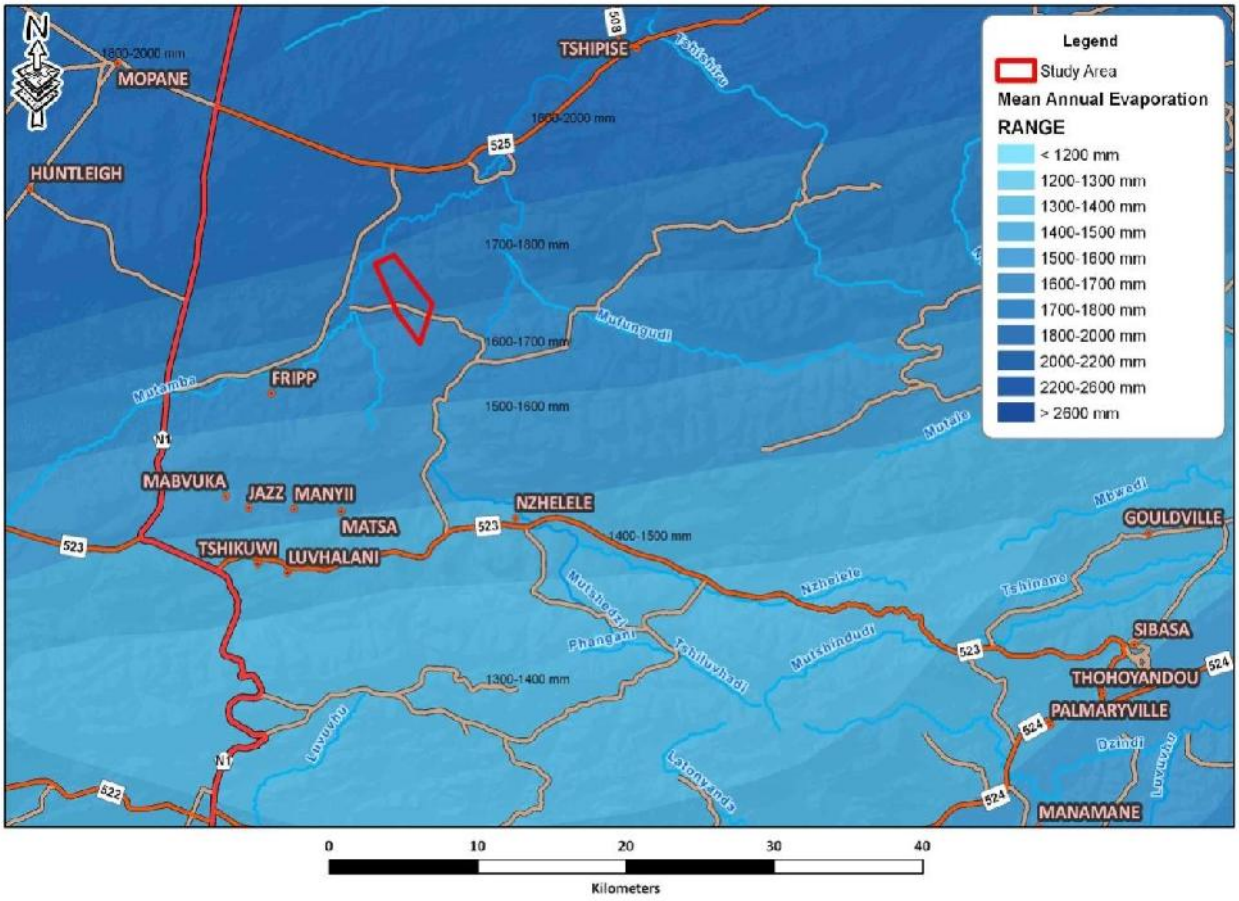


Figure 16: Regional mean annual evaporation (mm)

2.3.5 WINDS

Wind roses comprise of 16 spokes which represents the direction from which the winds blew during the period under review. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories.

Based on an evaluation of the site-specific meteorological data obtained from the South African Weather Services in Makhado, Limpopo Province, the following deductions regarding the prevailing wind direction and wind frequency can be presented.

Based on Figure 17 below, the predominant wind direction for the area under review is mainly from the south eastern region. Secondary winds occurred mainly from the eastern region. Calms wind (<0.5 m/s) were experienced 0.1 % of the time. The most frequent wind speed of 0.5-2.1 m/s occurred 40.7% of the time. Wind speeds between 2.1 -3.6 m/s were experienced 34.6% of the time, while wind speeds between 3.6 -5.7 m/s was experienced 22.9% of the time. High wind speeds of 5.7 -8.8 m/s occurred less frequently at 1.7% of the time.

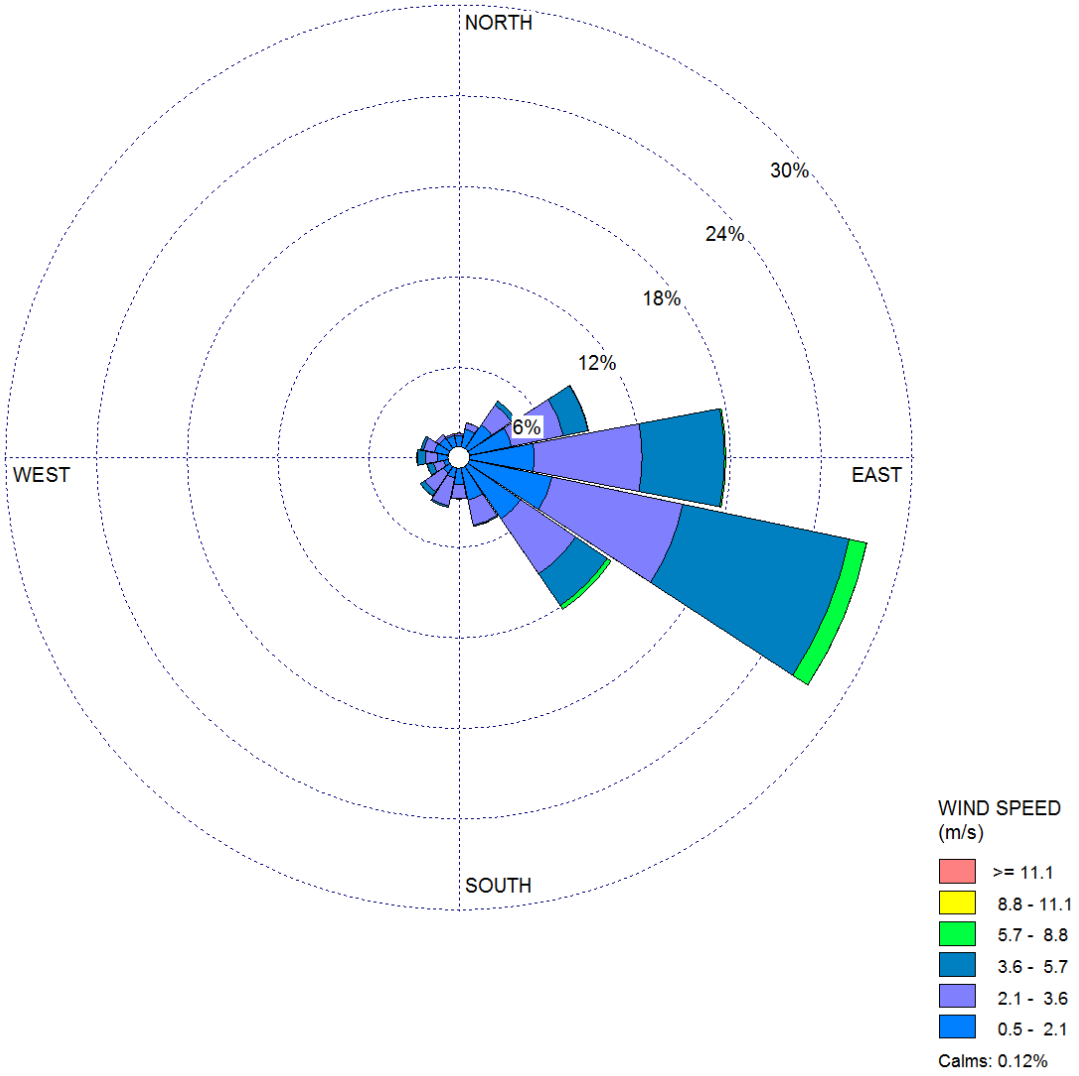
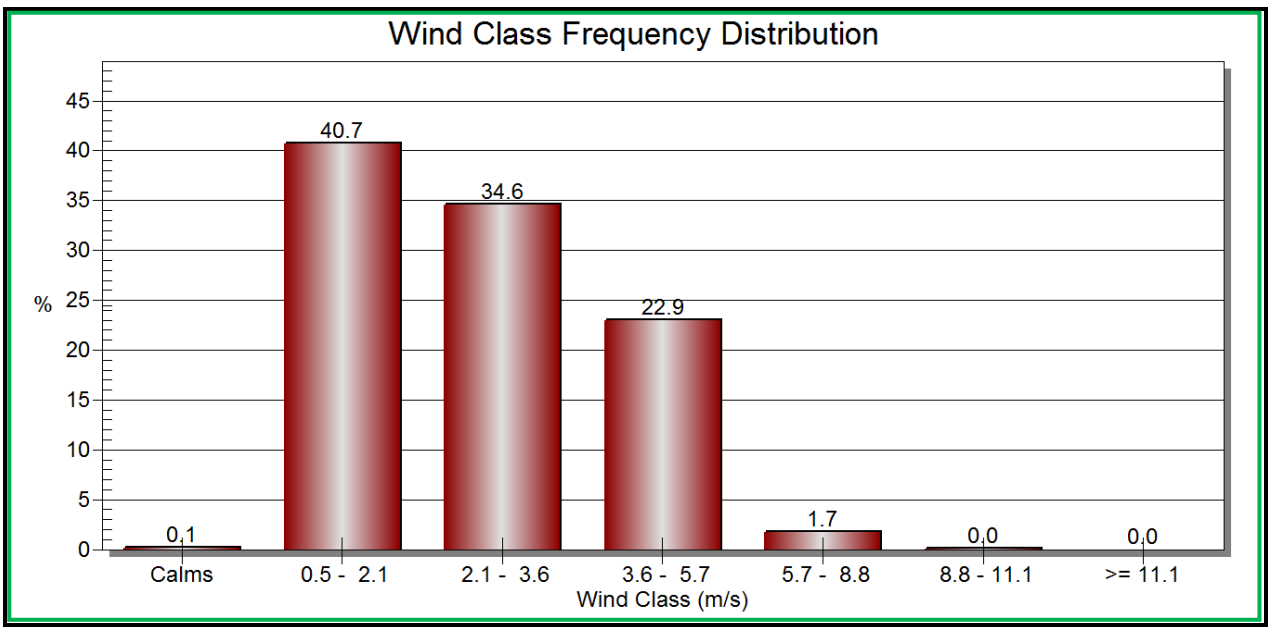


Figure 17: Period wind rose for the Jan 2008 – Dec 2012 monitoring period



2.3.5.1 Atmospheric stability

Atmospheric stability is commonly categorised into one of seven stability classes.

A	Very unstable	calm wind, clear skies, hot daytime conditions
B	Moderately unstable	clear skies, daytime conditions
C	Slightly Unstable	moderate wind, slightly overcast daytime conditions
D	Neutral	high winds or cloudy days and nights
E	Slightly Stable	moderate wind, slightly overcast night-time conditions
F	Moderately stable	low winds, clear skies, cold night-time conditions
G	Very stable	Calm winds, clear skies, cold clear night-time conditions

The atmospheric boundary layer is usually unstable during the day due to turbulence caused by the sun's heating effect on the earth's surface. The depth of this mixing layer depends mainly on the amount of solar radiation, increasing in size gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. The degree of thermal turbulence is increased on clear warm days with light winds. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral. A neutral atmospheric potential neither enhances nor inhibits mechanical turbulences. An unstable atmospheric condition enhances turbulence, whereas a stable atmospheric condition inhibits mechanical turbulence.

The site experienced mostly moderately stable atmospheric conditions (31.1%) which are characteristic of low winds, clear skies and cold night time conditions. 17.5% of the time was attributed to moderately unstable atmospheric condition which are characteristic of clear skies.

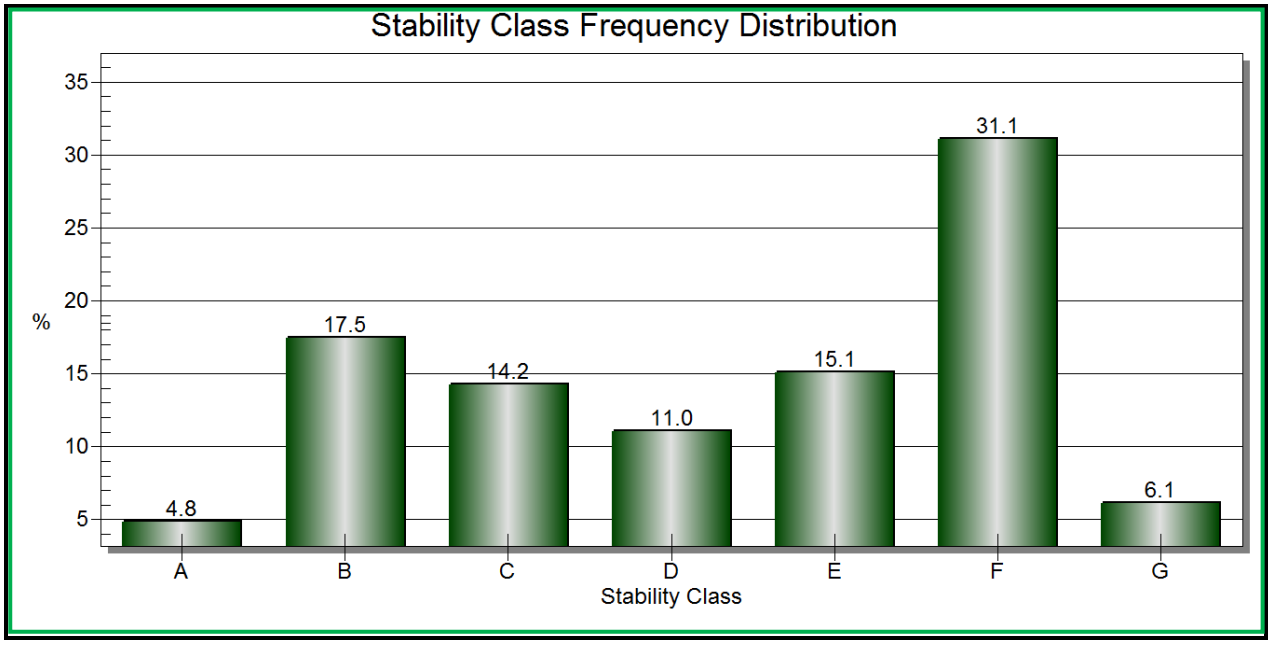


Figure 18: Stability class frequency distribution

2.4 SOILS, LAND USE AND CAPABILITY

2.4.1 SOIL FORM AND MORPHOLOGICAL FEATURES

Figure 19 illustrates the dominant soil forms for the area. The different soil polygons indicated on the map show the soils that dominate the area, but other soil forms are encountered within these polygons.

The higher lying, mountainous areas comprise shallow soils that mostly occur as soil-rock complexes. These areas comprise soils of the following soil forms:

- The ***Glenrosa soil form (Gs)*** comprises an orthic A-horizon overlying a lithocutanic B-horizon. The lithocutanic B-horizon is a pedologically young horizon where clay illuviation has occurred. It is often underlain by weathering rock. Soil depth ranges from 10 to 50 cm.
- The ***Mispah soil form (Ms)*** comprises an orthic A-horizon that overlies hard rock. These soils range in depth from 10 to 20 cm.

The lower lying, undulating areas comprise the following soil forms:

- The ***Brandvlei soil form (Br)*** comprises an orthic A-horizon which overlies a soft carbonate B-horizon. The soft carbonate B-horizon exhibits a morphology which is dominated by calcium and/or potassium–magnesium carbonates. These carbonates can be present as a powder in which case it dominates the colouration of the horizon, nodules, honeycombed structured material or blocks. In the case of the study area the carbonates are mainly present as a powder and/or honeycombed structured material. These soils are deeper than 150 cm. When reacted with 10 % HCl, the carbonate horizon bubbles. Mostly, these soils contain a high frequency of rocks and stones.
- The ***Augrabies soil form (Au)*** comprises an orthic A-horizon which overlies a neocarbonate B-horizon and unconsolidated material. The neocarbonate B-horizon is dominated by calcium and/or potassium–magnesium carbonates to such an extent that it reacts (fizzes) with 10 % HCl. The carbonate mineral phases do not dominate the morphology (colouration) of the soil as is the case with the soft carbonate B-horizon. These soils are deeper than 150 cm. Near the mountainous and rocky regions, but still within the flat, relatively large rocks and stones are encountered in these soils. Profile pits reveal that these soils are deeper than 150 cm.
- The ***Hutton soil form (Hu)*** comprises an orthic A-horizon overlying a red apedal B-horizon, underlain by unspecified material. The red apedal B-horizon has macroscopically weakly developed structure or is altogether without structure and reflects weathering under well drained, oxidised conditions. The clay fraction is dominated by non-swelling 1:1 clay minerals and the red colour of the soil is ascribed to iron oxide coatings on individual soil particles that are dominated by hematite. These soils are predominantly deeper than 150 cm. The soils of the Hutton soil form which are encountered close to the mountainous regions of the study area are very rocky and contain large stones. Augering into these soils are not possible, but profile pits showed that the soils are deeper than 100 cm.

The areas in the vicinity of drainage lines and drainage networks comprise, apart from some of the above mentioned, the following soils:

- The ***Oakleaf soil form (Oa)*** comprises an orthic A-horizon that overlies a neocutanic B-horizon and unspecified material. The neocutanic B-horizon is characterised by colour variation due to clay

movement and accumulation and an apedal or weakly developed structure. Soils of this soil form range in depth from 50 to 120 cm. These soils are encountered in the vicinity of drainage lines that regularly flood the surrounding soils.

- The ***Kimberley soil form (Ky)*** comprises an orthic A-horizon which overlies a red apedal B-horizon and a soft carbonate B-horizon.
- The ***Arcadia soil form (Ar)*** comprises a vertic A-horizon that overlies unspecified material. The vertic A-horizon has strongly developed structure and exhibits clearly visible, regularly occurring slickensides in some part of the horizon or in the transition to an underlying layer. The horizon has a high clay content, is dominated by smectite clay minerals and possess the capacity to swell and shrink markedly in response to moisture changes. Swell-shrink potential is manifested typically by the formation of conspicuous vertical cracks in the dry state and the presence, at some depth, of slickensides (polished or grooved glide planes produced by internal movement).

Table 7 summarises the hectares comprised by each soil form. None of the soils encountered on site showed hydromorphic characteristics within the top 50 cm of the soil profile. The high pH and carbonate content of the soils dictate that the dominant Fe mineral phase, upon re-oxidation after having been reduced, is siderite as opposed to hematite, goethite and lepidocrosite as is the case in less alkaline soils. Siderite forms colourless mottles. Drainage lines do occur on the site and soils such as the Oakleaf soil form are associated with the more prominent of these areas.

Table 7: A summary of the hectares which each soil form comprises

Soil Form	Hectares
Soil-Rock Complex	394.164299
Kimberly-Augrabies-Oakleaf-Mispah Complex	5.651457
Mispah-Glenrosa-Rocky Augrabies Complex	69.879813
Mispah/Glenrosa	53.759564
Mispah/Rocky Hutton	22.50479
Mispah/Rocky Augrabies	58.82174
Rocky Brandvlei	4.047013
Augrabies	153.38204
Mispah	17.926366
Rocky Hutton	15.10727
Rocky Hutton/Augrabies	23.072324
Alluvial deposits-Oakleaf-Hutton-Augrabies Complex	9.835983
Hutton	57.040612
Total	**885.193271**

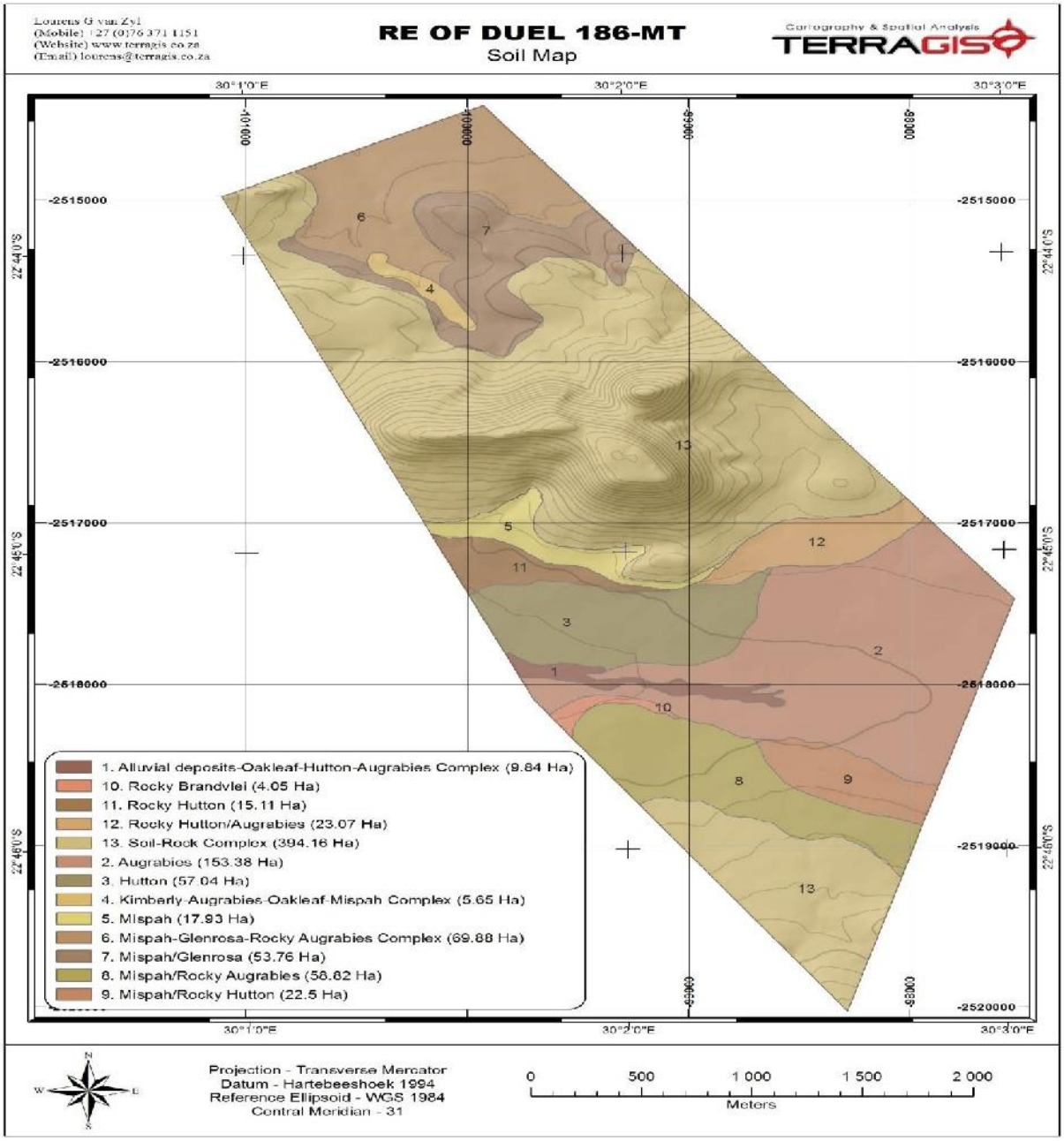


Figure 19: Soil map for the study area

2.4.1.1 Current Land Use

The present land cover of the region is shown in Figure 20. The overall population density of the region beyond the Soutpansberg Range is low. The greater majority of present land use is given to game and cattle farming, with the operating of guest lodges and hunting the major activity.

The project area is mainly used as a game farm. Numerous ephemeral streams are encountered. These represent watercourses with a distinct channel that is continuous and contains regular or intermittent surface flows. These watercourses lack base flow and wetland features as they only support surface flow for a short period of time after sufficient rainfall events.

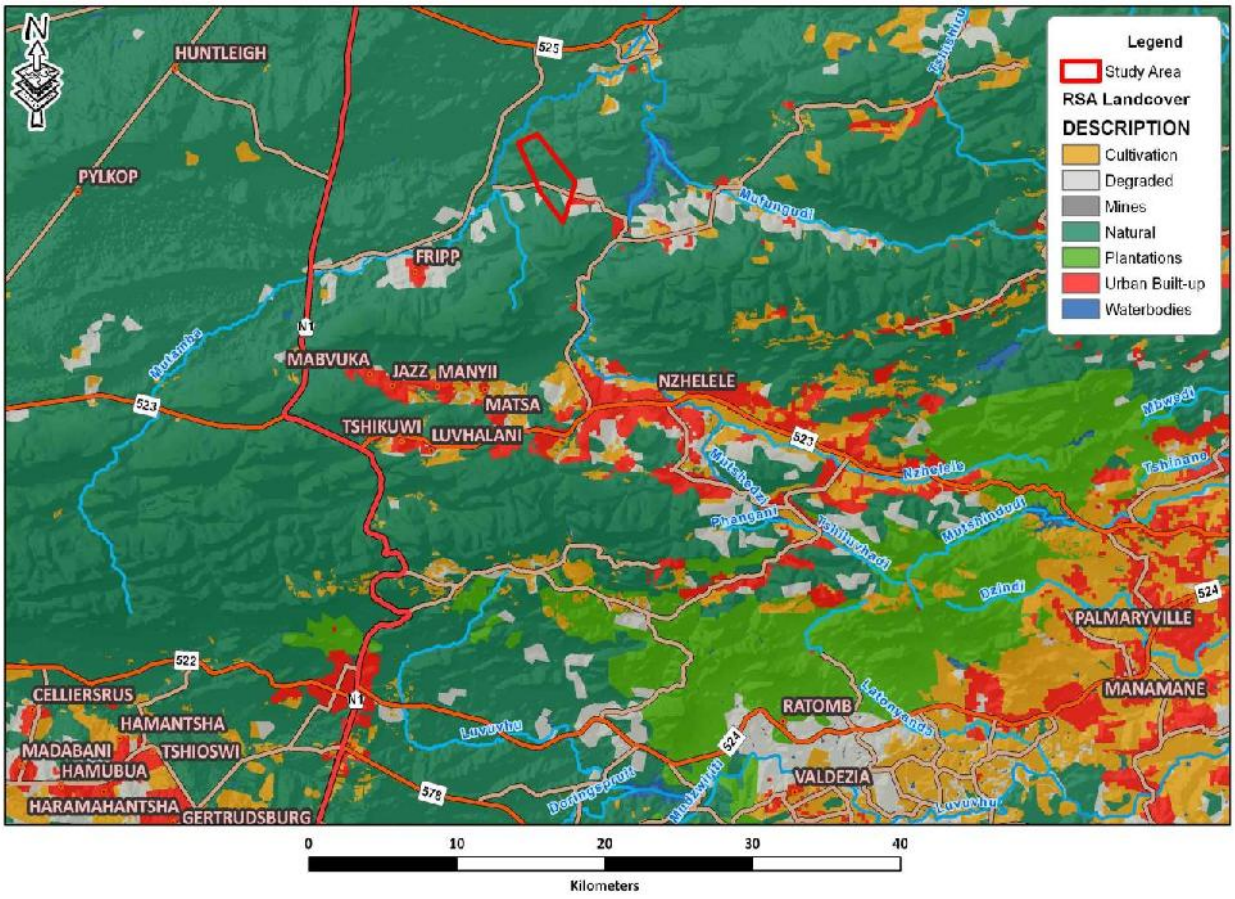


Figure 20: Present land cover in the region

2.4.1.2 Land Capability

Land capability classes were determined using the guidelines outlined in Section 7 of The Chamber of Mines Handbook of Guidelines for Environmental Protection (Volume 3, 1981). The Chamber of Mines pre-mining land capability system was utilised, given that this is the dominant capability class classification system utilized in the mining and industrial fields. The following land capability classes are identified:

- Wetland:
  - Land with organic soils, or;
  - A horizon that is gleyed throughout more than 50 % of its volume and is significantly thick, occurring within 750mm of the surface.
- Arable Land:
  - Land, which does not qualify as a wetland;
  - The soil is readily permeable to the roots of common cultivated plants to a depth of 750mm;
  - The soil has a pH value of between 4,0 and 8.4;
  - The soil has a low salinity and SAR;
  - The soil has a permeability of at least 1,5-mm per hour in the upper 500-mm of soil;

- The soil has less than 10 % (by volume) rocks or pedocrete fragments larger than 100-mm in diameter in the upper 750-mm;
- Has a slope (in %) and erodibility factor (K) such that their product is <2.0; and
- Occurs under a climatic regime, which facilitates crop yields that are at least equal to the current national average for these crops, or is currently being irrigated successfully.

- Grazing land:
  - Land, which does not qualify as wetland or arable land;
  - Has soil, or soil-like material, permeable to roots of native plants, that is more than 250-mm thick and contains less than 50 % by volume of rocks or pedocrete fragments larger than 100-mm; and
  - Supports, or is capable of supporting, a stand of native or introduced grass species, or other forage plants, utilizable by domesticated livestock or game animals on a commercial basis.
- Wilderness land:
  - Land, which does not qualify as wetland, arable land or grazing land.

Figure 21 depicts the land capability of the area. Table 8 correlates the land capability with certain soil types and lists the hectares each land capability class comprise. The area is divided into six land capability classes.

Table 8: Land capability correlated with soil form

Soil Type	Land Capability	Area (Ha)
Soil-Rock Complex	394.164299	Wilderness
Kimberly-Augrabies-Oakleaf-Mispah Complex	5.651457	Wetland
Mispah-Glenrosa-Rocky Augrabies Complex	69.879813	Grazing / Wilderness
Mispah/Glenrosa	53.759564	Grazing
Mispah/Rocky Hutton	22.50479	Grazing
Mispah/Rocky Augrabies	58.82174	Grazing
Rocky Brandvlei	4.047013	Grazing
Augrabies	153.38204	Medium Potential Arable Land
Mispah	17.926366	Grazing / Wilderness
Rocky Hutton	15.10727	Grazing
Rocky Hutton/Augrabies	23.072324	Grazing
Alluvial deposits-Oakleaf-Hutton-Augrabies Complex	9.835983	Riparian and Temporary Wetland
Hutton	57.040612	Medium Potential Arable Land

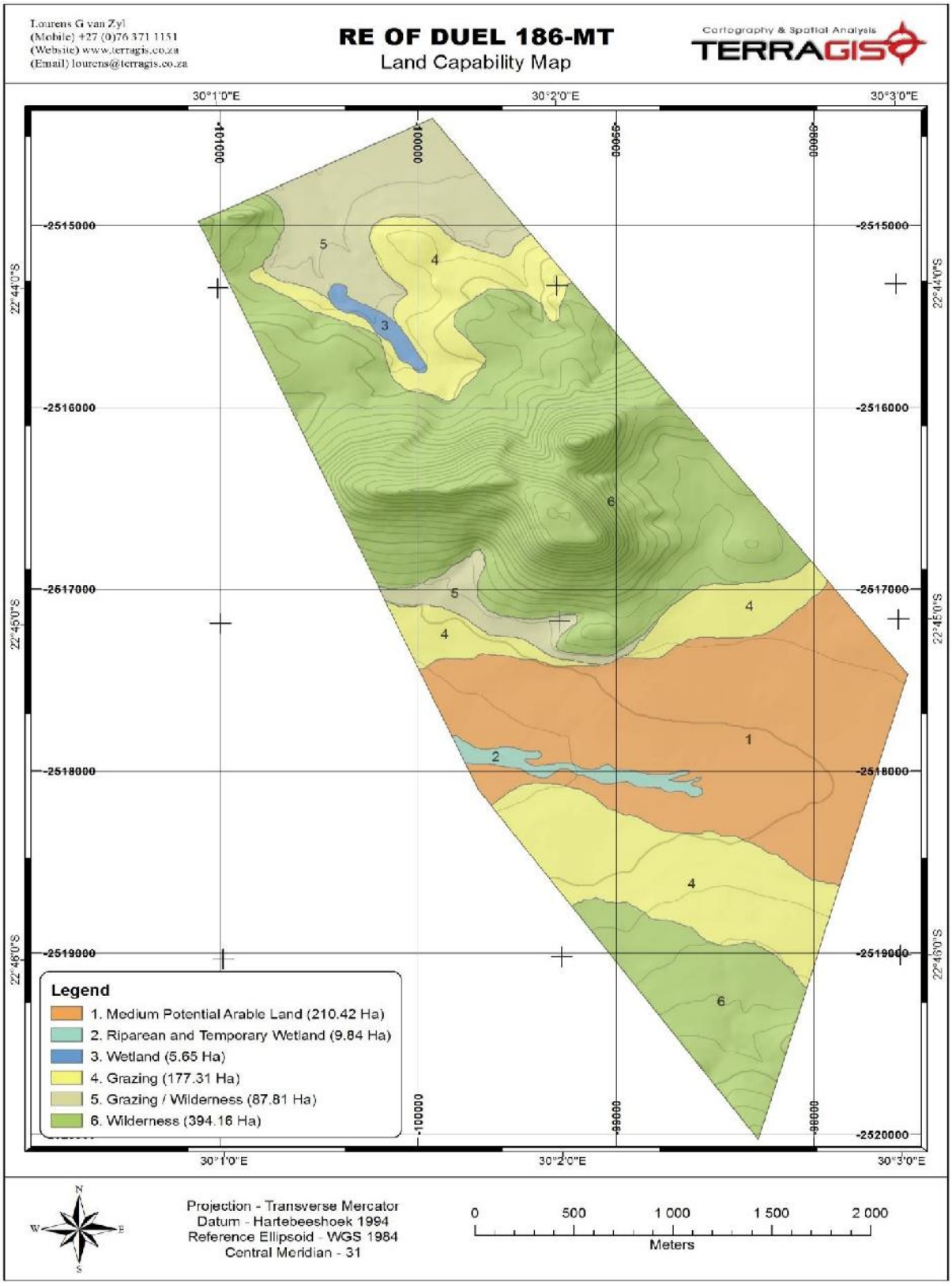


Figure 21: Land capability classes of the study area

2.5 BIODIVERSITY – FLORAL ASSESSMENT

2.5.1 BIOME AND BIOREGION

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford, 1997). The study area falls within the Savanna biome (Rutherford & Westfall, 1994). Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. The study area is situated within the Central Bushveld Bioregion, as well as the Mopane Bioregion (Mucina & Rutherford, 2006) (Figure 22).

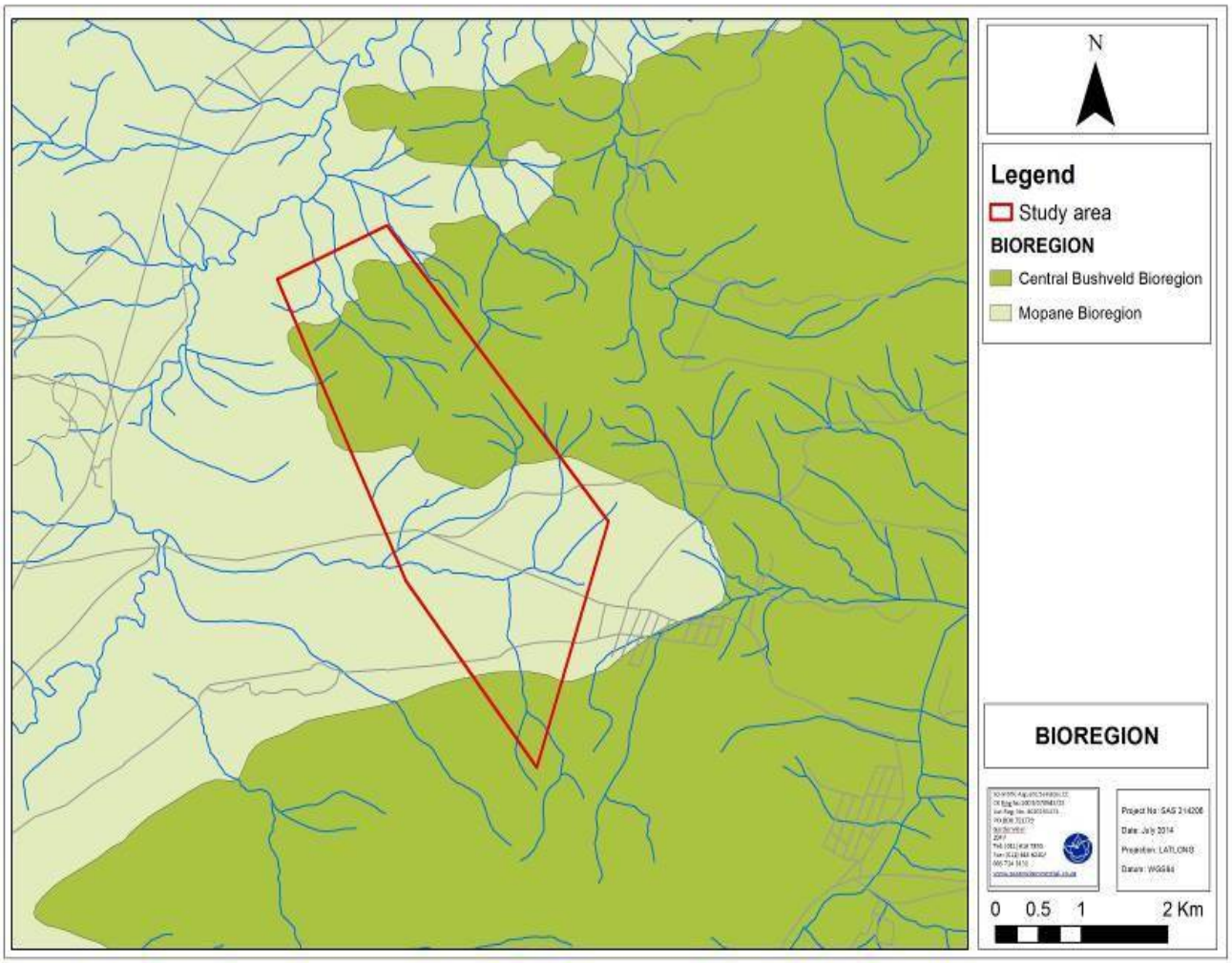


Figure 22: Bioregion associated with the study area (Mucina & Rutherford, 2006)

2.5.2 VEGETATION TYPE AND LANDSCAPE CHARACTERISTICS

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list and so give an accurate and timely description of the ecological integrity of the assessment site. When the boundary of the assessment site is superimposed on the vegetation types of the surrounding area (Figure 23), it is evident that the study area falls within two vegetation types namely Musina Mopane Bushveld and Soutpansberg Mountain Bushveld vegetation types (Mucina & Rutherford, 2006). The characteristics of these vegetation types are discussed below.

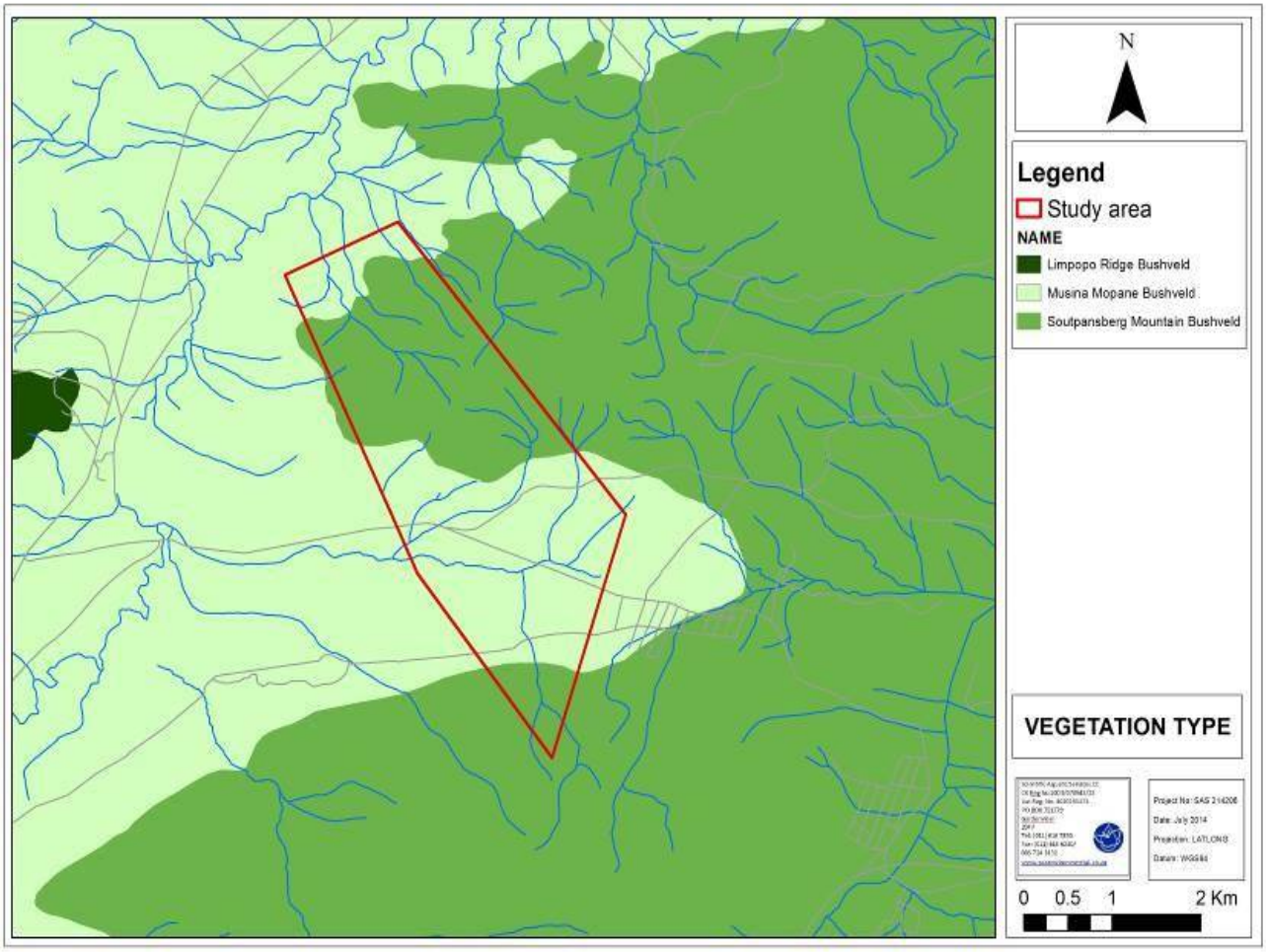


Figure 23: Vegetation types associated with the study area (Mucina & Rutherford, 2006)

2.5.2.1 Musina Mopane Bushveld

The Musina Mopane Bushveld occurs in Limpopo Province, on the undulating plains from around Baines Drift and Alldays in the west, remaining north of the Soutpansberg and south of the Limpopo River, through Musina and Tshipise to Malongavlakte, Masisi and Banyini Pan in the east. It occurs at an altitude that varies from 300 m to 800 m (Mucina and Rutherford, 2006).

The Musina Mopane Bushveld vegetation type is considered to be Least Threatened with a conservation target of 19%. Just over 2% statutorily conserved in the Mapungubwe National Park as well as in Nwandi and Honnet Nature Reserves. Additionally, about 1% is conserved in the Baobob Tree reserves. Roughly 3% is transformed, mainly by cultivation. Erosion is high to moderate (Mucina and Rutherford, 2006).

The Musina Mopane Bushveld vegetation type comprises of undulating to very irregular plains, with some hills. In the western section, open woodland to moderately closed shrubveld dominated by *Colophospermum mopane* on clayey bottomlands and *Combretum apiculatum* on hills. In the eastern section on basalt, moderately closed to open shrubveld is dominated by *Colophospermum mopane* and *Terminalia prunoiodes*. On areas with deep sandy soils, moderately open savannah dominated by *Colophospermum mopane, T. sericea, Grewia flava* and *Combretum apiculatum*. The field layer is well developed (especially on the basalt) and are open during the dry season; the herbaceous layer is poorly developed in areas with dense cover of *Colophospermum mopane* shrubs, for example, north of the Alldays bordering the Limpopo floodplain (Mucina & Rutherford, 2006).

Table 9: Dominant and typical floristic species of Musina Mopane Bushveld (Mucina & Rutherford, 2011)

Grass species	Forb species	Tree/Shrub Species
Aristida adscensionis *A. congesta* *Bothriocloa insculpta* *Brachiaria deflexa* *Cenchrus ciliaris* *Digitaria eriantha* subsp *eriantha* *Enneapogon cenchroides* *Eragrostis lehmanniana* *E. pallens* *Fingerhuthia africana* *Heteropogon contortus* *Schmidtia pappophroides* (d) *Sporobolus nitens* *Stipagrostis hirtigluma* subsp *patula* *S. uniplumis* *Tetrapogon tenellus* *Urochloa mosambicensis*	Herbs: • *Acrotome inflata* • *Becium filamentosum* • *Harpagophytum procumbens subsp transvaalense* • *Heliotropium steudneri* • *Hermbstaedtia odorata* • *Oxygonum delagoense* Succulent Herbs: • *Stapelia gettliffei* • *S. kwebensis.*	Tall Trees: • *Acacia nigrescens* • *Adansonia digitata* • *Sclerocarya birrea* subsp *caffra* Small Trees: • *Acacia senegal* var *leiorhachis* • *A. tortilis* subsp *heteracantha* • *Boscia albitrunca* • *B. foetida* subsp *rehmanniana* • *Colophospermum mopane* (d) • *Combretum apiculatum* (d) • *Commiphora glandulosa* • *C. tenuipetiolata* • *C. viminea* • *Sterculia rogersii* • *Terminalia prunioides* • *T. sericea* • *Ximenia americana* Shrubs: • *Commiphora pyracanthoides* • *Gardenia volkensii*

Grass species	Forb species	Tree/Shrub Species
		• *Grewia bicolor* • *G. flava* (d), • *Maerua parviflora* • *Rhigozum zambesiacum* • *Sesamothamnus lugardii* (d) • *Tephrosia polystachya* <u>Small Shrubs:</u> • *Acalypha indica* • *Aptosimum lineare* • *Barleria senensis* • *Dicoma tomentosa* • *Felicia clavipilosa subsp transvaalensis* • *Gossypium herbaceum subsp africanum* • *Hermannia glanduligera* • *Neuracanthus africanus* • *Pechuel-Loeschea leubnitziae* • *Ptycholobium contortum* • *Seddera suffruticosa* <u>Succulent Shrub:</u> • *Hoodia currorii* subsp *lugardii* <u>Herbaceous climber:</u> • Momordica balsamina (d)

***(d) – Dominant species for the vegetation type**

2.5.2.2 Soutpansberg Mountain Bushveld

Soutpansberg Mountain Bushveld occurs within the Limpopo Provinces. It also occurs on the slopes of the Soutpansberg Mountain and Blouberg and Leratauptje Mountains in the west and extends eastward along lower ridges, including Khaphamali and Makonde Mountains. The altitude varies between approximately 600m to 1 500m (Mucina and Rutherford, 2006).

The Soutpansberg Mountain Bushveld vegetation type is considered to be vulnerable with a conservation target of 24%. Just over 2% statutorily conserved in the Blouberg, Happy Rest and Nwanedi Nature Reserves. A smaller area is conserved in other reserves. Some 21% is transformed, with about 14% cultivated and 6% plantations. High rural human population densities in some lower lying parts of the eastern section of the unit. Erosion is very low to moderate (Mucina and Rutherford, 2006).

The Soutpansberg Mountain Bushveld comprises of low and high mountains, highest in the west, splitting into increased number of lower mountain ridges towards the east. Dense tree layer and poorly developed grassy layer. The topography of the east-west orientated ridges of the mountain changes drastically over short distances, resulting in orographic rain on the southern ridges, and a rainshadow effect on the northern ridges. Because of this topographic diversity, Soutpansberg Mountain Bushveld comprises of a complex mosaic of sharply contrasting kinds of vegetation within limited areas. The main vegetation variations within the Soutpansberg Mountain Bushveld are subtropical moist thickets (mainly along the lower-lying southern slopes, on steep clayey soils of volcanic origin), mistbelt bush clumps (within the

mistbelt of the southern and central ridges of the mountain, on rugged quartzitic outcrops with shallow sandy soils), relatively open savannah sandveld (on both deep and shallow quarzitic sands along the relatively dry middle and northern slopes of the mountain), and arid mountain bushveld (along the very arid northern ridges of the mountain) (Mucina & Rutherford, 2006).

Table 10: Dominant and typical floristic species of Soutpansberg Mountain Bushveld (Mucina & Rutherford, 2011)

Grass species	Forb species	Tree/Shrub Species
Subtropical Moist Thickets		
		Small Trees: • *Catha edulis (d)* • *Acacia karroo* • *Berchemia zeyheri* • *Bridelia mollis* • *Combretum molle* • *Dombeya rotundifolia* • *Dovyalis zeyheri* • *Kirkia acuminata* • *Mystroxylon aethiopicum subsp. schlechteri* • *Plectroniella armata* • *Zanthoxylum capense* • *Ziziphus mucronata* Tall Shrubs: • *Flueggea virosa (d)* • *Carissa edulis* • *Grewia occidentalis* • *Rhus pentheri* Low Shrubs: • *Pavonia burchellii*
Mistbelt Bush Clumps		
Coleochloa setifera (d) *Setaria sphacelata (d)* *Melinis nerviglumis* *Trachypogon spicatus*	Herbs: • *Fadogia homblei (d)* • *Dicoma anomala* • *Felicia mossamedensis* • *Gerbera viridifolia* • *Vernonia natalensis* Succulent Herbs: • *Crassula swaziensis* • *Plectranthus cylindraceus*	Small Trees: • *Englerophytum magalismontanum (d)* • *Mimusops zeyheri (d)* • *Syzygium legatii (d)* • *Apodytes dimidiata subsp. dimidiata* • *Combretum molle* • *Heteropyxis natalensis* • *Maytenus undata* • Tall Shrubs: • *Coddia rudis* • *Combretum moggii* • *Euclea linearis* • *Hyperacanthus amoenus* • *Olea capensis subsp. coddii (d)* • *Helichrysum kraussii* • *Heteromorpha stenophylla var. transvaalensis* • *Myrothamnus flabellifolius* Geoxylic Suffrutex: • Parinari capensis subsp. capensis (d)

Grass species	Forb species	Tree/Shrub Species
		Succulent Shrubs: • *Aloe arborescens* • *Kalanchoe sexangularis*
Open Savanna Sandveld		
Centropodia glauca (d) *Enneapogon cenchroides*	*Xerophyta retinervis (d)*	Small Trees: • *Burkea africana (d)* • *Ochna pulchra (d)* • *Combretum apiculatum* • *Ochna pretoriensis* • *Pseudolachnostylis maprouneifolia* • *Terminalia sericea* Tall Shrubs: • *Corchorus kirkii* • *Diplorhynchus condylocarpon* • *Elephantorrhiza burkei* • *Strychnos madagascariensis*
Arid Mountain Bushveld		
	Herbs: • *Hibiscus meyeri subsp. transvaalensis* Succulent Herbs: • *Kleinia fulgens*	Tall Trees: • *Acacia nigrescens* • *Adansonia digitata* Small Trees: • *Combretum apiculatum* • *Commiphora glandulosa* • *C. mollis* Tall Shrubs: • *Tinnea rhodesiana.* Low Shrubs: • *Blepharis diversispina* • *Gossypium herbaceum subsp. africanum* Woody Climbers: • *Acacia ataxcantha.*

***(d) – Dominant species for the vegetation type.**

2.5.3 RESULTS OF FLORAL INVESTIGATION

Three main habitat units were identified during the assessment namely:

- Soutpansberg Mountain Bushveld;
- Wetland and Riparian habitat; and
- Mopane Woodland.

Figure 24 depicts the habitat units identified during the site assessment in relation to the study area.

2.5.3.1 Habitat Unit 1: Soutpansberg Mountain Bushveld

This habitat unit occurs in sections in the central and extreme southern sections of the study area. This habitat unit was typically associated with steeper, undulating ridges within the study area. Figure 25 presents typical Soutpansberg Mountain Bushveld habitat present in the study area.

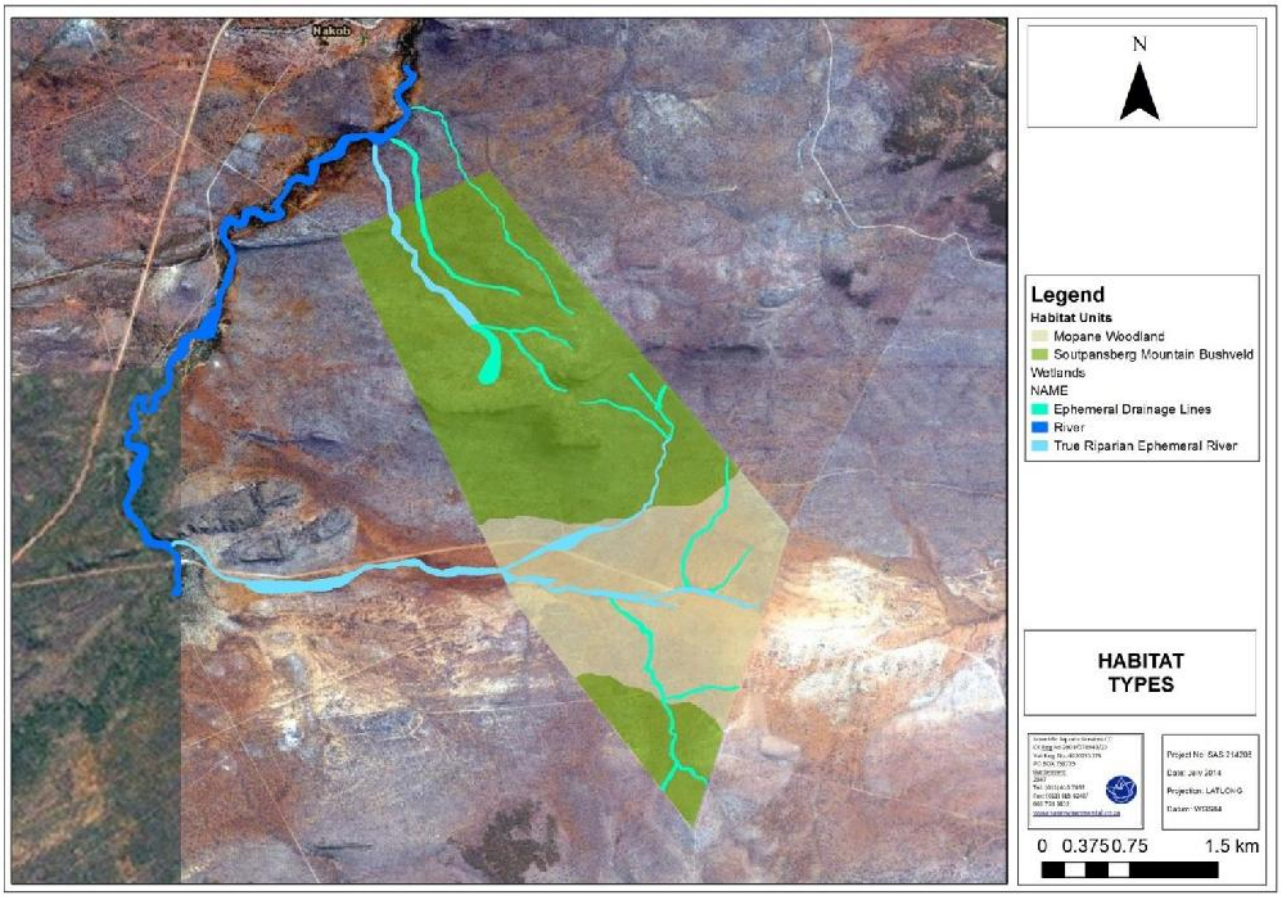


Figure 24: Conceptual illustration of the habitat units within the study area

Figure 25: The Soutpansberg Mountain Bushveld habitat unit

Dominant taller woody species occurring within this habitat unit include *Terminalia sericea, Burkea africana, Combretum apiculatum, Dombeya rotundifolia, Ozoroa paniculosa, Peltophorum africanum, Kirkia acuminata, Lannea schweinfurthii, Commiphora glandulosa* and *C. edulis,* while the shrub layer was characterised by *Euclea crispa, Grewia bicolor, G. occidentalis, Carissa bispinosa* and *Gardenia volkensii*. Succulent species included *Kalanchoe sexangularis* and *Kleinia fulgens.* Species such as *Stipagrostis hirtigluma, Schmidtia pappophoroides, Diheteropogon amplectens, Loudetia simplex, Heteropogon contortus, Cynodon dactylon, Tragus berteronianus* and *Elionurus muticus* dominate the graminoid layer. The vegetation composition in these areas is typical of the Soutpansberg Mountain Bushveld vegetation

type. Alien species diversity and abundance was generally low, with species such as *Zinnia peruviana, Opuntia ficus-indica, Cereus jamacaru* and *Tagetes minuta* encountered in isolated patches.

Table 11 lists the dominant floral species found within this habitat unit during the site assessment.

Table 11: Dominant species encountered in the Soutpansberg Mountain Bushveld habitat unit

Grass species	Forb species	Tree/Shrub species	Succulent species
Aristdia congesta subsp *barbicollis*	**Bidens pilosa*	***Adansonia digitata***	*Aloe arborescens*
Aristida congesta subsp *congesta*	**Tagetes minuta*	***Adenium multiflorum***	**Cereus jamacaru*
Artistida bipartita	**Zinnia peruviana*	*Acacia karroo*	*Kalanchoe sexangularis*
Cymbopogon plurinodes	*Asclepias fruticosa*	*Acacia nigrescens*	*Kleinia fulgens*
Cynodon dactylon	*Asparagus falcatus*	*Acacia ataxacantha*	**Opuntia ficus-indica*
Diheteropogon amplectens	*Commelina africana*	*Balanites pedicellaris*	
Eragrostis chloromelas	*Commelina erecta*	*Berchemia zeyheri*	
Eragrostis curvula	**Datura stramonium*	***Boscia albitrunca***	
Eragrostis superba	*Hermannia depressa*	*Boscia foetida*	
Eragrostis pallens	*Ipomoea crassipes*	*Carissa bispinosa*	
Enneapogon cenchroides	*Kohautia virgata*	*Combretum apiculatum*	
Elionurus muticus	*Senecio oxyriifolius*	*Combretum molle*	
Heteropogon contortus	**Solanum mauritianum*	***Combretum imberbe***	
Hyparrhenia hirta	*Vernonia oligocephala*	*Commiphora glandulosa*	
Loudetia simplex	*Xerophyta retinervis*	*Commiphora edulis*	
Melinis nerviglumis		*Dichrostachys cinerea*	
Melinis repens		*Diplorhynchus condylocarpon*	
Panicum maximum		*Diospyros lycioides*	
Schmidtia pappophoroides		*Dombeya rotundifolia*	
Themeda triandra		*Euclea crispa*	
Tristachya leucothrix		*Gardenia volkensii*	
Tragus berteronianus		*Grewia bicolor*	
Cenchrus ciliarus		*Grewia occidentalis*	
		Gymnosporia buxifolia	
		Kirkia acuminata	
		Lannea schweinfurthii	
		Lonchocarpus capassa	
		Olea europaea subsp. *africana*	
		Ozoroa paniculosa	
		Peltophorum africanum	
		Sesamothamnus lugardii	
		Sclerocarya birrea* subsp *caffra	
		Strychnos spinosa	
		Strychnos madagascariensis	
		Schotia brachypetala	
		Terminalia sericea	
		Ziziphus mucronata	

Alien species are indicated with an asterisk (*) and protected species are in bold font.

The Soutpansberg Mountain Bushveld habitat unit has general high ecological functionality and overall high levels of habitat integrity and is in a relatively undisturbed condition. The species composition of this habitat unit is also representative of the vegetation type in which it occurs, and the vegetation type is considered to be *Vulnerable* (Mucina & Rutherford, 2006). Furthermore, five tree species protected by the National Forest Act (1998), namely *Combretum imberbe, Sclerocarya birrea* subsp *caffra, Adansonia digitata, Lonchocarpus capassa* and *Boscia albitrunca* and one species protected under the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) Lists of Species that are Threatened or Protected (TOPS), namely *Adenium multiflorum,* are present in this habitat unit. *Adenium multiflorum* and *Adansonia digitata* are also protected under the Limpopo Environmental Management Act

(Act 7 of 2003). The above-mentioned ecological and botanical aspects of the Soutpansberg Mountain Bushveld habitat indicate that this habitat type is of increased ecological sensitivity and conservation value in relation to surrounding areas.

Thus, the Soutpansberg Mountain Bushveld habitat unit is considered to be of high ecological importance and sensitivity, and any impacts from the proposed mining activities and associated infrastructure are anticipated to be significant.

2.5.3.2 Habitat Unit 2: Wetland and Riparian habitat

Several types of wetlands are present on the study area, which were delineated. This habitat unit is characterised by perennial rivers and ephemeral drainage lines with weakly developed riparian zones.

Figure 26: The Mutamba River and associated riparian habitat

The river assessed (Mutamba River) was defined as a perennial system containing riparian habitat due to the presence of alluvial soil as well as the presence of vegetation, with a composition and physical structure, distinct from adjacent areas. Several very small drainage lines were also observed, most of which do not hold surface water for periods long enough for the formation of hydromorphic soil that would support vegetation adapted to life in saturated soils and lead to the formation of wetlands.

Figure 27: Typical views of the smaller ephemeral drainage lines

In terms of distinct wetland vegetation, the riparian zone of the Mutamba River was defined by the presence of large *Combretum imberbe, Spirostachys africana, Ficus salicifolia* and *F. craterostoma* trees. Furthermore, the permanent zones of the riparian systems were characterized by *Phragmites mauritianum, Cyperus sexangularis* and *Typha capensis.* The ephemeral drainage lines were also associated with distinct species, although these species are not necessarily associated with wetland conditions. The vegetation around the majority of ephemeral drainage lines was characterised by *Combretum imberbe* and *Spirostachys africana,* which often form dense belts along the banks of these features.

Table 12 lists the dominant floral species found within this habitat unit during the site assessment.

Table 12: Dominant species encountered in the Wetland and Riparian habitat unit

Grass/Sedge/Reed species	Forb species	Tree/Shrub species
Aristida congesta subsp *congesta*	*Commelina africana*	*Balanites pedicellaris*
Artistida bipartita	*Commelina erecta*	*Colophospermum mopane*
Bothriochloa insculpta	*Gerbera ambigua*	*Ficus salicifolia*
Cyperus sexangularis	*Helichrysum nudifolium*	*Ficus craterostoma*
Cyperus rupestris		***Combretum imberbe***
Cynodon dactylon		***Sclerocarya birrea* subsp *caffra***
Digitaria natalensis		*Schotia brachypetala*
Eragrostis chloromelas		*Spirostachys africana*
Eragrostis curvula		*Ziziphus mucronata*
Hyparrhenia hirta		
Hyparrhenia tamba		
Imperata cylindrica		
Phragmites mauritianum		
Panicum maximum		
Setaria sphacelata		
Sporobolus nitens		
Sporobolus pyramidalis		
Themeda triandra		
Typha capensis		

Alien species are indicated with an asterisk (*) and protected species are in bold font.

The riparian zones and ephemeral drainage lines are characterised by high ecological functionality and overall high levels of habitat integrity. In terms of RDL and protected floral species, two species protected by the National Forest Act (1998), namely *Sclerocarya birrea* subsp *caffra* and *Combretum imberbe* are present in this habitat unit especially within the thickets associated with the riparian zones and the ephemeral systems.

The wetland and riparian habitat unit provides niche habitat for a high diversity of floral and faunal species and acts as a very important network of migratory corridors for faunal species. Thus, this habitat unit is considered to be sensitive. As such, any impacts on the wetland and riparian systems associated with the study area are likely to be significant on a local and regional scale.

2.5.3.3 Habitat Unit 3: Mopane Woodland

The Mopane Woodland habitat unit covered the central portions of the study area and was encountered in the lower lying sections of the study area associated with deep red soils. Sections of this habitat unit have been transformed by road construction and edge effects associated with close anthropogenic activities, although not to such a degree that it is unrecognisable as Mopane Woodland.

Figure 28: Representative photograph of the Mopane Woodland habitat unit

The woody layer of this habitat unit was dominated by *Colophospermum mopane* and *Combretum apiculatum* interspersed by *Adansonia digitata*, while the shrub layer was characterised by *Terminalia prunioides, Grewia occidentalis* and *Grewia bicolor,* while the herbaceous layer was poorly represented, typical of this vegetation type. The graminoid layer was dominated by *Themeda triandra, Eragrostis lehmanniana, E. pallens, Hyparrhenia hirta, Schmidtia pappophoroides, Cynodon dactylon, Enneapogon cenchroides* and *Enteropogon macrostachyus*. The vegetation composition and relatively low species diversity in this habitat unit is typical of the Musina Mopane Bushveld vegetation type and the low diversity is not a result of disturbance or transformation.

Table 13 lists the dominant floral species found within this habitat unit during the site assessment.

Table 13: Dominant species encountered in the Mopane Woodland areas

Grass species	Forb species	Tree/Shrub species
Aristdia congesta subsp *barbicollis*	**Bidens pilosa*	***Adansonia digitata***
Aristida congesta subsp *congesta*	**Tagetes minuta*	***Adenium multiflorum***
Artistida bipartita	**Zinnia peruviana*	*Acacia nigrescens*
Cymbopogon plurinodes	*Asparagus falcatus*	*Balanites pedicellaris*
Cynodon dactylon	*Commelina africana*	***Boscia albitrunca***
Diheteropogon amplectens	*Vernonia oligocephala*	*Boscia foetida*
Eragrostis chloromelas	*Becium filamentosum*	*Carissa bispinosa*
Eragrostis curvula		*Combretum apiculatum*
Eragrostis superba		***Combretum imberbe***
Eragrostis pallens		*Dichrostachys cinerea*
Eragrostis lehmanniana		*Euclea crispa*
Enneapogon cenchroides		*Grewia bicolor*
Enteropogon macrostachyus		*Grewia occidentalis*
Elionurus muticus		*Gymnosporia buxifolia*
Heteropogon contortus		***Sclerocarya birrea* subsp *caffra***
Hyparrhenia hirta		*Sesamothamnus lugardii*
Loudetia simplex		*Terminalia sericea*
Melinis nerviglumis		*Terminalia prunioides*
Melinis repens		*Ziziphus mucronata*
Panicum maximum		
Schmidtia pappophoroides		
Themeda triandra		
Tristachya leucothrix		
Tragus berteronianus		
Cenchrus ciliarus		

Alien species are indicated with an asterisk and protected species are in bold font.

The Mopane Woodland habitat unit has general moderate to high ecological functionality and levels of habitat integrity and is in a relatively undisturbed condition. The species composition of this habitat unit is also representative of the vegetation type in which it occurs and the vegetation type is considered *Least Threatened* (Mucina & Rutherford, 2006). Furthermore, four tree species protected by the National Forest Act (1998), namely *Combretum imberbe, Sclerocarya birrea* subsp *caffra, Adansonia digitata* and *Boscia albitrunca* and one species protected under the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) Lists of Species that are Threatened or Protected (TOPS), namely *Adenium multiflorum,* are present in this habitat unit. *Adenium multiflorum* and *Adansonia digitata* are also protected under the Limpopo Environmental Management Act (Act 7 of 2003). The above-mentioned ecological and botanical aspects of the Mopane Woodland habitat indicate that this habitat type is of increased ecological sensitivity and conservation value.

The above characteristics indicate that the ecological sensitivity and conservation value of the less transformed areas of the habitat unit is of increased ecological significance. As mentioned, the more transformed areas of the habitat unit, while not as ecologically intact, are still moderately representative of the vegetation types they are situated in. Thus, the Mopane Woodland habitat unit is considered to be of moderate ecological sensitivity, and impacts from the proposed mining activities and associated infrastructure are likely to be significant.

2.5.3.4 Floral community assessment

Grass communities can provide information regarding the ecological status of specific areas within a study area. If the species composition is quantitatively determined and characteristics of all components of the

grass communities are taken into consideration, it is possible to determine the Present Ecological State (PES) of the portion of land represented by the assessment point. Any given grass species is specifically adapted to specific growth conditions. This sensitivity to specific conditions make grasses good indicators of veld conditions.

The sections below summarise the dominant grass species identified within the transects with their associated habitats and optimal growth conditions with reference to the table and figure below. It should be noted that transect locations were chosen within all areas moderately representative of vegetation in a good condition, therefore areas with a complete loss of indigenous grass community such as the wetland habitat unit, were not assessed using this method.

Table 14: Grouping of gasses (Van Oudtshoorn, 2006)

Pioneer	Hardened, annual plants that can grow in very unfavourable conditions. In time improves growth conditions for perennial grasses.
Subclimax	Weak perennials denser than pioneer grasses. Protects soils leading to more moisture, which leads to a denser stand, which deposits more organic material on the surface. As growth conditions improve climax grasses are replaced by subclimax grasses.
Climax	Strong perennial plants adapted to optimal growth conditions.
Decreaser	Grasses abundant in good veld.
Increaser I	Grasses abundant in underutilized veld.
Increaser II	Grasses abundant in overgrazed veld.
Increaser III	Grasses commonly found in overgrazed veld.

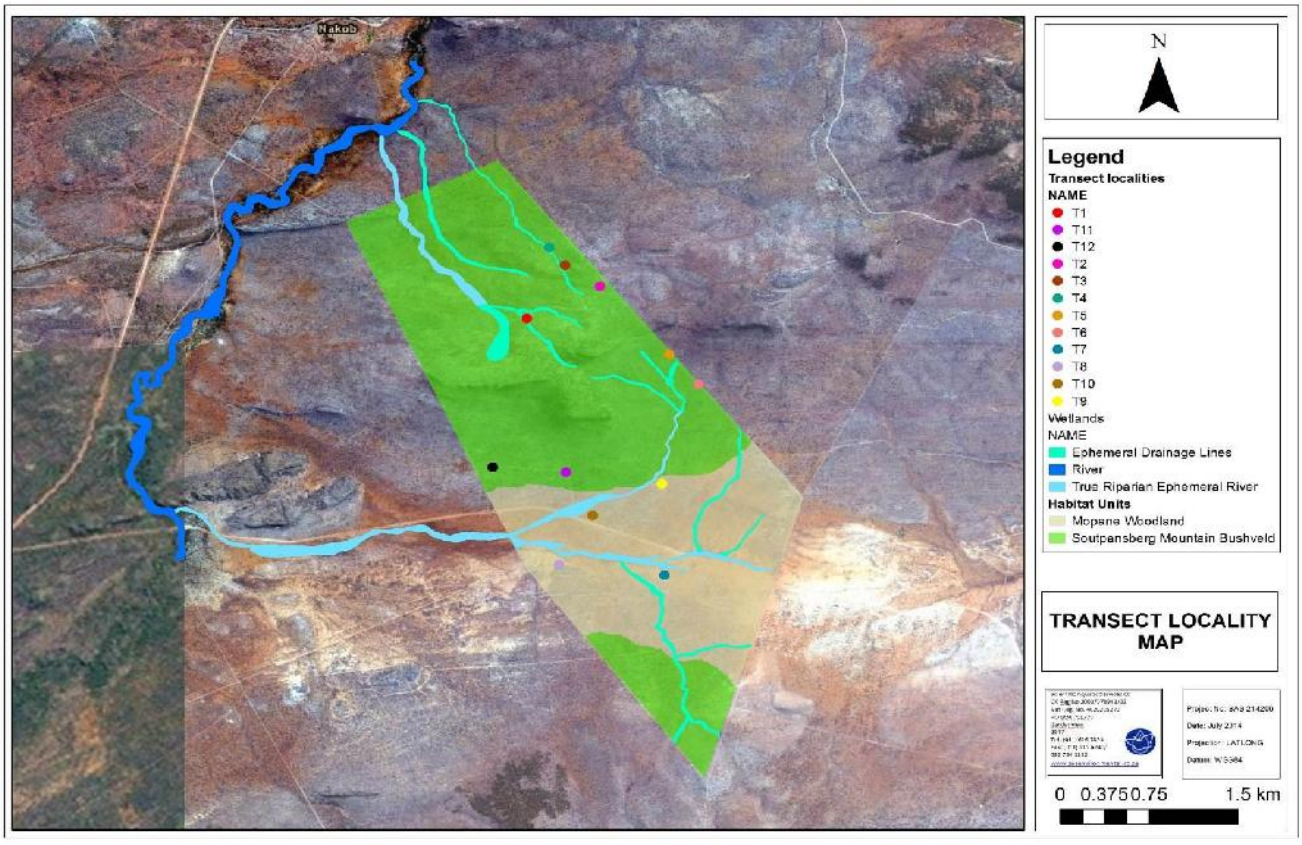
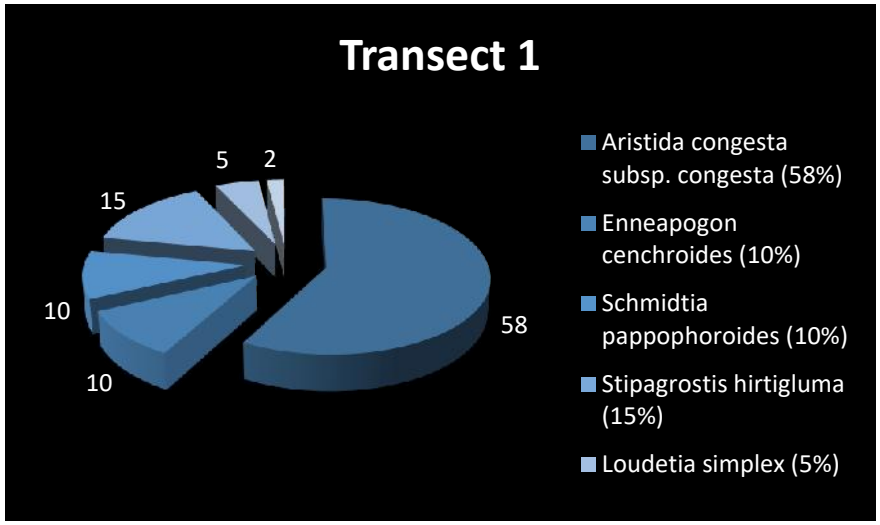


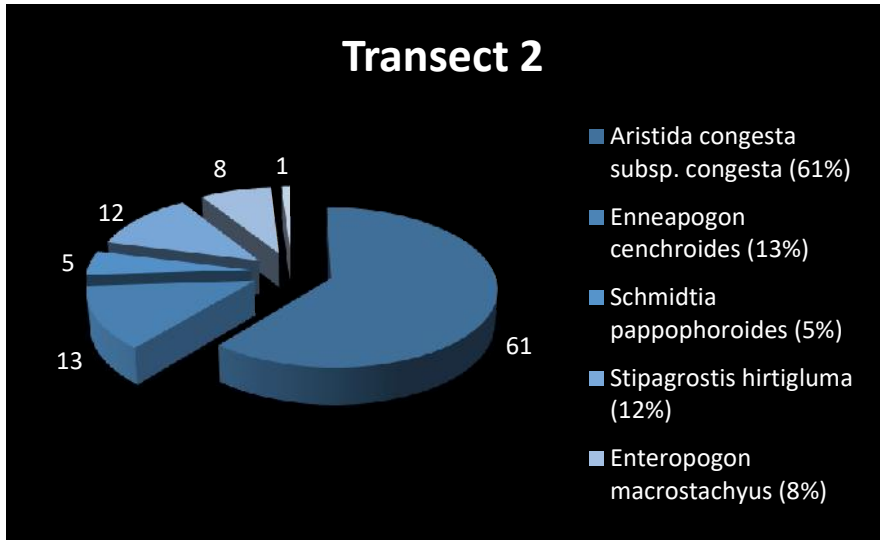
Figure 29: Digital satellite image depicting location of the transects



Transect 1 – Soutpansberg Mountain Bushveld

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

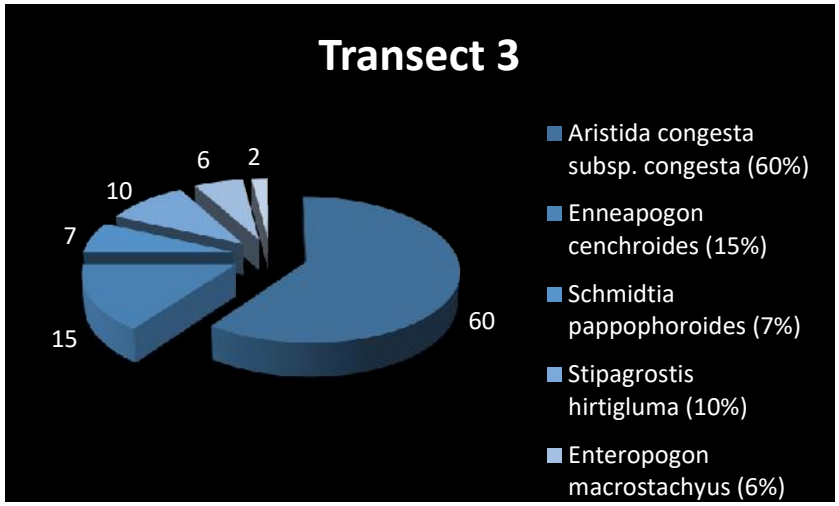
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 2 – Soutpansberg Mountain Bushveld

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Enteropogon macrostachyus* (Mopane grass) [Increaser II, subclimax grass]. Grows in warm areas, common in mopaneveld.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

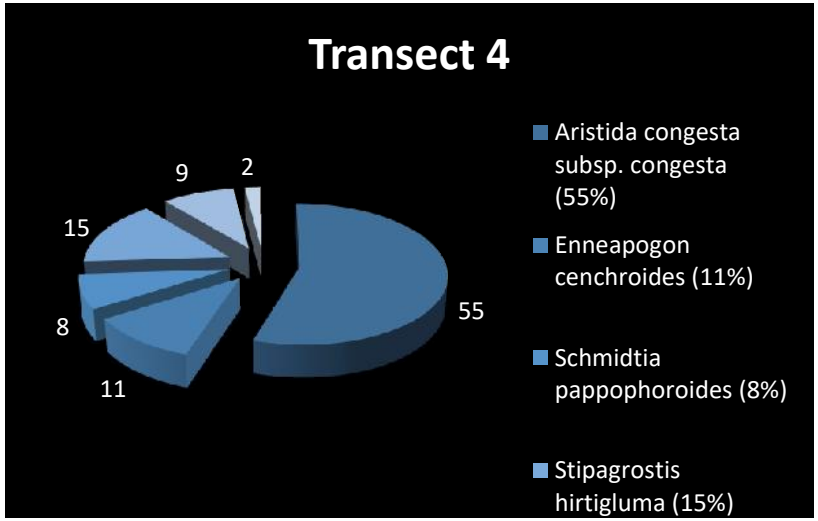
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 3 – Soutpansberg Mountain Bushveld

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted grass, grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Enteropogon macrostachyus* (Mopane grass) [Increaser II, subclimax grass]. Grows in warm areas, common in mopaneveld.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

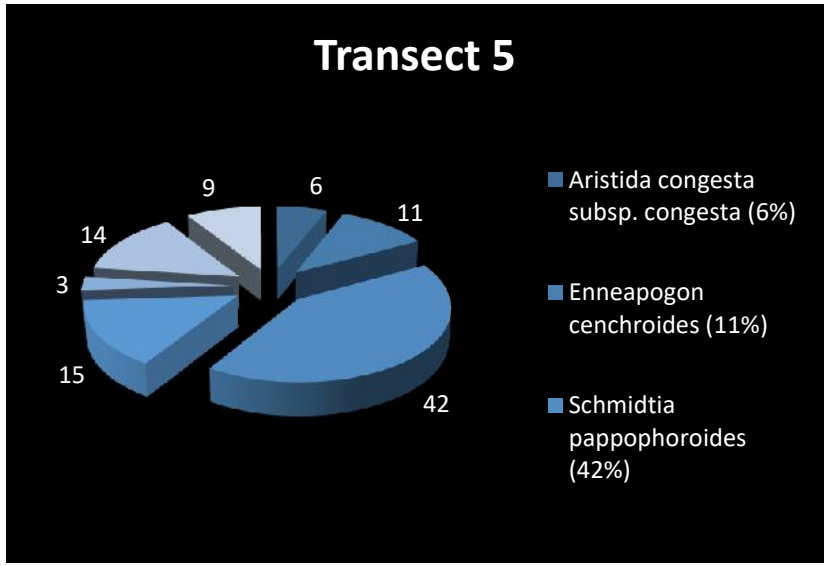
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 4 – Soutpansberg Mountain Bushveld

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Enteropogon macrostachyus* (Mopane grass) [Increaser II, subclimax grass]. Grows in warm areas, common in mopaneveld.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

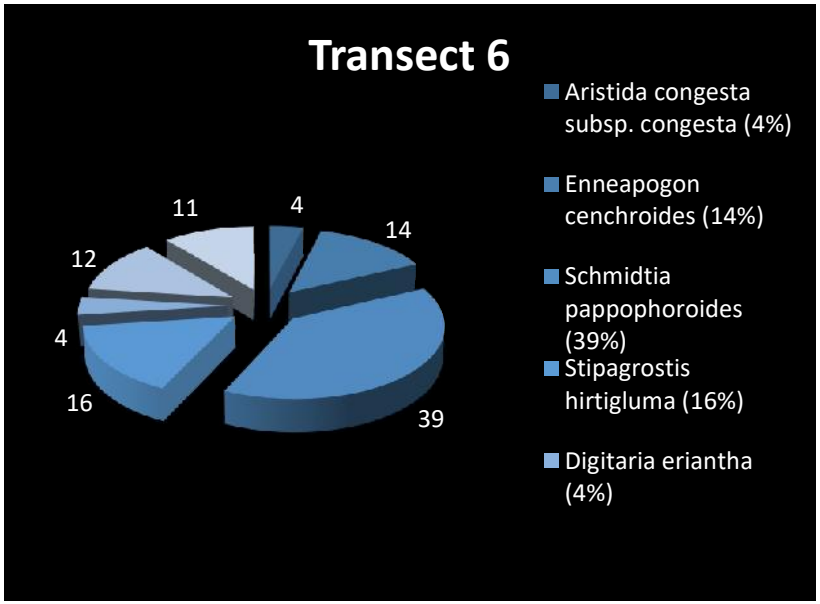
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 5 – Soutpansberg Mountain Bushveld

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Heteropogon contortus* (Mopane grass) [Increaser II, subclimax grass]. Grows in poor gravelly and sandy soils.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

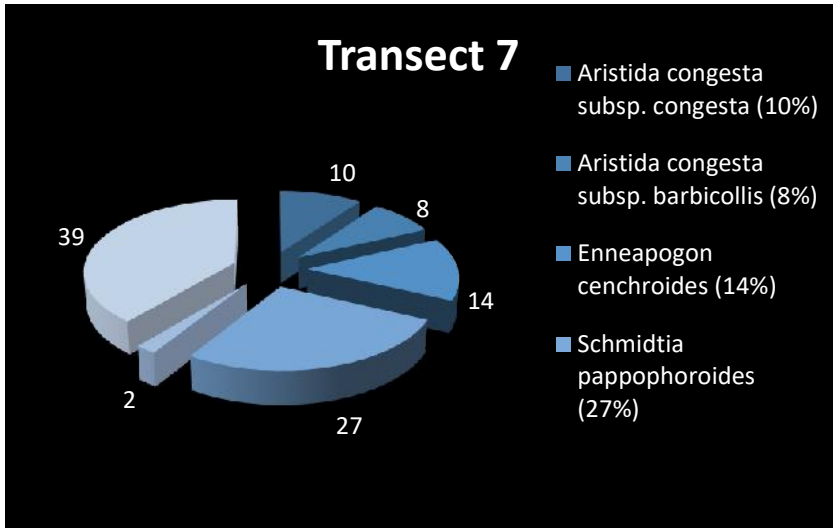
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 6 – Soutpansberg Mountain Bushveld

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Heteropogon contortus* (Giant spear grass) [Decreaser, Climax grass]. Grows in poor gravelly and sandy soils.
- *Diheteropogon amplectens* (Broadleaved blue stem) [Increaser II, subclimax grass]. Grows in poor gravelly and sandy soils.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

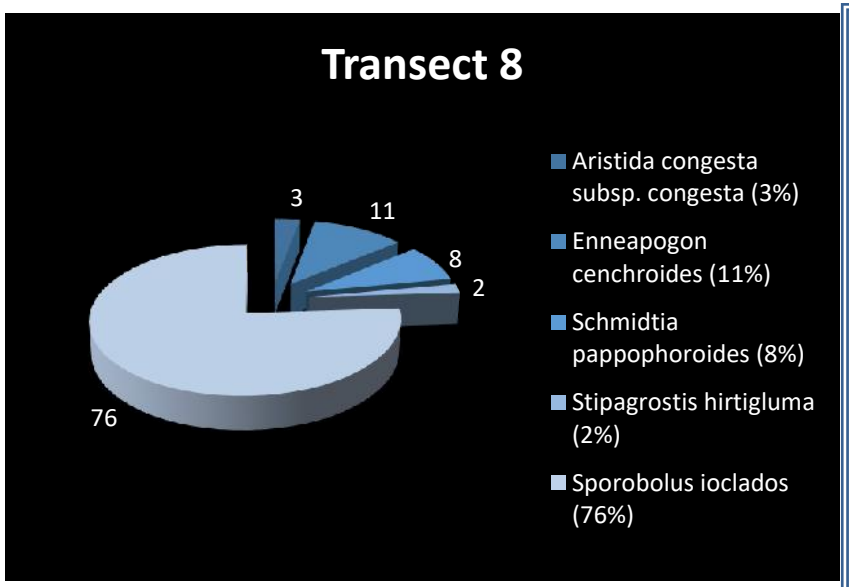
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 7 – Mopane Woodland

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Aristida congesta* subsp. *barbicollis* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Enteropogon macrostachyus* (Mopane grass) [Increaser II, subclimax grass]. Grows in warm areas, common in mopaneveld.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

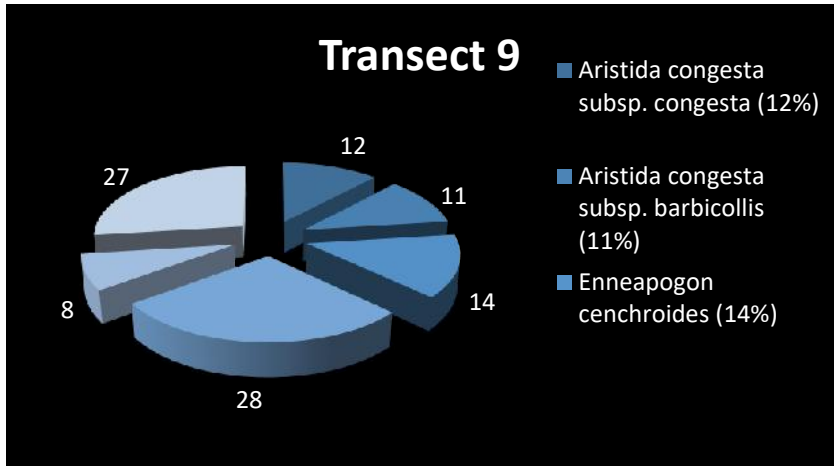
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the studv area.



Transect 8 – Mopane Woodland

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Sporobolus ioclados* (Pan dropseed) [Increaser II, Subclimax grass]. Grows in nutrient poor sandy and/or disturbed brackish soil.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Enteropogon macrostachyus* (Mopane grass) [Increaser II, subclimax grass]. Grows in warm areas, common in mopaneveld.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

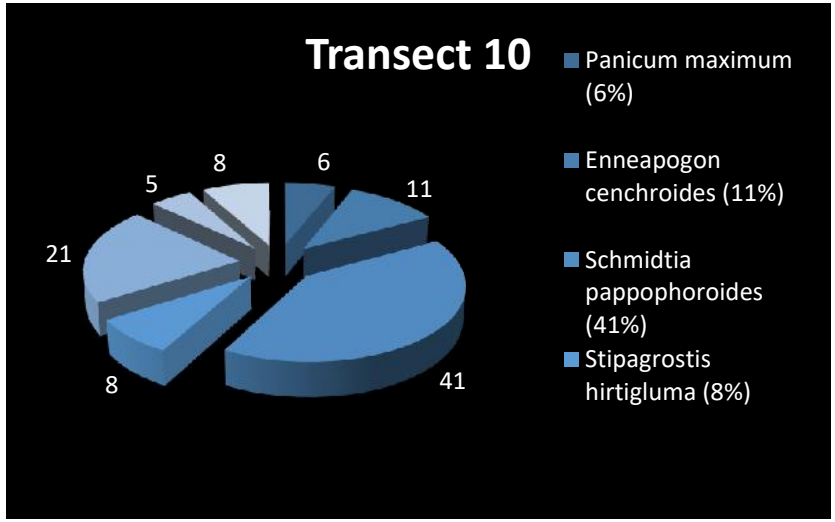
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 9 – Mopane Woodland

- *Aristida congesta* subsp. *congesta* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Aristida congesta* subsp. *barbicollis* (Tassel Three Awn) [Increaser II, Pioneer grass]. Annual, tufted, grass grows in nutrient poor sandy and/or disturbed soils and in very dry areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Enteropogon macrostachyus* (Mopane grass) [Increaser II, subclimax grass]. Grows in warm areas, common in mopaneveld.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

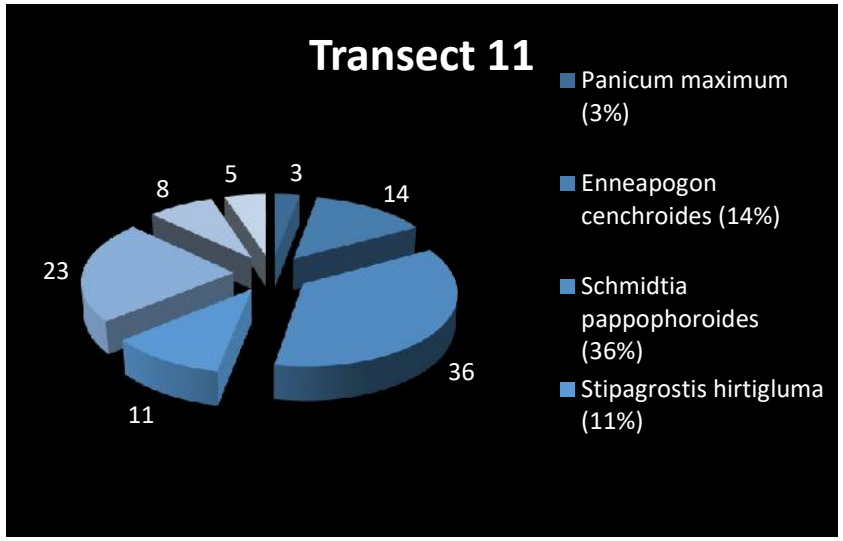
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 10 – Mopane Woodland

- *Digitaria eriantha* (Common finger grass) [Decreaser, Climax grass]. Perennial tufted grass common in sandy and gravelly soil in arid areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Enteropogon macrostachyus* (Mopane grass) [Increaser II, subclimax grass]. Grows in warm areas, common in mopaneveld.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

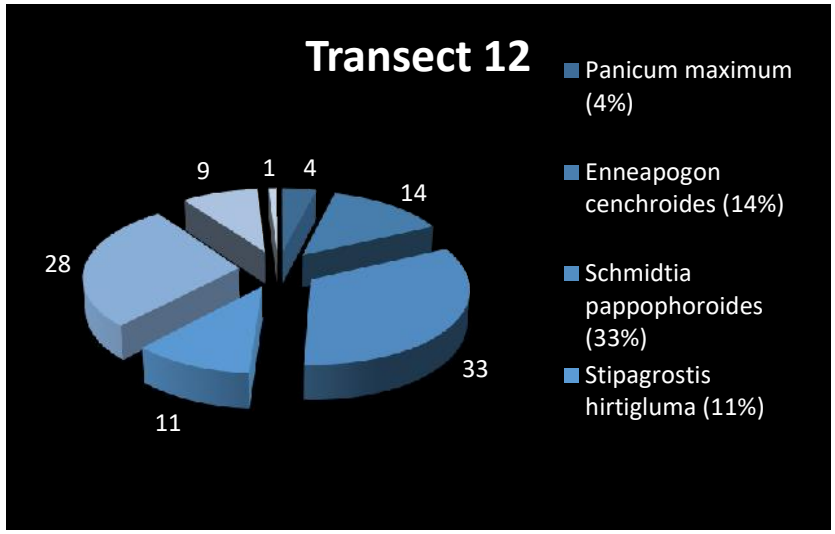
Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 11 – Soutpansberg Mountain Bushveld

- *Digitaria eriantha* (Common finger grass) [Decreaser, Climax grass]. Perennial tufted grass common in sandy and gravelly soil in arid areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.



Transect 12 – Mopane Woodland

- *Digitaria eriantha* (Common finger grass) [Decreaser, Climax grass]. Perennial tufted grass common in sandy and gravelly soil in arid areas.
- *Enneapogon cenchroides* (Nine Awned Grass) [Increaser II, Subclimax grass]. Grows in sandy and gravelly soil, common in mopaneveld and limestone areas.
- *Schmidtia pappophoroides* (Sand quick) [Increaser II, Climax grass]. Grows in warm areas with low rainfall, mostly in sandy and gravelly soil.
- *Stipagrostis hirtigluma* (Sand quick) [Increaser II, Subclimax grass]. Grows mostly in sandy and gravelly soil, often on rocky outcrops in warm areas.

Conclusion: The dominant grass species identified are indicators of poor sandy and gravelly soils, warm climate and low rainfall. These areas typical of the region in which the study area is situated and the dominant grass species are indicative of the vegetation type associated with the study area.

The dominant grass species are all indicative of nutrient-poor, sandy soils, which is the dominant soil type associated with the study area. Furthermore, the fact that the majority of grass species are sub-climax species does not necessarily indicate disturbance but is a function of the sandy nature of the soil and typical of the vegetation types in which the study area is situated. Thus, the grass layer is considered to be in a largely natural condition.

2.5.3.5 Floral Species of Conservational Concern Assessments

An assessment considering the presence of any plant species of concern, as well as suitable habitat to support any such species will be undertaken. The complete PRECIS (Pretoria Computer Information Systems) floral RDL lists for the grid reference 2230CC and 2230CA as acquired from SANBI (South African National Biodiversity Institute).

Table 15: IUCN RDL Categories – Version 2014.1 as supplied by SANBI

Category	Definition
EX	Extinct
EW	Extinct in the Wild
RE	Regionally Extinct
CE PE	Critically Endangered, Possibly Extinct
CE	Critically Endangered
EN	Endangered
VU	Vulnerable
NT	Near threatened
*CR	Critically Rare
*R	Rare
*Declining	Declining
LC	Least Concern
DDD	Data Deficient - Insufficient Information
DDT	Data Deficient - Taxonomically Problematic

Categories marked with * are non-IUCN, national Red List categories for species not in danger of extinction, but considered of conservation concern. The IUCN equivalent of these categories is Least Concern (LC).

Threatened species are species that are facing a high risk of extinction. Any species classified in the IUCN categories Critically Endangered, Endangered or Vulnerable is a threatened species.

SCC are species that have a high conservation importance in terms of preserving South Africa's high floristic diversity and include not only threatened species, but also those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare and Declining.

Table 16: PRECIS plant list for the QDS 2230CC and 2230 CA (Raimondo et al., 2009; SANBI, www.sanbi.org)

Family	Species	Threat status	Growth form	Habitat
APOCYNACEAE	*Ceropegia cimiciodora Oberm.*	VU	Perennial climber/ succulent	Distributed in KwaZulu-Natal and Limpopo Province, ranges from Soutpansberg, Swaziland and northern KwaZulu-Natal. It occurs in a Savanna habitat, in turf and sandy loam soils.
APOCYNACEAE	*Tylophora coddii Bullock*	Rare	Perennial herb/ shrub/ succulent	Distributed in the Limpopo Province, ranges from the southern end of Wylie's Poort to the Blouberg. It occurs in a terrestrial savannah habitat, in rock crevices, 1000 – 1600 m.
AQUIFOLIACEAE	*Ilex mitis (L.)Radlk. var. mitis*	Declining	Perennial shrub/ tree	Distributed in Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, North West and Western Cape Province, widespread from Table Mountain in the Western Cape to Ethiopia and also Madagascar. It occurs in a terrestrial Albany Thicket, Forest, Fynbos, Grassland, Indian Ocean Coastal Belt and Savanna habitat, along rivers and streams in forest and thickets, sometimes in the open. Found from sea level to inland mountain slopes.
CANELLACEAE	*Warburgia salutaris (G.Bertol.) Chiov.* .	EN	Perennial shrub/ tree	Distributed in KwaZulu-Natal, Limpopo and Mpumalanga Province, also occurs in Swaziland, Mozambique, Zimbabwe and Malawi. It occurs in a terrestrial forest and savannah habitat, in coastal, riverine, dune and montane forest, as well as open woodland and thickets.
CELASTRACEAE	*Elaeodendron croceum (Thunb.) DC.*	Declining	Perennial tree	Distributed in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga Province, as well as in Zimbabwe. It occurs in a terrestrial forest habitat, in the margins of coastal and montane forests.
CELASTRACEAE	*Elaeodendron transvaalense (Burtt Davy) R.H.Archer*	NT	Perennial shrub/ tree	Distributed in KwaZulu-Natal, Limpopo, Mpumalanga and North West Province. It occurs in a terrestrial Savanna or bushveld habitat, from open woodland to thickets, often on termite mounds. Declining due to heavy exploitation for the muthi market.
CORNACEAE	*Curtisia dentata (Burm.f.) C.A.Sm.*	NT	Perennial shrub/ tree	Distributed in Eastern Cape, Free State, KwaZulu-Natal, Limpopo and Mpumalanga Province, ranges from Cape Peninsula to the Zimbabwe-Mozambique highlands. It occurs in a terrestrial forest habitat, in evergreen forest from coast to an altitude of 1800 m.
CYATHEACEAE	*Alsophila capensis (L.f.) J.Sm.*	Declining	Perennial tree	Distributed in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga Province, as well as in Zimbabwe, Mozambique, Malawi and southern Tanzania. It occurs in a terrestrial forest, near waterfalls, streams and permanently moist seepages.
LAURACEAE	*Cryptocarya transvaalensis Burtt Davy* .	Declining	Perennial tree	Distributed in Limpopo and Mpumalanga Province, occurs along the eastern Escarpment, from Swaziland to the Wolkberg Mountains and also the Soutpansberg Mountains, and northwards to tropical Africa. It occurs in a terrestrial forest, limited to Afromontane forests up to an altitude of 1700 m.

Family	Species	Threat status	Growth form	Habitat
MESEMBRYANTHEMACEAE	*Khadia borealis L.Bolus*	Rare	Perennial succulent	Distributed in the Limpopo Province, in the Soutpansberg summit, from Lejuma to Mavhode. It occurs in a terrestrial grassland, in dry grasslands or savannah, in crevices of quartzitic rocks.
MYRSINACEAE	*Rapanea melanophloeos (L.) Mez*	Declining	Perennial tree	Distributed in Eastern Cape, Free State, KwaZulu-Natal, Limpopo and Mpumalanga Province, ranges from Cape Peninsula to Malawi. It occurs in a terrestrial forest, coastal, swamp and mountain forest, on forest margins and bush clumps, often in damp areas from coast to mountains.
ORCHIDACEAE	*Disa extinctoria Rchb.f.*	NT	Perennial geophyte/ herb	Distributed in Limpopo and Mpumalanga Province, ranges from Swaziland to Tzaneen. It occurs in a terrestrial grassland, crest of the escarpment in damp grassland and swamps, from an altitude of 1000 – 1300 m.
ORCHIDACEAE	*Mystacidium braybonіae Summerh.*	NT	Perennial epiphyte/ herb	Distributed in the Limpopo Province, in the Soutpansberg Mountains. It occurs in a terrestrial forest, in most, high altitude mistbelt forests and woodlands.
PASSIFLORACEAE	*Adenia gummifera (Harv.) Harms var. gummifera*	Declining	Perennial climber/ succulent	Distributed in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga Province, widespread in eastern Africa, from Somalia to Kei River mouth in the Eastern Cape, South Africa. It occurs in a terrestrial forest and savannah habitat, in forested ravines, forest patched and forest margins, forest scrub, miombo woodland, savannah, dune forest, on stony slopes, termitaria and littoral bush, from an altitude of 0 – 1800 m.
RHIZOPHORACEAE	*Cassipourea malosana (Baker) Alston*	Declining	Perennial shrub/ tree	Distributed in Eastern Cape, KwaZulu-Natal, Limpopo and Mpumalanga Province, ranges from Port St Johns district in the Eastern Cape to the Limpopo province and northwards to Ethiopia. It occurs in a terrestrial forest, in the understorey of Afromontane forest or in thickets on rocky outcrops in Mpumalanga, also in coastal and midland forests in KwaZulu-Natal.
ROSACEAE	*Prunus africana (Hook.f.) Kalkman*	VU	Perennial tree	Distributed in Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga and North West Province, widespread in Africa from the southern Cape, through KwaZulu-Natal, Swaziland and northwards in to Zimbabwe and central Africa and the islands of Madagascar and Comoros.
RUBIACEAE	*Vangueria soutpansbergensis N.Hahn*	Rare	Perennial shrub	Distributed in the Limpopo Province, in the Soutpansberg Mountains. It occurs in a terrestrial savannah, mixed woodlands on rocky slopes, only found growing on soils derived from quartzite, from an altitude of 1440m.

The Probability of Occurrence (POC) of each of the species listed above was calculated (Table 17) with reference to habitat suitability within the study area.

Table 17: POC for floral species of concern

Species	POC	Motivation
Ceropegia cimiciodora Oberm.	80%	High probability of occurring, especially in Soutpansberg Mountain Bushveld habitat unit. Not recorded during assessment.
Tylophora coddii Bullock	70%	High probability of occurring, especially in Soutpansberg Mountain Bushveld habitat unit. Not recorded during assessment.
Ilex mitis (L.) Radlk. var. mitis	5%	Very little suitable habitat present and overall arid conditions not suitable for this species. Not recorded during assessment.
Warburgia salutaris (G.Bertol.) Chiov.	60%	Suitable habitat available within the Soutpansberg Mountain Bushveld habitat unit. Not recorded during assessment.
Elaeodendron croceum (Thunb.) DC.	6%	No suitable habitat present and overall arid conditions not suitable for this species. Not recorded during assessment.
Elaeodendron transvaalense (Burtt Davy) R.H.Archer	60%	Suitable habitat available within the Soutpansberg Mountain Bushveld habitat unit. Not recorded during assessment.
Curtisia dentata (Burm.f.) C.A.Sm.	35%	No suitable habitat present and overall arid conditions not suitable for this species. Not recorded during assessment.
Alsophila capensis (L.f.) J.Sm.	20%	No suitable habitat present and overall arid conditions not suitable for this species. Not recorded during assessment.
Cryptocarya transvaalensis Burtt Davy.	0%	Very little suitable habitat available. Highly unlikely to occur.
Khadia borealis L.Bolus	0%	No suitable habitat present and highly unlikely to occur.
Rapanea melanophloeos (L.) Mez	5%	No suitable habitat present and overall arid conditions not suitable for this species. Not recorded during assessment.
Disa extinctoria Rchb.f.	0%	No suitable habitat available.
Mystacidium brayboniae Summerh.	0%	No suitable habitat available.
Adenia gummifera (Harv.) Harms var. gummifera	46%	Suitable habitat available within the Soutpansberg Mountain Bushveld habitat unit. Not recorded during assessment.
Cassipourea malosana (Baker) Alston	0%	No suitable habitat available.
Prunus africana (Hook.f.) Kalkman	0%	No suitable habitat available.
Vangueria soutpansbergensis N.Hahn	0%	No suitable habitat available.

From the above assessment, it is clear that several of the RDL floral species listed for the QDS 2230CC and 2230CA have a high probability of occurring within the study area, especially within the Soutpansberg Mountain Bushveld habitat unit.

Furthermore, five tree species protected by the National Forest Act (1998), namely *Combretum imberbe, Sclerocarya birrea* subsp *caffra, Adansonia digitata, Lonchocarpus capassa* and *Boscia albitrunca* are present in this habitat unit. In terms of this act, protected tree species may not be cut, disturbed, damaged or destroyed and their products may not be possessed, collected, removed, transported, exported, donated, purchased or sold - except under licence granted by the Department of Water Affairs (DWA) (or a delegated authority). Another species protected under the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) Lists of Species that are Threatened or Protected (TOPS), namely *Adenium multiflorum*, is also present within the Mopane Woodland and Soutpansberg Mountain Busveld habitat units. *Adenium multiflorum* and *Adansonia digitata* are also protected under the Limpopo Environmental Management Act (Act 7 of 2003). Thus, the study area is considered to be of high sensitivity

in terms of floral SCC conservation. Impacts from the proposed mining activities and associated infrastructure are deemed highly likely to have a significant impact on floral SCC and habitat.

2.5.3.6 Vegetation Index Score

The information gathered during the assessment of the study area was used to determine the Vegetation Index Score (VIS). Due to variation between the different habitat units within the site, all habitat units were assessed separately. The perennial rivers and ephemeral systems with established riparian zones and ephemeral systems with weakly developed or no riparian zones were also assessed separately in order to provide an accurate assessment of the ecological integrity of each feature group. Table 18 lists the scoring system and Table 19 the results of each habitat unit.

Table 18: Scoring for the Vegetation Index Score

Vegetation Index Score	Assessment Class	Description
22 to 25	**A**	Unmodified, natural
18 to 22	**B**	Largely natural with few modifications.
14 to 18	**C**	Moderately modified
10 to 14	**D**	Largely modified
5 to 10	**E**	The loss of natural habitat extensive
<5	**F**	Modified completely

Table 19: Vegetation Index Score

Habitat unit	Score	Class	Motivation
Soutpansberg Mountain Bushveld	21	**B - Largely natural with few modifications**	Soutpansberg Mountain Bushveld mostly undisturbed and representative of vegetation type, intact, high ecological functionality, low levels of alien floral invasion.
Mopane Woodland	18	**B/C – Largely natural/Moderately modified**	Isolated areas of disturbance, low levels of alien floral invasion and representative of vegetation type. This places the habitat unit between Class B and C VIS.
Systems with established riparian zone	19	**B – Largely natural**	Well established riparian zones with isolated areas of disturbance, low levels of alien floral invasion and high levels of indigenous species recruitment places this habitat unit within Class B VIS.
Ephemeral systems with weakly developed or no riparian zones	18	**B/C – Largely natural/Moderately modified**	Isolated areas of disturbance, low levels of alien floral invasion and high levels of indigenous species recruitment places this habitat unit between Class B and C VIS.

2.5.3.7 Alien and Invasive Floral Species

Alien invaders are plants that are of exotic origin and are invading previously pristine areas or ecological niches (Bromilow, 2001). Not all weeds are exotic in origin but, as these exotic plant species have very limited natural “check” mechanisms within the natural environment, they are often the most opportunistic and aggressively growing species within the ecosystem. Therefore, they are often the most dominant and noticeable within an area. Disturbances of the ground through trampling, excavations or landscaping often

leads to the dominance of exotic pioneer species that rapidly dominate the area. Under natural conditions, these pioneer species are overtaken by sub-climax and climax species through natural veld succession. This process however takes many years to occur, with the natural vegetation never reaching the balanced, pristine species composition prior to the disturbance. There are many species of indigenous pioneer plants, but very few indigenous species can out-compete their more aggressively growing exotic counterparts.

Alien vegetation invasion causes degradation of the ecological integrity of an area, causing (Bromilow, 2001):

- A decline in species diversity;
- Local extinction of indigenous species;
- Ecological imbalance;
- Decreased productivity of grazing pastures; and
- Increased agricultural input costs.

During the assessment, all exotic and weed, species were identified and are listed in Table 20.

Table 20: Exotic or invasive species within the assessment site

Species	English name	Origin	Category*
Trees/ shrubs			
Cereus jamacaru	Queen of the night	South America	1
Solanum mauritianum	Bugweed	South America	1
Opuntia ficus-indica	Prickly pear	Mexico	1
Forbs			
Bidens pilosa	Common blackjack	South America	N/A
Datura ferox	Large thorn-apple	Eurasia	1
Tagetes minuta	Tall khaki weed	South America	N/A
Zinnia peruviana	Redstar zinnia	South America	N/A

Category 1 – Declared weeds. Prohibited plants, which must be controlled or eradicated.
Category 2 – Declared invader plants with a value. "Invaders" with certain useful qualities (i.e. commercial). Only allowed in controlled, demarcated areas.
Category 3 – Mostly ornamental plants. Alien plants presently growing in, or having escaped from, areas such as gardens, but are proven invaders. No further planting or trade in propagative material is allowed (Bromilow, 2001).

Alien floral invasion was low to very low and limited to isolated patches of disturbance around roads and nearer to human settlements adjacent to the stud area. Alien and weed species encountered on the property are to be removed in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal and control of invasive plant species should take place throughout the pre-construction, construction, operational, and rehabilitation/ maintenance phases.

2.5.3.8 Medicinal Plant Species

Medicinal plant species are not necessarily indigenous species, with many of them regarded as alien invasive weeds. The medicinal species are all commonly occurring species and are not confined to the study area.

Table 21 presents a list of plant species with traditional medicinal value, plant parts traditionally used and their main applications, which were identified during the field assessment.

Table 21: Traditional medicinal plants identified during the field assessment

Species	Name	Plant parts used	Medicinal uses
Asclepias fruticosa	Milkweed	Leaves, sometimes roots	Used as snuff to treat headaches and tuberculosis.
Adansonia digitata	Baobab	Leaves, fruit, bark, roots	Leaves rich in vitamin C, sugars, potassium tartrate, and calcium. The fibrous bark is used to make items such as mats and ropes, fishing nets, fishing lines, sacks as well as clothing.
Adenium multiflorum	Impala lily	Bark and trunk	Used for fish poison and arrow poison. The poison is prepared from latex in the bark and fleshy parts of the trunk. Despite the toxicity, it is used in medicinal applications and as magic potions.
Boscia albitrunca	Shepherd's tree	Bark, roots, leaves	The root is pounded to make porridge. It is commonly used as a substitute for coffee or chicory. The root is also used to make a beer and to treat haemorrhoids. The leaves are nutritious and are often browsed by cattle. An infusion of the leaves is used to treat eye infections in cattle.
Combretum imberbe	Leadwood	Leaves, bark, roots and flowers	Smoke from burning leaves used to relieve coughs, colds and chest complaints. Flowers used as a cough mixture. Leaves believed to have magical powers. For treatment of diarrhoea and stomach pains, root decoctions are used. A combination of roots and leaves taken against bilharzia.
Commiphora edulis	Rough leaved corkwood	Gum	Gum boiled in water to form a soap for washing clothes.
Dichrostachys cinerea	Sickle bush	Root and often stems bark, leaves and pods	Root infusions have been used to treat body pain, backache, toothache, elephantiasis, syphilis, leprosy and as a styptic, diuretic, purgative and aphrodisiac.
Datura stramonium	Thornapple	Leaves and rarely the green fruit.	Generally as asthma treatment and pain reduction.
Dombeya rotundifolia	Wild pear	Mainly bark, sometimes roots	Infusions are used orally or as enemas to treat internal ulcers, haemorrhoids, diarrhoea and stomach problems.

Species	Name	Plant parts used	Medicinal uses
Lonchocarpus capassa	Apple leaf	Mostly roots	Most parts of the plant are used to treat diarrhoea. The roots are used for gastro-intestinal problems; powdered root-bark is used to treat colds and snakebite. Root infusions are commonly used as part of a hookworm remedy.
Olea europaea subsp *africana*	Wild olive	Dried leaves, sometimes stem and bark	The main use of the plant is as a hypotensive to lower blood pressure and to enhance renal function.
Spirostachys africana	Tamboti	Latex, bark	A drop of the fresh latex is applied to a painful tooth as painkiller. The bark is used to treat stomach pains but large dosages will cause damage to the internal organs.
Schotia brachypetala	Weeping boer bean	Bark and roots	Used to treat heartburn and hangovers. Bark and root mixtures are used to strengthen the body and purify the blood, to treat nervous heart conditions and diarrhoea, as well as for facial saunas.
Sclerocarya birrea subsp. *caffra*	Marula	Bark, roots and leaves	Diarrhoea, dysentery and unspecific stomach problems are treated with the bark. Also used as a general tonic, in combatting fever and in the treatment of malaria.
Tagetes minuta	Tall khaki bush	Leaves, flowers	The repellent properties of essential oil have been known for a long time and were found to be effective in preventing sheep from becoming infected with blow-fly larvae. Many gardeners use warm water extracts of the fresh plant to keep roses and other garden plants free from insects and fungal diseases. The essential oil is used in perfumery and as a flavourant in food, beverages and tobacco.
Vernonia oligocephala	Groenamara	Leaves and twigs	Infusions are taken as stomach bitters to treat abdominal pain and colic.
Ziziphus mucronata	Buffalo thorn	Roots, bark or leaves used separately or in combination.	Warm bark infusions (sometimes together with roots or leaves added) are used as expectorants (also as emetics) in cough and chest problems, while root infusions are a popular remedy for diarrhoea and dysentery. Decoctions of roots and leaves (or chewed leaves) are applied externally to boils, sores and glandular swellings, to promote healing and as an analgesic.

A moderate to high diversity of medicinal species is present, and it is highly likely that the local communities rely on these medicinal species as relatively few medical facilities are present in the local area. In addition, five medicinal tree species, namely *Sclerocarya birrea* subsp *caffra, Adansonia digitata, Lonchocarpus capassa, Combretum imberbe* and *Boscia albitrunca* are protected under the NFA (1998). Another medicinal species, namely *Adenium multiflorum,* is protected under the NEMBA TOPS list. *Adenium multiflorum* and *Adansonia digitata* are also protected under the Limpopo Environmental Management Act (Act 7 of 2003).

Thus, any detrimental impact on the medicinal species associated with the study area is likely to have a significant impact on surrounding communities relying on such species for medicinal use.

2.5.4 SENSITIVITY MAPPING

Figure 30 conceptually illustrates the areas considered to be of increased ecological sensitivity in relation to the proposed project. The areas are depicted according to their sensitivity in terms of faunal and floral habitat integrity and their suitability to provide habitat to faunal and floral communities.

The wetland and riparian habitat unit provides niche habitat for a high diversity of floral and faunal species and acts as a very important network of migratory corridors for faunal species. Thus, this habitat unit is considered to be highly sensitive. As such, any impacts on the wetland and riparian systems associated with the study area are likely to be significant on a local and regional scale.

The Soutpansberg Mountain Bushveld habitat unit has general high ecological functionality and overall high levels of habitat integrity and is in a relatively undisturbed condition. The species composition of this habitat unit is also representative of the vegetation type in which it occurs and the vegetation type is considered to be Vulnerable. Furthermore, this habitat unit contains several floral SCC. Thus, this habitat unit is considered to be highly sensitive.

The Mopane Woodland habitat unit has general moderate to high ecological functionality and levels of habitat integrity and is in a relatively undisturbed condition. The species composition of this habitat unit is also representative of the vegetation type in which it occurs and the vegetation type is considered Least Threatened. Furthermore, this habitat unit contains several floral SCC. Thus, this habitat unit is considered to be moderately sensitive.

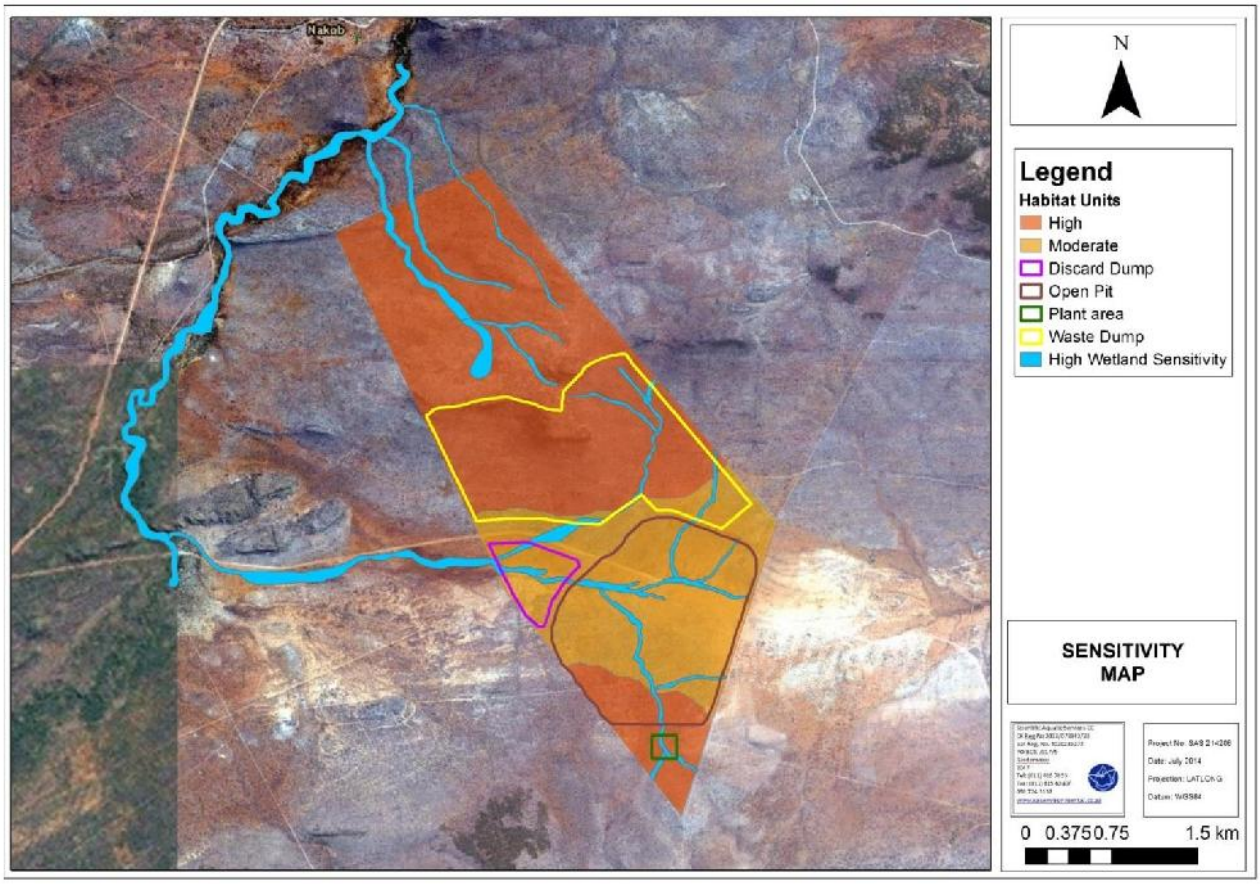


Figure 30: Terrestrial sensitivity map for the study area in relation to proposed mining infrastructure

2.6 BIODIVERSITY – FAUNAL ASSESSMENT

2.6.1 METHOD OF ASSESSMENT

Initially a desktop study was undertaken to gather background information regarding the study area and its surrounding areas. Documentation and species lists that have been made available to the public by relevant authorities and non-governmental organisations (NGO) were consulted, and all the latest available literature was utilised to gain a thorough understanding of the area and its surrounding habitats. Threatened or RDL faunal species which have been recorded in the Limpopo Province as per the Limpopo State of the Environment Report, which is in the Limpopo Department of Finance and Economic Development (Limpopo SoER) report of 2004, was cross-referenced with information from the International Union for the Conservation of Nature (IUCN) Red Data list for 2015 (http://www.iucnredlist.org). Faunal RDL species in Limpopo SoER (2004) were specifically focused on and addressed in the result section in this report with regards to the proposed study area.

This information was then used to determine the potential biodiversity lists, expected RDL lists and anticipated Red Data Sensitivity Index (RDSIS) list of faunal species for the proposed study area. This information incorporated (amongst others) data on vegetation types, habitat suitability and biodiversity potential coupled to this information.

A site visit was undertaken during January 2015 to determine the ecological status of the study area and the surrounding areas. A reconnaissance 'drive around' followed by a thorough 'walk through' on foot was undertaken to determine the general habitat types found throughout the study area and, following this, specific study sites or areas were selected that were considered to be representative of the habitats found within the study area. Special emphasis was placed on areas that may potentially support Red Data Listed (RDL) faunal species. Sites were investigated on foot in order to identify the occurrence of the dominant faunal communities, species and habitat diversities. The presence of any faunal inhabitants of the study area was also assessed through direct visual observation or identifying such species through calls, tracks, scats, burrows and other methods as described in the methodology.

Small mammals are unlikely to be directly observed in the field because of their nocturnal/crepuscular and cryptic nature. A simple and effective solution to this problem is to use Sherman traps. A Sherman trap is a small aluminium box with a spring-loaded door. Once the animal is inside the trap, it steps on a small plate that causes the door to snap shut, thereby capturing the individual. In the event of capturing a small mammal during the night, the animal would be photographed and then set free unharmed early the following morning. Traps were baited with a universal mixture of oats, peanut butter, and fish paste.

It is important to note that due to the nature and habits of fauna, varied stages of life cycles, seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. The presence of human habitation nearby the study area and the associated anthropogenic activities may have an impact on faunal behaviour and in turn the rate of observations. In order to increase overall observation time within the study area, as well as increasing the likelihood of observing shy and hesitant species, camera traps were strategically placed throughout the study area. Sherman traps were also used to increase the likelihood of capturing and observing small mammal species, notably small nocturnal mammals.

2.6.2 FIELD OBSERVATIONS

The vegetation type found within the study area is Mopane Bushveld and Soutpansberg Mountain Bushveld (Mucina and Rutherford 2006). The faunal habitat within the study area was relatively intact, and comprised of Mopane veld, Savanna and Mountain Bushveld areas. The Mopane veld in the southern section of the study area was fairly uninhabited by faunal species, as is to be expected of this vegetation type. The Mountain bushveld and the Savanna areas in the central and northern portions of the study area were noted to have the highest level of habitat provision for faunal species within the study area. Rocky outcrops interspersed amongst the trees provided suitable habitat to a variety of invertebrate, reptile and small mammal species. The open savanna was inhabited by medium to large herbivore, omnivore and carnivore species whilst the large trees and rocky hill slopes within the study area provide suitable nesting sites for large raptors.

The faunal categories covered in this assessment are mammals, avifauna, reptiles, amphibians, general invertebrates, spiders and scorpions.

2.6.2.1 Mammals

Mammal species recorded during the January 2015 survey throughout the study area are discussed below.

Table 22: Mammals species recorded during the field survey at the Duel

Scientific name	Common Name	IUCN Red List Status
Sylvicapra grimmia	Common Duiker	LC
Aepyceros melampus	Impala	LC
Kobus ellipsiprymnus	Waterbuck	LC
Hyaena brunnea	Brown Hyaena	NT
Phacochoerus africanus	Warthog	LC
Civettictis civetta	African Civet	LC
Panthera pardus	Leopard	NT
Canis mesomelas	Black-backed Jackal	LC
Otocyon megalotis	Bat-eared Fox	LC
Tragelaphus strepsiceros	Kudu	LC
Hystrix africaeaustralis	Cape Porcupine	LC
Chlorocebus aithiops	Vervet Monkey	LC
Papio cynocephalus	Chacma Baboon	LC
Lepus saxatilis	Scrub Hare	LC
Procavia capensis	Rock Dassie	LC
Galerella sanguinea	Slender Mongoose	LC
Gerbilliscus leucogaster	Bushveld Gerbil	LC
Paraxerus cepapi	Tree Squirrel	LC
Tragelaphus angasii	Nyala	LC
Taphozous mauritianus	Mauritian tomb bat	LC

LC = Least Concern, NT = Near Threatened

The above listed species were all observed either directly, by spoor, territorial markings or through the use of motion sensitive camera traps placed throughout the study area. The camera traps recorded a total of 425 hours, greatly increasing the likelihood of a species being observed. The northern section of the study

area, although fairly dry at the time of the field assessment, had the highest faunal diversity of the study area. This can be attributed to the fact that the only surface water within the study area was located within the northern portion, and the northern portion of the study area is afforded less anthropogenic disturbances in comparison to the remaining areas of the study area nearer to Makushu village. The northern portion of the study area is also open to the remaining areas of study area to the north, west and east allowing for greater movement of game species. The portion of the study area to the south, bordering the local community had a very low diversity and abundance of faunal species, with only the spoor of *Sylvicapra grimmia* (Common Duiker) being observed. The more central section of the study area, between the main road and the centrally located hills in the study area was also noted to have a low faunal diversity, with only the spoor of *Sylvicapra grimmia* (Common Duiker) and *Aepyceros melampus* (Impala) being observed. No surface water was noted in the central and southern portions of the study area, which will be a contributing factor to the lack of game species observed within these areas. Furthermore, these areas border the local community and as such there is an increased likelihood that these areas may be targeted more for poaching and the setting of snares. These anthropogenic activities are likely to have influenced the behavioural and movement patterns of the faunal species within the study area, resulting in the faunal species selecting to avoid these areas as far as possible, or to alter their activity patterns.

From the above tabled species it must be noted that both *Panthera pardus* and *Hyaena brunnea* are both listed as Near Threatened by the IUCN. *Panthera pardus* is also listed under Schedule 3 of the Limpopo Environmental Management Act 2004 (LEMA) as a protected wild animal. Both of these species are listed as Near Threatened by the IUCN due to decreasing habitat, habitat fragmentation and human carnivore conflict. These threats may be significant enough that Panthera pardus may soon qualify for Vulnerable status. Furthermore, both *Hyaena brunnea* and *Panthera pardus* are listed as protected under the National Environmental Management Act 2004 (NEMBA).

Figure 31: *Panthera pardus* (Leopard) spoor on the left and *Hyaena brunnea* (Brown Hyaena) pasting on the right

Figure 32: *Tragelaphus angasii* (Nyala) on the left and *Sylvicapra grimmia* (Common Duiker) to the right captured on the camera traps

Figure 33: *Kobus ellipsiprymnus* (Waterbuck) on the left and *Aepyceros melampus* (Impala) to the right captured on the camera traps

2.6.2.2 Avifauna

The birds that were identified within the study area during the field assessment in January 2015 are listed in Table 23, either by direct visual observation or via calls.

Table 23: Avifaunal species recorded during the field survey at The Duel

Scientific name	Common Name	IUCN Red List Status
Streptopelia capicola	Cape turtle-dove	LC
Eremomela usticollis	Burnt-necked Eremomela	LC
Cossypha humeralis	White-throated Robin-chat	LC
Petronia superciliaris	Yellow-throated Sparrow	LC
Cuculus solitarius	Red-chested Cuckoo	LC
Vidua regia	Shaft tailed whydah	LC
Centropus superciliosus	Burchell's Coucal	LC
Vidua paradisaea	Paradise-whydah	LC
Melierax gabar	Gabar Goshawk	LC
Vidua macroura	Pin-tailed Whydah	LC

Scientific name	Common Name	IUCN Red List Status
Bubalornis niger	Red-billed Buffalo-weaver	LC
Lanius collaris	Fiscal Shrike	LC
Hieraaetus spilogaster	African Hawk Eagle	LC
Merops pusillus	Little Bee-eater	LC
Prinia subflava	Tawny flanked Prinia	LC
Turtur chalcospilos	Emerald-spotted Wood-dove	LC
Amadina fasciata	Cut-throat Finch	LC
Lagonosticta rubricata	African Firefinch	LC
Streptopelia senegalensis	Laughing dove	LC
Tockus leucomelas	Southern Yellow-billed Hornbill	LC
Tockus nasutus	African Grey Hornbill	LC
Estrilda astrild	Common Waxbill	LC
Uraeginthus angolensis	Blue Waxbill	LC
Coturnix coturnix	Common Quail	LC
Streptopelia senegalensis	Laughing Dove	LC
Oena capensis	Namaqua Dove	LC
Cinnyricinclus leucogaster	Plum-coloured Starling	LC
Laniarius atrococcineus	Crimson-breasted Shrike	LC
Thamnolaea cinnamomeiventris	Mocking Chat	LC
Phoeniculus purpureus	Green Woodhoopoe	LC
Delichon urbica	House Martin	LC
Riparia paludicola	Brown-throated Martin	LC
Hirundo dimidiata	Pearl-breasted Swallow	LC
Ardea melanocephala	Black-headed Heron	LC
Scopus umbretta	Hammerkop	LC
Halcyon senegalensis	Woodland Kingfisher	LC
Coracias caudatus	Lilac-breasted Roller	LC
Corythaixoides concolor	Grey Go-away Bird	LC
Oenanthe monticola	Mountain Wheatear	LC
Clamator levaillantii	Striped Cuckoo	LC
Dicrurus adsimilis	Fork-tailed Drongo	LC
Buteo vulpinus (B.buteo)	Steppe buzzard	LC
Anthus cinnamomeus	African Pipit	LC
Urocolius indicus	Red-faced Mousebird	LC
Passer domesticus	House sparrow	LC
Lagonosticta rhodopareia	Jameson's Firefinch	LC
Tchagra senegalus	Black-crowned Tchagra	LC
Tchagra australis	Three-streaked Tchagra	LC
Lanius collurio	Red-backed Shrike	LC
Numida meleagris	Helmeted Guineafowl	LC
Anthus leucophrys	Plain Backed Pipit	LC
Prinia flavicans	Black-chested Prinia	LC
Mirafra sabota	Sabota Lark	LC
Lanius minor	Lesser Grey Shrike	LC
Lamprotornis chalybaeus	Greater Blue-eared Glossy Starling	LC

LC = Least concerned. NYBA = Not yet been assessed by the IUCN

According to Birdlife South Africa the study area falls within the Soutpansberg Important Bird Areas (IBA) which has been identified within South Africa (www.birdlife.org.za). This IBA provides habitat to numerous listed bird species, with special focus on larger raptors that are known to inhabit the Soutpansberg. Furthermore, the study area borders the Nzhelele Nature Reserve (NNR). Listed in Table 24 are avifaunal species of concern that have been directly observed within the NNR.

Table 24: Avifaunal SCC recorded and known to occur within the NNR

Scientific Name	Common Name	Regional Conservation Status	Global Conservation Status
Terathopius ecaudatus	Bateleur	EN	NT
Gyps coprotheres	Cape Vulture	EN	VU
Ardeotis kori	Kori Bustard	NT	NT
Falco biarmicus	Lanner Falcon	VU	LC
Torgos tracheliotos	Lappet-faced Vulture	EN	VU
Polemaetus bellicosus	Martial Eagle	EN	VU
Sagittarius serpentarius	Secretarybird	VU	VU
Bucorvus leadbeateri	Southern Ground-Hornbill	EN	VU
Aquila rapax	Tawny Eagle	EN	LC
Gyps africanus	White-backed Vulture	EN	EN

All avifaunal species listed in Table 24 have previously been observed within the NRR, and as this reserves borders the study area, and the same habitat persists through both properties, it is highly likely that species listed within Table 24 may occur either permanently or temporarily within the study area, either for breeding purposes or whilst foraging. Furthermore, the steeper slopes in the hills and the large trees within the study area are capable of providing nesting sites to many of the large raptor species that area known to occur within the area.

In terms of avifaunal conservation the study area is considered to be of a high conservation value due to the likely presence of the above listed species (Table 24) as well as the study area being located within the Soutpansberg IBA. The development of the mine is highly likely to have a marked impact on avifaunal species both in the study area and the adjacent NNR.

Figure 34: *Merops pusillus* (Little Bee-eater) on the left and a juvenile *Melierax gabar* (Gabar Goshawk) on the right

Figure 35: *Tockus leucomelas* (Southern Yellow-billed Hornbill) to the left and *Cinnyricinclus leucogaster* (Plum-coloured Starling) and *Lamprotornis chalybaeus* (Greater Blue-eared Glossy Starling) on the right

2.6.2.3 Amphibians

Chiromantis xerampelina (Southern Foam Nest Frog) was the only amphibian species observed within the study area during the field assessment. The remnants of foam nests were located above a small stagnant pool within the study area. Other amphibian species that may inhabit the study area are *Cacosternum boettgeri* (Boettger's Coca), *Tomopterna cryptotisi* (Tremolo Sand Frog), *Tomopterna krugerensis* (Knocking Sand Frog), *Ptychadena mossambica* (Broad-banded Grass Frog) and *Ptychadena anchietae* (Plain Grass Frog).

Consideration needs to be given to *Pyxicephalus adspersus* (Giant Bullfrog), as this species remains buried within the soil up to 1m deep for the majority of the year, emerging during periods of high rainfall to breed. In the northern portion of the study area, a small water filled depressions, sandy ephemeral drainage lines as well as larger drainage lines with a riparian zone were present, where *P. adspersus* may be found. This species is not listed in the Limpopo SoER (2004), however it is listed as a protected species in the LEMA (2004) under schedule 3 (Protected Wild Animals).

2.6.2.4 Reptiles

Reptile species observed during the site visit in January 2015 as well as during subsequent site visits by project related specialists are listed in Table 25.

Table 25: Reptile species recorded during the field survey at The Duel

Scientific name	Common Name	IUCN Red List Status
Bitis caudalis	Horned Adder	NYBA
Naja mossambica	Mozambique Spitting Cobra	NYBA
Trachylepis varia	Variable Skink	NYBA
Heliobolus lugubris	Bushveld Lizard	NYBA
Pachydactylus vansoni	Van Son's Gecko	LC
Chondrodactylus turneri	Turner's Tubercled Gecko	NYBA
Trachylepis punctatissima	Montane Speckled Skink	LC
Stigmochelys pardalis	Leopard tortoise	NYBA

No RDL reptile species were encountered during the site visit. One RDL reptile species which may occur in the distribution range of the study area is *Python natalensis* (South African Python) which is considered Vulnerable in South Africa (Limpopo SoER, 2004). This species may occur throughout the study area and surrounding areas. The development of the mine will negatively impact on both the habitat availability as well as the prey availability for *P. natalensis*, further compounding conservation efforts for this species.

Figure 36: *Naja mossambica* (Mozambique Spitting Cobra) on the left and *Bitis caudalis* (Horned Adder) on the right (courtesy Frans Roodt and Junior)

Figure 37: *Chondrodactylus turneri* (Turner's Tubercled Gecko) on the left and *Stigmochelys pardal*is (Leopard tortoise) on the right

2.6.2.5 Invertebrates

The invertebrate assessment conducted was a general assessment with the purpose of identifying common species and taxa located within the study area. As such, the invertebrate assessment will not be an indication of the complete invertebrate diversity potential of the study area and surrounding area. Mention must be made that very little detailed or general information exists on terrestrial invertebrates in the Limpopo Province, thus in general, there is very little consolidated information regarding invertebrates

(Limpopo SoER, 2004). Representatives of commonly encountered families in the Insecta class that were observed during the assessment are listed in Table 26.

Table 26: Invertebrate species recorded during the field survey at The Duel

Order	Family	Scientific Name	Common Name	IUCN 2015 Status
Lepidoptera	Pieridae	*Belenois aurota*	Brown-veined White	NYBA
		Eurema brigitta brigitta	Broad-bordered Grass Yellow	NYBA
		Pontia helice helice	Meadow White	NYBA
		Phalanta phalanta	Common Leopard	NYBA
		Byblia ilythia	Spotted Joker	NYBA
		Colotis auxo	Sulphur Orange Tip	NYBA
		Colotis pallene	Bushveld Orange Tip	NYBA
		Colotis danae	Scarlet Tip	NYBA
		Hamanumida daedalus	Guinea Fowl	NYBA
	Nymphalidae	*Ypthima asterope*	African Ringlet	NYBA
		Junonia octavia	Gaudy Commodore	NYBA
		Junonia hierta	Yellow Pansy	LC
		Danaus chrysippus	African Monarch	NYBA
	Lycaenidae	*Chilades trochylus*	Grass Jewel Blue	NYBA
		Euchrysops Osiris	Osiris Smoky Blue	NYBA
		Cacyreus marshalli	Common Geranium Bronze	NYBA
	Papilionidae	*Papilio demodocus*	Citrus Swallowtail	NYBA
		Papilio constantinus constantinus	Constantine's Swallowtail	NYBA
	Hesperiidae	*Leucochitonea levubu*	White-cloaked Skipper	NYBA
Orthoptera	Acrididae	*Cannula gracilis*	Grass mimicking Grasshopper	NYBA
		Orthoctha dasycnemis	N/A	NYBA
		Eyprepocnemis plorans		NYBA
		Rhachitopis sp.	N/A	NYBA
		Orthoctha dasycnemis	N/A	NYBA
		Conistica saucia	Rock Grasshopper	NYBA
	Bradyporidae	*Acanthoplus armiventris*	Corn Cricket	NYBA
	Thericleidae	*Thericles sp*	N/A	NYBA
Odonata	Libellulidae	*Pantala flavescens*	Wandering Glider	LC
		Hemistigma albipuncta	Piedspot	LC
		Orthetrum julia	Julia Skimmer	LC
		Urothemis assignata	Red Basker	LC
Hemitera	Cicadidae	*Platypleura haglundi*	Orange-wing	NYBA
		Stagira sp	Green-wings	NYBA
		Colotis euippe	Smoky Orange Tip	NYBA
		Pynca semiclara	Giant Forest Cicada	NYBA
	Scutelleridae	*Solenostethium liligerum*	N/A	NYBA
	Alydidae	*Hypselopus gigas*	Giant Broad-headed Bug	NYBA
Coleoptera	Meloidae	*Decapotoma lunata*	Lunate Blister Beetle	NYBA
	Scarabaeidae	*Anachalcos convexus*	Plum Dung Beetle	NYBA
		Pachylomerus femoralis	Flattened Giant Dung Beetle	NYBA

Order	Family	Scientific Name	Common Name	IUCN 2015 Status
	Tenebrionidae	*Psammodes virago*	Giant Toktokkie	NYBA
Phasmatodea	Heteronemiidae	*Bactrododema tiaratum*	Giant Stick Insect	NYBA
Diptera	Asilidae	*Pegesimallus pulchriventris*	N/A	NYBA
Mantodea	Sibyllidae	*Idolomorpha dentifrons*	Cone-headed Mantid	NYBA
		Miomantis Sp		NYBA
Hymenoptera	Formicidae	*Anoplolepis custodiens*	Pugnacious Ant	NYBA
		Plectroctena mandibularis	N/A	NYBA
	Sphecidae	*Ammophila ferrugineipes*	Thread-waisted Wasp	NYBA
	Apidae	*Apis mellifera*	Honey Bee	NYBA
		Meliponula sp	Mopane Bees	NYBA

NYBA = Not Yet Been Assessed, LC = Least Concern

Figure 38: *Psammodes virago* (Giant toktokkie) on the left and *Anachalcos convexus* (Plum Dung Beetle) on the left

None of the listed threatened invertebrates observed within the study area are invertebrate species of conservational interest in the Limpopo Province. F urthermore they have not yet been assessed by the IUCN (2014), the vast majority of the species that were observed within the study area have yet to be assessed by the IUCN in terms of their conservation status, however from what data is available on these species it appears that they can all be considered fairly common within southern Africa.

2.6.2.6 Arachnids

Table 27 and Table 28 list the scorpions and spiders that were observed within the study area in January 2015.

Table 27: Scorpion species recorded during the field survey at the Duel

Scientific name	Common Name	IUCN Red List Status
Hottentotta trilineatus	N/A	NYBA
Parabuthus transvaalicus	Transvaal Thick-tailed Scorpion	NYBA
Cheloctonus jonesii	Burrowing Scorpion	NYBA
Hadogenes troglodytes	Black Rock Scorpion	NYBA
Damon variegatus	Whip Scorpion	NYBA

Table 28: Spider species recorded during the field survey at the Duel

Scientific name	Common Name	IUCN Red List Status
Ceratogyrus darlingi	Horned Baboon Spider	NYBA
Selenopidae sp	Wall Crab Spider	NYBA
Nephila senegalensis	Banded-legged Orb Spider	NYBA
Nephila inaurata	Red-legged Orb Spider	NYBA
Soligfuge sp	Red Roman Spider	NYBA

Five spider species were identified during the site assessment. These species are considered to be common within the region and are not listed as threatened on either the IUCN, Provincial or National databases. However, due to *Ceratogyrus darling* being located within the proposed mining area, and this species being restricted to the eastern regions of South Africa, as well as into Mozambique and Zimbabwe, it is recommended that consideration be given to a rescue and relocation program for this species prior to any mining activities taking place.

Five Scorpion species were identified within the study area, always favouring rocky well shaded habitat. None of the observed scorpions are listed as threatened at a Provincial or National level, nor are they listed as such by the IUCN. It is highly likely that these scorpions will be found throughout the study area due to the relative uniformity of available and suitable habitat for them.

Figure 39: *Ceratogyrus darlingi* (Horned Baboon spider) on the left and *Solifuge sp* (Red Roman Spider) on the right

Figure 40: *Hottentotta trilineatus* on the left and *Hadogenes troglodytes* (Black Rock Scorpion) on the right

Figure 41: *Hadogenes troglodytes* (Black Rock Scorpion) under UV light at night

2.6.3 SPECIES OF CONSERVATIONAL CONCERN

During the field assessment of the study area, the only species of conservational concern (SCC) that were observed either directly or by signs thereof were that of *Panthera pardus* and *Hyaena brunnea*. The study area in all likelihood forms part of these species home ranges, which will extend well beyond that of the study area alone. The reduction in these species home ranges will could result in a loss of both foraging and breeding potential, as well as place them in further competition with neighbouring rivals as they try to compensate for the decrease in their own home range by extending into neighbouring home ranges. *Ceratogyrus darlingi* is not listed as threatened as of yet, however baboon spiders as a species are under threat as a result of habitat loss and collection for the pet trade. It is therefore recommended that the precautionary principal be applied here, and consideration be given to rescue and relocation activities for *Ceratogyrus darlingi* observed, as well as for any other individuals of this species within the study area.

The study area lies within the Soutpansberg IBA of which a large diversity of avifaunal species inhabit, notably large raptors. Although no avifaunal SCC were observed at the time of the site assessment, the neighbouring Nzhelele Nature Reserve has recorded a number of avifaunal SCC over the years, and as such these species are presumed to also utilise and inhabit the neighbouring study area.

Overall the study area is considered to be of conservational value, as it provides suitable habitat for a variety of faunal species, and the large trees and hill slopes provide suitable nesting sites for large raptors. Furthermore, the abundance of prey species and intact nature of the vegetation enables medium to large predators to utilise the study area effectively, helping to support predator populations outside of large formally protected areas, and ensuring the genetic diversity of species overall is maintained.

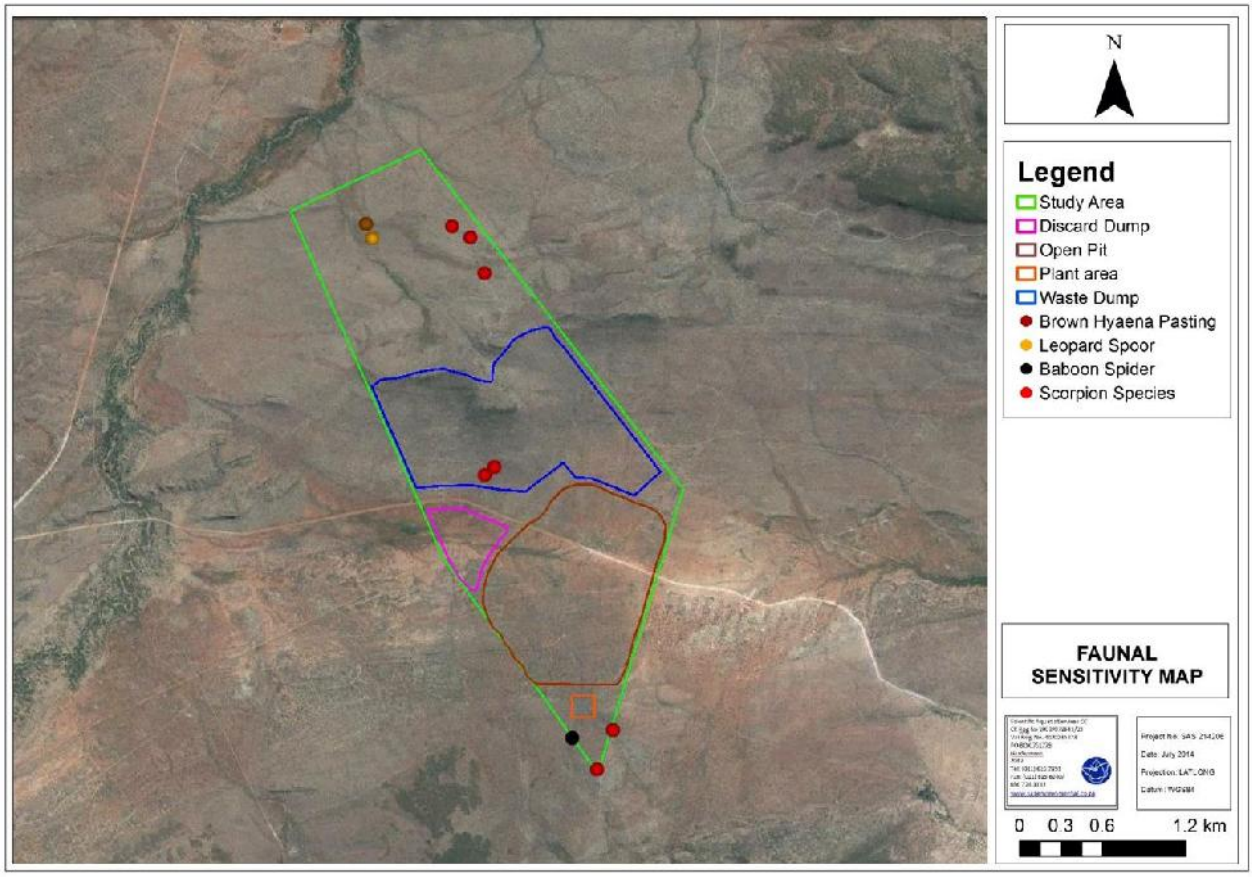


Figure 42: Localities of species observed that are considered to be of an increased conservational concern

2.7 SURFACE WATER

2.7.1 LOCALITY AND BACKGROUND INFORMATION

The Duel Coal Project is located in the Mutamba River basin, which is a tributary of the Nzhelele River. The Nzhelele River, together with the Nwanedzi River, form the secondary catchment area A80, which has been subdivided into nine quaternary sub-catchments (no tertiary sub-divisions were made). The Nzhelele River has its confluence with the Limpopo River about 35 kilometres east of Musina. The Nzhelele Basin covers an area of approximately 425 km^2, which is 1% of the South African portion of the Limpopo Basin.

The Duel Coal Project area spans across the quaternary catchment A80F as defined in the WR2005 Study (Middleton and Bailey, 2009) and shown Figure 43.

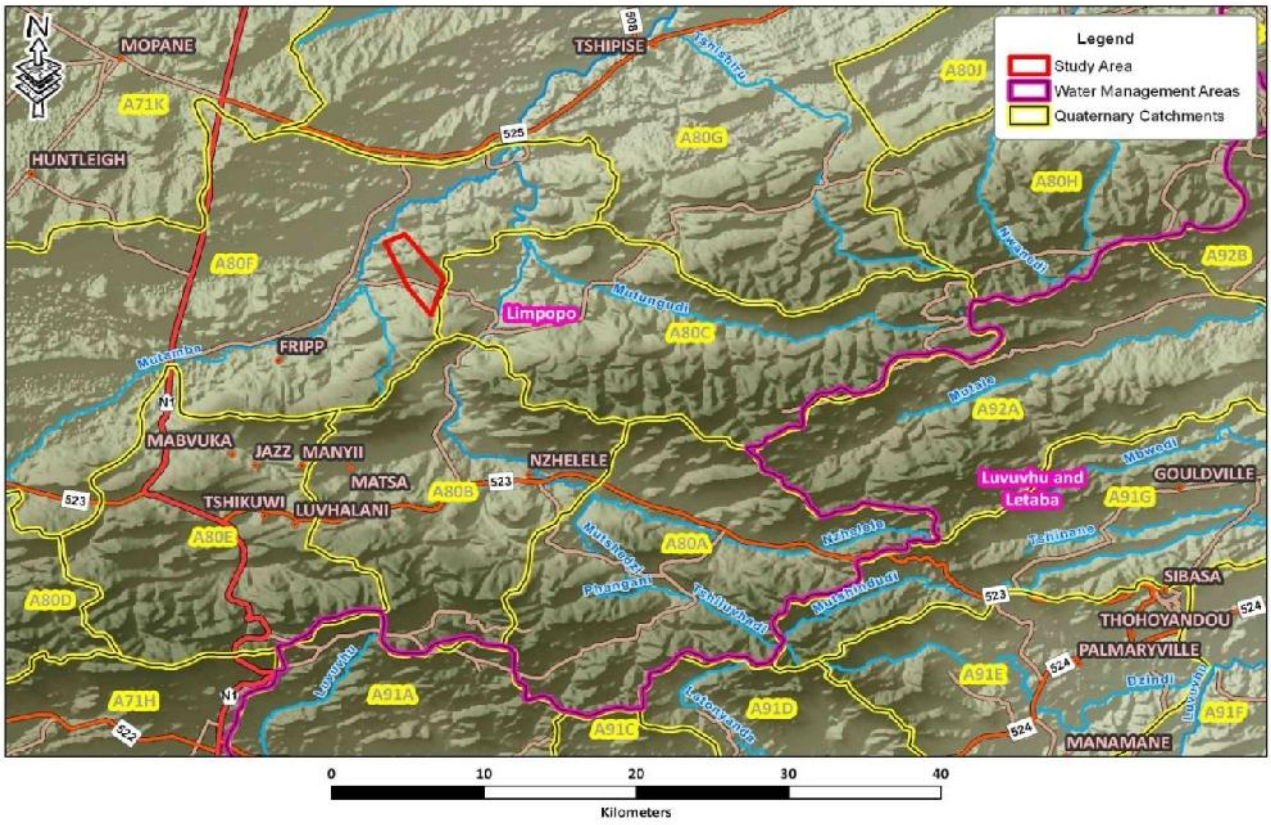


Figure 43: Quaternary catchments

2.7.2 STATUS OF THE RIVERS AND STREAMS IN THE REGION

The information below was sourced from Kleynhans, Thirion & Moolman (2005).

2.7.2.1 Eco-regions

The Duel Project Area falls within the Soutpansberg Aquatic Ecoregion and is located within the A80F quaternary catchment. Table 29 indicates the aquatic ecoregions and quaternary catchment of The Duel Project Area.

Table 29: Summary of the ecological status of the Soutpansberg Aquatic Region

MAIN ATTRIBUTES	SOUTPANSBERG
Terrain Morphology: Broad division (dominant types in bold) (Primary)	Plains; Low Relief; Plains; Moderate Relief (very limited); Lowlands; Hills and Mountains; Moderate and High Relief Closed Hills; Mountains; Moderate and High Relief
Vegetation types (dominant types in bold) (Primary)	Sour Lowveld Bushveld, Soutpansberg Arid Mountain Bushveld; Mopane Bushveld (very limited) Patches AfroMontane Forest
Altitude (m a.m.s.l) (modifying)	300-1700
MAP (mm) (Secondary)	200 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 40
Rainfall concentration index	55 to >65
Rainfall seasonality	Mid-summer
Mean annual temp. (°C)	16 to >22
Mean daily max. temp. (°C): February	22 to 32
Mean daily max. temp. (°C): July	16 to 24
Mean daily min. temp. (°C): February	14 to >20
Mean daily min temp. (°C): July	4 to >10
Median annual simulated runoff (mm) for quaternary catchment	<5 to 200; >250 (limited)

2.7.2.2 Ecostatus Classification

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the Ecological Importance and Sensitivity (EIS), Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems, prior to assessment or as part of a desktop assessment.

This database was searched for the catchment of concern in order to define the EIS, PEMC and DEMC. The results of the assessment are summarised in the table below. It must be noted however that the assessment point for the quaternary catchment is located on the Nzhelele River which is a perennial river system and as such some significant deviations from the conditions in the Mutamba River adjacent to the proposed mining project area are likely. Extrapolation of these observations must therefore be done with caution.

Table 30: Summary of the ecological status of quaternary catchments A80F based on Kleynhans (1999)

Catchment	Resource	EIS	PESC	DEMC
A80F	Nzhelele River	High	Class D	B: Sensitive system

According to the ecological importance classification for the quaternary catchment, the system can be classified as a Sensitive system which, in its present state, can be considered a Class D (largely modified) stream.

The points below summarise the impacts on the aquatic resources in the A80F quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been marginally affected by scouring of the system.
- Flow modification within the catchment is considered very high due to the control of flow by a dam upstream.
- Marginal impacts from inundation of the system occur.
- Riparian zones and stream bank conditions are considered to be moderately impacted by erosion.
- A low impact occurs as a result of the introduction of instream biota with special mention of *Azzola* sp. (Water Fern) and *Cyprinus carpio* (Carp).
- Impacts on water quality in the system are considered high as water released by the dam has a modified temperature and quality.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in this catchment:

- The riverine systems in this catchment have a high diversity of habitat types.
- The site has a moderate importance in terms of conservation with special mention of a gorge in the system.
- The riverine resources in this system have a moderate intolerance to flow and flow related water quality changes.
- The aquatic resources in the area have a high importance in terms of migration of species and form a transition zone between mountain and low veld. Special mention is made of the migration of eels, fish and birds.
- The system is considered to be of high importance in terms of rare and endemic species conservation. Some species may occur upstream of Nzhelele Dam.
- The aquatic resources in this catchment are moderately important in terms of the provision of refuge areas.
- The riverine resources in this system have a moderate sensitivity to changes in water quality and flow. The gorge area is particularly sensitive to changes in flow.
- The aquatic resources in this area are of high importance in terms of Species/Taxon richness with up to 16 different species present.
- The system is of high importance with regards to unique or endemic species with special mention of *Barbus eutenea* (Orangefin Barb), *Barbus lineamaculatus* (Line-spotted Barb).

2.7.2.3 Ecostatus Classification according to the DWS PES/EIS database

The Duel Project Area is located between the Mutamba River in the west and north, an unnamed tributary of the Mutamba towards the south-west and the Nzhelele River towards the east. Information for the following sub-quaternary catchment reaches (SQRs) is thus applicable:

2.7.2.3.1 A80F-00063 (Mutamba)

The Ecological Importance (EI) data for SQR A80F-00063 (Mutamba); indicate that the following fish species are expected to occur: *Barbus pal*udinosus (Peters, 1852); *Barbus trimaculatus* (Peters, 1852); *Barbus unitaeniatus* (Günther, 1866); *Barbus viviparus* (Weber, 1897); *Clarias gariepinus* (Burchell, 1822);

Labeobarbus marequensis (Smith, 1841); *Labeo cylindricus* (Peters, 1852); *Labeo molybdinus* (Du Plessis, 1963); *Oreochromis mossambicus* (Peters, 1852); *Pseudocrenilabrus philander* (Weber, 1897); and *Tilapia sparrmanii* (Smith, 1840).

The Ecological Importance (EI) data for SQR A80F-00063 (Mutamba) indicate that the following macro-invertebrate species are expected to occur:

Atyidae	Gyrinidae	Naucoridae
Aeshnidae	Gomphidae	Notonectidae
Ancylidae	Gerridae	Nepidae
Baetidae 2 spp.	Hirudinea	Oligochaeta
Belostomatidae	Hydracarina	Potamonautidae
Caenidae	Hydrometridae	Pleidae
Coenagrionidae	Hydroptilidae	Turbellaria
Corixidae	Hydrophilidae	Tabanidae
Ceratopogonidae	Hydropsychidae 1 sp.	Tipulidae
Chironomidae	Libellulidae	Thiaridae
Culicidae	Leptophlebiidae	Simuliidae
Corbiculidae	Lymnaeidae	Veliidae/Mesoveliidae
Dytiscidae	Leptoceridae	
Elmidae/Dryopidae	Muscidae	

The Present Ecological State (PES) of the Mutamba River (SQR A80F-00063) is categorised as Class C: Moderately modified.

- The instream habitat continuity modification and the riparian/wetland zone modification have a small impact rating, meaning that the modifications are only present at a small number of localities and the impact on the habitat quality, diversity, size and variability are also very small; and
- The riparian/wetland zone habitat continuity modification, the potential physico-chemical modification levels, the potential instream habitat modification and the potential instream flow modification have a moderate impact rating, meaning that the modifications are only present at a small number of localities and the impact on the habitat quality, diversity, size and variability are limited.

The Ecological Importance (EI) is considered moderate.

- The number of fish species estimated per sub quaternary reach is 11;
- The fish representivity per secondary class (FREP) is considered low;
- The fish rarity per secondary class (IRAR) is considered low;
- The Ecological Importance of the riparian-wetland-instream vertebrates (excluding fish) rating is high;
- The riparian-wetland natural vegetation importance, which is based on the percentage of natural vegetation within 500m is considered high;
- The riparian-wetland natural vegetation importance based on expert rating is considered low;
- The number of invertebrate taxa per sub quaternary reach is 40;
- The invertebrate representivity per secondary class (IREP) is considered high;
- The invertebrate rarity per secondary class (IRAR) is considered very moderate;

- The habitat diversity class is considered low;
- The habitat size (Length) class is considered low;
- The instream migration link class is very high;
- The riparian-wetland zone migration link is very high;
- The riparian-wetland zone habitat integrity class is high; and
- The instream habitat integrity class is high.

The Ecological Sensitivity (ES) is considered high.

- Both the fish and invertebrate physico-chemical sensitivity descriptions are high. Fish and macro-invertebrate species are thus moderately intolerant, with species being able to survive and breed under moderately modified to largely unmodified physico-chemical conditions;
- The fish no-flow sensitivity description is high. meaning species require flow during certain phases of the life cycle for breeding purposes (often fast flows) or for creation of nursing areas with adequate cover. Generally increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. For the majority of these species increased flow may also stimulate breeding activities and/or migration;
- The invertebrate velocity sensitivity description is very high. Such species generally requires flow during all phases of the life cycle for breeding purposes. Generally fast flows and clear water conditions are required;
- The riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description is high, meaning that taxa with a high sensitivity to water level or flow are expected to occur. Suitable water level and flow is required during certain life-stages to ensure viable populations;
- The stream size sensitivity to modified flow/water level changes description is high;
- The riparian-wetland vegetation intolerance to water level changes is low;
- The main habitats within the system are small seasonal river, alluvial stream bed, riparian trees and shrubs, pools, grassy edges and reeds; and
- The main adverse conditions within this system are Lack of surface flows, return flows and irrigation.

Table 31: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR A80F-00063 (Mutamba) based on the DWS RQS PES/EIS database

Synopsis (SQ reach A80F-00063 (Mutamba)					
PES[1] category median	**Mean EI[2] class**	**Mean ES[3] class**	**Length**	**Stream order**	**Default EC[4]**
C	Moderate	High	17.74	2	B
PES details					
Instream habitat continuity MOD		Small	**Riparian/wetland zone MOD**		Moderate
RIP/wetland zone continuity MOD		Small	**Potential flow MOD activities**		Moderate
Potential instream habitat MOD activities		Moderate	**Potential physico-chemical MOD activities**		Moderate
EI details					
Fish spp/SQ		11.00	**Fish average confidence**		1.00
Fish representivity per secondary class		Low	**Fish rarity per secondary class**		Low
Invertebrate taxa/SQ		40.00	**Invertebrate average confidence**		1.00
Invertebrate representivity per secondary class		High	**Invertebrate rarity per secondary class**		Moderate
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		High	**Habitat diversity class**		Low
Habitat size (length) class		Low	**Instream migration link class**		Very High
Riparian-wetland zone migration link		Very High	**Riparian-wetland zone habitat integrity class**		High
Instream habitat integrity class		High	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**		High
Riparian-wetland natural vegetation rating based on expert rating					Low
ES details					
Fish physical-chemical sensitivity description		High	**Fish no-flow sensitivity**		High
Invertebrates physical-chemical sensitivity description		High	**Invertebrates velocity sensitivity**		Very high
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					High
Stream size sensitivity to modified flow/water level changes description					High
Riparian-wetland vegetation intolerance to water level changes description					Low
Main habitats		Small seasonal river, alluvial stream bed, riparian trees and shrubs, pools, grassy edges and reeds			
Main adverse conditions		Lack of surface flows, return flows and irrigation			

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;

[2] EI = Ecological Importance;

[3] ES = Ecological Sensitivity;

[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

2.7.2.3.2 A80F-00070 (unnamed tributary of the Mutamba)

No expected fish species or invertebrate taxa lists are available which may be due to the ephemeral nature of this system.

The Present Ecological State (PES) of the unnamed tributary of the Mutamba River (SQR A80F-00070) is categorised as Class C: Moderately modified.

- The instream habitat continuity modification has a small impact rating, meaning that the modifications are only present at a small number of localities and the impact on the habitat quality, diversity, size and variability are also very small;
- The riparian/wetland zone habitat continuity modification, riparian/wetland zone modification and the potential physico-chemical modification levels have a moderate impact rating, meaning that the modifications are only present at a small number of localities and the impact on the habitat quality, diversity, size and variability are limited; and
- The potential instream habitat modification has a large impact rating, meaning that the modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability limited to a few localities and the impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.

The Ecological Importance (EI) is considered high.

- The number of fish species estimated per sub quaternary reach is 11;
- The fish representivity per secondary class (FREP) is considered moderate;
- The fish rarity per secondary class (IRAR) is considered high;
- The Ecological Importance of the riparian-wetland-instream vertebrates (excluding fish) rating is high;
- The riparian-wetland natural vegetation importance, which is based on the percentage of natural vegetation within 500m is considered moderate;
- The riparian-wetland natural vegetation importance based on expert rating is considered high;
- The number of invertebrate taxa per sub quaternary reach is 44;
- The invertebrate representivity per secondary class (IREP) is considered high;
- The invertebrate rarity per secondary class (IRAR) is considered very high;
- The habitat diversity class is considered very low;
- The habitat size (Length) class is considered moderate;
- The instream migration link class is very high;
- The riparian-wetland zone migration link is high;
- The riparian-wetland zone habitat integrity class is high; and
- The instream habitat integrity class is moderate.

Table 32: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR A80F-00070 (unnamed tributary of the Mutamba) based on the DWS RQS PES/EIS database

Synopsis (SQ reach A80F-00070 (unnamed tributary of the Mutamba)					
PES[1] category median	**Mean EI[2] class**	**Mean ES[3] class**	**Length**	**Stream order**	**Default EC[4]**
B	Moderate	Moderate	9.14	1	C
PES details					
Instream habitat continuity MOD		None	**Riparian/wetland zone MOD**		Small
RIP/wetland zone continuity MOD		Small	**Potential flow MOD activities**		None
Potential instream habitat MOD activities		None	**Potential physico-chemical MOD activities**		None
EI details					
Fish spp/SQ			**Fish average confidence**		
Fish representivity per secondary class			**Fish rarity per secondary class**		
Invertebrate taxa/SQ		1.00	**Invertebrate average confidence**		1.00
Invertebrate representivity per secondary class		Very Low	**Invertebrate rarity per secondary class**		High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		Low	**Habitat diversity class**		Moderate
Habitat size (length) class		Very low	**Instream migration link class**		
Riparian-wetland zone migration link		Very high	**Riparian-wetland zone habitat integrity class**		Very high
Instream habitat integrity class			**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**		Very High
Riparian-wetland natural vegetation rating based on expert rating					Low
ES details					
Fish physical-chemical sensitivity description			**Fish no-flow sensitivity**		
Invertebrates physical-chemical sensitivity description		Very High	**Invertebrates velocity sensitivity**		Very high
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					Low
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Low
Main habitats		Mountain drainage, seasonal.			
Main adverse conditions		Lack of perennial flows.			

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;

[2] EI = Ecological Importance;

[3] ES = Ecological Sensitivity;

[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

The Ecological Sensitivity (ES) is considered moderate.

- Both the fish and invertebrate physico-chemical sensitivity descriptions are high. Fish and macro-invertebrate species are thus moderately intolerant, with species being able to survive and breed under moderately modified to largely unmodified physico-chemical conditions;
- The invertebrate physico-chemical sensitivity description is high. Macro-invertebrate species are thus moderately intolerant, with species being able to survive and breed under moderately modified to largely unmodified physico-chemical conditions;
- The fish no-flow sensitivity description is moderate. These species generally require flow during certain phases of the life cycle for breeding purposes (often fast flows) or for creation of nursing areas with adequate cover. Generally increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. For many of these species increased flow may also stimulate breeding activities and/or migration;
- The stream size sensitivity to modified flow/water level changes description is high;
- The riparian-wetland vegetation intolerance to water level changes is high;
- The main habitats within the system are seasonal mountain drainages; and
- The main adverse conditions within this system are lack of perennial flows.

2.7.2.3.3 A80F-00065 (Nzhelele)

The Ecological Importance (EI) data for SQR A80F-00065 (Nzhelele); indicate that the following fish species are expected to occur: *Aplocheilichthys Johnstoni* (Günther, 1893); *Barbus paludinosus* (Peters, 1852); *Barbus trimaculatus* (Peters, 1852); *Barbus unitaeniatus* (Günther, 1866); *Barbus viviparous* (Weber, 1897); *Clarias gariepinus* (Burchell, 1822); *Labeobarbus marequensis* (Smith, 1841); *Labeo cylindricus* (Peters, 1852); *Labeo molybdinus* (Du Plessis, 1963); *Marcusenius macrolepidotus* (Peters, 1852); *Oreochromis mossambicus* (Peters, 1852); *Petrocephalus catostoma* (Günther, 1866); *Pseudocrenilabrus philander* (Weber, 1897); *Schilbe intermedius* (Rüppell, 1832); and *Tilapia sparrmanii* (Smith, 1840).

The Ecological Importance (EI) data for SQR A80F-00065 (Nzhelele) indicate that the following macro-invertebrate species are expected to occur:

Atyidae
Aeshnidae
Ancylidae
Baetidae 2 spp.
Belostomatidae
Caenidae
Coenagrionidae
Corixidae
Ceratopogonidae
Chironomidae
Culicidae
Corbiculidae
Dytiscidae
Elmidae/Dryopidae
Gyrinidae
Gomphidae
Gerridae
Hirudinea
Hydracarina
Hydrometridae
Hydroptilidae
Hydrophilidae
Hydropsychidae 1 sp.
Libellulidae
Leptophlebiidae
Lymnaeidae
Leptoceridae
Muscidae
Naucoridae
Notonectidae
Nepidae
Oligochaeta
Palaemonidae
Potamonautidae
Pleidae
Turbellaria
Tabanidae
Tipulidae
Thiaridae
Simuliidae
Veliidae/Mesoveliidae

Table 33: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR A80F-00065 (Nzhelele) based on the DWS RQS PES/EIS database

Synopsis (SQ reach A80F-00065 (Nzhelele)					
PES[1] category median	**Mean EI[2] class**	**Mean ES[3] class**	**Length**	**Stream order**	**Default EC[4]**
D	Moderate	Moderate	9.83	2	C
PES details					
Instream habitat continuity MOD		Large	**Riparian/wetland zone MOD**		Moderate
RIP/wetland zone continuity MOD		Moderate	**Potential flow MOD activities**		Serious
Potential instream habitat MOD activities		Large	**Potential physico-chemical MOD activities**		Large
EI details					
Fish spp/SQ		15.00	**Fish average confidence**		1.13
Fish representivity per secondary class		Moderate	**Fish rarity per secondary class**		High
Invertebrate taxa/SQ		41.00	**Invertebrate average confidence**		1.00
Invertebrate representivity per secondary class		High	**Invertebrate rarity per secondary class**		High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		High	**Habitat diversity class**		Moderate
Habitat size (length) class		Very low	**Instream migration link class**		Moderate
Riparian-wetland zone migration link		High	**Riparian-wetland zone habitat integrity class**		High
Instream habitat integrity class		Moderate	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**		High
Riparian-wetland natural vegetation rating based on expert rating					Low
ES details					
Fish physical-chemical sensitivity description		High	**Fish no-flow sensitivity**		High
Invertebrates physical-chemical sensitivity description		High	**Invertebrates velocity sensitivity**		Very high
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					High
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Low
Main habitats		Incised channel with flow, grassy edge, thin band of riparian shrubs and trees, riffles, and rapids, pools.			
Main adverse conditions		Vegetation removal, water temperature increase, agricultural activities.			

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;

[2] EI = Ecological Importance;

[3] ES = Ecological Sensitivity;

[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

The Present Ecological State (PES) of the Nzhelele River (SQR A80F-00065) is categorised as Class D: Largely impaired.

- The riparian/wetland zone habitat continuity modification and riparian/wetland zone modification levels have a moderate impact rating, meaning that the modifications are only present at a small number of localities and the impact on the habitat quality, diversity, size and variability are limited;
- The instream habitat continuity modification, the potential physico-chemical modification and the potential instream habitat modification have a large impact rating, meaning that the modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability limited to a few localities and the impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced; and
- The potential instream flow modification has a serious impact rating, meaning that the modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.

The Ecological Importance (EI) is considered moderate.

- The number of fish species estimated per sub quaternary reach is 15;
- The fish representivity per secondary class (FREP) is considered moderate;
- The fish rarity per secondary class (IRAR) is considered high;
- The Ecological Importance of the riparian-wetland-instream vertebrates (excluding fish) rating is high;
- The riparian-wetland natural vegetation importance, which is based on the percentage of natural vegetation within 500m is considered high;
- The riparian-wetland natural vegetation importance based on expert rating is considered low;
- The number of invertebrate taxa per sub quaternary reach is 41;
- The invertebrate representivity per secondary class (IREP) is considered high;
- The invertebrate rarity per secondary class (IRAR) is considered very high;
- The habitat diversity class is considered moderate;
- The habitat size (Length) class is considered very low;
- The instream migration link class is moderate;
- The riparian-wetland zone migration link is high;
- The riparian-wetland zone habitat integrity class is high; and
- The instream habitat integrity class is moderate.

The Ecological Sensitivity (ES) is considered moderate.

- Both the fish and invertebrate physico-chemical sensitivity descriptions are high. Fish and macro-invertebrate species are thus moderately intolerant, with species being able to survive and breed under moderately modified to largely unmodified physico-chemical conditions;
- The fish no-flow sensitivity description is high. Species requiring flow during certain phases of the life cycle for breeding purposes (often fast flows) or for creation of nursing areas with adequate cover. Generally increased habitat suitability and availability resulting from increased flow can be expected to benefit such species. For the majority of these species increased flow may also stimulate breeding activities and/or migration;

- The invertebrate velocity sensitivity description is very high. Such species generally requires flow during all phases of the life cycle for breeding purposes. Generally fast flows and clear water conditions are required;
- The riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description is high, meaning that taxa with a high sensitivity to water level or flow are expected to occur. Suitable water level and flow is required during certain life-stages to ensure viable populations;
- The stream size sensitivity to modified flow/water level changes description is low;
- The riparian-wetland vegetation intolerance to water level changes is low;
- The main habitats within the system are Incised channel with flow, grassy edge, thin band of riparian shrubs and trees, riffles, and rapids, pools; and
- The main adverse conditions within this system are Vegetation removal, water temperature increase, agricultural activities, dams, irrigation, pollution, abstraction and eutrophication.

2.7.2.4 Importance according to the RSA wetland types database (2010) and the National Freshwater Ecosystem Priority Areas (2011) database

The RSA Wetland Types (2010) and National Freshwater Ecosystem Priority Areas (NFEPA) (2011) databases were consulted to define the ecology of the wetland or river systems that may be of ecological importance. Aspects applicable to The Duel Project Area and surroundings are discussed below:

- The Duel Project Area falls within the Limpopo Water Management Area (WMA). Each Water Management Area is divided into several sub-Water Management Areas (subWMA), where catchment or watershed is defined as a topographically defined area which is drained by a stream or river network. The subWMA indicated for The Duel Project Area is the Sand subWMA.
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors.
- The subWMA is not considered important in terms of translocation and relocation zones for fish.
- The subWMA is not listed as a fish Freshwater Ecosystem Priority Area.
- Several NFEPA rivers were indicated on the NFEPA database that is within close proximity of the study area. The Mutamba River is situated approximately 600 m north of the study area, and the Nzhelele River is situated east of the study area. An unknown tributary of the Mutamba River is situated approximately 2.4 km south west of the study area;
- Both the Mutamba and Nzhelele Rivers are perennial systems classified as Class D (largely modified) rivers with a river condition ranging between Class A and C/D, as depicted in Figure 44 with tributaries of the Mutamba River showing the highest levels of integrity, and are not indicated as free flowing, flagship or as FEPA Rivers;
- No wetland features were indicated on the NFEPA wetland database layer within the study area, as well as within a 500m radius of the study area.

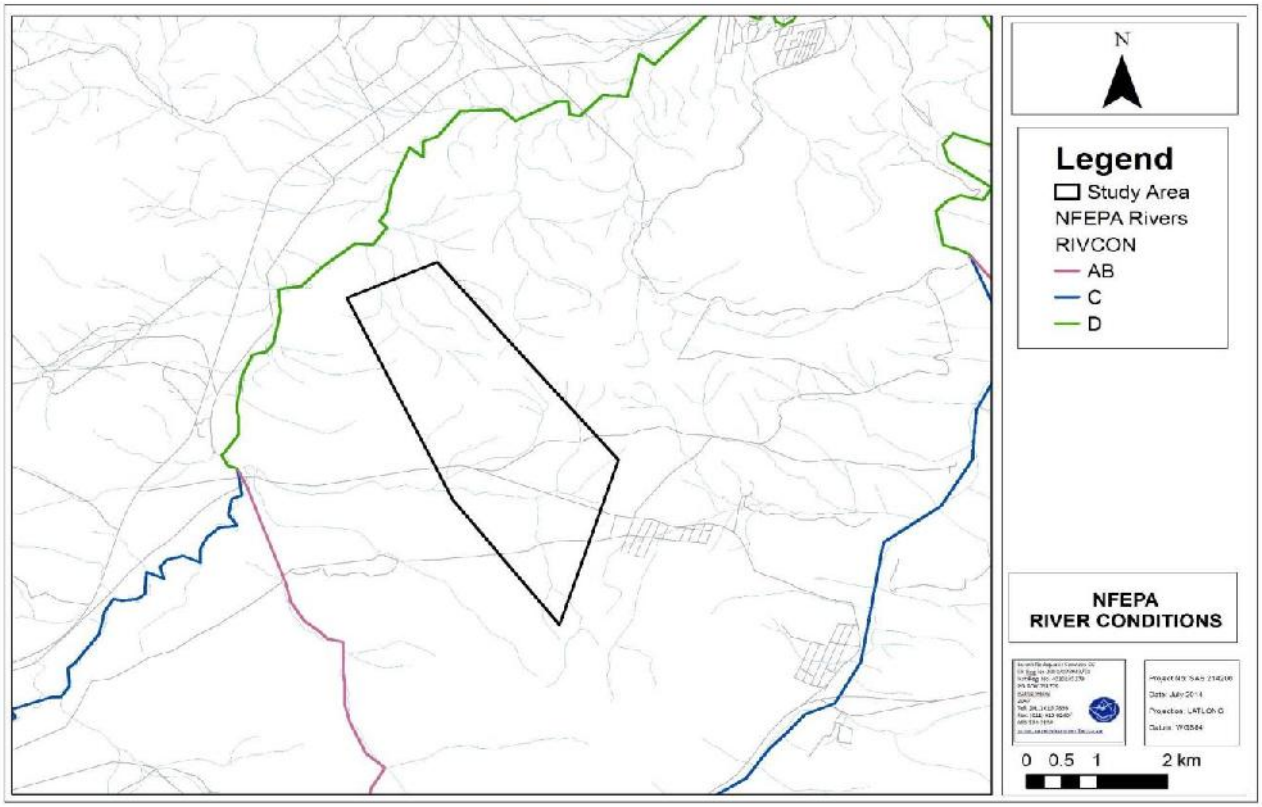


Figure 44: The condition of the NFEPA rivers that are in close proximity of the study area

2.7.3 WETLAND SYSTEMS

With the use of Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis et al, 2013) all features within the study area could be divided into two main groups namely rivers and smaller drainage lines. The features identified during the assessment where further divided into either wetland or riparian habitat based on the characteristics as defined by the NWA No 36 of 1998.

Table 34: Classification for the Rivers and drainage lines with wetland conditions present (SANBI 2013)

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The study area falls within the Limpopo Plain Ecoregion and Mopane Group 1 and 2 wetland vegetation groups (NFEPA WetVeg).	Valley floor: The base of a valley, situated between two distinct valley side slopes, where alluvial or fluvial processes typically dominate.	Channelled valley bottom wetland: a valley bottom wetland with a river channel running through it.	N/A

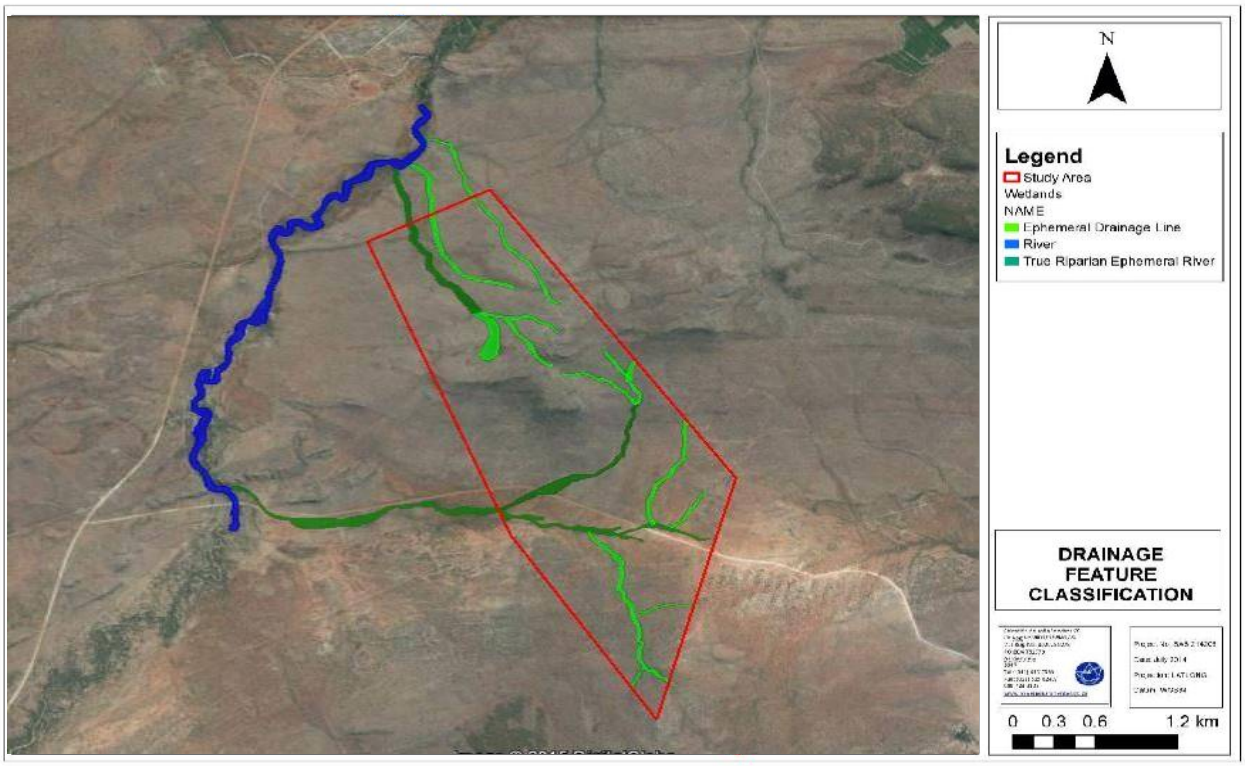


Figure 45: Locations of the wetland types in relation to the study area

The Mutamba River were defined as systems containing riparian habitat due to the presence of alluvial soil as well as the presence of vegetation, with a composition and physical structure, distinct from adjacent areas. Several smaller drainage lines within the study area also display these characteristics and were therefore also defined as systems with riparian habitat. The catchment of some of the drainage lines are however smaller and did not allow for the establishment of the defined riparian habitat characteristics and were therefore considered non-riparian ephemeral drainage lines.

In summary, the rivers and smaller drainage lines were subdivided into riparian or non-riparian habitat. In the sections that follow riparian habitat was assessed with use of the VEGRAI, Wetland Function Assessment, Wetland EIS, and Wetland IHI.

2.7.3.1 The Mutamba River

The Mutamba River is the main river within the study area with numerous tributaries and drainage lines also identified throughout the study area.

- Terrain Units: The degree of incision of the various riverine features formed a clear continuum. Smaller drainage features showed very limited levels of incision while the larger drainage features were more incised. The Mutamba River showed the most incision and confinement of the channel and obvious stream banks.
- Soil: The active channel of all drainage features mainly constituted of alluvial soil and within the larger Mutamba River larger boulders and cobbles in certain areas were observed. The coarse alluvial sands showed clear indications of surface water movement from time to time with the degree of development characterised by the size of the system and the runoff received by the

system. Water movement for prolonged periods has resulted in leaching of soil components such as iron and manganese from the soil resulting in alluvial sands with a lower chroma than the adjacent terrestrial areas. A distinct increase in chroma and decrease in particle size is evident on the banks where significantly less leaching has taken place and where soil material is more related to the local parent material and less associated with alluvium washed in from areas further upstream.

- Vegetation: The larger drainage features are considered characteristic of the Subtropical Alluvial vegetation type characterised by flat alluvial riverine terraces supporting an intricate complex of macrophytic vegetation, marginal reed belts (in sheltered oxbows and along very slow flowing water courses) as well as riverine thickets (Mucina and Rutherford, 2006). Abundance and diversity of vegetation were assessed at each site selected for a river system giving attention to zonation of the wetland assessment. A distinctive change in vegetation abundance as well as diversity was noted in the lower and upper zones compared to the surrounding terrestrial zones. Although the width of the active channel of the different rivers varied, the dominant riparian vegetation communities within the lower and upper zones were considered uniform. The most distinct difference between the different rivers assessed was identified in the vegetation structure of the marginal zone. The Mutamba River hosted *Cyperus* spp., *Phragmites mauritianus* (grass reed) and *Typha capensis* (bulrush) not identified within any of the marginal zones of the other smaller river systems. These floral species are obligate wetland/riparian floral species and are therefore adapted to the anaerobic soil conditions found within the active channel of larger river systems or in areas which regularly become saturated with water. Therefore their presence is directly related to the availability of baseflow within a system for the largest part of the year. The additional permanent and seasonal habitat provided by the Mutamba River do increase the importance of the system in terms of wetland biodiversity and it is deemed likely that with the continuation and possible increase in the volume of water abstracted from these systems that a decline in obligate/facultative floral species habitat may occur. It should further be noted that larger tree species located within the lower and upper zones would most likely also be impacted upon by a decrease in the water table resulting from ongoing and/or increased water abstraction.

Table 36 lists the dominant floral species identified during the assessment of all the rivers, the dominant species listed for the marginal zone are only applicable to the Mutamba River.

2.7.3.1.1 Riparian Vegetation Response Assessment Index (VEGRAI)

The VEGRAI index was applied to the Mutamba River to assist in defining the ecological integrity and PES of the riparian zone of the system.

Table 35: VEGRAI Ecological Category Description Scores for the Mutamba River

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	83.5	37.1	3.0	2.0	80.0
NON MARGINAL	76.7	42.6	0.0	1.0	100.0
	2.0				180.0
LEVEL 3 VEGRAI (%)				79.7	
VEGRAI EC				**B/C**	
AVERAGE CONFIDENCE				1.5	

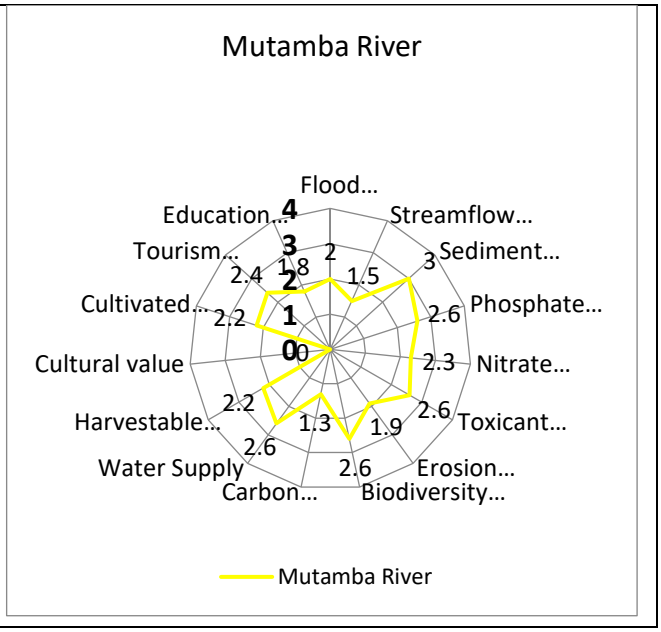
Table 36: Dominant floral species identified during the assessment of the rivers

Upper zone	Lower zone	Marginal zone
Colophospermum mopane (Mopane)	*Faidherbia albida* (Ana tree)	*Phragmites mauritianus* (Grass reed)
Combretum apiculatum (Red bushwillow)	*Grewia flava* (Velvet raisin)	*Cyperus sexangularis*
Dichrostachys cinerea (Sickle bush)	*Cyperus fastigiatus*	*Cyperus fastigiatus*
Acacia karroo (Sweet thorn)	*Cynodon dactylon* (Couch grass)	*Cyperus distans*
Acacia nigrescens (Knob thorn)	*Panicum maximum* (Guinea grass)	*Ammannia baccifera* (Waterbessiekruid)
Terminalia prunioides (Lowveld cluster-leaf)	*Heliotropium sp.*	*Typha capensis* (Bulrush)
Ficus craterostoma (Strangler fig)		
Ficus salicifolia (Willow leaf fig)		
Ziziphus mucronata (Buffalo-thorn)		
Sclerocarya birrea subsp. *caffra* (Marula)		
Euclea crispa (Blue guarri)		
Grewia bicolor (White raisin)		
Gymnosporia senegalensis (Red spike thorn)		
Combretum imberbe (Leadwood)		
Xanthocercis zambesiaca (Nyala tree)		
Schotia brachypetala (Weeping boerbean)		
Combretum molle (Velvet bushwillow)		
Spirostachys africana (Tamboti)		

It is evident from the VEGRAI results that the riparian ecosystem has remained largely intact, with limited change of cover, abundance and species composition when compared to the reference condition in both the marginal as well as non-marginal zones. The score is as a result of some disturbance from anthropogenic activity in the immediate surroundings, which resulted in an increase in non woody species and some loss of tree diversity within the riparian zone and the presence of some alien forbs. It is also considered highly likely that the water abstracted along the river for agricultural purposes, leads to increasing stress on the riparian zone in a downstream direction. An increased impact on the non-marginal zone in relation to the marginal zone is also evident due to impacts from moisture stress and altered species composition.

Table 37: Wetland service and function assessment

Ecosystem service	Mutamba River
Flood attenuation	2
Streamflow regulation	1.5
Sediment trapping	3
Phosphate assimilation	2.6
Nitrate assimilation	2.3
Toxicant assimilation	2.6
Erosion control	1.9
Biodiversity maintenance	2.6
Carbon Storage	1.3
Water Supply	2.6
Harvestable resources	2.2
Cultural value	0
Cultivated foods	2.2
Tourism and recreation	2.4
Education and research	1.8
SUM	**31.0**
Average score	**2.1**



All the features are considered to be of moderately high importance in terms of wetland function and service provision. The Mutamba River calculated the highest scores for sediment trapping. The Mutamba River is also considered of importance in terms of biodiversity, due to persisting surface water providing habitat for various faunal and floral species within a water stressed region.

2.7.3.1.2 Wetland Index of Habitat Integrity (IHI)

The Wetland IHI index was applied to the various riverine resources in order to assist in defining the EC of these systems. The sections below present the summaries of the calculations undertaken as well as discussions of the results.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**1.4**		
Hydrology	1	100	1.3	*3.2*	**C**
Geomorphology	2	80	2.1	*2.9*	**D**
Water Quality	3	30	0.1	*3.9*	**A**
WETLAND LANDUSE ACTIVITIES:		**80**	**0.7**	***3.5***	
Vegetation Alteration Score	1	100	0.7	*3.5*	**B**
Weighting needs to consider the sensitivity of the type of wetland *(e.g.: nutrient poor wetlands will be more sensitive to nutrient loading)*					
OVERALL SCORE:			**1.1**	*Confidence Rating*	
	PES %		**78.1**		
	PES Category:		**B/C**	*1.6*	

The average score calculated for the Mutamba River with the use of the Wetland IHI indicates that the feature can be considered to fall within PES Category B/C (Largely Natural to moderately modified). A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. Water is also abstracted from the Mutamba River that resulted in a lowered PES Category for hydrology and geomorphology is considered significantly impaired due to reduced sediment transport capacity, however water quality and as well as riparian vegetation condition has remained largely unchanged. This results in slightly lower ecological scores in the area of The Duel Coal Project in relation to the upstream areas although the habitat integrity at this point can still be considered largely natural with few modifications (Class B).

After the assessment it can be concluded that the Mutamba River is important in terms of function and service provision with special mention of biodiversity as well as water provision for farmers within a water stressed region. Game farming is also the present land use of the majority of the farms in the area with limited areas utilised for crop cultivation, consequently the river systems have remained largely undisturbed and are therefore important in terms of biodiversity value. The Mutamba River has significant downstream importance for socio-cultural purposes with special mention of water supply as well as biodiversity maintenance and other basic ecosystem services. Measures to ensure the ongoing functioning of these rivers in the area are therefore considered to be of high importance.

Mining related activities and infrastructure as proposed by the present layout provided by the proponent have the potential to impact on the tributaries of the Mutamba River. Should mining activity encroach onto the allocated 100m buffer zones, effective mitigation of impacts would be unlikely to minimize the

impacts on these smaller systems, however with mitigation the impact on the major drainage lines in the area can be significantly limited.

It should be noted that the region in the vicinity of the study area is significantly water stressed and as a result farmers depend on water from the rivers for general water provision for agriculture as well as livestock and game farming with specific reference to the Nzhelele River and Mutamba River. Furthermore, it would be difficult to substitute the water supply from rivers with alternative water sources except for possible groundwater use due to the extensive distribution network that would be required from the Nzhelele Dam. If the proposed mining activity results in a substantial decrease in available water volumes in the aquifers associated with these water courses or result in the formation of a cone dewatering, there is the potential that farmers within the study area as well as downstream areas would be affected in addition to the ecology of the area. The Nzhelele and Mutamba Rivers are also considered to be of increased significance with regards to biodiversity maintenance due to the presence of fish that would be restricted to river corridors and refugia formed during the winter months. Therefore, reduced water volumes or impaired water quality will directly impact on the survival as well as migratory corridors of aquatic species. Any reduction of streamflow that leads to the loss of refugia for aquatic species or the significant loss of downstream water supply or impaired water quality is be considered potential impact on the lower reaches of the Mutamba River and to a lesser degree the Nzhelele River.

It is recommended that all requirements in terms of GN 704, Section 21 of the NWA as well as General Notice no. 1199 of 2009 as it relates to the NWA, be adhered to for any proposed activities associated with mining in these areas. In this regard specific mention is made of obtaining authorisation in terms of Section 21 c and i of the NWA for all activities which would affect these water courses.

2.7.3.2 Smaller Drainage Lines with True Riparian Ephemeral Habitat

Numerous ephemeral drainage lines with poorly defined riparian zones were identified throughout the study area. As a result, many of these features could not be considered as either wetland or riparian habitat due to the lack of characteristics as defined by the NWA (Act 36 of 1998) and DWA (2005). Consequently, the digital signatures identified on a desktop level and verified during the field survey were used to distinguish between drainage lines with riparian zones and drainage lines without riparian zones. True riparian features were delineated as accurately as possible.

Features resembling drainage lines were also encountered, however many of these features were considered to be mainly as a result of roads or other anthropogenic activity that canalised streamflow and consequently resulted in erosion canals being formed and cannot be defined as true wetland or riparian features.

- Terrain Units: Terrain units associated with drainage lines were considered uniform throughout the study area. All features assessed had a distinct active channel consisting of leached alluvial soil and incised banks. The incision of banks results from the sandy nature of the soil that is prone to erosion during rainfall events.
- Soil: Soil within the drainage lines without riparian zones had a higher chroma and finer texture when compared to soil from drainage lines with riparian zones. This is considered to be a result of more volumes of water conveyed by the drainage lines with riparian zones that resulted in the leaching of minerals and the transport of smaller soil particles downstream. Soils in riparian systems had a characteristically clear alluvial substrates.

- Vegetation: Due to the sandy nature of the soil, surface water within smaller drainage lines is only expected during a couple of days after sufficient rainfall and therefore saturated soil will not be present long enough within the majority of drainage lines to support floral species which are representative of riparian zones of small drainage lines. As a result the smaller drainage lines were divided based on the presence or absence of distinctive riparian vegetation. The dominant floral species of the riparian community is considered similar to the river systems, with a slight decrease in tree species diversity. The drainage lines with riparian zones do however capture enough water to support larger tree species such as Combretum imberbe (leadwood) (protected in accordance to the National Forests Act (Act No 84 of 1998 as amended September 2008).

Figure 46: Example of a drainage line with a true riparian zone within the study area

The dominant floral species identified during the field survey are listed in Table 38. All the drainage lines are considered ephemeral and therefore no facultative or obligate floral species were encountered that could be considered indicative of a marginal wetland/riparian zone.

Table 38: Dominant floral species identified during the assessment of the smaller drainage lines

Upper zone	Lower zone
Balanites pedicellaris (Small green thorn)	*Setaria verticillata* (Bur Bristle grass)
Colophospermum mopane (Mopane)	*Cynodon dactylon* (Couch grass)
Combretum apiculatum (Red bushwillow)	*Panicum maximum* (Guinea grass)
Terminalia prunioides (Lowveld clusterleaf)	*Panicum maximum* (Guinea grass)
Sclerocarya birrea subsp. *Caffra* (Marula)	
Acacia karroo (Sweet thorn)	
Ziziphus mucronata (Buffalothorn)	
Euclea crispa (Blue guarri)	
Grewia bicolor (White raisin)	
Gymnosporia senegalensis (Red spike thorn)	
Combretum imberbe (Leadwood)	

2.7.3.2.1 VEGRAI

Two major drainage lines were observed in the study area, which were assessed within the study area to determine the characteristics of the riparian communities. When results were compared it was evident that

the riparian vegetation abundance as well as diversity at the different drainage lines were very similar. One VEGRAI assessment was therefore undertaken as representative of all smaller drainage lines.

The limited disturbance on the subject property means that the only impact on the drainage lines is the crossing of dirt tracks as well as the crossing of the main dirt road on the southern feature resulting in erosion and sedimentation within the immediate vicinity of the features. Within some features less woody species and more non woody species with special mention of graminoids were noted that decreased the overall score to some degree. However, the EC class B/C (largely natural moderately modified) is considered representative of the two drainage lines located within the study area.

Table 39: VEGRAI Ecological Category Description Scores for the drainage lines with riparian zones

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	79.3	44.0	3.0	1.0	100.0
NON MARGINAL	75.1	33.4	0.0	2.0	80.0
	2.0				180.0
LEVEL 3 VEGRAI (%)				77.4	
VEGRAI EC				**B/C**	
AVERAGE CONFIDENCE				1.5	

2.7.3.2.2 Surface Water

The field assessment was undertaken during late summer and even at this time the northern system only had a small pool of surface water behind a small concrete weir while the southern feature was completely dry. It is also considered highly unlikely that surface water would remain present for extended time periods, even after significant rainfall events, due to the high permeability of the soil.

2.7.3.2.3 Biodiversity

It is regarded unlikely that any of the drainage lines will retain water long enough to provide breeding and foraging habitat for aquatic macro-invertebrates, amphibians as well as avifaunal species. However, the drainage lines with riparian zones may provide migratory connectivity as well as sheltered nesting habitat for terrestrial avifaunal species. Amphibians and waterfowl may however opportunistically utilise these systems in times of increased rainfall. The systems can be considered to have some importance in terms of provision of drinking water for mammal species in the area.

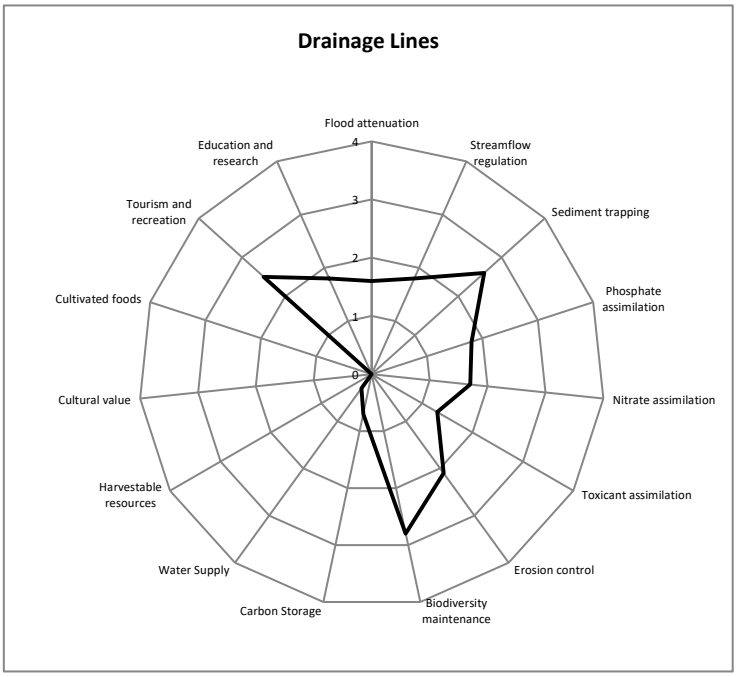
Furthermore, these features provide an important habitat type due to the longitudinal connectivity of the habitat offered by the riparian zones. The vegetation cover within riparian zones is often denser and therefore offers better habitat cover for many faunal species for longer periods of the season. This aspect consequently leads to a higher predator species component that not only relies on the better habitat cover, but also the more reliable prey source. This complex habitat type therefore often has relatively high species diversity. Localised impacts invariably have negative impacts on the system as a whole.

2.7.3.2.4 Wetland Function Assessment

The function and service provision was calculated for the drainage lines according to characteristics discussed in the previous sections. The average score is presented in Table 40.

Table 40: Wetland service and function assessment

Ecosystem service	Drainage Lines
Flood attenuation	1.6
Streamflow regulation	1.8
Sediment trapping	2.6
Phosphate assimilation	1.8
Nitrate assimilation	1.7
Toxicant assimilation	1.3
Erosion control	2.1
Biodiversity maintenance	2.8
Carbon Storage	0.7
Water Supply	0.3
Harvestable resources	0
Cultural value	0
Cultivated foods	0
Tourism and recreation	2.5
Education and research	1.8
SUM	21.0
Average score	1.4



From the results of the assessment, it is evident that the smaller drainage lines encountered within the study area are not regarded to be of exceptional importance in terms of function and service provision. This is mainly as a result of lack of surface water for extended periods of time limiting the ability to support any aquatic ecological communities, or the formation of seasonal and permanent wetland zones that could support a more diverse riparian floral community.

The drainage lines cannot be considered important in terms of harvestable resources or cultivated foods due to lack of sufficient water that would support such activities. However, drainage lines are still considered important in terms of biodiversity maintenance, tourism and recreation as well as sediment trapping.

2.7.3.2.5 Index of Habitat Integrity (IHI)

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**0.8**		
Hydrology	1	100	0.4	*3.2*	**A**
Geomorphology	2	80	1.6	*2.9*	**C**
Water Quality	3	30	0.1	*3.9*	**A**
WETLAND LANDUSE ACTIVITIES:		**80**	**0.3**	***3.4***	
Vegetation Alteration Score	1	100	0.3	*3.4*	**A**
Weighting needs to consider the sensitivity of the type of wetland *(e.g.: nutrient poor wetlands will be more sensitive to nutrient loading)*					
OVERALL SCORE:			0.6	*Confidence Rating*	
	PES %		**88.3**		
	PES Category:		**A/B**	***1.5***	

The average score calculated for the smaller drainage lines with the use of the IHI, indicates that the features can be considered to fall within PES Category A/B (Unmodified/ Largely Natural). Smaller drainage lines have been left largely undisturbed with marginal change for hydrology and geomorphology identified.

Characteristics of smaller drainage lines with riparian zones are considered to be largely uniform throughout the study area. The features are located within isolated areas and are therefore intact and the lack of water for extensive periods of the year does not make it feasible for abstraction. All these aspects have resulted in drainage features with limited levels of present impact, which can be considered important in terms of biodiversity conservation.

Due to the ephemeral nature of the drainage lines, not all drainage lines could be considered riparian habitat as defined by NWA No 36 of 1998. Therefore, distinction was made between drainage lines with riparian zones and drainage lines without riparian zones. Smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year flood lines of watercourses exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA will also apply and therefore a Water Use License will be required.

Smaller drainage lines without riparian zones are not considered wetlands but are still defined as watercourses. If any activities are to take place with the 1:100 year flood line exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained, however Section 21 of the NWA (Act 36 of 1998) as well as General Notice no. 1199 of 2009 as it relates to the NWA does not apply and therefore no Water Use License will be required.

2.7.3.3 Ecological Importance and Sensitivity

Table 41: EIS determination for the various river systems within the study area

System	Mutamba River		Smaller drainage lines	
Determinant	**Score**	**Conf**	**Score**	**Conf**
PRIMARY DETERMINANTS				
1. Rare & Endangered Species	3	2	2	2
2. Populations of Unique Species	3	3	1	2
3. Species/taxon Richness	3	2	2	2
4. Diversity of Habitat Types or Features	2	3	1	3
5. Migration route/breeding and feeding site for wetland species	3	3	1	3
6. PES as determined by WET-Health assessment*	3	3	4	3
7. Importance in terms of function and service provision	3	3	2	3
MODIFYING DETERMINANTS				
8. Protected Status according to NFEPA Wetveg	3	4	4	3
9. Ecological Integrity	3	3	3	2
TOTAL	**26**	**26**	**20**	**23**
MEDIAN	**2.9**	**2.9**	**2.2**	**2.6**
OVERALL EIS	**B**		**B**	

***WET IHI used in Place of WET Health**

Based on the findings of the study it is evident that from a wetland point of view, the EIS of the river systems are largely similar. The Mutamba River can be defined as a Class B system indicating a high EIS. Drainage lines also calculated an overall EIS score of B.

2.7.3.4 Wetland Delineation and Buffer Allocations

During the field survey it became evident that the majority of features has remained largely undisturbed and can still be regarded to be in a high PES. Furthermore, features with surface water throughout the year play a vital role in the provision of water for both wildlife as well as agricultural activities further downstream. To comply with legislative requirements as defined above as well as to aid with conservation of habitat within the study area, during the proposed mining activities, 100m buffer zones are recommended for all features. The location of the features in relation to the study area is conceptually depicted in Figure 47 and Figure 48.

2.7.3.5 Recommended Ecological Category

According to the resource directed measures for protection of water resources a wetland or river may receive the same class for the PES, as the REC, if the habitat is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the feature. The results obtained from the assessments indicate a relatively low level of transformation on all levels of ecology. It is therefore recommended that the features be assigned the same REC as the PES Class calculated. The EIS and REC values are presented in Table 42.

Table 42: Assigned REC Classes

Feature	VEGRAI Ecostatus	Wetland PES Classes	EIS Class	REC Class
Mutamba River	B/C	B/C	B	B
Smaller drainage lines	B/C	A/B	B	B

* = not applicable

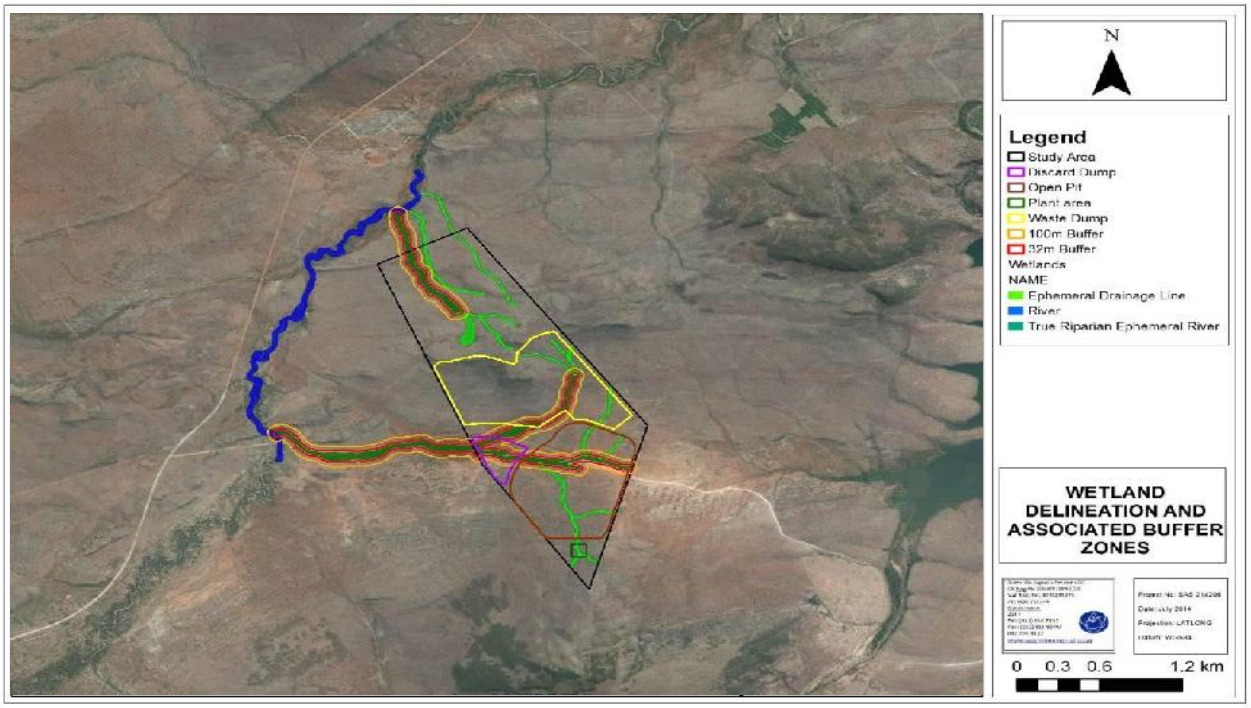


Figure 47: Wetland delineation and associated buffer zones in relation to the mining footprint

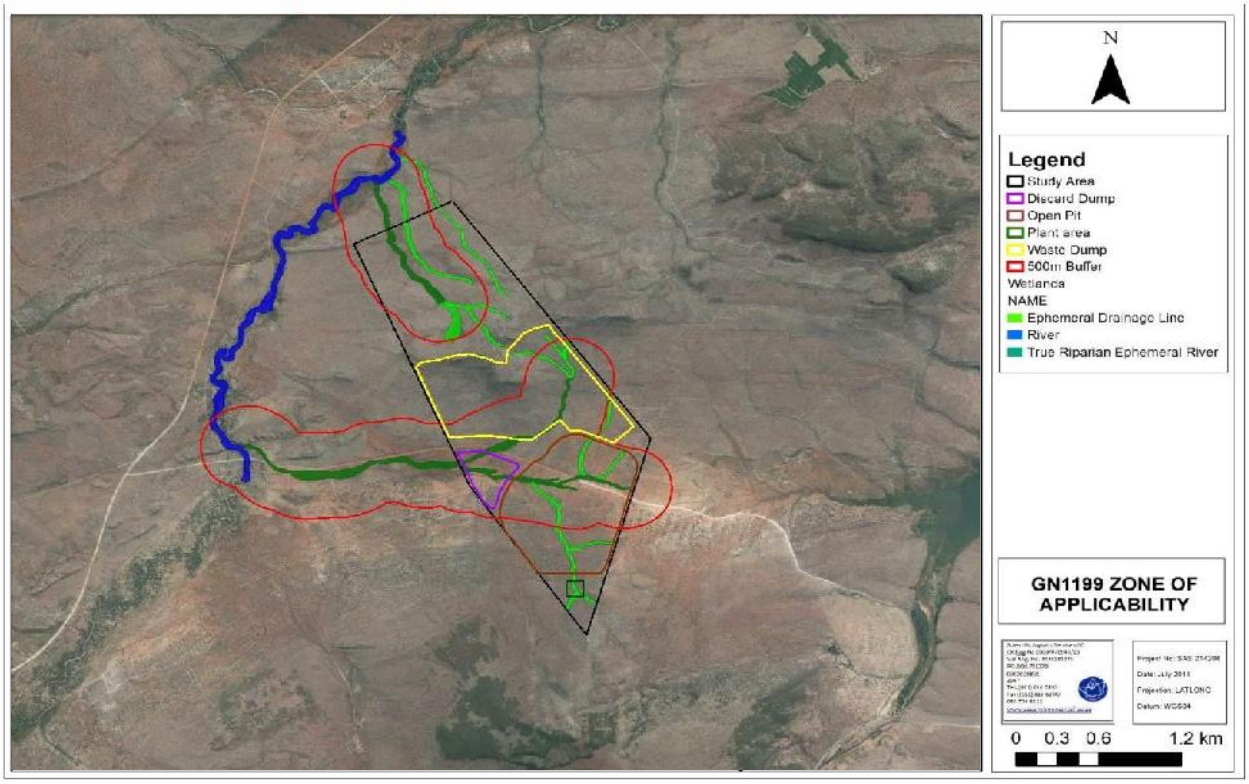


Figure 48: Wetland delineation and associated 500m buffer zone in relation to the mining footprint

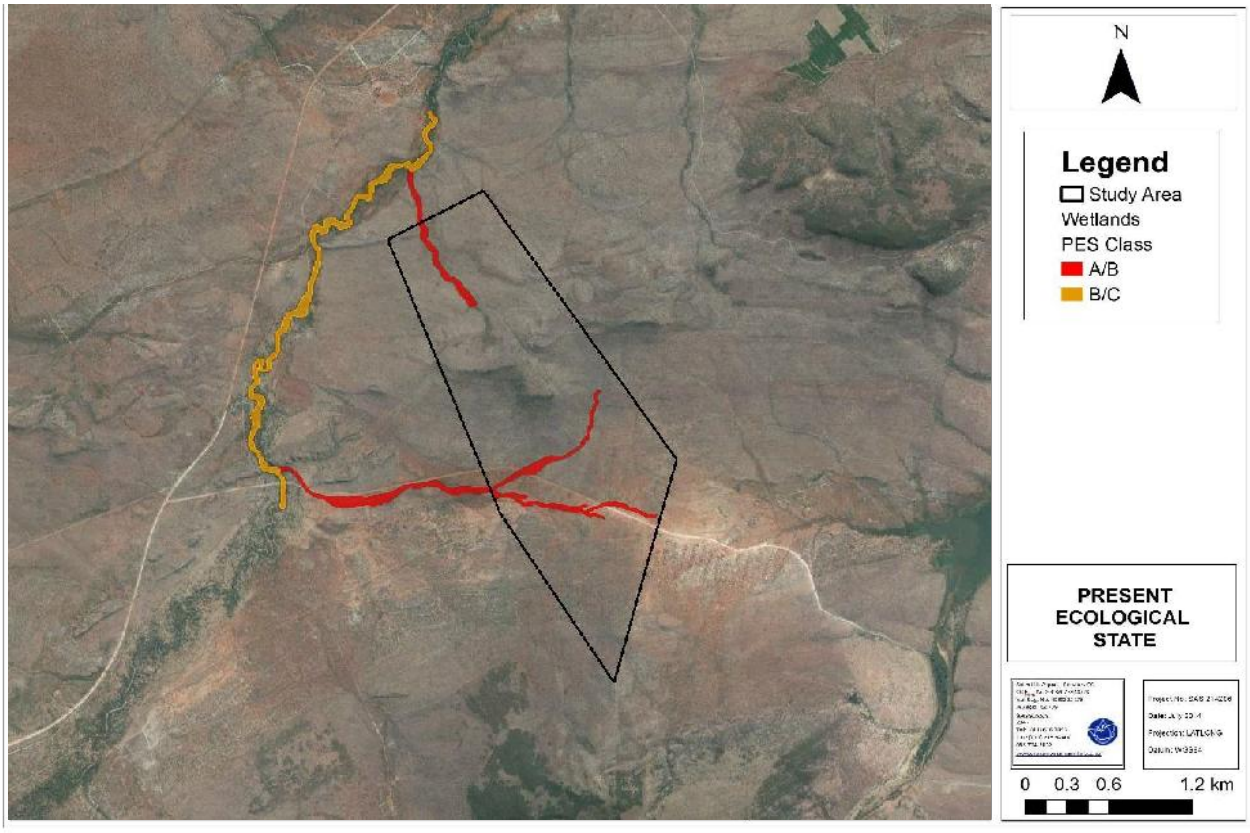


Figure 49: Wetland PES map

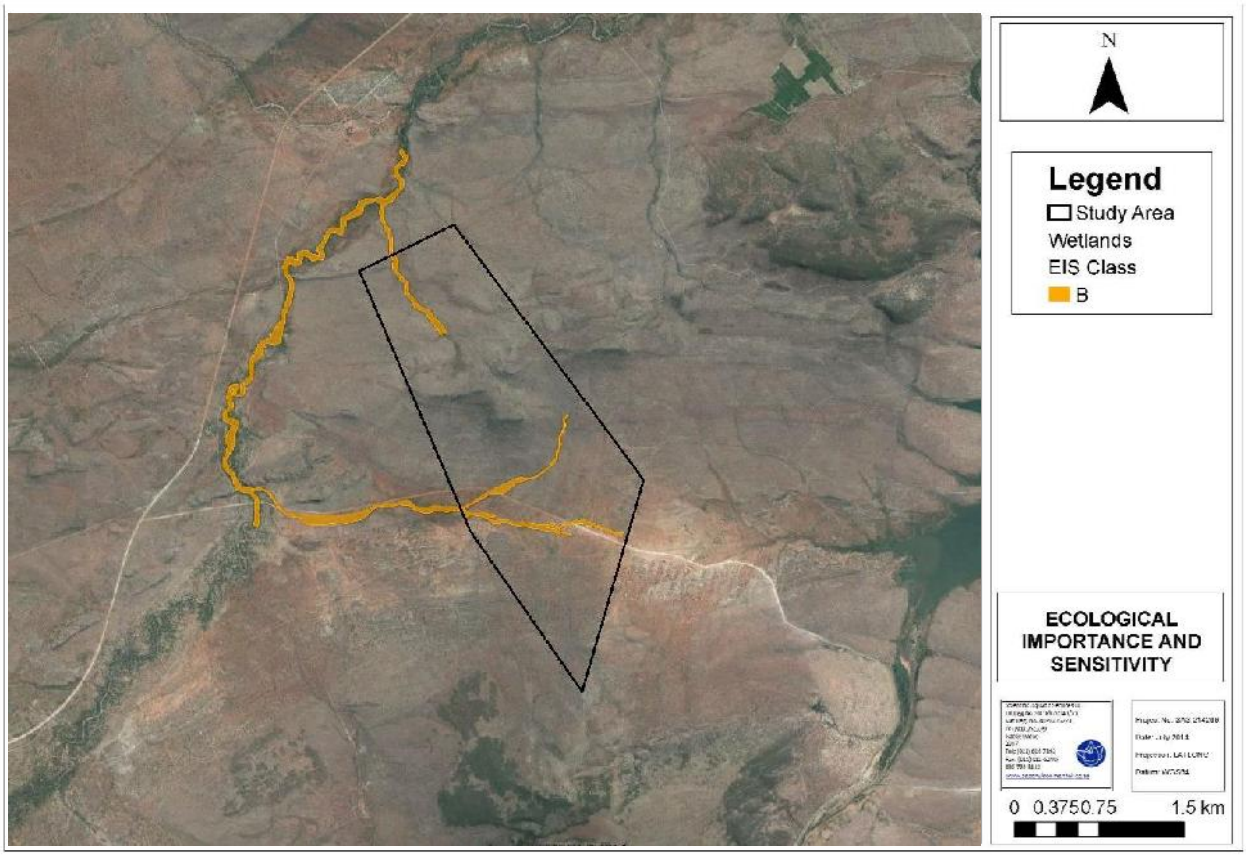


Figure 50: Wetland EIS map

2.7.4 SURFACE WATER QUALITY

2.7.4.1 Macro-chemistry

There are no published surface water quality data for the Mutamba River. DWS collects water quality data at the dams on the Nzhelele River system, upstream from Nzhelele Dam. This information is not deemed applicable to The Duel Project.

Water quality sampling was done as part of the surface water assessment for the Makhado Colliery Project (WSM Leshika Consulting, 2012). All but two of the monitoring points are located in the Mutamba River and its major downstream tributary, the Kandanama River. The other two points are in the Nzhelele River just upstream (Smon-13) and downstream (Smon-2) of its confluence with the Mutamba River (refer to Figure 51). Due to the arid nature of the area, streams and the rivers are mostly dry and surface flow only occurs after significant downpours. The surface flow after storms events are also often of short duration and therefore the sampling sets do not include all monitoring points. The test results of the samples collected between 2009 and 2011 are shown in Table 43.

In January 2013 an extreme rainfall event occurred in the northern Limpopo region. At the mine site over 300 mm of rain was measured in 6 days. The Mean Annual Precipitation (MAP) as measured by the close-by weather station at Mutamba Ranch is only 304 mm. The runoff after this event where the MAP occurred in less than one week was of sufficiently long duration to enable collection of the first full set of surface water samples. The test results are shown in Table 44 (WSM Leshika Consulting, 2013).

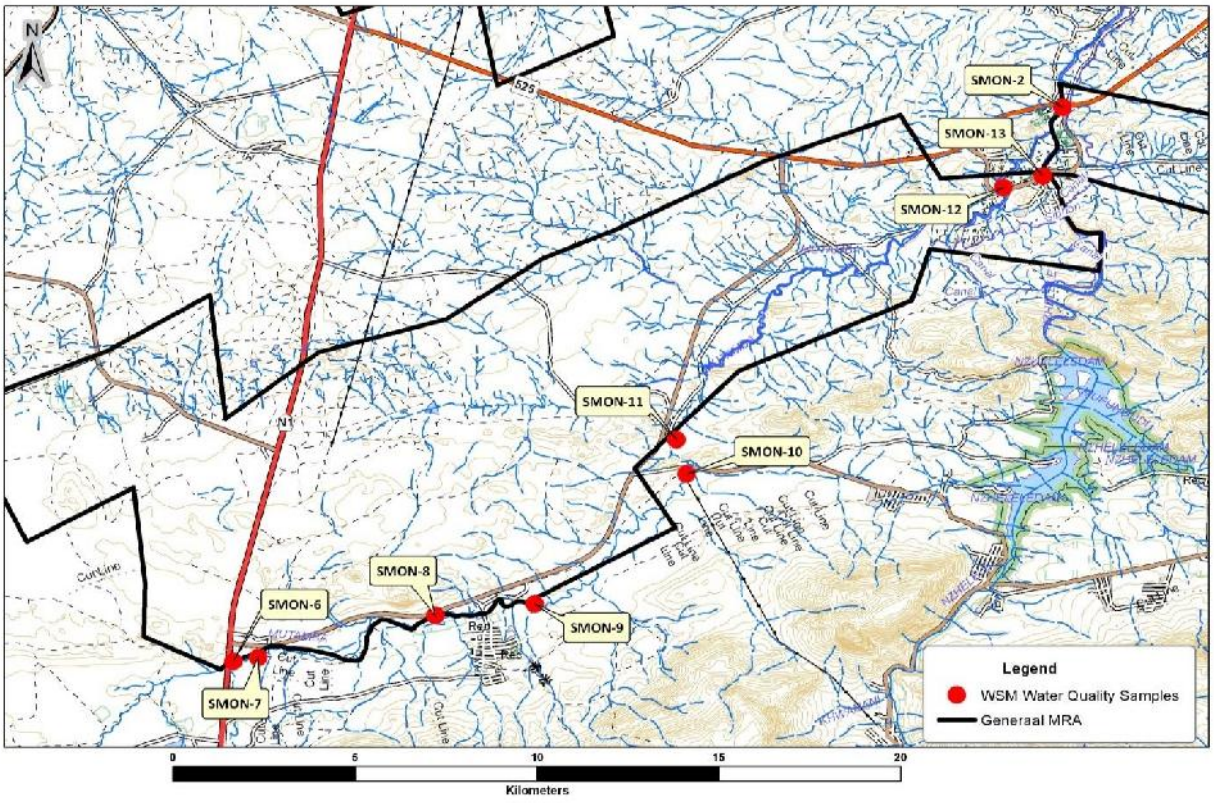


Figure 51: Locality of Makhado Colliery Project long term surface water monitoring points

The 2008/2011 results indicate fairly pristine water at the monitoring points except for elevated levels of nitrate. In contrast, the 2013 values indicate a sudden decrease in water quality from Smon-11 and further downstream. The value at Smon-13 in the Nzhelele River upstream of the Mutamba River confluence is quite good. The values at Smon-2 downstream of the confluence are on par with the Mutamba River values. There is only a small area of irrigation development upstream of Smon-13 of about 50 ha which may indicate that Smon-13 values reflect the Nzhelele Dam quality.

2.7.4.2 Micro-biological test

Micro-biological tests were conducted on samples taken in the Mutamba River in March 2009 and in May 2011 and the test results are given in Table 45. The results are evaluated against the health risk levels for drinking water (DWA, 1996) and it showed faecal coliform contamination at health risk levels for all samples, with the higher values occurring in the main stem of the Mutamba River (Smon9 to Smon 11). With the river mostly dry, the first major rainfall event of the wet season will wash pollutants down so that high levels of microbiological contamination may occur.

Table 43: Mutamba River water quality data 2009/11

Macro-elements

Element	Unit	WSM Leshika Monitoring Results 2009 to 2011								Aquatic Ecosystem WQT	Drinking Water WQT	Agriculture WQT (irrigation)	Agriculture WQT (livestock)
Figure Ref No													
WSML Number		Smon-6	Smon-6	Smon-8	Smon-9	Smon-9	Smon-10	Smon-10	Smon-11				
DATE		03/2009	12/2011	12/2011	03/2009	05/2011	05/2011	12/2011	05/2011				
pH		8.3	7.5	8.1	8.4	7.20	7.2	8.2	7.3		6.0 - 9.0	6.5-8.4	
E.C	mS/m	26.1	12.2	25.1	29.9	13.6	8.8	21.1	34.5		150	40	
TDS	mg/l	238	91	228	194	105	72	174	320		1000		1000
NO_3	mg/l		0.8	1.1		2.64	31.68	1.3	1.32	0.5	6	5	100
F	mg/l	0.5	<0.2	0.20	0.3	0.30	0.10	0.20	0.80	0.75	1	2	2
SO_4	mg/l	12	11	29	11	17	15	17	59		400		1000
Cl	mg/l	25	7	30	31	10	11	14	38		200	100	1500
Ca	mg/l	16	12	42	21	18	12	30	20		150		1000
Mg	mg/l	9	7	19	10	7	6	15	7		100		500
Na	mg/l	18	7	19	21	6	4	15	46		200	70	2000
TAL	mg/l		56	96		44	28	100	52				
HCO_3			56	96		44	28	100	52				
CO_3	mg/l		<5	<5		<5	<5	<5	<5				
P	mg/l		<0.025	<0.025		0.6	7.2	<0.025	0.3				

Table 44: Mutamba River water quality data 2013

Macro-elements

Element	Unit	Makhado Mine Monitoring Results									Aquatic Ecosystem WQT	Drinking Water WQT	Agriculture WQT (irrigation)	Agriculture WQT (livestock)
Figure Ref No														
WSML Number		Smon-6	Smon-7	Smon-8	Smon-9	Smon-10	Smon-11	Smon-12	Smon-13	Smon-2				
DATE		Jan-13												
pH		7.9	8.2	8.2	8.3	8	8	8	8	8.2		6.0 - 9.0	6.5-8.4	
E.C	mS/m	8.3	18.8	22.8	23.3	19.1	160.9	64.9	37.7	146.5		150	40	
TDS	mg/l	64	122.2	148.2	151.5	124.2	1045.9	421.9	245.1	952.3		1000		1000
NO_3	mg/l	0.2	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	0.5	6	5	100
F	mg/l	<0.2	0.11	0.15	0.13	0.13	5.8	0.89	0.35	1.4	0.75	1	2	2
SO_4	mg/l	<5	13.75	32.18	28.46	5.66	301.98	28.4	25.52	99.94		400		1000
Cl	mg/l	<5	13.9	12.5	12.8	5.5	144.4	60.9	17.5	142.4		200	100	1500
Ca	mg/l	18	13.59	16.48	15.92	17.57	62.07	28.63	17.3	33.36		150		1000
Mg	mg/l	9	5.72	6.75	6.35	6.02	17.4	21.32	8.27	31.95		100		500
Na	mg/l	3	13.06	20.2	19.81	11.27	282.21	80.27	48.92	268.62		200	70	2000
TAL	mg/l													
HCO_3														
CO_3	mg/l													
P	mg/l	5.9	0.45	0.52	0.36	0.17	0.16	0.12	0.64	0.3				

Table 45: Results of microbiological tests

ANALYSES	UNIT	DATE	Smon1	Smon6	Smon3	Smon9	Smon10	Smon11	Target Water Quality Range for Drinking Water		
									Negligible risk	Slight risk	Health risk
Faecal Coliform	/100 mℓ	Mar-09	-	5200	-	6000	-	-			
		May-11	330	-	90	2900	26000	3600	0	0 -10	>10

2.7.4.3 Aquatic Assessment

An aquatic ecological assessment was undertaken at one point on the Mutamba River, just downstream of The Duel Project area.

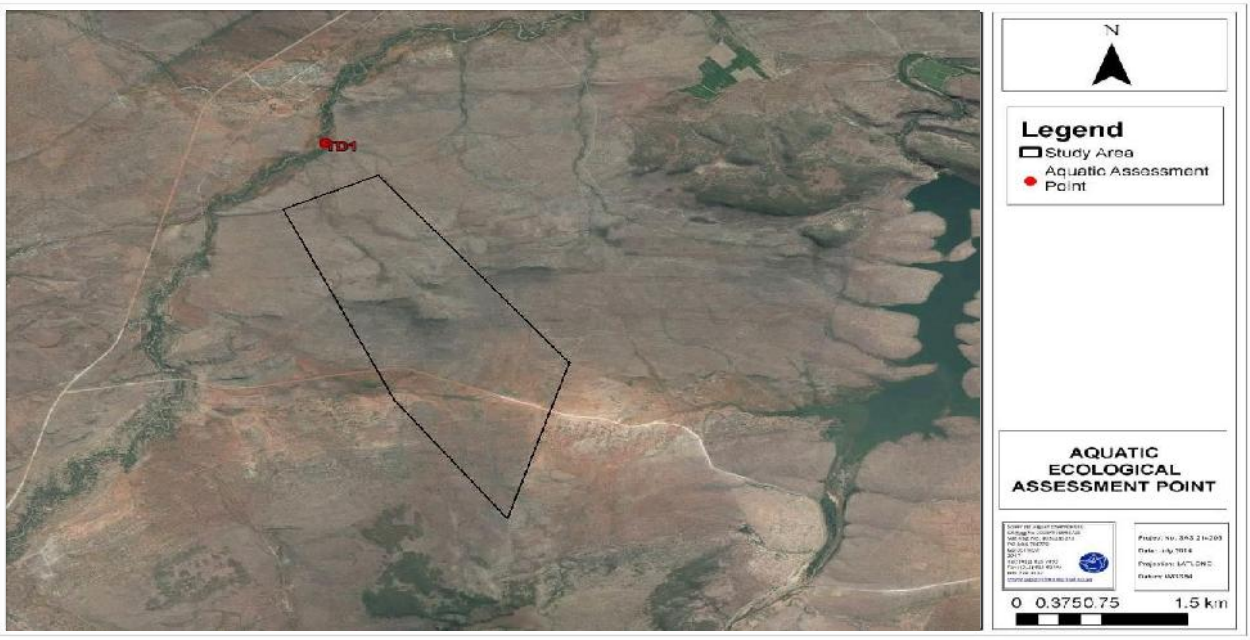


Figure 52: Aquatic assessment monitoring point

Upstream view of the TD1 site on the Mutamba River showing the inundated section upstream of the weir

Downstream view of the TD1 site showing the shallow laminar flow at the point

2.7.4.3.1 Physico-chemical water quality

Water quality variables were measured at TD1 on the Mutamba River where surface water was present.

Site	Description	pH (pH units)	Conductivity (mS/m)	DO (mg/L)	Temp (ºC)
TD1	Mutamba River – representative point near the project area	6.83	90.2	6.8	25.6

Oxygen (mg/L)	Temperature when measured (°C)	Maximum oxygen at that temperature (mg/L)	Oxygen measured expressed as percentage of maximum
6.8	25.6	8.09	**84.05**

The following key points on the water quality of the Mutamba River system were observed:

- The water quality guideline for aquatic ecosystems (DWA, 1997) states that: 1) Total dissolved salts (TDS) concentrations (i.e. as indicated by the EC measurements) should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year; and 2) the amplitude and frequency of natural cycles in TDS concentrations should not be changed:
    - Dissolved solids were elevated from what can be expected under natural conditions. This is in congruence with the PES desktop assessment that indicates moderate physico-chemical water quality modifications as well as historical studies undertaken on the system as part of the GSP / Makhado Projects (CoAL, 2013).
- The water quality guideline for aquatic ecosystems (DWA, 1997) states that pH values should not be allowed to vary from the range of the background pH values for a specific site by > 5 %:
    - The pH conditions can be viewed as largely natural to slightly acidic. As the absolute value is close to 7, no negative impact from pH is likely at present.
- The water quality guideline for aquatic ecosystems (DWA, 1997) states that dissolved oxygen concentrations should range between 80% and 120% of saturation. Saturation (i.e. maximum dissolved oxygen concentrations) shall in turn depend on the temperature of the water sampled (USA EPA website).
    - Dissolved oxygen concentration at site TD1 complies with the recommended guideline.
    - The temperature observed at each of the points is deemed natural for the time of year and the nature of the system.

2.7.4.3.2 Intermediate Habitat Integrity Assessment (IHIA)

For site TD1, small instream zone habitat integrity impacts include bed modification, channel modification and solid waste disposal. No moderate impacts were reported, but flow modification, water quality and inundation were indicated as large impacts. Water abstraction was indicated as a critical impact. Site TD1 obtained a “D” (“Largely modified”) classification with regard to instream habitat integrity.

The most significant riparian zone impacts at site TD1 were vegetation removal and water abstraction, both large impacts. Moderate impacts included alien encroachment, bank erosion, flow modification, channel modification and water quality. Site TD1 obtained a borderline “C/D” (“Moderately to largely modified”) classification with regard to riparian habitat integrity.

An overall score of 50.1% (TD1) was calculated, placing site TD1 in “D” (“Largely modified”) classification. This is lower than expected based on the desktop assessment, where PES is indicated as C, EI as

"moderate", ES as "high" and the default EC as B. The most significant reason for this observation is the impact on flow in the system, due to upstream abstraction, which affects the aquatic and riparian ecology of the system.

2.7.4.3.3 Invertebrate Habitat Assessment System (IHAS)

Table 46 is a summary of the results obtained from the application of the IHAS Index to one river assessment site on the Mutamba River (TD1). This index determines habitat suitability, with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpreting the SASS5 results.

- The TD1 site on the Mutamba River was dominated by pools and runs;
- Water was discoloured at the time of assessment;
- Water flow was mixed but generally slow;
- Fringing vegetation was present, as was bank/riparian vegetation (mix of reeds and shrubs) providing good cover and limiting potential for erosion;
- Suitable rocky substrate in current was present at the TD1 site, increasing the ability to support a diverse and sensitive aquatic community at this point significantly;
- The other habitat types noted were sand, mud and gravel substrate;
- Habitat diversity and structure was considered adequate for supporting a diverse and sensitive aquatic macro-invertebrate community.

Table 46: A summary of the results obtained from the application of and IHAS indices to the assessment site on the Mutamba River

SITE	TD1
IHAS score	68
IHAS Adjustment score (illustrative purposes only)	+21
McMillan, 1998 IHAS description	Habitat diversity and structure is adequate to support a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones habitat characteristics	Adequate loose cobbles and rocks in current present. Stones out of current absent.
Vegetation habitat characteristics	Bank/riparian fringing vegetation (mix of reeds and shrubs) was present. Aquatic vegetation was absent.
Other habitat characteristics	Sand, mud and gravel habitats available. No bedrock substrate present. Isolated patches of algae present.
IHAS general stream characteristics	The stream at this point has a fair diversity of flow, is fairly wide (2 m to 5 m) and of average depth (less than 0.5 m) under the current conditions. Water is discolored and bank cover is good, thus limiting the potential for erosion at this point.

2.7.4.3.4 Aquatic Macro-Invertebrates – SASS5

Table 47 indicates the results obtained per biotope sampled whilst SASS5 scores are tabulated in Table 48.

Table 47: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment site (TD1)

PARAMETER	SITE	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	TD1	0	22	48	56
Number of taxa		0	4	9	11
ASPT		0	5.5	5.0	5.1

Table 48: Summary of the results obtained from the application of the SASS5 index to the assessment site on the Mutamba River

Type of Result	TD1
Biotopes sampled	Sand, mud, gravel, stones in current, fringing vegetation, patches of algae.
Sensitive taxa* present**	*Atyidae; Gomphidae; Naucoridae.*
Sensitive taxa* absent**	*Hydracarina; Caenidae; Leptophlebiidae; Aeshnidae; Hydrometridae; Hydroptilidae; Leptoceridae; Elmidae/Dryopidae; Ancylidae*
SASS5 score	56
Adjusted SASS5 score	77
SASS5 % of theoretical reference score*	30.4
ASPT % of theoretical reference score**	69.8
Dickens & Graham, 2001 SASS5 classification	Class E (Severely impaired)
Dallas 2007 Classification	Class E/F (Extensively to critically impaired)

***SASS5 reference score = 185; **ASPT reference score = 7.2; *** Based on expected list for SQR A80F-00063 (Mutamba)**

- Habitat limitations are likely to limit the diversity, abundance and sensitivity of the aquatic community to some degree, with specific reference to absence of aquatic vegetation;
- Suitable habitat in the form of rocky substrate indicates suitable macro-invertebrate habitat conditions at this point. The absence of vegetation biotopes, however, is the most likely reason for the lower than expected SASS score obtained at site TD1;
- In addition, taxa dependent on faster flow conditions are also likely to be largely absent;
- Water quality is likely to be an additional limiting factor, with specific reference to EC, shaping the aquatic community in the lower reaches of the system. As more data on the system is collected, better inferences on the ecological condition of the community will be possible;
- At site TD1, the stream may be considered to be in a class E (severely impaired) condition according the Dickens & Graham (2001) classification system. According to the Dallas (2007) classification system, the site can be classified as class E/F (extensively to critically impaired);
- The classifications obtained are lower than to the SQR PES rating of C, EI rating of “moderate” and expected default EC rating of B as determined during the desktop assessment, indicating higher levels of impact from what could be expected under natural conditions;
- The ephemeral nature of the Matumba River reduces the EIS of the system in this area significantly. This is compounded by the effects of water abstraction for agricultural purposes;
- The Mutamba River system is expected to exhibit broad variability in aquatic community integrity on a temporal scale due to variations in flow and habitat availability in the system. As more data on

the system is collected, better inferences on the ecological condition of the community will be possible;

- Due to the degree of sensitivity of the system to habitat changes and loss of instream flow careful design and operational procedures will be required to limit the impact on the Mutamba River.

2.7.4.3.5 Aquatic Macro-Invertebrates: MIRAI

Table 49: Percentage of taxa (actually present expressed as percentage of expected) showing flow, habitat and water quality preferences at the TD1 assessed during January 2015

Variable	Criteria	Percentage occurrence of taxa showing preferences at each of the sites
		TD1
Flow	Very Fast (>0.6 m/s)	20.00
	Moderately Fast (0.3-0.6 m/s)	71.43
	Slow (0.1-0.3 m/s)	16.67
	Very Slow (<0.1 m/s)	16.67
Habitat	Bedrock	0.00
	Cobbles	37.50
	Vegetation	33.33
	Gravel, Sand, Mud	14.29
	Water	44.44
Water quality	High	100.00
	Moderate	28.57
	Low	36.84
	Very Low	15.38

Table 50: Summary of the results (ecological categories) obtained from the application of the MIRAI to the TD1 assessment site on the Mutamba River, compared to classes awarded using SASS5

Variable / Index	TD1
Ecological category (MIRAI)	D
Dickens and Graham (SASS5)	E
Dallas (SASS5)	E/F

In terms of general ecological category classification, the values obtained are in congruence with previous studies performed in the same system. The MIRAI classification, considered to be slightly more robust compared to the SASS5 assessment, indicates slightly improved ecological conditions compared to that obtained using the two SASS5 classification systems. However, it is still clear that the system is impacted upon to a greater extent as anticipated based on the desktop PES/EI assessment. The latter indicated a PES classified as C, EI as "moderate", ES as "high" and default EC as B.

It is clear that ecological drivers, such as seasonal flow compounded by flow modifications resulting from water abstraction, have a negative effect on the diversity and sensitivity of the macro-invertebrate aquatic communities within this system.

2.7.4.3.6 Fish Community Assessment

The HCR (Habitat Cover Rating) results for the TD1 site indicate that shallow and slow conditions predominated at this site, with slow and deep conditions also represented. Fish species with biological requirements for faster flow is thus expected to be absent at this site. With regard to application of the FRAI, fish collected and scores employed are provided in Table 51.

Table 51: Fish species collected at the various sites indicating abundance (i.e. numbers collected used for site TD1 score evaluation in the FRAI assessment) with natural ranges included in the Mutamba River (Limpopo River system) of the study area

SPECIES NAME	Number of fish collected	Abundance score (AS)	FROC[1] score (below Nzhelele Dam)
Barbus trimaculatus	3	**1**	**1** [2]
Barbus paludinosis	22	**3**	**1**
Barbus unitaeniatus	12	**2**	**1**
Barbus viviparus	3	**1**	**1**
Oreochromis mossambicus	36	**4**	**1**

[1] Fish species previously encountered below the Nzhelele Dam (catchment A80G) for which FROC (reference frequency of occurrence) values are listed (Kleynhans *et al.* 2007). Where fish species were collected that were not previously listed, the FROC scores employed were derived as described in the respective footnotes. Only these species (i.e. previously encountered plus actually encountered but not previously listed) were used for application of the FRAI assessment for the Mutamba River.

[2] FROC score from above Nzhelele Dam catchment A80B (fish species FROC score not listed below dam in catchment A80G).

[4] AS = Abundance score. For site specific analyses abundance scores were determined for each site and used as FROC scores in the FRAI assessment. Abundance scores (AS) were classified as follows: 1 to 5 fish = 1; 6 to 15 fish = 2; 16 to 30 = 3; 31 to 60 = 4; 61 to 120 = 5

Table 52 summarises the EC obtained using the FRAI. For ease of comparison the EC values obtained by using the MIRAI have again been included.

Table 52: Summary of the results (ecological categories) obtained from the application of the FRAI to the TD1 assessment site on the one site on the Mutamba River, compared to that obtained using MIRAI

River assessed	Mutamba
Variable / Index	TD1
Automated FRAI (%)	33.2
Automated EC (FRAI)	E
Refined FRAI (%)	45.2
Refined EC (FRAI)	D
Ecological category (EC) (MIRAI)	D

EC = Ecological category

From the above it is clear that the EC calculated for the FRAI largely corresponds to that obtained for the MIRAI and the Dallas and Graham (2001) SASS5 classification system. In terms of general ecological category classification, the FRAI EC's obtained are lower compared to previous studies performed in the same system under higher flow conditions but similar to historical studies undertaken in low flow conditions. The EC values calculated during the current assessment are, however, in congruence with results obtained using macro-invertebrate indices (MIRAI and SASS5). It once again indicate that conditions are deteriorated from what could be expected based on the PES/EIS desktop assessment.

2.7.4.3.7 Conclusions

Based on the findings of the aquatic study the Mutamba River is seen to be a water stressed system, characterized by seasonal flow variation compounded by water abstraction for agricultural purposes. Desktop EIS/PES assessment indicate a PES classified as C, EI classified as “moderate”, ES as “high” and default EC as B. Indices employed, however, yielded the following classifications:

Table 53: Summary of the aquatic assessment results for site TD1 assessed January 2015

IHAS	IHIA	SASS5		MIRAI	FRAI
		Dickens and Graham (2001)	Dallas (2007)		
Adequate	D	E	E/F	D	D

The current assessments indicate that conditions in the project area is deteriorated from what could be expected based on the desktop assessment. The Mutamba River can thus be considered to be a system of reduced Ecological Importance and Sensitivity due to the limited provision of refugia and the limited support it provides to the aquatic ecology of the area. The system is however deemed important in terms of the provision of services to the terrestrial fauna of the area as well as fair significance from a socio-cultural point of view. It is deemed essential that all effort is made to ensure that impacts on the Mutamba River as a result of the proposed project are minimised.

2.7.5 EXISTING WATER USE

There are no DWS registered dams in the Mutamba River catchment.

Surface water is utilized for irrigation from the lower reach of the Mutamba River. The water requirements of households and livestock (including game) are mainly supplied from groundwater sources.

2.7.6 CURRENT DRAINAGE SYSTEM

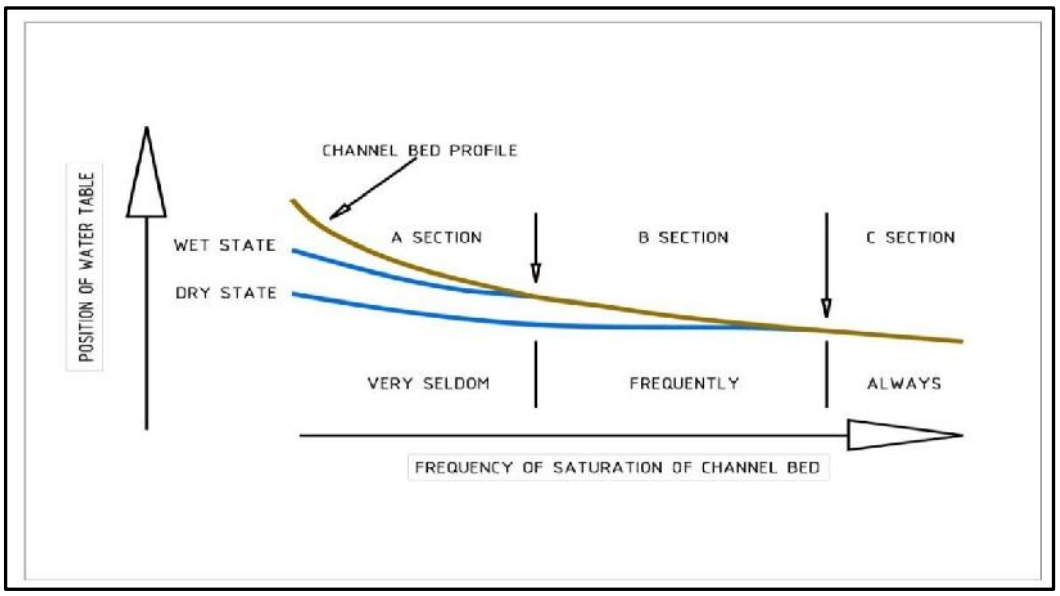
2.7.6.1 Stream classification

A water course is defined in the NWA as follows:

- River or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

River channels may be classified according to guidelines by DWA in "A practical field procedure for identification and delineation of wetlands and riparian areas" as shown below (taken from DWA, 2005). Three sections along the length of a watercourse is defined, with the upper Section “A” defined as being above the zone of saturation and it therefore does not carry baseflow. They are mostly too steep to be associated with alluvial deposits and are not flooded with sufficient frequency to support riparian habitat or wetlands. This type does however carry storm runoff during fairly extreme rainfall events, but the flow is of

short duration, in the absence of baseflow. The “A” watercourse sections are the least sensitive watercourses in terms of impacts on water yield from the catchment.



On the site, Section A channels occur on the mountain slopes and foothill slopes in this dry region, also along the smaller streams on the lower region.

The Mutamba River is classified as only a Section B stream. According to the DWA's guidelines, the “B” Sections are those channels that are in the zone of the fluctuating water table and only have baseflow at any point in the channel when the saturated zone is in contact with the channel bed. In these B Sections, baseflow is intermittent with flow at any point in the channel depending on the current height of the water table. Because the channel bed is in contact with, or in close proximity to, the water table, residual pools are often observed when flow ceases. The gradient of the channel bed is flat enough in these sections for deposition of material to take place and initial signs of flood plain development may be observed.

2.7.6.2 Drainage Density

Each organized system of stream tributaries exhibits spatial characteristics that provide important information about the nature of the drainage basin. The extent of channelization can be represented by measuring the drainage density. Drainage density indicates how dissected the landscape is by channels, thus it reflects both the tendency of the drainage basin to generate surface runoff and the erodibility of the surface materials.

Characteristics associated with high drainage densities are impermeable land surface, steep slopes, limited vegetation cover, limited rainfall, gentle slopes, large channel frequency (tributaries). Characteristics associated with low drainage densities are permeable rock, much vegetation cover, limited rainfall, gentle slopes, and lower channel frequency.

The drainage density of the catchments associated with the study area was envisaged to be intermediate of nature with permeable to semi-permeable land surface, relatively high vegetated land cover, limited rainfall and gentle slopes.

The drainage lines and drainagedensity of rivers and streams surrounding and including the study area are shown in Figure 53.

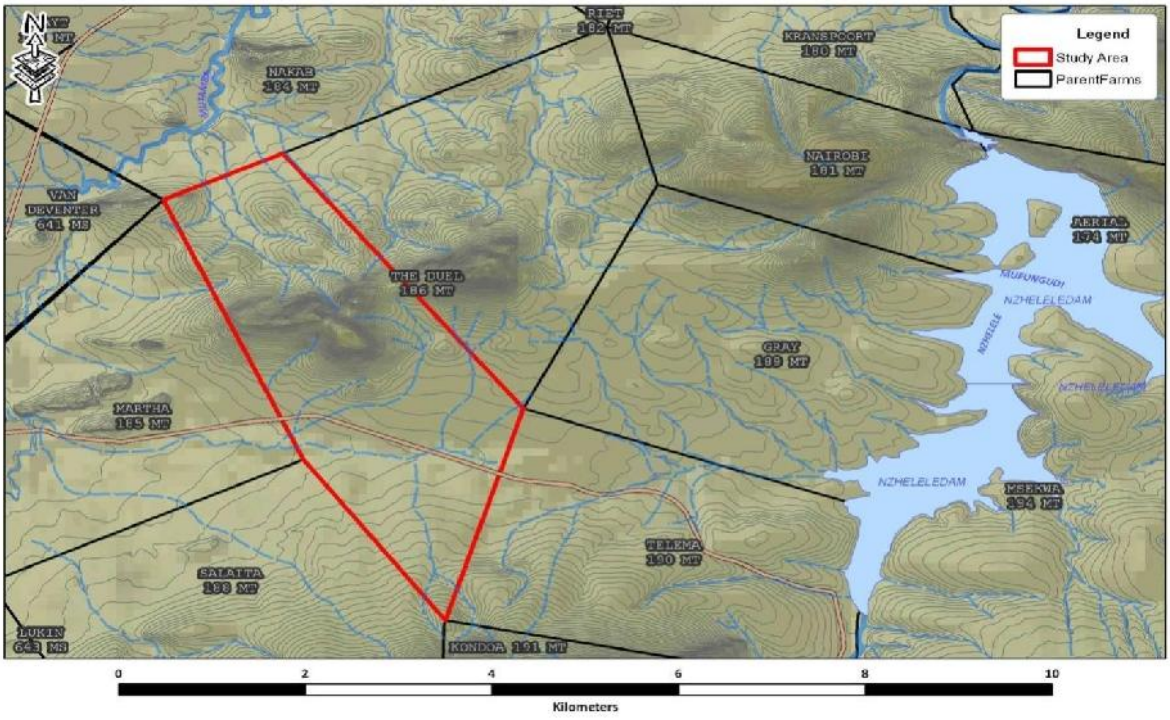
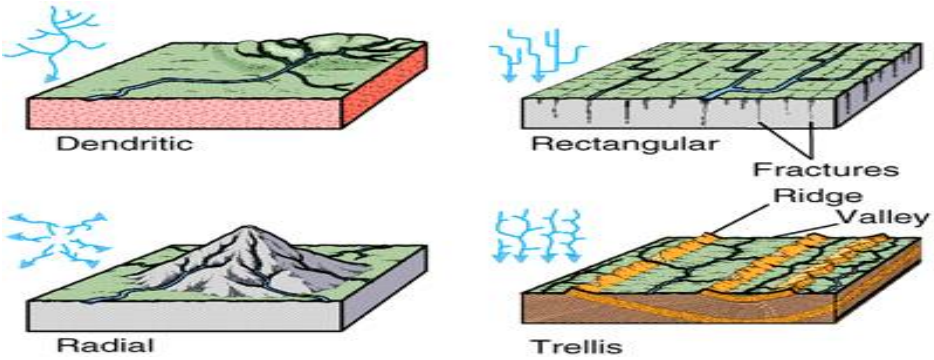


Figure 53: Drainage density of the study area

2.7.6.3 Drainage Pattern

The following lists some of the most common drainage patterns that rivers and/or streams follow:

- Dendritic—This type of river or stream forms a spreading, treelike pattern, usually in horizontal sediments or in crystalline rocks.
- Rectangular—These rivers and streams form a compact, perpendicular network of channels, usually with the channels predominantly lying in two directions.
- Trellis—Trellis drainage patterns have one dominant direction, with secondary streams perpendicular to the main river. Trellises closely resemble rectangular drainage patterns but are more elongated (along the main river) and less compact.
- Radial—Radial drainage patterns are just what their name implies: rivers or streams radiating from a central point.



The general drainage pattern of the rivers and streams in and around the study area is envisaged to be dentric of nature.

2.8 GROUNDWATER

2.8.1 HYDROCENSUS

Available borehole information was obtained from data collected during the Makhado Project (CoAL, 2011) and recently drilled exploration holes. The springs and hydro-census borehole data are summarized in Table 54 to Table 56. The springs and boreholelocalities are indicated on Figure 54.

Table 54: Summary table of springs occurring in the study area

FARM(Village)	BH No	Longitude	Lattitude	Yield (l/s)	Pump Cycle	Method	(Kl/day)	CLASS
LUKIN	LUK S-1	29.99813	-22.80328	1.0	24	Estimate	86.4	0
TELEMA	H25S0093	30.08102	-22.77180	0.1	24	Estimate	8.6	
TELEMA	H25S0098	30.10264	-22.80121	0.2	24	Estimate	17.3	
TELEMA	H25S0103	30.07204	-22.77768	1.0	24	Estimate	86.4	0
van DEVENTER	VAND-S1	29.99926	-22.74564	0.3	24	Estimate	25.9	II

Springs occur where the water table intersects the surface, usually along some structure. There are two known springs at Phumembe and a spring on Lukin. No springs occur on The Duel area.

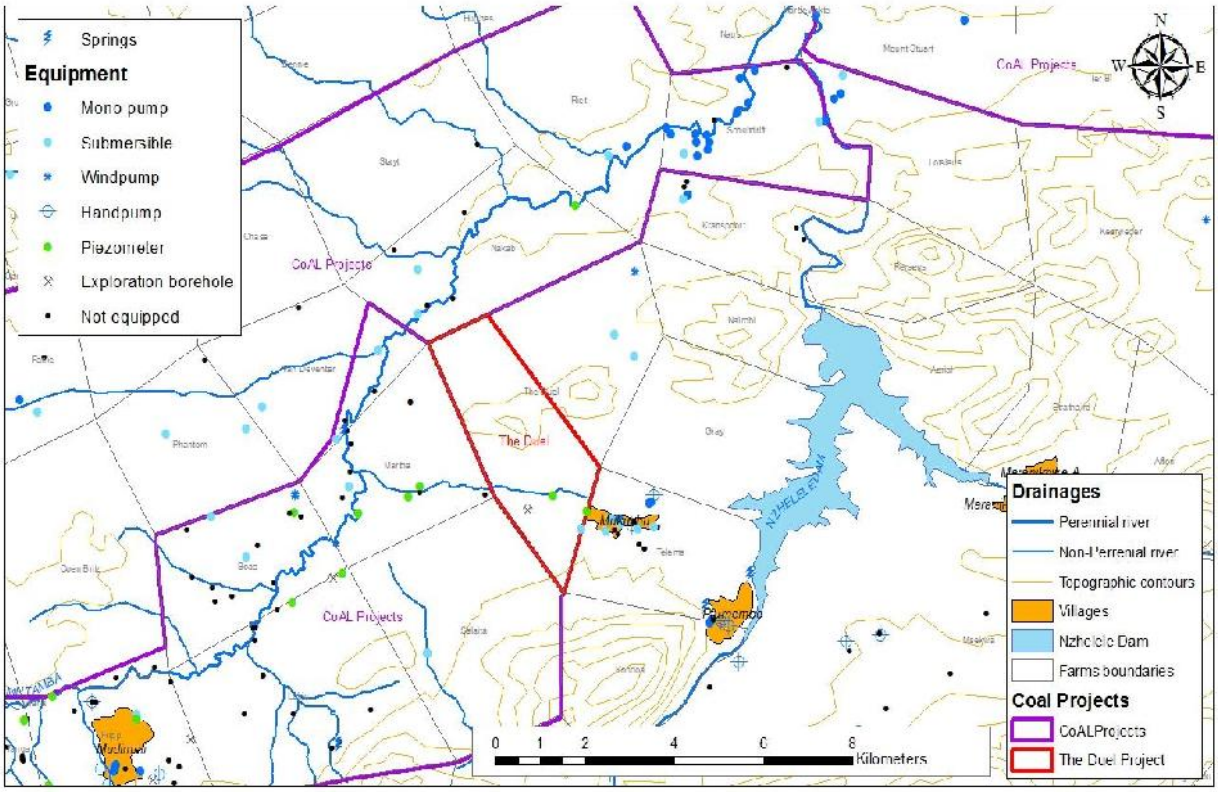


Figure 54: Hydrocensus borehole and spring localities

Table 55: Hydrocensus borehole data

Equipment*: N-none,S-submersible,M-mono,W-windpump,H-handpump,P-piezometer,E-Coal exploration
USER**: PP-Private production,VP-Community production ,MP-Mine production,MM-Mine monitor,N-not used
Status***:IU-in use, NIU-not in use

FARM/Village	BH No	Longitude	Lattitude	Equipment*	USER**	Depth	SWL (mbgl)	Date	Data Source	CLASS	Kl/day	Status***	Comment
BOAS	BOAS-1	29.96751	-22.76368	N	N		38	2008	census			NIU	
BOAS	BOAS-2	29.97945	-22.7686	S	PP		-	2008	census		9	IU	
BOAS	CAS-1	30.00011	-22.75575	S	MP	54	10	2009	census	IV	144	IU	
BOAS	CAS-2	29.98929	-22.75738	W	PP		17.3	2009	census		NR	IU	
BOAS	CAS-3	29.99883	-22.75768	N	MP		9.5	2010	census	IV	58	NIU	
BOAS	WBOAS-1	29.97266	-22.7744	N	N	61	-	2010	drilling			NIU	
BOAS	WBOAS-2	29.96856	-22.77243	N	N	80	-	2010	drilling			NIU	
BOAS	WBOAS-3	29.97656	-22.77588	N	N	81	-	2010	drilling			NIU	
BOAS	WBOAS-4	29.97319	-22.77681	N	N	85	-	2010	drilling			NIU	
BOAS	WBOAS-5	29.98174	-22.76652	N	MP	72	27	2010	drilling	III	43	NIU	
BOAS	WCAS-1	29.98907	-22.76038	P	MM	122	11.8	2010	drilling			IU	Piezometer installed
BOAS	WCAS-2	29.98814	-22.76061	N	N	120	-	2010	drilling			NIU	
BOAS	WCAS-3	29.99054	-22.76114	N	MP	128	15.1	2010	drilling	IV	144	NIU	
BOAS	WCAS-4	29.98571	-22.77839	N	MP	122	14.8	2010	drilling		1037	NIU	Mine supply/dewatering
CASTARO	Coal exp	29.99892	-22.77162	P	MM	300	16	2009	drilling			NIU	
CASTARO	Coal exp	29.98879	-22.77696	P	MM	300	13	2009	drilling			NIU	
CASTARO	NHOLE_E	30.0144	-22.75576	P	MM	107	17.5	2009	drilling			IU	Piezometer installed
CASTARO	NHOLE-1	30.00213	-22.76056	P	MM	67	13.4	2009	drilling			IU	Piezometer installed
CHASE	BF-3	29.96964	-22.72689	N	N		17.8	2011	census			NIU	Water has elevated temperature
FANIE	FANI-2	29.9337	-22.73964	M	PP		?	2009	census	III	3	IU	Domestic use
FANIE	FANI-3	29.93878	-22.73188	N	N		?	2009	census			NIU	44 gal drum capping borehole
FANIE	WFAN-4	29.93737	-22.7419	S	PP	0	5.18	2013	D		1	IU	
FRIPP	FXXXX54	29.96058	-22.80953	E	N		31.1	2009	census			NIU	
FRIPP	Geo-camp	29.96584	-22.80725	N	N		24.3	2009	census			NIU	
FRIPP	H25-0000	29.95298	-22.80755	M	VP	103	51.4	2009	census		29	IU	
FRIPP	H25-0016	29.94839	-22.79551	H	N	72	6.9	2009	census		415	NIU	
FRIPP	H25-0017	29.95512	-22.80761	N	N	100	44	2009	census		3	NIU	Destroyed
FRIPP	H25-0019	29.96201	-22.8087	H	N	98	44	2009	census		6	NIU	
FRIPP	H25-0043	29.95018	-22.80789	H	N	74	35.2	2009	census		3	NIU	
FRIPP	H25-0054	29.95737	-22.79763	S	N	66	13.2	2009	census			NIU	
FRIPP	H25-0109	29.94909	-22.7955	N	N	58	-	2009	census		14	NIU	
FRIPP	H25-0114	29.95326	-22.80689	M	N	104	51.4	2009	census		29	NIU	
FRIPP	H25-0155	29.96099	-22.78895	N	N		20.4	2009	census			NIU	
FRIPP	H25-0160	29.95741	-22.7984	P	MM	101	13.2	2009	census			IU	Piezometer installed
FRIPP	MUD-1	29.95809	-22.80796	M	VP		-	2009	census			IU	
FRIPP	MUD-2	29.95274	-22.80802	M	VP		-	2009	census			IU	
FRIPP	WFRIPP-10	29.93531	-22.7984	N	N	72	-	2009	drilling			NIU	
FRIPP	WFRIPP-4	29.96391	-22.80604	N	MP	81	19.1	2009	drilling	II	86	NIU	
FRIPP	WFRIPP-5	29.94839	-22.79551	N	MP	100	7.8	2010	drilling	IV	101	NIU	
FRIPP	WFRIPP-6	29.94036	-22.79435	P	MM	100	6.9	2010	drilling	IV	9	IU	Installed incorrectly-to be fixed
FRIPP	WFRIPP-7	29.94478	-22.79689	N	MP	100	9.5	2010	drilling	IV	230	NIU	
FRIPP	WFRIPP-8	29.93532	-22.79839	N	N	72	-	2010	drilling			NIU	
FRIPP	WFRIPP-9	29.95325	-22.79094	N	N	66	-	2010	drilling			NIU	
JAPIE	JAPI1	29.97318	-22.69263	M	PP	0	0	2013	D		2	IU	
KEERWEERDER	DOLI3	30.17293	-22.70655	W		0	-	2013	census		0	NIU	
KRANSPOORT	KRAN1	30.06825	-22.69962	N		0	-	2013	census		0	NIU	open hole now silted up
KRANSPOORT	KRAN2	30.0677	-22.7005	N		0	0.5	2013	census		0	NIU	Cement block
KRANSPOORT	KRAN3	30.06858	-22.702	M	PP	0	3.5	2013	census		0	NIU	Strong hole
KRANSPOORT	KRAN4	30.0675	-22.70278	S	PP	0	-	2013	census		0	NIU	Irrigation
KRANSPOORT	KRAN5	30.09047	-22.70807	N		0	6.9	2013	census		0	NIU	capped hole
LOTSIEUS	LOTS1	30.09617	-22.68823	M	PP	0	-	2013	census		0	NIU	Strong
LOTSIEUS	LOTS2	30.09795	-22.68432	M	PP	0	-	2013	census		0	NIU	Strong
LOTSIEUS	LOTS3	30.09925	-22.68328	M	PP	0	-	2013	census		0	NIU	Strong
LOTSIEUS	LOTS4	30.09973	-22.67997	S	PP	0	11.5	2013	census		0	NIU	Domestic supply
LUKIN	LUK - 4	29.98929	-22.75706	W	PP		-	2009	census			IU	
LUKIN	LUK-1	30.01607	-22.78629	M	PP		-	2009	census			IU	
LUKIN	LUK-3	29.98487	-22.77332	N	N		11	2009	census			NIU	
LUKIN	LUK-5	30.01607	-22.78629	S	PP		-	2009	census			IU	
LUKIN	LUK-6	29.96827	-22.80212	E	N	285	16.4	2009	census			NIU	
LUKIN	RXXXXX1	29.99695	-22.77249	E	N	280	15.1	2009	census			NIU	
LUKIN	WLUK-10	29.96416	-22.79161	N	N	70	7.1	2010	drilling	IV	14	IU	
LUKIN	WLUK-11	29.99673	-22.8038	N	N	101	-	2010	drilling			IU	
LUKIN	WLUK-12	29.98135	-22.78154	N	N	121	12.3	2010	drilling	IV	10	IU	
LUKIN	WLUK-13	29.97902	-22.79758	N	MP	58	15.5	2011	drilling	I	43	IU	
LUKIN	WLUK-1a	29.98283	-22.79047	N	N	37	-	2009	drilling			IU	
LUKIN	WLUK-1b	29.9829	-22.79047	N	N	55	17.5	2009	drilling	IV	5	IU	
LUKIN	WLUK-2	29.98894	-22.79747	N	N	73	17	2009	drilling	II	5	IU	
LUKIN	WLUK-3	29.98104	-22.78173	N	N	55	-	2009	drilling			IU	
LUKIN	WLUK-4	29.98114	-22.78404	N	N	286	15	2010	drilling	IV	10	IU	
LUKIN	WLUK-5	30.00464	-22.7968	N	N	78	-	2010	drilling			IU	
LUKIN	WLUK-7	29.96424	-22.79156	N	N	81	-	2010	drilling			IU	
LUKIN	WLUK-8	29.96416	-22.79161	N	N	113	-	2010	drilling			IU	
LUKIN	WLUK-9	29.99822	-22.80262	N	N	101	-	2010	drilling			IU	
MAKUSHU	Stand No 210	30.04709	-22.76354	S	PP		-	2014	census	III	3	IU	Domestic supply
MAKUSHU	Stand No C38	30.0585	-22.7635	S	PP		55	2014	census		1	IU	Domestic supply
MAKUSHU	Stand No E104	30.05204	-22.76376	S	PP		36.1	2014	census	III	3	IU	Domestic supply
MAKUSHU	Stand No E83a	30.05287	-22.76149	S	PP		48.4	2012	census			IU	
MAKUSHU	Stand No F106	30.06173	-22.76308	S	PP		43.3	2012	census			IU	Gardening
MAKUSHU	Stand No G146	30.05497	-22.7625	S	PP		29.8	2014	census		3	IU	Domestic supply
MARTHA	NHOLE-2	30.01212	-22.7576	P	MM	31	14.3	2011	drilling			IU	Piezometer installed
MARTHA	WCAS-5	30.01451	-22.75676	N	MP	31	14.3	2011	drilling	II	15	NIU	
MARTHA	WMA-1	30.02753	-22.75728	N	N	132	-	2011	drilling			IU	
MOUNT STUART	MTS1	30.09770	-22.67681	N	N		1.6	2013	census			NIU	NaNO3 strong hole
MOUNT STUART	MTS2	30.09447	-22.66897	M	PP	0	-	2013	census		1	IU	1 - domestic / cattle

Table 56: Hydrocensus borehole data (cont)

Equipment*: N-none,S-submersible,M-mono,W-windpump,H-handpump,P-piezometer,E-Coal exploration
USER**: PP-Private production,VP-Community production ,MP-Mine production,MM-Mine monitor,N-not used
Status***:IU-in use, NIU-not in use

FARM/Village	BH No	Longitude	Lattitude	Equipment*	USER**	Depth	SWL (mbgl)	Date	Data Source	CLASS	Kl/day	Status***	Comment
MSEKWA	H25-0004	30.07325	-22.78014	M	VP		-	2009	census			IU	TO TEST
MSEKWA	H25-0005	30.12867	-22.779	N	N	72	19	2009	census	IV		NIU	TESTED
MSEKWA	H25-0026	30.10724	-22.783	H	VP		-	2009	census			IU	TO TEST
MSEKWA	H25-0095	30.0788	-22.78796	H	N	6	3.6	2009	census			NIU	BLOCKED
MSEKWA	H25-0096	30.12138	-22.7901	N	N		-	2009	census			NIU	DESTROYED
MSEKWA	H25-0099	30.10847	-22.79661	N	N	107	26.5	2009	census	II	7	NIU	TESTED
MSEKWA	H25-0100	30.10102	-22.78592	N	N		-	2009	census			NIU	TO TEST
MSEKWA	H25-0101	30.1005	-22.78425	H	VP		-	2009	census			IU	TO TEST
MSEKWA	H25-0102	30.10722	-22.78273	N	N	79	17.5	2009	census		4	NIU	TESTED
MUKUSHU	H25-0197	30.05765	-22.76242	N	N	81	29.1	2012	census	III	26	NIU	New unequipped hole
MUKUSHU	MUK-1	30.05457	-22.76158	M	VP		-	2012	census			IU	Village supply
MUKUSHU	MUK-2	30.06075	-22.75871	M	VP		-	2012	census			IU	Village supply
NAKAB	NHOLE-9	30.0459	-22.70397	P	MM	70	2.7	2011	drilling			IU	Piezometer installed
NAKAP	NAK-1	30.02105	-22.721	N	N		5.7	2011	census			NIU	
NAKAP	NAK-2	30.01414	-22.71575	S	PP		15.9	2011	census			IU	
NAKAP	NAK-3	30.01604	-22.7224	N	N		6	2011	census			NIU	
NAKAP	NAK-4	30.01402	-22.72389	S	PP		-	2011	census			IU	
NAKAP	NAK-5	30.00934	-22.71211	N	N		16.3	2011	census			NIU	
NAKAP	NAK-6	30.02349	-22.7052	N	N		16.6	2011	census			NIU	
NJELELEPOORT	H25-0094	30.0728	-22.79262	N	N	114	4.3	2008	census	II	1	NIU	PUMP SUCTION
OOM JAN	OJAN1	29.93187	-22.69823	S	PP	0	21.9	2013	census		2	IU	10m3/day
OOM JAN	OJAN2	29.93832	-22.71513	M	PP	0	0	2013	census		1	IU	5m3/week
PERSEUS	PERS1	30.09193	-22.71027	N		0	-	2013	census		0	BU	Screened pump now blocked
PHANTOM	PHAN-1	29.97235	-22.76112	S	PP	71	35.8	2011	census			IU	solar powered submersible
PHANTOM	PHAN-2	29.96329	-22.74594	S	PP	116	13.2	2011	census			IU	solar powered submersible
PHANTOM	PHAN-3	29.97952	-22.74504	S	PP	42	22.9	2011	census			IU	generator powered submersible
RIET	RIET1	30.0525	-22.6948	S	PP	0	-	2013	census		3	IU	Working under sand
RIET	RIET2	30.0561	-22.693	M	PP	0	-	2013	census		3	IU	Working
RIET	RIET7	30.06418	-22.68953	N		0	-	2013	census		0	NIU	
SCHUITDRIFT	SDRIF1	30.08202	-22.679	M	PP	0	-	2013	census		0	NIU	Strong hole - river bed
SCHUITDRIFT	SDRIF12	30.0677	-22.6943	S		0	7.5	2013	census		3	IU	
SCHUITDRIFT	SDRIF13	30.07252	-22.69362	M	PP	0	-	2013	census		0	NIU	Cable stolen - strong hole
SCHUITDRIFT	SDRIF14	30.07048	-22.69483	M	PP	0	-	2013	census		0	NIU	Cable stolen - strong hole
SCHUITDRIFT	SDRIF15	30.07285	-22.69223	M		0	-	2013	census		0	NIU	Open hole now set up
SCHUITDRIFT	SDRIF151	30.095	-22.68852	S	PP	0	-	2013	census		30	IU	Water supply to farm community
SCHUITDRIFT	SDRIF16	30.08852	-22.67868	N		0	-	2013	census		0	NIU	
SCHUITDRIFT	SDRIF2	30.07902	-22.68043	M	PP	0	-	2013	census		0	NIU	Strong hole - river bed
SCHUITDRIFT	SDRIF3	30.08077	-22.68498	M	PP	0	-	2013	census		0	NIU	Strong hole - hard rock
SCHUITDRIFT	SDRIF4	30.07842	-22.68672	M	PP	0	-	2013	census		0	NIU	Strong hole on river bank
SCHUITDRIFT	SDRIF5	30.07377	-22.68825	N		0	2.6	2013	census		0	NIU	Strong hole
SCHUITDRIFT	SDRIF6	30.07227	-22.6909	M	PP	0	4.5	2013	census		0	NIU	Very strong hole
SCHUITDRIFT	SDRIF7	30.06419	-22.68954	M	PP	0	-	2013	census		0	NIU	Silted up
SCHUITDRIFT	SDRIF8	30.06508	-22.69072	M	PP	0	-	2013	census		0	NIU	Very strong
SCHUITDRIFT	SDRIF9	30.06995	-22.69085	M	PP	0	-	2013	census		0	NIU	Two holes
SCHUITDRIFT	SDRIFT11	30.07018	-22.69237	M	PP	0	-	2013	census		0	NIU	Strong hole
STAYT	WSTAY-1	30.02608	-22.6927	N	MM	72	18.9	2012	drilling			IU	
TELEMA	H25-0002	30.0611	-22.75857	M	VP	101	41.1	2012	census	I		IU	PUMP SUCTION
TELEMA	H25-0020	30.06165	-22.75746	H	N	105	39.3	2012	census	II		NIU	PUMP SUCTION
TELEMA	H25-0024	30.07517	-22.78058	H	N	103	9.4	2012	census	II	13	NIU	TESTED
TELEMA	H25-0025	30.07672	-22.78134	H	N		-	2012	census			NIU	TO TEST
TELEMA	H25-0041	30.05727	-22.76287	H	N	89	35.8	2012	census	III	17	NIU	TESTED
TELEMA	H25-0085	30.05971	-22.76701	N	N		-	2012	census			NIU	TO TEST
TELEMA	H25-0086	30.05967	-22.76703	N	N		-	2012	census			NIU	TO TEST
TELEMA	H25-0087	30.0586	-22.76624	N	N		-	2012	census			NIU	TO TEST
TELEMA	H25-0088	30.06244	-22.76307	N	N		-	2012	census			NIU	TO TEST
TELEMA	H25-0089	30.05363	-22.7636	N	N		-	2012	census			NIU	TO TEST
TELEMA	H25-0090	30.05447	-22.76442	N	N		-	2012	census			NIU	TO TEST
TELEMA	H25-0091	30.04803	-22.7598	N	N		-	2012	census			NIU	DRY-INFO
TELEMA	H25-0104	30.07297	-22.78073	M	VP	34	14.2	2012	census	0	22	IU	PUMP SUCTION
TELEMA	H25-0190	30.07372	-22.78025	N	N	78	4.9	2012	census		35	NIU	TESTED
TELEMA	NHOLE-10	30.04819	-22.76027	P	MM	79	29.4	2012	drilling			IU	Piezometer installed
TER BLANCHE	TER1	30.12417	-22.66993	M	PP	0	-	2013	census		1	IU	
TER BLANCHE	TER2	30.15932	-22.67712	N		0	35.3	2013	census		0	NIU	Old Iscor holes
TER BLANCHE	TER3	30.1616	-22.67683	S	PP	0	35.3	2013	census		1	IU	4 holes in this locality. 2 water holes.
THE DUEL	JMAT-1	30.05362	-22.72765	S	PP		-	2011	census			IU	submersible
THE DUEL	JMAT-2	30.05758	-22.73163	S	PP		-	2011	census			IU	submersible
THE DUEL	JMAT-3	30.05785	-22.71602	W	PP		-	2011	census			IU	Windpump
THE DUEL	M-16	30.03615	-22.75976	E	N	150+	28.2	2014	census	II		NIU	Exploration borehole with strong water strike
THE DUEL	NHOLE-3	30.0412	-22.75736	P	MM	97	28.8	2014	census			IU	Piezometer installed
van DEVENTER	BF-1	29.99015	-22.72278	N	N		24.9	2011	census	I		IU	Testing at time of survey. Game use
van DEVENTER	BF-2	29.97116	-22.73239	N	N		18.8	2011	census	IV		NIU	Not equipped
van DEVENTER	BF-4	29.9826	-22.74096	S	PP		?	2011	census	I		IU	Lodge supply
van DEVENTER	VAND-1	29.99776	-22.74692	S	PP	30	4.1	2009	census	III	86	IU	Domestic supply to T. Smith
van DEVENTER	WVAND-1	29.99934	-22.74346	N	N	79	-	2009	drilling			NIU	
van DEVENTER	WVAND-2	30.01263	-22.7402	N	N	36	-	2009	drilling			NIU	
van DEVENTER	WVAND-3	30.01261	-22.74012	N	N	39	-	2009	drilling			NIU	
van DEVENTER	WVAND-4	30.00064	-22.74785	N	N	79	-	2009	drilling			NIU	
van DEVENTER	WVAND-5	29.99982	-22.74544	N	N	61	-	2009	drilling			NIU	
van DEVENTER	WVAND-6	30.00541	-22.73821	N	N	73	-	2009	drilling			NIU	
van DEVENTER	WVAND-7	30.00607	-22.73047	S	PP	105	6.2	2010	drilling	III	14	IU	Submersible installed
van DEVENTER	WVAND-8	30.00036	-22.75293	N	MP	60	8	2010	drilling	IV	346	NIU	
WILDGOOSE	WILDG-1	29.96442	-22.71032	S	PP	127	22.1	2011	census			IU	solar powered submersible

2.8.2 PIEZOMETRY AND GROUNDWATER FLOW

If the water table is undisturbed, the groundwater surface tends to mimic a subdued form of the topography. Water levels obtained for the available borehole data were used to compile a piezometric map. The water level data was colour coded to piezometric height ranges consisting of 25m intervals from which contours were drawn (Figure 55).

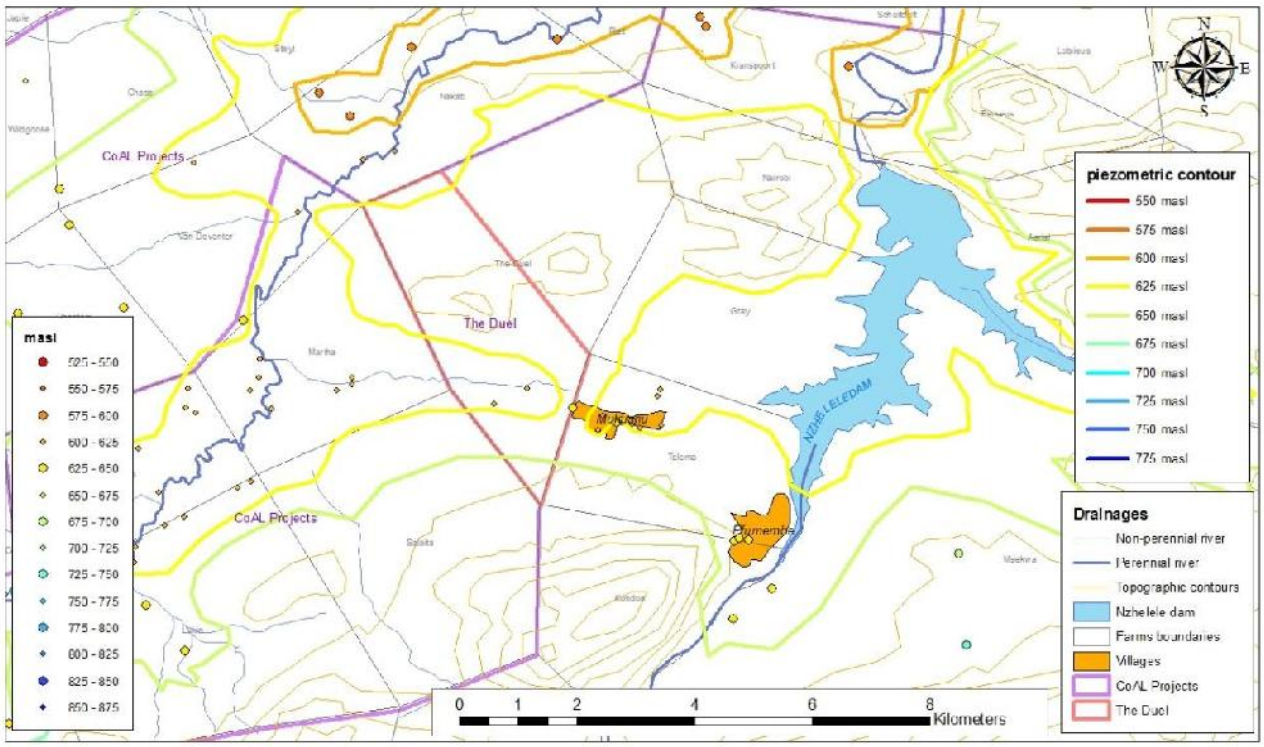


Figure 55: Piezometric contour map showing general groundwater flow direction

The available data allows for the following general observations:

- The piezometric surface forms a subdued sub-surface expression of the topography.
- Some localized dewatering is evident at Makushu village where low yielding boreholes are being dewatered. The areas ofdewatering around these boreholes are of limited extent.
- Apart from Makushu the water table is approximately in an undisturbed state.

2.8.3 GROUNDWATER QUALITY

Groundwater quality is dependent on the concentrations of soluble salts and the residence time of water within the host rock. Water derived from secondary aquifers in the area can vary considerably. Good quality groundwater can be found in the quartzites and lavas of the Soutpansberg strata. Moderate to brackish water can be found in the Nzhelele shale and the lower Karoo strata. The Bosbokpoort formation marks a climatic change to increasing aridity which culminates in the aeolian sands of the Tshipise Member of the Clarens formation. The sediments of the Bosbokpoort Formationto Red Rocks Member reflect the changing climate with a concurrent increase in salinity up the sequence.

Samples were taken from exploration borehole M-16 and 2 private boreholes in Makushu. Chemistry data from the Makhado Project was also included. The chemistry data will be presented with reference to the

Water Quality Threshold (WQT) according to DWAF-SA Water Quality Guidelines for Rivers and Streams for the following water uses:

- Drinking water
- Agriculture-irrigation
- Agriculture-livestock

2.8.3.1 Macro chemistry

Table 57: DWAF Water Quality Threshold Classification – Macro chemistry

Species	pH	E.C	TDS	NO_3	F	SO4	Cl	Ca	Mg	Na
Unit		mS/m	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Drinking	6.0 - 9.0	150	1000	6	1	400	200	150	100	200
Agriculture (irrigation)	6.5 - 8.4	40		5	2		100			70
Agriculture (livestock)			1000	100	2	1000	1500	1000	500	2000

The data is tabulated below. Concentrations exceeding the WQT for any of the above uses are marked in red.

Table 58: Macro-chemistry data

Species			E.C	TDS	NO_3	F	SO_4	Cl	Ca	Mg	Na
Unit	date	pH	mS/m	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BF-1	15/07/2011	7.5	139	898	0.7	3.1	157	181	56	53	159
BF-2	15/07/2011	6.9	773	4960	0.8	0.8	185	0	237	372	778
BF-4	15/07/2011	7.3	72	461	0.5	0.4	28	62	42	43	44
BOAS -1	3/04/2008	6.7	135	984	0.0	0.5	62	186	165	107	110
EKL-15	23/05/2011	7.8	142	832	3.0	0.5	11	151	33	46	143
EKL-16	5/09/2011	7.4	85	524	0.6	0.2	27	121	36	22	74
FANI-1	14/11/2011	7.7	201	1290	0.2	3.7	5	380	8	9	390
FANI-2	14/11/2011	7.2	525	3360	3.0	0.5	157	0	122	235	614
H18-0006	15/07/2011	7.9	294	1718	0.2	0.4	110	552	34	16	511
H25-0010	8/09/2013	7.3	246	1601	64.0	0.3	127	333	161	144	150
H29-0011	8/09/2013	7.2	179	1165	29.8	0.2	50	224	141	70	154
Jap-1	8/09/2013	7.1	143	929	9.2	1.8	46	63	77	100	121
Kran-1	8/09/2013	7.9	104	676	1.6	2.8	105	111	25	12	194
Mon-13	27/06/2011	7.8	108	612	0.5	1.8	49	141	65	63	115
Mon-13	15/07/2011	8.6	99.7	580	0.5	1.6	45	98	58	61	109
Mon-18	8/02/2011	8.6	150	932	5.6	0.6	41	196	26	40	174
Mon-18	15/07/2011	8.7	140	862	0.2	0.6	39	184	54	59	212
Mon-24	23/04/2012	7.4	150	932	8.1	1.0	57	120	95	98	109
MTS-1	8/09/2013	7.9	154	998	1.4	2.8	18	241	28	37	256
Nak-2	21/06/2011	7.2	242	1452	7.7	2.3	138	346	91	108	274
Nak-3	21/06/2011	7.4	331	1986	0.2	3.0	170	519	83	124	529
Nak-4	21/06/2011	7.5	276	1662	3.4	3.7	159	442	61	95	421
Ojan-1	8/09/2013	7.6	232	1507	18.5	2.4	98	236	75	110	301
PHAN-1	12/09/2011	7.6	93	612	13.0	0.5	48	53	117	61	31
PHAN-2	12/09/2011	7.6	79.9	444	4.3	0.2	6	35	66	49	43
PHAN-3	12/09/2011	7.4	80.9	490	5.8	0.2	10	36	57	54	42
PHAN-3	23/04/2012	7.2	89.5	548	5.3	0.2	10	40	62	62	53
Riet-2	8/09/2013	7.5	298	1936	3.2	1.7	317	525	68	98	440
Sdrif-15	8/09/2013	7.7	124	804	3.4	4.2	147	146	53	30	175
Ter-1	8/09/2013	7.7	191	1243	8.2	1.4	79	218	60	75	273
Ter-3	8/09/2013	7.9	116	757	1.4	0.6	45	90	73	71	90
WILDG-1	12/09/2011	7.4	198	1270	10.0	1.3	113	195	118	111	167
M-16	15/09/2014	7.5	210	1 038	0.4	0.9	14	527	25	28	299
Stand No 210	15/09/2014	7.1	295	1 732	0.2	0.8	122	588	124	165	204
Stand No E104	15/09/2014	7.2	271	1 552	0.5	0.9	138	536	142	146	165

The study area is characterized by poor groundwater quality typical of arid environments and of upper Karoo strata with elevated salts.

2.8.3.2 Microchemistry

Table 59: DWAF Water Quality Threshold Classification – Micro chemistry

Element	Al	As	B	Cd	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Se	V	Zn
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Drinking	0.50	0.05		0.005		0.050	1.3		0.4			0.010	0.05	0.100	5.000
Agriculture(irrigation)	5.00	0.1	0.5	0.010	0.05	0.100	0.2		0.02	0.010	0.200	0.200	0.02	0.100	1.000
Agriculture(livestock)	5.00	1	5	0.010	1	1.000	0.5		10	0.010	1.000	0.100	0.05	1.000	20.000

The data is tabulated below. Concentrations exceeding the WQT for any of the above uses are marked in red.

Table 60: Micro-chemistry data

Element	Al	As	B	Cd	Co	Cr	Cu	Mn	Mo	Ni	Pb	Se	V	Zn
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BF-1	0.10	0.01	0.35	0.005	0.025	0.025	0.025	0.05	0.025	0.025	0.020	0.020	0.025	0.025
BF-2	1.65	0.01	0.64	0.005	0.025	0.025	0.037	1.54	0.025	0.025	0.020	0.020	0.025	0.319
BF-4	0.10	0.01	0.19	0.005	0.025	0.025	0.025	0.27	0.044	0.025	0.020	0.020	0.025	0.025
EKL-15	0.10	0.13	0.25	0.005	0.025	0.025	0.025	0.14	0.025	0.025	0.020	0.020	0.036	0.025
EKL-16	0.14	0.01	0.16	0.005	0.025	0.025	0.083	0.60	0.025	0.025	0.020	0.020	0.025	0.196
FANI-1	0.20	0.01	0.78	0.005	0.025	0.025	0.025	0.04	0.025	0.025	0.020	0.020	0.025	0.102
FANI-2	0.10	0.01	0.74	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.037	0.025
H18-0006	0.10	0.01	0.96	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.025	0.157
H25-0010	<0,01	<0,03	0.25	<0,01	<0,01	<0,01	<0,01	<0,01	<0,05	<0,01	<0,09	0.02	0.05	0.06
H29-0011	<0,01	<0,03	0.31	<0,01	<0,01	<0,01	<0,01	<0,01	<0,05	<0,01	<0,09	0.03	0.02	0.08
Jap-1	<0,01	<0,03	0.21	<0,01	<0,01	<0,01	<0,01	0.20	<0,05	<0,01	<0,09	<0,02	0.03	1.00
Kran-1	<0,01	<0,03	0.28	<0,01	<0,01	<0,01	<0,01	<0,01	<0,05	<0,01	<0,09	<0,02	<0,01	<0,01
Mon-13	0.59	0.01	0.37	0.005	0.025	0.025	0.025	0.07	0.060	0.025	0.020	0.020	0.025	0.025
Mon-13	0.10	0.01	0.41	0.005	0.025	0.025	0.025	0.34	0.025	0.025	0.020	0.020	0.025	0.025
Mon-18	0.10	0.01	0.22	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.050	0.025
Mon-18	0.13	0.01	0.36	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.030	0.025
Mon-2	0.13	0.01	0.98	0.005	0.025	0.025	0.025	1.40	0.025	0.025	0.020	0.020	0.025	0.025
Mon-24	2.81	0.03	0.29	0.005	0.025	0.025	0.025	0.42	0.025	0.025	0.020	0.020	0.025	2.210
MTS-1	<0,01	<0,03	0.33	<0,01	<0,01	<0,01	<0,01	0.05	<0,05	<0,01	<0,09	0.03	<0,01	0.01
Nak-2	0.10	0.01	0.50	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.025	0.025
Nak-3	0.49	0.01	0.97	0.005	0.025	0.025	0.025	0.91	0.025	0.071	0.047	0.034	0.177	1.550
Nak-4	0.12	0.01	0.69	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.032	0.036
Ojan-1	<0,01	<0,03	0.71	<0,01	<0,01	<0,01	0.02	<0,01	<0,05	<0,01	<0,09	<0,02	0.03	0.02
PHAN-1	0.10	0.01	0.10	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.032	0.025
PHAN-2	0.10	0.01	0.16	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.026	0.025
PHAN-3	0.11	0.02	0.17	0.005	0.025	0.025	0.025	0.03	0.025	0.025	0.020	0.020	0.025	0.027
PHAN-3	0.10	0.01	0.16	0.005	0.025	0.025	0.092	0.03	0.025	0.025	0.020	0.020	0.040	0.096
Riet-2	<0,01	<0,03	0.75	<0,01	<0,01	<0,01	<0,01	0.02	<0,05	<0,01	<0,09	<0,02	0.02	0.03
Sdrif-15	<0,01	<0,03	0.24	<0,01	<0,01	<0,01	<0,01	<0,01	<0,05	<0,01	<0,09	<0,02	0.01	0.01
Ter-1	<0,01	<0,03	0.39	<0,01	<0,01	<0,01	<0,01	0.30	<0,05	<0,01	<0,09	<0,02	0.03	0.35
Ter-3	<0,01	<0,03	0.22	<0,01	<0,01	<0,01	<0,01	<0,01	<0,05	<0,01	<0,09	0.02	<0,01	0.01
WILDG-1	0.10	0.01	0.35	0.005	0.025	0.025	0.027	0.03	0.035	0.025	0.020	0.020	0.025	0.073
M-16	0.436	0.002	0.065	0.000	0.001	0.001	0.006	0.069	0.004	0.024	0.005	0.006	0.006	1.090
Stand No 210	0.013	0.001	0.073	0.000	0.000	0.000	0.001	0.018	0.000	0.003	0.000	0.005	0.000	0.102
Stand No E104	0.009	0.002	0.062	0.000	0.000	0.000	0.003	0.133	0.000	0.003	0.000	0.003	0.000	0.465

The data indicates slightly elevated boron and manganese with the higher molybdenum and lead due to the restriction of analysis.

Figure 56 shows TDS distribution with contours on a geology background. The map shows a relationship between the host strata and salt content with elevated TDS found in middle Karoo strata and low TDS in Soutpansberg rocks.

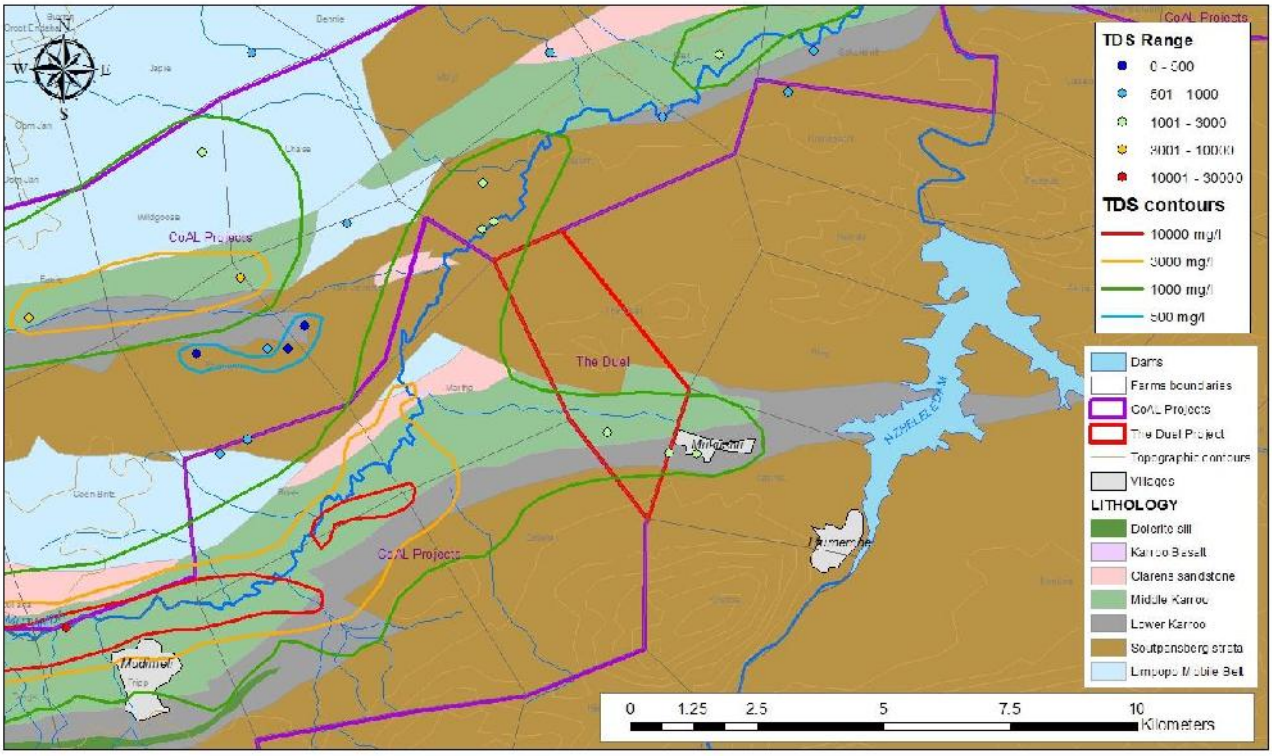


Figure 56: TDS contour map

2.8.4 GROUNDWATER CONCEPTUAL MODEL

Aquifers in the study area consist mainly of confined secondary aquifers in consolidated rocks.

Secondary Aquifers consist of crystaline basement rocks of the LMB and stratified Soutpansberg and Karoo sediments and lavas and is the only aquifer type for most of the study area. In the unfractured state these rocks are impermeable and of low groundwater potential. Groundwater is associated with faults, shear zones and dykes.

- LMB: The weathered zone of the LMB is generally poorly developed and not more than 20 m deep. Most drill targets encounter early strikes between 20 and 30 m. Although the potential to intersect water diminishes with depth the heterogeneous nature of the LMB does produce water in fractures at deeper levels in some boreholes.
- The Soutpansberg Group: forms the hills and mountains to the north and south of the coal beds as a consequence of the weather resistant quartzitesof the Soutpansberg Group. These hills and mountains form a zone of higher recharge which feed into aquifer systems below.
- Karoo strata: Groundwater capacity within the sedimentary layers can be enhanced along brittle horizons such as sand stone or coal layers brecciated byfault/shear displacement. Dolerite sills and dykes are also zones of enhanced groundwater occurrence.

2.8.5 GROUNDWATER AVAILABILITY

Groundwater availability is a function of recharge, storage and current use.

2.8.5.1 Groundwater Recharge

Recharge is the replenishment of water to the groundwater system. It can occur by rainfall, rivers or artificially by pumping back into the aquifer.

The Groundwater Resources Assessment Study of the Department of Water Affairs (GRA II) calculated the recharge at 12.36 mm/unit area for sub-catchment A80F.

Recharge to the Mining Right Application Area (1 000ha) is estimated at 131 325 m^3/annum.

2.8.5.2 Groundwater Storage

Storage is the volume of water that can be held by an aquifer and is usually expressed as a product of the storage coefficient (fraction of pore space) of the host rock and the volume of host rock (aquifer thickness x the area).

Secondary aquifers: Two basic types of aquifer storage are assumed to exist in secondary aquifers, namely the 'Weathered Zone' (WZ) and the 'Fractured Zone' (FZ). According to GRA II, the storage coefficients for the two storage zones within the study area are estimated as follows:

- Weathered Zone: 0.0075 with an average thickness of 13.5 m.
- Fractured Zone: 0.00027 with an average thickness of 120 m.

The groundwater held in storage is estimated at 1 356 000 m^3 for the MRA area.

2.8.5.3 Groundwater Use

For purposes of the scoping report, groundwater use for the properties within a two-farm margin around the MRA area is considered. These include the following: Telema, Gray, Nairobi, Kranspoort, Riet, Stayt, Nakab, Chase, Wildgoose, Phantom, van Deventer, Martha, Lukin, Salaita and Kondoa. Groundwater use is mainly for farmsteads, hunting and game lodges, game and stock watering. The closest irrigation occurs on the farms Skuitdrift and Mount Stuart, but these are outside the area of consideration and obtain water from the Nzhelele irrigation scheme. Boreholes are used as backup in drought when the surface water is not available.

The estimated existing groundwater abstraction for the above listed farms mainly from the secondary hard rock aquifers is summarised in Table 61. Approximately 57 ML/annum is abstracted from groundwater currently from the area making up the two-farm buffer zone around the MRA area.

Table 61: Estimated Groundwater use

Quaternary	Owner/Business	Farms	Estimated Groundwater Use					Comments
			House hold and Lodges (m3/day)	Game and stock watering (m3/day)	Cleared Land (Ha)	Irrigated Land (Ha)	Total Estimated groundwater use ML /annum	
A80F	CoAL	Lukin						
		Salaita	9				3	
	Joshua nDambe	The Duel (Remaining Portion)		20			7	Cattle watering
		Nairobi	0	0				
	Tony Zambakides	Wildgoose 577 MS	3	3	-	-	2	Water use for domestic and game
		Phantom 640 MS						
	Born Free Investments	Chase 576 MS	3	3	-	-	2	Water use for lodge, domestic and game
		Van Deventer 641 MS						
	Clint Howes	Stayt 183 MT	1	2	-	-	1	Water use for lodge, domestic and game
		Nakab 184 MT						
	Maswiri Boerdery	Riet 182 MT	3	3	-	-	2	Water use for lodge, domestic and game. Irrigation from Nzhelele scheme 830
		Kranspoort	0	0	-	-		
A80C	Mukushu	Telema 190 MT	63				23	Village water supply and private boreholes
	Phumembe		44				16	
		TOTAL	117 m3/day				57	

2.9 AIR QUALITY

2.9.1 AMBIENT AIR QUALITY

Based on satellite imagery the following surrounding sources of air pollution have been identified in the area:

- Domestic fuel burning
- Unpaved roads
- Agricultural
- Mining activities

A qualitative discussion of each identified source is provided in the subsection below. The aim of this section is to highlight the potential contribution of surrounding sources to the overall ambient air quality within the area.

2.9.1.1 Domestic fuel burning

It is anticipated that low income households and communities within the area are likely to combust domestic fuels for space heating and/or cooking purposes. Typical domestic fuels used are wood, paraffin and coal as the economic benefits are advantageous, however the environmental and health effects can be detrimental. Emissions released from biomass and coal combustion emit a large number of pollutants and known health hazards including criteria pollutants such as Particulate matter (PM), Carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2) as well as formaldehyde, Polycyclic organic matter and carcinogenic compounds such as benzo (a) pyrene.

The combustion of coal in particular results in an incomplete process that releases CO, methane (CH_4) and NO_2. The implications for indoor pollution as a result is a growing concern and has been indicated in varying

degrees of evidence as a causal agent of acute respiratory infections, chronic pulmonary diseases and lung cancer in developing countries (Barnes et al, 2009).

2.9.1.2 Unpaved roads

When vehicles travel on unpaved roads, the force of the wheels on the road surface causes the pulverisation of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to stronger air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Emissions are also dependant on certain source parameters such as the condition of the road and the associated vehicle traffic. Dust emissions from unpaved roads have been found to vary directly with the fraction of silt in the road surface material. Other variables are important in addition to the silt content of the road surface material. For example, at industrial sites, where haul trucks and other heavy equipment are common, emissions are highly correlated with vehicle weight.

Exhaust tailpipe emission from vehicles is a significant source of particulate emissions and can be grouped into primary and secondary pollutants. Primary pollutants which are CO_2, CO, hydrocarbons, SO_2, NOX, particulates and lead are those emitted directly into the atmosphere and secondary pollutants which are nitrogen dioxide, ozone which is a photochemical oxidant, hydrocarbons, sulphuric acid, sulphates, nitric acid and nitrate aerosols are those formed in the atmosphere as a result of chemical reactions. Toxic hydrocarbons include acetylaldehyde, benzene and formaldehyde, carbon particles, sulphates, aldehydes, alkanes, and alkenes.

2.9.1.3 Agricultural

Agricultural activity can be considered a significant contributor to particulate emissions, although tilling, harvesting and other activities associated with field preparation are seasonally based. The main focus internationally with respect to emissions generated due to agricultural activity is related to animal husbandry, with special reference to malodours generated as a result of the feeding and cleaning of animals. The types of livestock assessed included pigs, sheep, chicken, goats and cattle, with game farming being the largest commercial enterprise. Odorous pollutants associated with animal husbandry are ammonia and hydrogen sulphide

The activity associated with farming particularly irrigation farming includes the application of pesticides, herbicides, weed control, fertilizers, harvesting activities, phosphate and nitrogen addition. Little information is available with respect to the emissions generated due to the growing of crops. The activities responsible for the release of particulates and gases to atmosphere would however include:

- Particulate emissions generated due to wind erosion from exposed areas;
- Particulate emissions generated due to the mechanical action of equipment used for tilling and harvesting operations;
- Vehicle entrained dust on paved and unpaved road surfaces;
- Gaseous and particulate emissions due to fertilizer treatment and Gaseous emissions due to the application of herbicides and pesticides

2.9.1.4 Mining Activities

There is numerous planned coal mines located within the vicinity of the proposed Duel project. There exists a potential that air quality impacts from other mines could influence the cumulative air quality impacts at and near the site.

The main emission to air from mining operations consists of wind-borne dust, and the products of combustion from blasting, vehicle usage, materials handling and mine power generation (if any). Mining operation involves the mobilization of large amounts of material and waste piles containing small size particles that are easily dispersed into the atmosphere. The largest sources of air pollution in mining operations are:

- Particulate matter transported by Aeolian action as a result of excavation, blasting, transportation of materials, wind erosion of exposed surfaces, fugitive dust from tailings dumps and haul roads and exhaust emissions from mobile sources also raises these levels;
- Gaseous emission from combustion of fuels in stationary and mobile sources, explosions, and mineral processing.

Once a pollutant enters the atmosphere, they undergo physical and chemical changes before reaching a receptor. These pollutants can cause serious effects to human health and to the environment. Large scale mining has the potential to contribute significantly to air pollution, especially during the operation phase. All activities during ore extraction, processing, handling and transportation depend upon the equipment, generators, processors and materials that generate hazardous air pollutants such as particulate matter, heavy metals, carbon monoxide, sulphur dioxide and nitrogen oxides.

2.9.2 NATIONAL AMBIENT AIR QUALITY STANDARDS

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 guideline values 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 Department of Environmental Affairs and Tourism (DEAT) have issued ambient air quality guidelines to support receiving environment management practices. Ambient air quality guidelines are only available for such criteria pollutants which are commonly emitted, such as Particulates, SO_2, Pb, NOx, benzene and CO. The guidelines specific to the relevant pollutants during this assessment are detailed in the sections below.

2.9.2.1 Particulate matter

Particulate matter is the collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. Particulate matter includes dust, smoke, soot, pollen and soil particles (Kemp, 1998). Particulate matter has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute

respiratory symptoms, chronic bronchitis, decreased lung function, and an increased risk of myocardial infarction (USEPA, 1996).

Particulate matter represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behaviour and method of measurement. The concentration of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere (USEPA, 1996).

Particulate Matter can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions (USEPA, 1996):

- PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung);
- PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less)
- PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and
- Ultra fine particles generally defined as those less than 0.1 microns.

Fine and coarse particles are distinct in terms of the emission sources, formation processes, chemical composition, atmospheric residence times, transport distances and other parameters. Fine particles are directly emitted from combustion sources and are also formed secondarily from gaseous precursors such as sulphur dioxide, nitrogen oxides, or organic compounds. Fine particles are generally composed of sulphate, nitrate, chloride and ammonium compounds, organic and elemental carbon, and metals.

Table 62: Ambient air quality standards and guidelines for particulate matter

Pollutant	Averaging period (µg/m^3)	Guideline (µg/m^3)	Number of Exceedance Allowed Per Year
PM10	Daily average	75	4 4
	Annual average	40	0 0
PM2.5	Daily average	65 (3) 40 (4) 25 (5)	4 4 4
	Annual average	25 (3) 20 (4) 15 (5)	0 0 0

2.9.2.2 Nuisance Dust

On the 7th of December 2012 the Minister of Water and Environmental Affairs published the new National Dust Control Regulations. This document now enforces the monitoring of dust fallout from activities that is suspected of contributing significantly to dust fallout in its region. The regulation provides a set standard for dust fallout to comply to, enforces that a baseline should be established to projects that would give rise to increased dust fallout, specifications for dust fallout monitoring and the format of reports if the activity should exceed the thresholds.

If an activity exceeds the standard the entity must submit a dust monitoring report to the air quality officer (local authority), before December 2013 (Section 4, GN1007 of 2012). The entity must develop a dust management plan, within three months after the submission of a dust monitoring report (Section 5, GN1007 of 2012). If the dust fallout is continued to be exceeded, the authority may request that continuous PM10 monitoring be conducted at the site.

Table 63: Acceptable Dust fallout rates as measured (using ASTM d1739:1970 or equivalent) at and beyond the boundary of the premises where dust originates

Restriction area	Dustfall rate, D (mg/m²/day, 30-day average)	Comment
Residential	D < 600	Two within a year, not sequential months.
Non-residential	600 < D < 1200	Two within a year, not sequential months.

2.10 AMBIENT NOISE

2.10.1 AMBIENT NOISE CONDITIONS

2.10.1.1 Existing Noise Climate

The existing noise climate of the study area was determined by means of a field inspection, survey measurements and a continuous 24-hour measurement. During the measurements at each point, the noise character of the noise climate was described. This is an objective view from the listener regarding only noiseperceived. The existing noise climate along the main road were measured and calculated according to the SANS 1210 guidelines. The traffic volumes and patterns were established during the time of measurement. These noise levels were checked with the noise levels generated with the modelling software, CadnaA that will be used in modelling the impacts in the full impact assessment.

Ambient sound level measurements were undertaken at the proposed The Duel Project site. The field survey measurements were taken on 15 September 2014, with a 24hour measurement taken from 12:30 on 15 September till the following day. An additional long-term monitoring point was added on 16 September 2014. The baseline measurements were done under normal circumstances as the area was not exposed to other external and/or unusual noises. It should be noted, that the geological coring survey was under way during the time of the noise measurements. The noise received from the geologists coring was minimal and did not influence the noise level. The measurements recorded can be classified as the typical noise level at each of the points.

All sound level measurement procedures were undertaken according to the relevant South African Code of Practice (SANS 10103, SANS 10328, SANS 10210, SANS 10205, etc.). This included the selection of monitoring locations, microphone positioning and equipment specifications among others. The day- and night-time measurements were taken during the prescribed timeframes as in SANS 10103:2008, with daytime ranging from 06:00 to 22:00 and night-time ranging from 22:00 to 06:00, with the measurement interval of not less than 15 minutes.

The noise parameters recorded were in Z-, A- and C-weighted bands:

- L_{eq} The equivalent continuous sound level;
- L_{max} The maximum sound pressure level of a noise event;
- L_{min} The minimum sound pressure level of a noise event;
- L_{10} The noise level which is exceeded for 10% of the time;
- L_{90} The noise level which is exceeded for 90% of the time (typically referred to the background noise level);
- L_{peak} The peak noise level experienced during the measurement; and
- Octave Bands The noise level experienced is measured in different set frequency ranges ranging from the 32Hz band to 8 kHz band.

All monitoring equipment is classified as Class1/Type1 instruments according to the applicable SANS standards.

Figure 57 indicates the different monitoring locations assessed during the baseline noise measurements, including the two long-term monitoring locations.

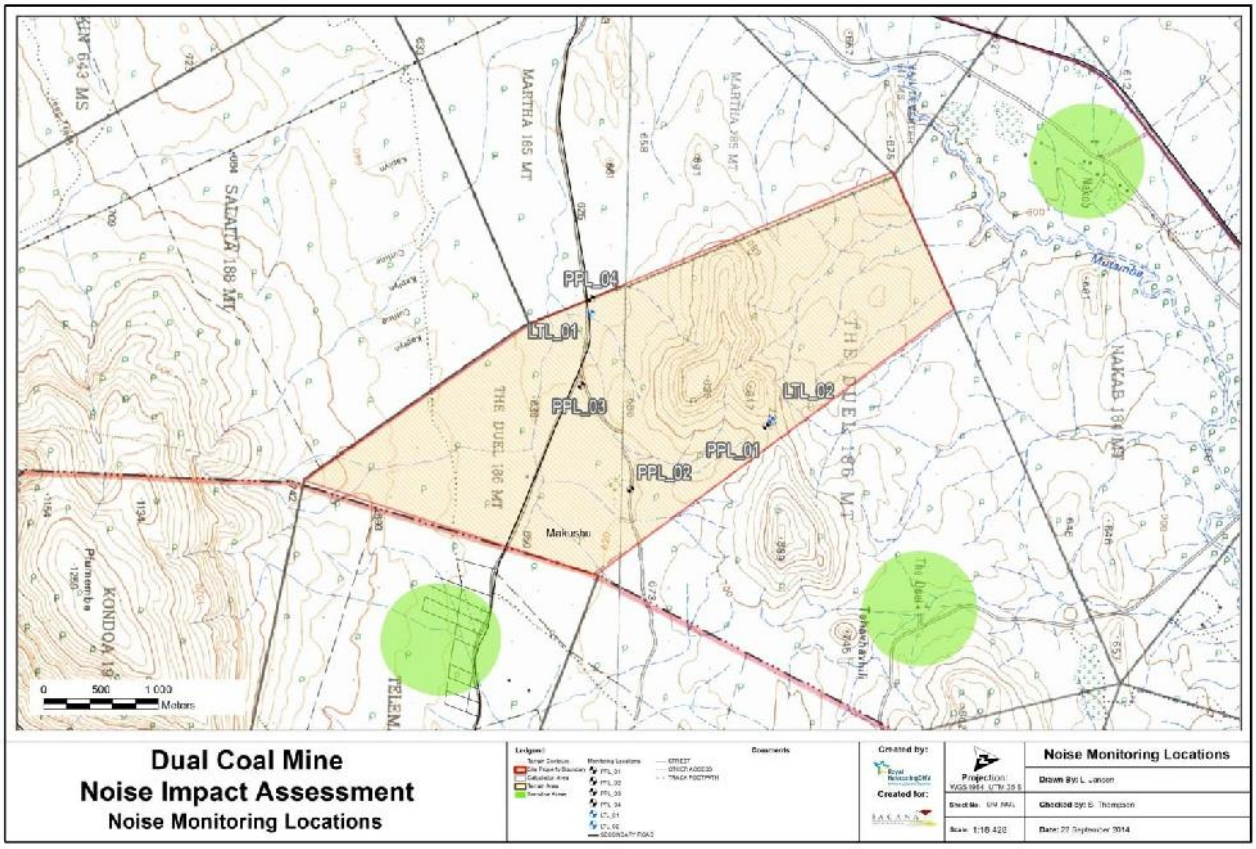


Figure 57: Baseline noise monitoring points

Table 64 and Table 65 present the summarised results from the field measurements.

Table 64: Baseline noise measurement results

ID	Latitude	Longitude	L_{Aeq} (dBA)	L_{Amin} (dBA)	L_{Amax} (dBA)	Target Guideline Value (dBA)
PPL_01	-22.73957	30.03759	38.2	21.6	66.6	45
PPL_02	-22.75011	30.04318	35.4	20.6	54.0	45
PPL_03	-22.75419	30.03443	36.0	21.1	68.1	45
PPL_04	-22.75352	30.02707	40.7	22.3	65.0	45

Table 65: Long term continuous measurement results

ID	Latitude	Longitude	$L_{Req,dn}$ (dBA)	$L_{Req,day}$ (dBA)	$L_{Req,night}$ (dBA)	Equivalent continuous rating level (dBA)		
						Day/Night	Day	Night
LTL_01	-22.75352	30.02831	50.5	49.7	42.7	45	45	35
LTL_02	-22.73917	30.03705	42.1	41.2	34.5	45	45	35

The results of the long-term noise monitoring locations indicate that the area close to the gravel road is more in line with a land use classification of Suburban districts with little road traffic, than the general Rural classification. The reason being that the noise source of the area affected the location is at a relative short distance from the source (gravel road). The monitoring location away from the gravel road indicated that it fits within the ranges of the rural classification (SANS 10103).

2.10.1.2 Existing Noise Sources

Attention was raised to identify noise sources in the region, however the area was very quiet and the only identifiable noise source was the gravel access roads. The first long-term noise monitoring location (during the daytime), next to the road, was impacted by the traffic passing along the gravel road. During the night, the noise level was very low and only bird calls were significant events. The majority of the high noise readings at the second monitoring location (LTL_02) were from bird calls before sunset. During the night there were little to no noise.

2.10.1.3 Roads

Some of the roads in the region are:

- National Route 1 (N1) – The road travels from Makhado to Musina at the Zimbabwe border, the traffic consists out of a large number of trucks using the road and small vehicles;
- Unnamed Road 01 (N1 to Mudimeli Village) – gravel road linking the town of Mudimeli with the National road N1 towards the west. The road continuous north to connect with the R525; and
- Unnamed Road 02 (Mudimeli to Nzhelele Dam) – gravel road linking the town of Mudimeli to the Nzhelele Dam, the road also connects to the DS 3671 tarred road, travelling south towards Makhado.

Table 66: Existing noise sources (roads) in the region

Road	Sound Power Level (dBA)	Number of Vehicles per hour	% heavy vehicles	Sound Power Level (dBA)	Number of Vehicles per hour	% heavy vehicles
	Daytime (06:00 – 22:00)			Night-time (22:00 – 06:00)		
Unnamed Road 01	56.3	22.8	10	50.7	8	4
Unnamed Road 02	49.5	26.0	10	42.4	8	2

* Width of road is 15m; light vehicle speed is 60km/hr& heavy vehicle speed is 50 km/hr; gravel local road.

2.10.2 NATIONAL NOISE STANDARDS

SANS 10103 should also be adhered to for the measurements of noise levels at specific locations. This document prescribes the methodology of how a noise investigation should be conducted and prescribes the selection of monitoring locations, placement of the microphone and specific equipment and calibration of the equipment.

The "Typical rating levels for noise in districts" is provided Table 67. These in/out-door noise level standards are not a standard as such but are guidelines of typical noise values that can be experienced in the different regions of South Africa.

Table 67: Typical rating levels for noise in districts (adapted from SANS 10103:2008)

Type of District	Equivalent Continuous Rating level for Noise ($L_{Req,T}$) (dBA)					
	Outdoors			Indoors (with windows open)		
	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)
a) Rural	45	45	35	35	35	25
b) Suburban (with little road traffic)	50	50	40	40	40	30
c) Urban	55	55	45	45	45	35
d) Urban (with one or more of the following: workshops, business premises and main roads)	60	60	50	50	50	40
e) Central Business Districts	65	65	55	55	55	45
f) Industrial District	70	70	60	60	60	50

Table 68: Categories of community/group response (adapted from SANS 10103:2008)

Excess ($\Delta L_{Req,T}$)[a] dBA	Estimated Community/Group response	
	Category	Description
0 – 10	Little	Sporadic Complaints
5 – 15	Medium	Widespread Complaints
10 – 20	Strong	Threats of community/group action
>15	Very Strong	Vigorous community/group action

NOTE: Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.

a. $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:

1) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation);

2) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level of the ambient noise given in Table 1 of the code;

3) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from Table 2 of the code; or

4) $L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in the area because of the proposed development under investigation.

2.10.3 TARGET NOISE LEVELS

It should be noted, that in the different guidelines and standards, listed above, the impact from noise could be calculated on different "type" of equations and formulas. In SANS 10328 the impact is derived from the change of the future noise levels and the typical rating noise level for the receptor (maximum permissible noise level as identified in Table 67). This type of impact can be described as the noise impact; however this excludes the baseline of the region that would impact on the cumulative noise levels.

The other "type" of calculation is based on the change in noise level estimated at the receptor (Table 68). This calculates the change in noise level experienced by the receiver at a location. It binds with the theory of noise which states that any +3dBA change in noise level is a doubling of the noise sources. Thus should be noted, that there are different categories from different institutions regarding this aspect of environmental noise. A summary is presented in the table below (Table 69), which also will summaries the environmental impact rating (regarding severity), as measured at the closest applicable receptor point.

The outdoor (environmental) noise level is the basis for calculation perceived at the receptors. It is noted that the majority of complaints arise from residents during the night, these types of complaints are more characteristic to indoor noise levels. If any of the receptors' night-time noise levels are exceeded, a calculation of the perceived noise will be done.

Table 69: Environmental Impact Rating from the change in noise level

Change in Noise level	SANS 10103	WHO (IFC EHS Section 1.7)	***Disturbing noise (Noise Regulations)	**Environmental Impact Rating (Severity)**
Δ +15 dBA	Strong Response "Threats of Community Action"	Significant	Disturbing noise	Very High
Δ +14 dBA				
Δ +13 dBA				
Δ +12 dBA				
Δ +11 dBA				
Δ +10 dBA	Medium Response "Widespread Complaints"			High
Δ +9 dBA				
Δ +8 dBA				
Δ +7 dBA				Medium
Δ +6 dBA				
Δ +5 dBA	Little Response "Sporadic complaints"		Not Disturbing	Low
Δ +4 dBA				
Δ +3 dBA		Insignificant		Very Low
Δ +2 dBA				
Δ +1 dBA				

** It should be noted that the WHO is only applicable to the closest receptor to the source, located offsite from the source.*
*** The environmental impact rating level will be used to determine the severity of the impact.*
**** it should be noted that this form of describing a noise as disturbing was removed from the majority of provincial noise regulation by-laws.*

Based on the MRA locality the typical noise level rating (also referred to as the maximum allowable noise level) for the area is classified Rural, unless specified other wise at receiver. It should be noted once the

mine is in operation the land use zoning of the farm will be reclassified to Industrial within the boundaries of the mine area.

Table 70: Typical Rating Noise Level for The Duel Project

Equivalent continuous rating noise level (L_{Req})	Outdoor			Indoor		
	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)	Day/Night ($L_{Req,dn}$)	Day ($L_{Req,d}$)	Night ($L_{Req,n}$)
Rural	45	45	35	35	35	25

2.11 VISUAL AND AESTHETIC CHARACTER

2.11.1 VISUAL AND LANDSCAPE CHARACTER

Vegetation, geology and topography, as well as cultural factors including land use, settlement patterns and the manner in which humans have transformed their natural surroundings. According to Swanwick (2002), landscape character may be defined as a distinct, recognisable and consistent pattern of elements in the landscape that makes it unique and provides it with a particular sense of place. Individual "landscape elements" that contribute to landscape character include hills, rolling plains, valleys, woods, trees, water bodies, as well as buildings and roads. "Landscape features" are those elements that are prominent or eye-catching.

Figure 58: Landscape character of the study area, indicating the steep hills, which is the most prominent landscape feature within the study area

Landscapes may be divided into landscape character types, which are defined as distinct types of landscape that are relatively homogeneous in character. Such landscape character types are generic in nature and may occur in different areas in different parts of the country, but wherever they occur, they share broadly similar combinations of geology, topography, drainage patterns, vegetation, land use and settlement patterns (Swanwick, 2002).

The landscape associated with the study area and its immediate surroundings exhibit a common, discernible pattern, is considered to have broadly similar landforms, vegetation and settlement configurations, and thus comprise a single landscape character type. This landscape character type can be described as rural, mountainous, closed bushveld (Figure 58), with a number of prominent and eye-catching features present in the form of steep hills and outcrops. Although the landscape character within the larger region is relatively homogeneous, the landscape at a finer scale, associated with the study area itself is considered to be diverse as a result of the variety of topographical features. Other prominent landscape features in the region include Mutamba River immediately to the northwest of the study area and the Nzehelele River and Nzehelele Dam towards the east.

General views of the landscape associated with the study area and surrounds are indicated in Figure 59.

Figure 59: General views of the study area and the surrounding region

Key aesthetic aspects of the landscape are described in Table 71, according to the method prescribed by Swanwick (2002).

Table 71: Aesthetic aspects of landscape character

Aspect	Characteristics				Motivation
Scale	Intimate	Small	Large	Vast	The scale of the landscape is considered to be **large** due to significant vistas visible as one approaches the study area from the southwest and northeast, particularly when viewed from higher-lying areas.
Enclosure	Tight	Enclosed	Open	Exposed	The study area is **enclosed**, with steep hills present within the centre and to the south of the study area
Diversity	Uniform	Simple	Diverse	Complex	The landscape is considered to be **diverse**, with variations in vegetation pattern, structures and type, as well as varying topography being present.
Texture	Smooth	Textured	Rough	Very rough	The texture associated with the landscape is **rough**, textured and coarse, which can mainly be attributed to the bushveld vegetation dominating the region.
Form	Vertical	Sloping	Rolling	Horizontal	The dominant form of the landscape is **sloping**, due to the relatively steeply undulating topography with steep slopes present.
Line	Straight	Angular	Curved	Sinuous	When considering the larger area, the line landscape element is mostly **curved** with limited linear man-made elements present and due to the steeply undulating and mountainous nature of the general region.
Colour	Monochrome	Muted	Colourful	Garish	The colours associated with the landscape are **muted**, with vegetation forming the dominant colour palette of shades of green. Limited seasonal effects due to formal farming activities are evident, however seasonal colour displays from vegetation, during spring and autumn are expected.
Balance	Harmonious	Balanced	Discordant	Chaotic	The landscape is considered to be **balanced** in terms of the relationship between the vertical and horizontal landscape elements.
Pattern	Random	Organised	Regular	Formal	The landscape pattern is **regular**, with elements being evenly spaced and well-balanced.

Aspect	Characteristics				Motivation
Movement	Dead	Still	Calm	Busy	The level of movement within the majority of the study area is very low and **still**, with low levels of pedestrian and vehicular movement limited to the southern portion of the study area.

In addition to the above, other aspects of landscape perception, such as perception of beauty and scenic attractiveness also play a role in defining landscape character. These aspects are more subjective and responses thereto are personal and based on the experience and preference of the observer. Factors simultaneously perceived by senses other than sight, such as noisiness, tranquillity, exposure to the elements and sense of safety, further influence landscape character. Although these aspects are hard to quantify, it can be said that the landscape in its current state provides a positive and highly scenic viewing experience and mining within the study area will result in partial loss of this landscape character type within the region.

2.11.2 VISUAL ABSORPTION CAPACITY (VAC)

Visual Absorption Capacity (VAC) refers to the inherent ability of a landscape to accommodate change without degeneration of the visual quality and without resulting in an overall change of the identified landscape character type. A high VAC rating implies a high ability to absorb visual impacts and manmade structures and the ability of natural features such as trees or higher-lying areas to screen or hide an object where it would have visible otherwise (Oberholzer, 2005), while a low VAC rating implies a low ability to absorb or conceal visual impacts.

The factors that have been considered during the VAC analysis are listed and explained in the table below, according to the methodology prescribed by the United States Bureau of Land Management (BLM, 2004) and as adapted to the South African context (Table 73). Five factors have been considered, namely vegetation, soil contrast, visual variety, topographical diversity and recovery time.

Through applying the scoring categories as outlined above, the following scores have been calculated for the study area:

Table 72: VAC Scores achieved

Factor	Score obtained	Motivation
Vegetation	**3**	Vegetation within the majority of the study area comprises closed bushveld with a high cover and a large proportion of tall trees. Bare soils are mostly limited to the low-lying southern portion of the study area.
Soil contrast	**2**	Further surface disturbance within areas where soils are already exposed would further contribute to the degree of contrast with surrounding vegetation, while soil exposure within areas where soils have not yet been exposed would lead to significant contrast.
Visual variety	**2**	The vegetation within study area is largely homogeneous when viewed from a distance, but visual variety is present due to local landforms and steep slopes.
Topographical diversity	**3**	Plains as well as steep slopes are present within the study area, with an overall high level of topographic variety.
Recovery time	**1**	The recovery time of the environment is considered to the greater than 5 years after closure due to a high degree of natural vegetation loss expected.
Total	**11**	**Medium**

Scores, when added, amounting to between 5 and 7 are categorised as Low, scores between 8 and 11 as Medium and between 12 and 15 as High. The total score for the study area added to 11, which defines the VAC of the study area as being medium.

Table 73: VAC Factors and Rating Table

Factors	Rating Criteria and Score		
Vegetation	Low, uniform vegetation or sparse vegetative cover, typically less than 1m in height, lacking in variety, uniform colour, minimal screening capability, typically low scrub or grass type vegetation. **Score: 1**	Vegetation of moderate height (1 – 2m), some species variety (2 to 3 types), some variation in colour, mostly continuous vegetative cover, effectively screens low-profile projects such as low-profile surface disturbance, scrub/grass, and intermingled shrubs. **Score: 2**	Higher vegetation (>2m height), lush, continuous vegetative cover; some variety of vegetative types is typical but not mandatory, provides significant screening capability of projects up to 4 – 6m in height, woodlands. **Score: 3**
Soil contrast	Surface disturbance would expose a high degree of contrast in colour with surrounding soil, rock and vegetation. **Score: 1**	Surface disturbance would expose a medium degree of contrast in colour with surrounding soil, rock and vegetation. **Score: 2**	Surface disturbance would expose only a low degree of contrast in colour with surrounding soil, rock and vegetation. **Score: 3**
Visual variety	Rating unit exhibits a low degree of visual variety in terms of the landscape character elements of form, line and texture and may also exhibit minimal variety in landforms, vegetation, or colour. **Score: 1**	Rating unit exhibits a medium degree of visual variety in terms of the landscape character elements of form, line, and texture and may also exhibit medium variety in landforms, vegetation, or colour. **Score: 2**	Rating unit exhibits a high degree of visual variety in terms of the landscape character elements of form, line, and texture and may also exhibit high degree of variety in landforms, vegetation, or colour. **Score: 3**
Topographical diversity	Landform has low amount of topographic diversity and variety. **Score: 1**	Landform has moderate amount of topographic diversity and variety. **Score: 2**	Landform has high amount of topographic diversity and variety. **Score: 3**
Recovery time	Long-term recovery time (greater than 5 years) **Score: 1**	Medium recovery time (3 to 5 years) **Score: 2**	High (rapid) recovery time (1 to 2 years) **Score: 3**

VAC is further closely related to visual intrusion, which refers to the physical characteristics and nature of the contrast created by a project on the visual aspects of the receiving environment. It is also, as with VAC, a measure of the compatibility or conflict of a project with the existing landscape and surrounding land use. The visual intrusion ratings are listed in Table 74.

Table 74: Visual intrusion rating

Rating	Explanation
High visual intrusion	Results in a noticeable change or is discordant with the surroundings.
Moderate visual intrusion	Partially fits into the surroundings, but clearly noticeable.
Low visual intrusion	Minimal change or blends in well with the surroundings.

Due to the nature of the project and its location within a region currently unaffected by mining activity, the proposed project will lead to a high level of visual intrusion on the landscape and is expected to be clearly noticeable in relation to its surroundings. The medium VAC of the study area, with particular reference to topographical diversity, will however serve to somewhat limit such intrusion from certain receptor sites.

2.11.3 LANDSCAPE QUALITY

Landscape visual quality, integrity or 'scenery beauty' relates primarily to human impact on a landscape and the physical state of the landscape in terms of intactness from visual, functional and ecological perspectives (Swanwick, 2002). It also serves as an indication of the condition of landscape elements and features, which in turn depends largely on an observer's visual perception through either increasing or reducing the visual quality of a landscape. Visual quality is thus a factor of an observer's emotional response to physical landscape characteristics and therefore assigning values to visual resources is a subjective process.

According to the BLM Visual Resource Management (VRM) system (1984), a system specifically developed for minimising the visual impacts of surface-disturbing activities and maintaining scenic values for the future, landscape, visual and scenic quality evaluation may be determined based on seven key factors, as outlined in the tables below and adapted to the South African environment. It is important to note that there may be cases where a separate evaluation of each of the key factors does not give a true picture of the overall scenic quality of an area, however within the context of the proposed project, this method of assessment is deemed suitable as an indication of landscape quality.

Table 75: Landscape Quality - Explanation of Rating Criteria

Factor	Definition
Landform	Topography becomes more interesting as it gets steeper or more massive, or more severely or universally sculptured. Outstanding landforms may be monumental or they may be exceedingly artistic and subtle.
Vegetation	Give primary consideration to the variety of patterns, forms, and textures created by plant life. Consider short-lived displays when they are known to be recurring or spectacular. Consider also smaller scale vegetation features, which add striking and intriguing detail elements to the landscape.
Water	That ingredient which adds movement or serenity to a scene. The degree to which water dominates the scene is the primary consideration in selecting the rating score.
Colour	Consider the overall colour(s) of the basic components of the landscape (e.g., soil, rock, vegetation, etc.) as they appear during seasons or periods of high use. Key factors to use when rating "colour" are variety, contrast, and harmony.
Adjacent Scenery	Degree to which scenery outside the scenery unit being rated enhances the overall impression of the scenery within the rating unit. The distance which adjacent scenery will influence scenery within the rating unit will normally range from 0-8 kilometres, depending upon the characteristics of the topography, the vegetative cover, and other such factors. This factor is generally applied to units that would normally rate very low in score, but the influence of the adjacent unit would enhance the visual quality and raise the score.
Scarcity	This factor provides an opportunity to give added importance to one or all of the scenic features that appear to be relatively unique or rare within one physiographic region. There may also be cases where a separate evaluation of each of the key factors does not give a true picture of the overall scenic quality of an area. Often it is a number of not so spectacular elements in the proper combination that produces the most pleasing and memorable scenery - the scarcity factor can be used to recognize this type of area and give it the added emphasis it needs.

Cultural Modifications	Cultural modifications in the landform/water, vegetation, and addition of structures should be considered and may detract from the scenery in the form of a negative intrusion or complement or improve the scenic quality of a unit. Rate accordingly.

Table 76: Scenic Quality - Rating Criteria and Scoring system

Factor	Rating Criteria and Score		
Landform	High vertical relief as expressed in prominent cliffs, spires, massive rock outcrops, areas of severe surface variation, highly eroded formations, dune systems or detail features that are dominant and exceptionally striking and intriguing. **Score: 5**	Steep canyons, mesas, buttes, interesting erosional patterns, landforms of variety in size and shape or detail features, which are interesting though not dominant or exceptional. **Score 3**	Low rolling hills, foothills, or flat valley bottoms or few or no interesting landscape features. **Score: 1**
Vegetation	A variety of vegetative types as expressed in interesting forms, textures, and patterns. **Score: 5**	Some variety of vegetation, but only one or two major types. **Score: 3**	Little or no variety or contrast in vegetation. **Score: 1**
Water	Clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. **Score: 5**	Flowing, or still, but not dominant in the landscape. **Score: 3**	Absent, or present, but not noticeable. **Score: 0**
Colour	Rich colour combinations, variety or vivid colour; or pleasing contrasts in the soil, rock, vegetation, water or snow fields. **Score: 5**	Some intensity or variety in colours and contrast of the soil, rock and vegetation, but not a dominant scenic element. **Score: 3**	Subtle colour variations, contrast, or interest; generally mute tones. **Score: 1**
Adjacent Scenery	Adjacent scenery greatly enhances visual quality **Score: 5**	Adjacent scenery moderately enhances overall visual quality. **Score: 3**	Adjacent scenery has little or no influence on overall visual quality. **Score: 0**
Scarcity	One of a kind, unusually memorable or very rare within region. Consistent chance for exceptional wildlife or wildflower viewing, etc. **Score: 5**	Distinctive, though somewhat similar to others within the region. **Score: 3**	Interesting within its setting, but fairly common within the region. **Score; 1**
Cultural Modifications	Modifications add favourably to visual variety while promoting visual harmony. **Score: 2**	Modifications add little or no visual variety to the area, and introduce no discordant elements **Score: 0**	Modifications add variety but are very discordant and promote strong disharmony. **Score: -4**

Table 77: Scenic Quality – Results and motivation

Factor	Score obtained	Motivation
Landform	**5**	The study area contains prominent hills, slopes and vertical areas, leading to high visual interest.
Vegetation	**3**	The majority of vegetation within the study area is intact, with good levels of diversity present.
Water	**1**	Very limited surface water is present within the study area and although the Mutamba River is present immediately to the north and northwest, these features do not visually dominate the study area.
Colour	**3**	The colours associated with the landscape are, although somewhat muted, considered to be vibrant with seasonal colour present.
Adjacent Scenery	**3**	Adjacent scenery, with the same landscape character results in a cumulatively greater landscape viewing experience. Views across the study area and beyond are large from higher-lying areas.
Scarcity	**3**	The landscape character type is representative of the larger region and is not considered a rare landscape type, however characteristic slopes and hills make the area distinctive.
Cultural Modifications	**0**	Cultural modifications and modern, man-made structures are largely absent from the study area.
Total	**18**	Medium

Scores, when added, amounting to less than 11, are categorised as Low, scores between 12 and 18 as Medium and scores more than 19 as High. The total score for the study area calculated as 18, and thus the overall landscape is considered to have medium scenic quality and is considered to exhibit positive character, with a recognisable landscape structure and sense of place, including some detracting features.

2.11.4 LANDSCAPE VALUE

Landscape value is concerned with the relative value that is attached to different landscapes. Landscape values are described as the environmental or cultural benefits, including services and functions that are derived from various landscape attributes (Department of the Environment and Local Government, Ireland (DOE), 2000). A landscape may be valued by different communities for many different reasons without any formal designation, recognising, for example, perceptual aspects such as scenic beauty, tranquillity or wildness, special cultural associations, the influence and presence of other conservation interests, or the existence of a consensus about importance, either nationally or locally (DOE, 2000). These attributes include the components and image of the landscape as already established in the assessment of landscape character, including aesthetic and ecological components, but also includes historical and socio-cultural associations, as well as religious and mythological dimensions.

In determining landscape value, the people or groups of people who could be affected by the proposed development should be considered, due to landscapes being valuable to people in different ways. In this regard, consideration is given to:

- People who live and work in an area may have a different perception of the landscape to that held by visitors because of their more regular contact with the landscape and the ongoing changes within it;

- Special interest, for example the ecological, cultural or historic value of the landscape, as knowledge of these issues can often affect people's perception and appreciation of a landscape; and
- Landscapes valued by a public wider than the local population, because they have a strong image or are well known and valued nationally and internationally.

With reference to the above, the study area itself is likely to be most valued by local residents and workers and, as far as is known to the consultants at the current stage, does not contain value for special interest groups and is not known to be of provincial, national or international cultural historical importance.

The proposed project may lower the landscape value of the study area through the direct loss of natural vegetation and historical and cultural artefacts. Landscape value in terms of historical and socio-cultural significance will be discussed in more detail during the final visual impact assessment.

2.11.5 SENSE OF PLACE

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. It is created by the land use, character and quality of a landscape, as well as by the tangible and intangible value assigned thereto. The landscape character type, defined as rural mountainous, closed bushveld, containing mostly intact vegetation, is not unique to the study area and can also be found within the larger region. However, a number of landforms and topographical features are present within the study area that distinguishes the study area from the surrounding areas, which have similar landscape character type. The sense of place of the study area is therefore somewhat significant when compared to its surroundings and may be considered to be moderate to high with its sense of place largely attributed to its rural, undeveloped character with intact vegetation structure and well-defined topography.

3 SOCIO-ECONOMIC BASELINE ENVIRONMENT

The Socio-economic baseline is provided for the Municipal area (regional perspective), and the Ward analysis for the Local / Project area.

3.1 TOWNS AND SETTLEMENTS

3.1.1 URBAN SETTLEMENTS

The nearest formal urban settlement is the Louis Trichardt (Makhado) and Thohoyandou towns.

Table 78: Towns in the region and their distance from the planned project

TOWN	DIRECTION	DIRECT DISTANCE
Mopane	North-West	21 km
Tshipise	North-East	20 km
Louis Trichardt	South-west	35 km
Musina	North	40 km
Thohoyandou	South-east	49 km

3.1.2 RURAL SETTLEMENTS

There are rural settlements in the surrounding environment of the MRA area.

Table 79: Settlementsand their distance from the planned project

SETTLEMENT	DIRECTION	DIRECT DISTANCE
Makushu	South-east	50 m
Mosholombe	South-east	950 m
Pfumembe	South-East	3 km
Musekwa (Ngundu)	South-east	6 km
Maranikhwe	East	8 km
Mudimeli/Fripp	West	8.5 km
Maangaani	South	9 km

The closest communities are the Makushu and Mosholombe communities. Refer to Figure 60 that indicates their locations in relation to the proposed project.

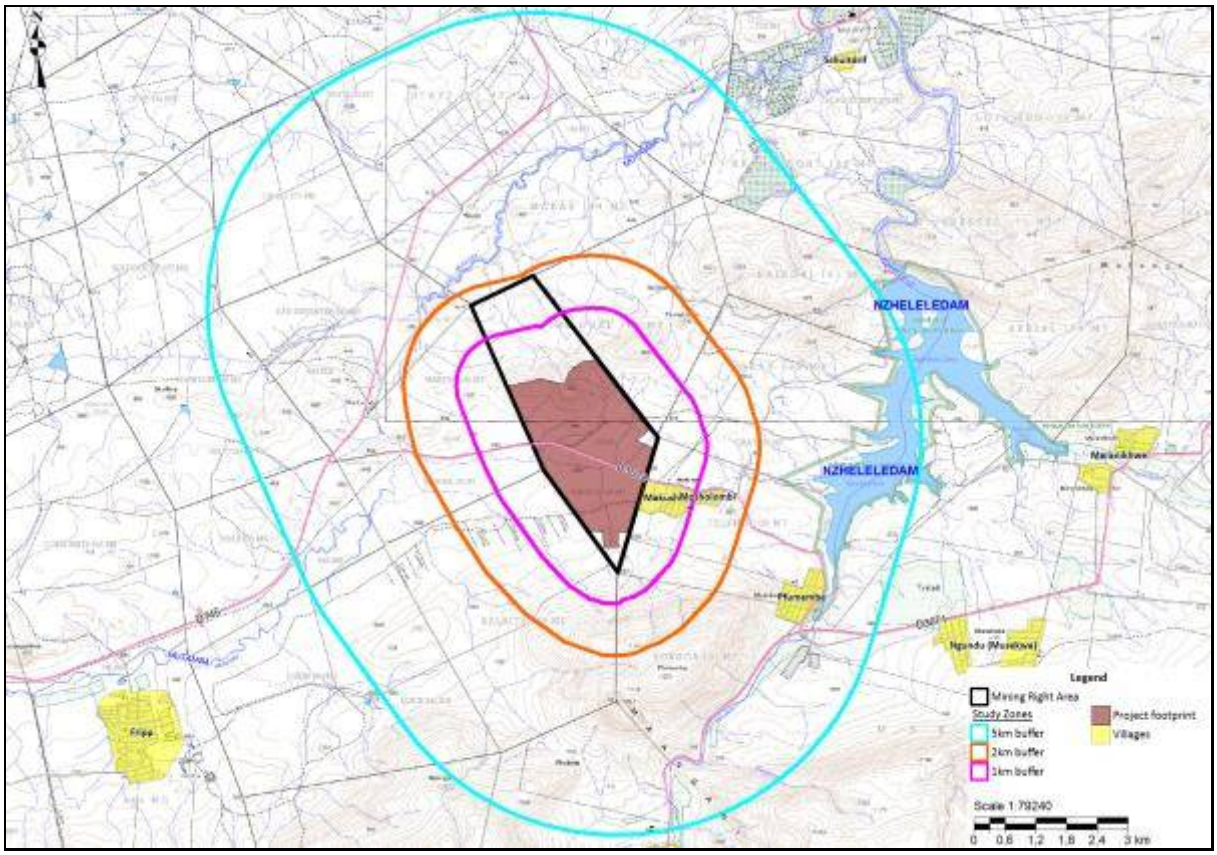


Figure 60: Settlements neighbouring and surrounding the MRA area

3.2 SURFACE OWNERSHIP AND TRADITIONAL STRUCTURES

3.2.1 MINING RIGHT AREA

The farm The Duel 186 MT, subdivided into two parts of which the MRA only covers the Remaining Extent portion, is a privately-owned farm used for game ranching. The areal extent of the property 888.5039 ha and the current surface owner is the Clint Howes Family Trust.

Table 80: Surface ownership

Farm Name	Farm no.	Reg Div	Portion	Title deed nr	Extent (ha)	Surface owner
The Duel	186	MT	RE	T101476/1998	888.5039	Clint Howes Family Trust

The property is under Land Claim by the Nemamilwe Trust under Government Gazette 29397 published on 24 November 2006. The validation is in process.

3.2.2 ADJACENT AFFECTED LANDOWNERS AND PARTIES

3.2.2.1 Neighbouring Properties

The following properties neighbour the Duel Project:

Table 81: Neighbouring Properties

PROPERTY NAME	DIRECTION	LANDOWNER	LAND USE
The Duel 186 MT Portion 1	North-east	Josias Nndwambi	Livestock grazing
Gray 189 MT	East	Republic of South Africa T337/1950VN	Communal Grazing Nature Reserve
Telema 190 MT	South-east	Republic of South Africa T337/1950VN	Communal Grazing Rural Settlement
Kondoa 191 MT	South	Republic of South Africa T337/1950VN	Communal Grazing
Salaita 188 MT	South-west	Akkerland Boerderye T79230/1998	Game farming and hunting
Martha 185 MT Portion 1	West	Fumaria Holdings	Game grazing
Martha 185 MT RE	North-west	Fumaria Holdings	Game grazing
Nakab 184 MT	North	Clint Howes Family Trust	Game farming & Private hunting

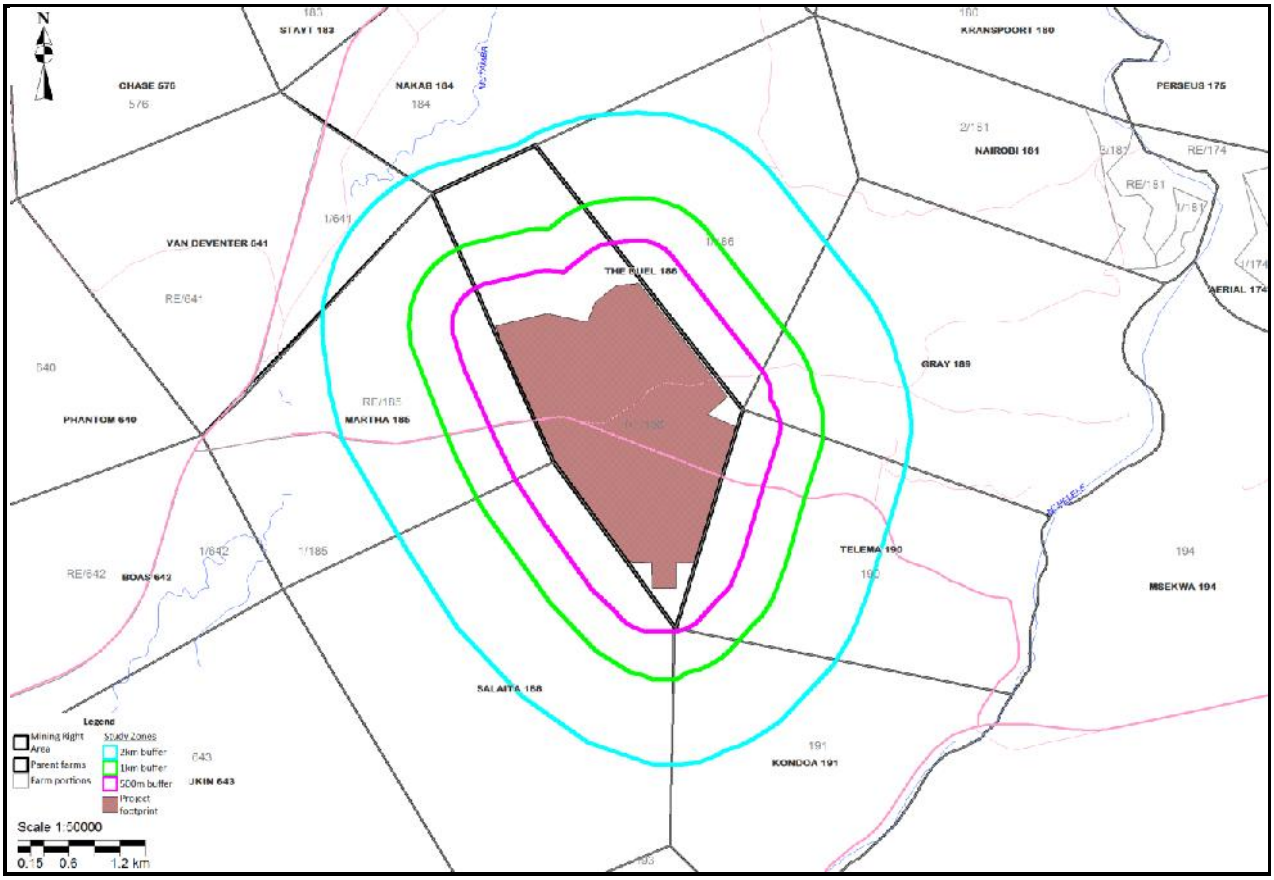


Figure 61: Neighbouring properties

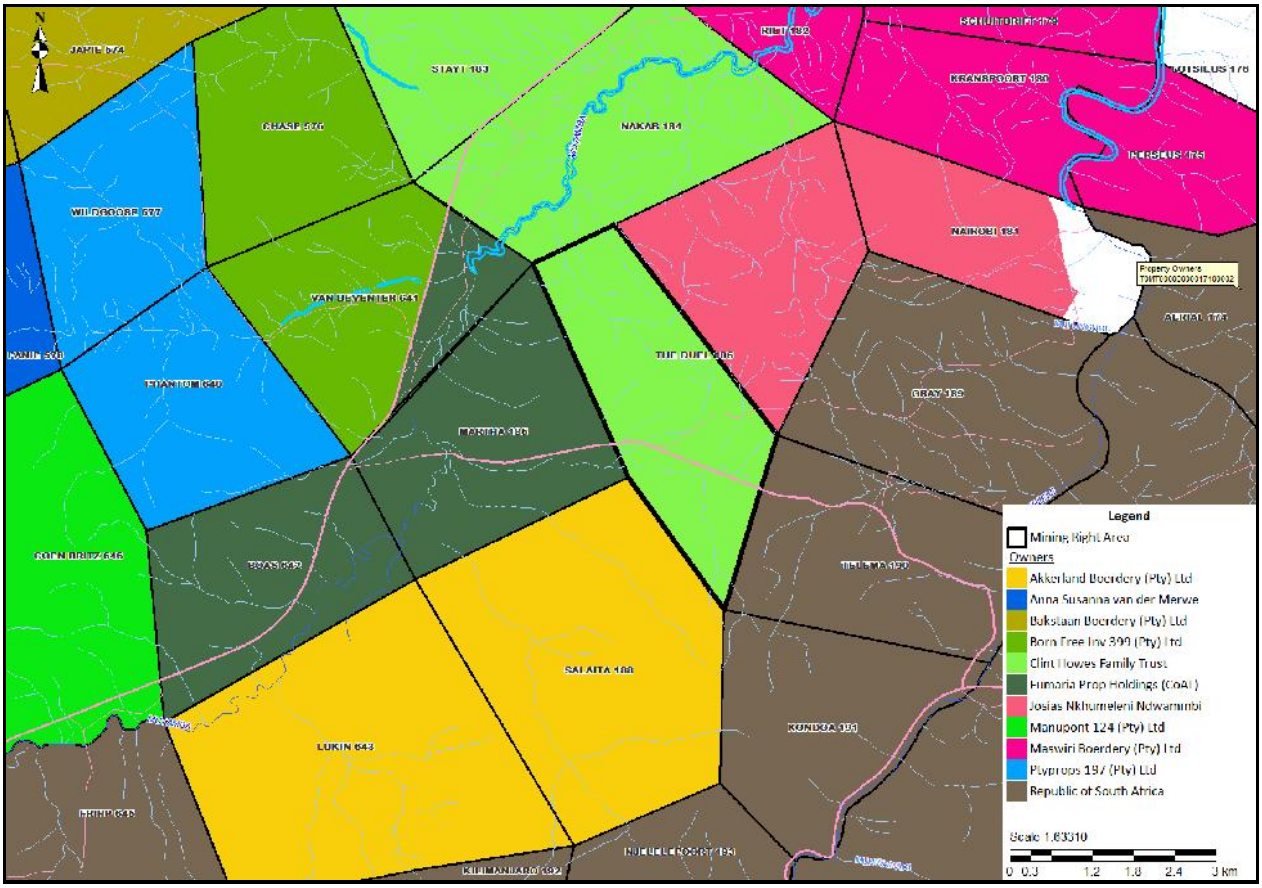


Figure 62: Neighbouring Landowners

3.2.2.2 Neighbouring Traditional Leadership and Communities

3.2.2.2.1 Makushu Traditional Leadership and Community

The Makushu village is under the jurisdiction of the Mphephu Traditional Authority with a local Traditional Leader. The village was established in 1980 and has been settled here for the last 30 years. The people of Makushu originally come from the Musina area. There are currently approximately 250 households and a population of 1,750 people.

3.2.2.2.2 Mosholombe Traditional Leadership and Community

The Mosholombe village is under the jurisdiction of the Mphephu Traditional Authority with a local Traditional Leader. The village was established in 1980 and has been settled here for the last 30 years. The people of Mosholombe originally come from the Pontdrift area. There are currently approximately 185 households and a population of 1,295 people.

3.2.2.2.3 NepfumembeTraditional Leadership and Community

The Pfumembe village is under the jurisdiction of the Mphephu Traditional Authority with a local Traditional Leader. There are currently approximately 220 households and a population of 1,540 people.

3.3 DEMOGRAPHY AND POPULATION STRUCTURE

The project is located within the Makhado Local Municipal area, within the Vhembe District's jurisdiction. The project area falls within Ward 21 but is bordered by Ward 37 to the east and south. Ward 37 contains the nearest settlements to the MRA area. Figure 63 indicates the boundaries of the Municipality and relevant Wards.

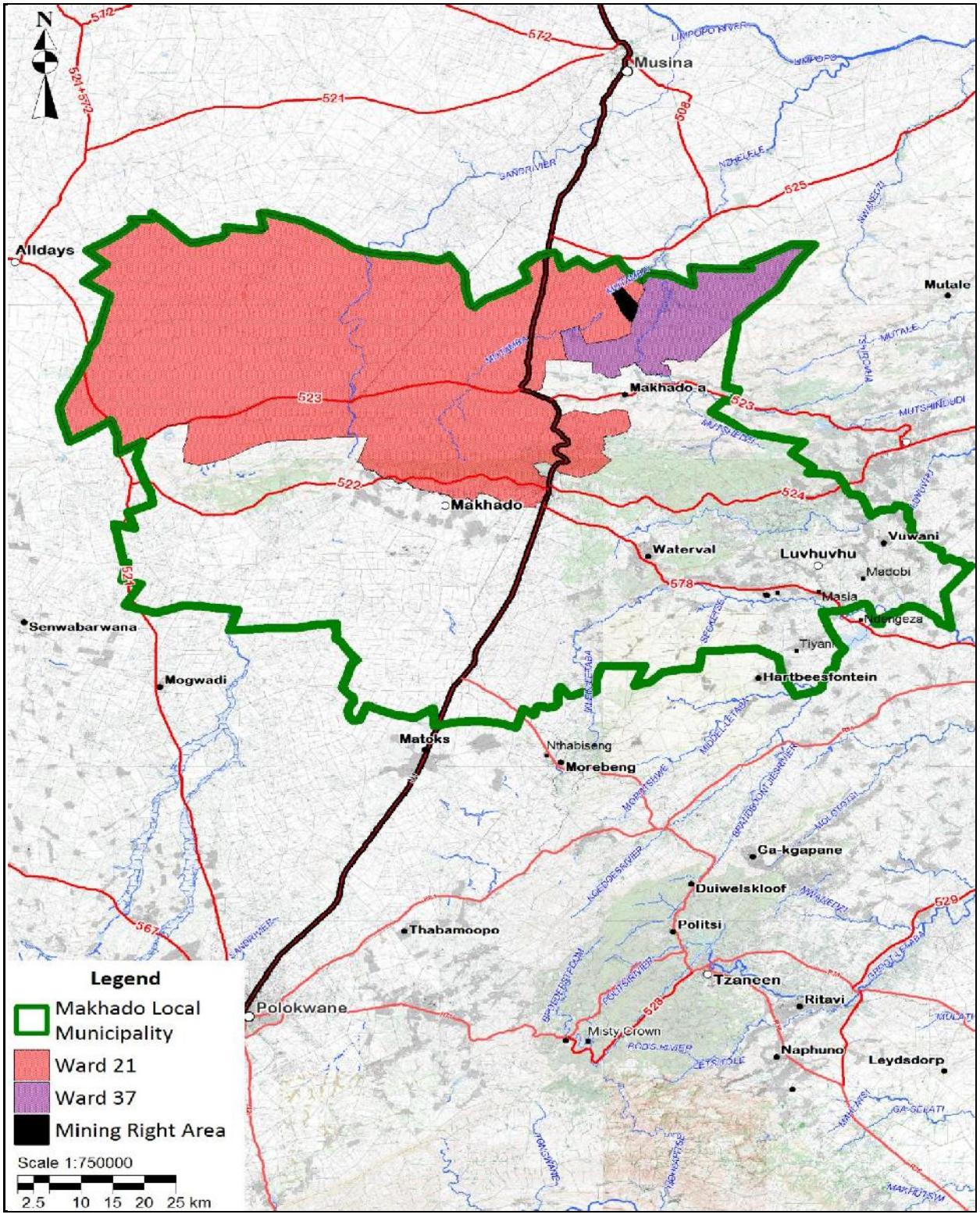


Figure 63: Project in relation to the Makhado Local Municipal area and Ward 21 and 37

3.3.1 POPULATION

The Makhado Local Municipality is one of the most populous municipalities in Limpopo Province. Females are more than males, which is normal for the Province and for the country. Ward 21 is where the proposed The Duel Coal Project will be located. This ward is also considerably larger than the project footprint, but a more detailed level of analysis of the 2011 Census is not possible yet. Ward 21 has a population of slightly more than 21,000 people, who all live on farms. It is significant that there a substantially more men than women in this ward. In Ward 37, where the communities are located, women are more than men, and it has a population of 12,000 people of which approximately 1,500 reside in the Makushu and Mosholombe villages.

Table 82: Population in the Project Area, 2011

AREA	MALE	FEMALE	TOTAL
Makhado LM	236,795	279,236	516,031
Makhado Ward 21	11,079	9,959	21,038
Makhado Ward 37	4,917	6.087	12,004

Source: Statistics South Africa, Census 2011

In Ward 21 of Makhado LM the proportion of the population aged 19 years and younger is considerably smaller than for the respective municipalities. This proportion is also smaller than the equivalent for Limpopo Province. This is due to most of the people residing in this ward are working in commercial activities with the families residing in nearby villages outside the ward. In Ward 37, where communities reside the age distribution is in line with the municipality and province.

3.3.2 LITERACY RATES AND EDUCATION

Less than 29% of the population who have passed school-going age in Ward 21 and 17.5% in Ward 37 have completed secondary school or obtained a post-school qualification. More than half of this population has completed some secondary school or lower.

Table 83: Education Profile in the Project Area for People Above School-going Age, 2011

EDUCATION LEVEL	MAKHADO WARD 21	MAKHADO WARD 37	TOTAL
No Schooling	6%	22%	34.9%
Some Primary	19%	26%	12%
Some Secondary	47%	34.5%	31.9%
Senior Certificate	18%	16.5%	14%
Post School Qualification	11%	1%	7.2%
Total	100%	100%	100%

Source: Statistics South Africa, Census 2011

This relatively low education level will have a negative implication for employability.

3.3.3 GENERAL HEALTH AND WELFARE

The Municipal area is reasonably well served with health infrastructure such as clinics and hospitals. General problems experienced include:

- Services to facilities (water and electricity)
- Medicines and certain equipment
- Emergency vehicles and fuel
- Skilled and experienced personnel.
- Access to transport from rural settlements to health facilities
- The incidence of HIV/AIDS
- Diarrhea and respiratory diseases
- Water borne diseases such as Malaria and Bilharzia
- Malnutrition among children and elderly people
- Immunisations
- Alcohol and drug abuse

Table 84: Makhado Population – HIV/AIDS

CATEGORIES	SOUTH AFRICA	LIMPOPO	MAKHADO
% of population HIV+	10.9%	9.1%	9.0%
AIDS related deaths (% of total deaths)	46.7%	40.2%	39.0%

Although 9% of Makhado's population is HIV+, it is still lower than the provincial and national total. Approximately 39% of total deaths in Makhado are AIDS related, which is lower than the provincial and national total. Of concern, however, is that the amount of people with AIDS is increasing according to the IDP.

3.4 BASIC SERVICES AND HOUSING

3.4.1 HOUSING

In the Makhado Local Municipal area about 16 807 people stay in houses that are below the required RDP standard and the current housing allocations are insufficient to meet the set targets. A rapid increase in the population will worsen the situation. Private land ownership is also very difficult to obtain particularly in the rural communities where there is no real housing market. Very few of the current home owners have bought their houses from another person or have sold a house to another person. The majority of the population resides in the rural areas or in informal settlements.

Private land ownership is very difficult to obtain in the rural areas and there is no real housing market driven by the market forces of supply and demand. Very few of the current house owners have bought their current house from another owner or have sold a house to another person. Most of the population resides in the rural areas or in informal settlements. In general, people are informed about the housing schemes and policy through their tribal chiefs, ward committees and ward councillors.

Housing projects are focused in urban and in the rural areas where housing problems remain unsolved. Both the RDP and the Peoples Housing Project (PHP) policies are being used. For the RDP housing scheme approach, the Department of Housing and Local Government appoints developers who built houses where

the communities are residing in the villages. For the PHP approach the DHLG transfers funds to the municipality whereby local builders from the communities are appointed to build the houses with the assistance of the beneficiaries. In the rural settlements, stands are allocated by the Traditional Leader through the Permission to Occupy system.

3.4.2 WATER AND SANITATION

Households are generally well serviced as far as water is concerned in Ward 21. But in Ward 37, 38% of households have water supply that are below RDP levels.

Table 85: Household Water Service Levels, 2011

CATEGORY –WATER SUPPLY	WARD 21	WARD 37	TOTAL
Piped (tap) water inside dwelling/institution	45%	0%	7%
Piped (tap) water inside yard	41.3%	0%	33%
Piped (tap) water on community stand less than 200m from dwelling	9.2%	38%	20%
Piped water on community stand between 200m and 500m from dwelling	0.7%	46%	28%
Private Borehole	2%	2%	2%
No access to piped (tap) water	1.8%	14%	10%
Total	100%	100%	100%

Source: Statistics South Africa, Census 2011

The number of households with not toilet facilities in the two wards under consideration is strangely high. This information from the 2011 does not fit the profile of the area. It will require investigation and verification.

Although the percentage of households with access to flush toilets have increased since 2001 to 2011, the majority of rural households still make use of pit latrines or have no access to sanitation facilities at all.

3.4.3 ELECTRICITY

The use of electricity for lighting is not as prevalent in the project area as in urban areas. A significant proportion of households (almost 26% in Musina ward 2 and 14 in Makhado ward 21) still use candles for lighting purposes. The use of wood for cooking is even more prevalent than the use of candles for lighting.

Table 86: Household Energy Source for Lighting, 2011

CATEGORY - ENERGY OR FUEL FOR LIGHTING	WARD 21	WARD 37	TOTAL
Electricity	82%	50%	67%
Gas	0.5%	0%	0.2%
Paraffin	2.5%	30%	12.5%
Candles (not a valid option)	13.6%	20%	19.5%
Solar	0.9%	0%	0.3%
Other	0.5%	0%	0.5%
Total	7 312	5 481	100

Source: Statistics South Africa, Census 2011

3.4.4 REFUSE REMOVAL

The percentage of households that has access to weekly municipal refuse services increased from 9.4% to 12.3% from 2001 to 2011. Although the number of households that has their own dumps decreased, it still represents the majority of households in Makhado, which can have major implications for health conditions in the area. The number of households with no access to refuse facilities has also increased due to population growth. The Louis Trichardt town, air force base and surrounding townships have proper waste management systems with sufficient capacity for at least the short to medium term. The waste disposal sites in the rural areas do not have permits and observations indicate that households in the rural areas usually burn their waste. The waste sites also contribute to the contamination of ground water.

3.5 ECONOMIC PROFILE

3.5.1 ECONOMIC SECTORS

The Makhado local economy has a value of production of close to R13 billion. Government is the driver of this local economy, mostly because of the public sector needs of the very large population, which includes education, public health, safety and security, as well as local government services.

The finance sector is significant, largely due to the imputed rent estimates of extensive tracts of land that command very high prices.

The third largest sector is trade and catering. Makhado town provides a service function for a large hinterland that stretches beyond its borders. Attractive landscapes have also provided opportunities to create accommodation and catering product offerings.

Agriculture is stagnant at best, but with a tendency to shrink. Important commodities include fruit, timber and meat.

Mining has never been an important sector in the Makhado local economy, but this could change in the foreseeable future due to the interest that the Soutpansberg Coalfield is receiving with its attractive metallurgical properties.

Table 87: Gross Value Added for Makhado LM at Current Prices

SECTOR	2009	2010	2011	2011%
Agriculture, forestry and fishing	470	457	467	3.6
Mining and quarrying	232	243	274	2.1
Manufacturing	434	442	459	3.5
Electricity, gas and water	306	342	380	2.9
Construction	430	519	616	4.7
Wholesale and retail trade, catering and accommodation	1921	2150	2406	18.6
Transport, storage and communication	1295	1340	1459	11.2
Finance, insurance, real estate and business services	2189	2422	2574	19.9
Community, social and personal services	596	747	823	6.3
General government	2782	3138	3507	27.0
Total	10656	11798	12966	100.0

Source: Quantec, 2013

3.5.2 EMPLOYMENT PROFILE

Table 88: Employment Profile in the Project Area

AREA	EMPLOYED	UNEMPLOYED	DWS	SUR %	EUR %
Makhado LM	78,768	45,705	24,383	36.7%	47.1%
Makhado Ward 21	10,636	821	269	7.2%	9.3%
Makhado Ward 37	714	633	678	31.3%	65%

DWS: Discouraged Work Seeker; SUR: Strict Unemployment Rate; EUR: Expanded Unemployment Rate

Source: Statistics South Africa, Census 2011

Unemployment in Makhado Ward 37 is significantly higher than in Ward 21. Only 35% of the theoretically employable people in Ward 21 are likely to have completed secondary school, which numbers approximately 382 people.

The total number of unemployed people (strictly unemployed as well as discouraged work seekers) in the two wards who have completed secondary school is therefore approximately 741. This suggests that the proposed The Duel Coal Project will have to recruit from outside the project area.

The census does not indicate employment per sector, but useful information in this regard can be obtained from commercial providers of statistical information such as Quantec. The information below has been procured from them. It indicates that only 1.2% of the workforce in Makhado LM is employed in the mining sector, but this could change in the foreseeable future considering the pipeline of potential coal mining projects. Increased employment in the mining sector will have a positive impact on employment in other sectors through the indirect employment effect, particularly on construction, trade and transport.

The Trade, Accommodation and Catering sector is the biggest employer in the municipality. Agriculture is also a major employer.

Table 89: Employment by Sector in Makhado Municipality, 2011

SECTOR	MAKHADO	MAKHADO %
Agriculture, forestry and fishing	5578	7.8
Mining and quarrying	832	1.2
Manufacturing	4735	6.6
Electricity, gas and water	264	0.4
Construction	6062	8.5
Wholesale & retail trade, catering and accommodation	21193	29.7
Transport, storage and communication	2943	4.1
Finance, insurance, real estate and business services	5622	7.9
Community, social and personal services	10320	14.5
General government	13801	19.3
Total	71350	100.0

Source: Quantec 2013

3.5.3 INCOME PROFILE

Household incomes are generally low, with 64% of households in Ward 21 and 90% in Ward 37 earning less than R38,200 per annum (R3200/month).

Table 90: Annual Household Income in the Project Area, 2011

ANNUAL HOUSEHOLD INCOME CATEGORY	WARD 21	WARD 21 %	WARD 37	WARD 37 %
No income	546	7.5%	450	16%
R 1 - R 4800	207	2.8%	279	10%
R 4801 - R 9600	453	6.2%	456	16%
R 9601 - R 19 600	1935	26.5%	783	28%
R 19 601 - R 38 200	1540	21.1%	576	20%
R 38 201 - R 76 400	792	10.8%	159	6%
R 76 401 - R 153 800	691	9.5%	69	2%
R 153 801 - R 307 600	595	8.1%	36	1.5%
R 307 601 - R 614 400	390	5.3%	9	0.4%
R 614 001 - R 1 228 800	118	1.6%	0	0%
R 1 228 801 - R 2 457 600	26	0.4%	3	0.1%
R 2 457 601 or more	19	0.3%	0	0%
Total	7312	100	2820	100

Source: Statistics South Africa, Census 2011

3.6 REGIONAL DEVELOPMENT NEEDS

The needs assessment was conducted based on the current valid Integrated Development Plan of the Makhado Local Municipality and initial meetings held with stakeholders in Government and the Local Communities. Ongoing consultation may strengthen these needs or reveal further needs.

Table 91: Regional Development Needs

GENERAL	SPECIFIC	TYPE OF NEED
Infrastructure and Service Delivery	Reliability, quantity and water supply and sanitation service distribution Upgrade of internal and main roads Electricity Supply Waste management	Establishment / Installation of the required services and infrastructure
Education / Skills Support Services and Infrastructure	Reduce high levels of illiteracy and lack of skills base	Training Centre Education Facilities
	Support education facilities and schools	Establishment / Installation of the required services and infrastructure at schools and clinics
Employment	Job creation opportunities	Economic Development linked to waste management, tourism, agriculture, SMME's
Business	Business opportunities	Economic Development
Agriculture	Rural subsistence farming	Optimize the productive use of arable land through supporting agribusiness development, co-operatives, value chain developments
Technology and communication	Community access to community facilities, technology and communication	Support community centres with access to information technology
Vulnerable Groups	Participation of Disabled, women and youth in all projects and programmes	Ensuring participation and involvement of vulnerable groups in projects
Natural Resources	Protection of natural resources	Land use management Environmental Framework Awareness Protection of resources
Housing	Provision of RDP level housing	Backlog in RDP housing provision

4 CULTURAL AND HERITAGE RESOURCES

Most of the information was obtained through the field survey of the area supplemented by relevant Heritage Impact Assessment (HIA) reports. The topocadastral 1:50000 map and especial Google Earth was studied for signs of archaeological or historical sites. Standard archaeological observation practices were followed. Aspects such as favorable geographical and ecological conditions were considered with regard to suitable habitation in the past and such places were inspected where potential heritage remains may be located. Locations of noteworthy heritage remains were recorded by a handheld GPS and plotted on Google Earth. Archaeological material and the general conditions of the terrain were photographed with a NIKON Digital camera.

No limitations were experienced. However, it must be noted that most archaeological and palaeotological remains are subterranean and there is always a chance that archaeological material may be exposed during earthworks.

Refer to Appendix 3 for the Phase 1 HIA report.

4.1 LITERATURE SURVEY

In terms of Huffman's (2007) distribution sequences of the Iron Age, the project area may contain the remains of the under-mentioned culture historical groups:

Urewe Tradition, originating in the Great Lakes area of Central Africa, was a secondary dispersal centre for eastern Bantu speakers. It represents the eastern stream of migration into South Africa.

- Kwale Branch:
    - Mzonjanifacies (Broederstroom) AD 450 – 750 (Early Iron Age)
- Moloko (Sotho-Tswana) Branch (Late Iron Age)
    - Icon facies AD 1300 – 1500: This pottery is associated with the first Sotho Tswana people entering the country.

Kalundu Tradition, originating in the far North of Angola, was another secondary dispersal centre for eastern Bantu speakers and represents the western stream of migration into South Africa.

- Benfica Sub-branch:
    - Bambatafacies AD 150 – 650 (Early Iron Age)
- Happy Rest Sub-branch:
    - Happy Rest facies AD 500 – 750 (Early Iron Age)
    - Malapatifacies AD 750 – 1030 (Early Iron Age)
    - Eilandfacies AD 1000 – 1300 (Middle Iron Age)
    - Mapungubwefacies AD 1250 – 1300 (Middle Iron Age)
    - Mutambafacies AD 1250 – 1450 (Middle Iron Age)
    - Khamifacies AD 1430 – 1680 (Late Iron Age)
    - Tavatshenafacies AD 1450 – 1600 (Later Iron Age)
    - Letabafacies AD 1600 – 1840 (Later Iron Age)

The project area lies adjacent to the Makhado Colliery for which the heritage specialist had undertaken heritage impact studies during the period 2008 - 2011. Numerous heritage sites and the presence of

heritage remains were recorded on the adjacent farms Windhoek 649 MS, Tanga 648 MS, Fripp 645 MS, Lukin 643 MS and Salaita 188 MT. This varied from Stone Age, Iron Age and recent historical sites, including pottery from the Mutambafacies AD 1250 – 1450 (Middle Iron Age), Tavatshenafacies AD 1450 – 1600 (Later Iron Age) and Letabafacies AD 1600 – 1840 (Later Iron Age).

In addition, a number of Venda related archaeological sites have been identified by Loubser (1991), while doing research on Venda ethno-archaeology for his PhD during the mid-1980s. Loubser integrated oral traditions, archaeology and ethnography to show that the Venda people originated locally and inhabited the Zoutpansberg a century before the Singo conquest of the current ruling lineages. The archaeology shows a local development of a Venda ceramic style (called Letaba) from the overlap between Shona and Sotho styles and independently supports linguistic evidence that the Venda language is an amalgamation of Shona and Sotho.

Loubser (1991) distinguishes five (5) settlement patterns in the Zoutpansberg area according to a chronological order.

- The first and presumably the oldest is the central cattle pattern, where settlements have one or several contiguous dung concentrations and the settlement is arranged around the dung concentration.
- The second settlement pattern is the Zimbabwe pattern, characterized by regularly coursed-walls arranged in tight semi-circles and irregular enclosures along the upper portion of the site. Dwelling remains occur among the walls, but also extends well beyond the limits of the walls.
- Loubser also distinguishes the Dzata pattern, which is very similar to the Zimbabwe pattern, but are characterised by short sections of walls that are semi-coursed and long sections of roughly stacked walls. The semi-coursed walls occur either in isolation or as part of roughly stacked walls.
- The fourth is the Mutzheto pattern where settlements have stacked terraced walls (mutzheto). The walls demarcate the main residential area and are arranged in interlinking terraced enclosures along the upper portion of the settlement. Dwellings sometimes occur in a wide arc below the main walled cluster. Mutzheto sites share features with both Zimbabwe and Dzata patterns.
- Lastly, from the 1830's conquered chiefs were forced to abandon their Mutzheto settlements by their victors and forced to settle on the open flats, the Dzanani pattern. This was also the case after the Boers defeated the Ramabulana Singo in 1889. The subsequent re-settlement programme under British rule from 1902 forced the Western Venda to settle on the plains. Thereafter western Venda villages seldom included stone walling.

4.2 SURVEY RESULTS

4.2.1 STONE AGE REMAINS

There is ample evidence for Stone Age remains in the affected area. Recordings 2 – 6 (refer to Figure 64) represent some of these finds. Although Stone Age remains are scattered throughout most eroded areas, no intact primary sites with high concentrations of material was found and no formal tools were observed. The most prominent scattered material seems to be Middle Stone Age flakes. Isolated Earlier Stone Age material is also present. No Later Stone Age material was noted. It is the contention of the HIA that no further assessment is necessary. Significance: Low.

The terrain is not suitable for Rock Art as there are no large lose-standing boulders or rock overhangs which facilitates rock art.

4.2.2 IRON AGE

No Iron Age sites were recorded. A scattering of non-diagnostic potsherds was recorded at coordinates S22º45'30.1" E30º02'06.9" (recording 1 in Figure 64) and surrounding area. This was probably the result of agricultural activities in the past. Significance: Low

4.2.3 INTANGIBLE HERITAGE

No signs of ritual use or the presence of graves were noted in the project area. The area is used for the collecting of natural resources such as wood, plants and clay by the Makhushu community. During the ongoing social consultative process, local communities may come up with heritage issues concerning them not yet addressed in the HIA.

4.2.4 THE BUILT ENVIRONMENT

The built environment mainly consists of the Makushu village. The village is not under threat. The Duel Coal Project area contains no original farmstead buildings. No threat exists for the built environment.

4.2.5 PALAEONTOLOGY

Plant fossils have been observed in the project area. SAHRA has developed a Palaeontological Sensitivity Map. The map is colour-coded with RED indicating a very high sensitivity. The project area falls within SAHRA's red category where the prescribed action is "…*a field assessment and protocol for finds is required*". A SAHRA recognized palaeontologist (Dr Barry Millsteed) conducted a desktop palaeontological assessment of the project area, with the following results:

- The sediments of the Ecca Group (represented by the Madzaringwe and Mikambeni Formations in the study area) are known to be fossiliferous and are known for containing an important palaeontological heritage particularly in respect of plant macrofossils of the *Glossopteris* flora. Fossils of this flora were identified within the Madzaringwe Formation of this region during the coal exploration phase of the project. However, the occurrence of fossils within the geological record is erratic in general and the chance of impacting upon most macrofossil types at any particular point within the Ecca Group strata is moderate. It must be noted however, that where plant macrofossils are present within a sequence (as they have been proven to be in the Madzaringwe Formation) they are often in dense accumulations and the probability of a negative impact is accordingly assessed as being moderate to probable.
- The rocks of the Tshidzi Formation have a low fossiliferous potential and underlie the coal-bearing strata in most areas, and as such, are unlikely to be affected by most of the mining activities.
- The Fripp Formation usually consists of coarse-grained arenites and rudites and is generally unfossiliferous. However, plant macrofossils belonging to the *Dicroidium* Flora have been identified within the formation in the region. In general, the potential for any negative impact to the palaeontological heritage contained within this unit is characterised as low.
- The Solitude and Clarens Formations are known to be fossiliferous and have historically yielded a diverse fauna of dinosaurs, synapsid reptiles and mammals. These fossils tend not to be common, but over such a large aerial extent as their outcrops within the project area, it is possible that fossil materials will be present. The probability of any negative impacts occurring upon the fossil heritage of these units is assessed as low. The rocks of these two formations will not be targeted for mining

and, thus, will only be potentially be affected by the construction of superficial infrastructure elements.

- All the rock units constituting the Soutpansberg Group are unfossiliferous and, accordingly, the potential for any negative impact on the palaeontological heritage is nil. The rocks of this stratigraphic unit comprise most of the aerial extent of the project area and will not be targeted by the mining activities. Therefore, the greater the amount of mine infrastructure elements that are constructed on these bedrock areas, the lower the potential for the project to impact on the fossil record will become.

4.2.6 CONCLUSIONS

Previously surveyed areas along the foothills of the Soutpansberg to the west of The Duel Coal Project have yielded numerous heritage remains and archaeological sites. Notwithstanding this, the project area on The Duel contains no definite archaeological sites, although scatterings of archaeological remains in the form of Stone Age material and some potsherds were observed. The reason that no Iron Age sites were located seems to be two-fold: firstly, the area is mostly mountainous and/or rocky and not suitable for past settlement and secondly, the sandy soils where settlement may have been possible is highly eroded.

The palaeontological desk-top study concluded that there is a definite potential for a negative impact on palaeontological heritage, with varying levels of significance:

- The potential for a negative impact upon the palaeontological heritage of the coalbearing strata of the Ecca Group (the Madzaringwe and Mikambeni Formations) is assessed as moderate; that of the underlying Tshidzi Formation is assessed as being low. However, all three formations should be expected to contain highly scientifically significant plant macrofossils of the *Glossopteris* flora. Any negative impact upon these fossil floras would result in a high negative impact. The probability of such a negative impact is elevated by the fact that both the Madzaringwe and Mikambeni Formations will be targeted during the open cast mining phase and the Madzaringwe Formation will be targeted during the underground mining phase.
- The fossil potential of the Triassic Fripp Formation is assessed as being low, but it is known to contain plant macrofossils belonging to the highly scientifically significance *Dicroidium* flora. Accordingly, any negative impact caused by the mining operations would be of high significance. This unit will not be targeted during the mining operations and, as a result, any negative impacts caused by the construction will be limited to the upper-most 1-2 m of the land surface.
- The Solitude and Clarens Formations are known to be fossiliferous and to contain diverse vertebrate fossil faunas. However, vertebrate fossils are usually sparsely distributed and relatively uncommon. As such, the probability of a negative impact upon these fossil faunas has been assessed as low. However, the vertebrate faunas are of the highest scientific significance and any negative impacts would be highly significant.

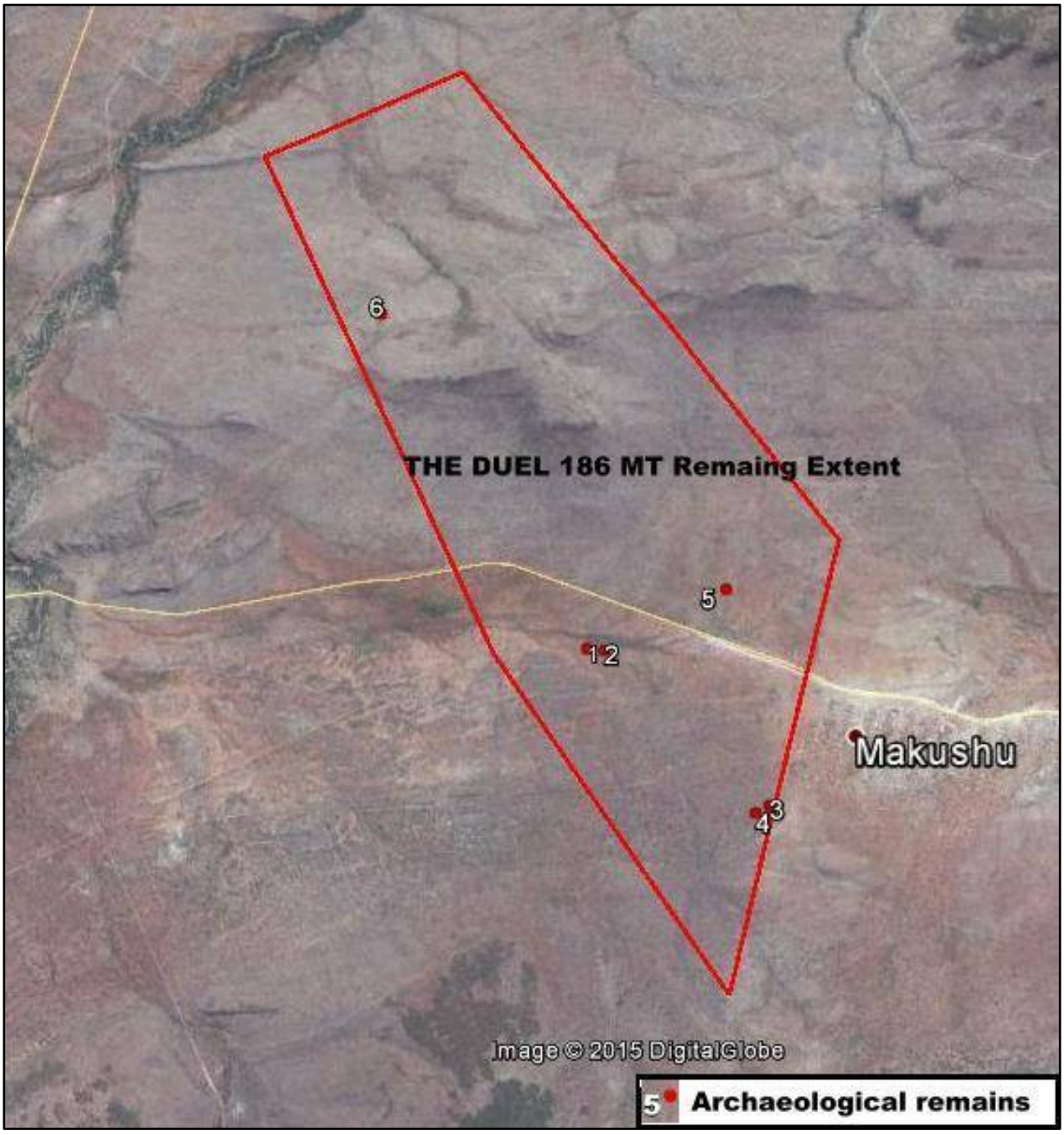


Figure 64: Archaeological remains on The Duel Coal Project footprint

5 DESCRIPTION OF CURRENT LAND USE

For some years now a certain land use pattern has developed in the project area, the area has changed from a predominantly beef producing (cattle farming) area in the past to game farming with the related activities. The three village communities of Makushu, Mosholombe and Pfumembe on the farm Telema 190 MT are located within a 5 km radius of The Duel Coal Project. The village of Makushu borders the proposed mining area and will be directly affected by the mining activities.

In this section the baseline activities are identified, analysed and converted to macro-economic parameters (Mosaka Economists, 2015).

5.1 CURRENT (BASELINE) ACTIVITIES

Land use within The Duel and surrounding area is predominantly hunting and game farming. Game farms within this area offer activities such as trophy and biltong hunting. Natural grazing within this area is used for game ranching. Irrigation farming is concentrated in the northern part of the area along the banks of the Nzhelele River.

5.1.1 GAME FARMING

The land use in the area is predominantly game ranching. Some of the game farms accommodate game lodges. Beef farming has over time been overtaken by game as the major land use activity and is presently less than 10%. Game farming supports the value-added components of eco-tourism and also stimulates the hunting industry.

5.1.2 IRRIGATION

Irrigation agriculture (mainly citrus) is practiced along the banks of the Mutamba and Nzhelele Rivers. The farms Schuitdrift 179 MT and Mount Stuart 153 MT have intensive irrigated agricultural activities focused along the river. On the Mount Stuart farms vegetables are also cultivated. Most of the irrigation water is supplied by means of water canals from the Nzhelele Dam. The irrigation agricultural area is utilised for predominantly export citrus production. Several packing houses for citrus are present in the Mount Stuart Section area.

The fear amongst citrus farmers is the possible loss of their Phytosanitary “Phyto” Registration and Good Agriculture Practise (GAP) accreditation due to mining dust, water contamination and possible re-allocation of water from the Nzhelele Dam. The citrus industry is currently in a very problematic situation as the European Union is considering stopping the importation of citrus from South Africa because of the so-called “black spot” disease.

5.1.3 COMMUNITIES

Traditional communities with traditional structures in place and some cattle, goats and chicken farming activities are practiced. Because of the very low rainfall and a shortage of water very little garden and crop production takes place. The unemployment rate in the Makhado Ward 37 which includes the Makushu and Mosholombe villages is rather high.

5.1.4 WATER

Water within the surrounding area of The Duel is scarce due to the dry climate. Water scarcity impacts greatly on agriculture and therefore the type of land use. On farms where cultivation of crops occurs, farmers rely on water from the Nzhelele Government Water Scheme and the abstraction of groundwater, therefore several boreholes are found throughout the study area. Groundwater for crop cultivation is mainly used for a back-up in emergency situations. A dominant form of land use within the area is game farming where farmers also rely on groundwater for their animals. Farms situated in close proximity to the confluence of the Nzhelele and Mutamba Rivers utilise this surface water supply for irrigation of their crops. Greater evidence of cultivated land is therefore present around the Nzhelele and Mutamba Rivers than on other portions of the study area.

5.2 MACRO-ECONOMIC ANALYSIS OF BASELINE ACTIVITIES

5.2.1 APPROACH

A Macro-Economic Impact Model (MEIM) is used, based on the Limpopo Social Accounting Matrix (SAM) which has been converted to an econometric model to be used in the project area. The MEIM was adapted to accommodate each of the identified project areas and was then populated with the baseline data.

The magnitude of the current activities in the project area has been calculated according to the methods as explained. In the following sections the current economic activities are expressed in terms of the following economic and socio-economic parameters as provided by the Macro-Economic Model:

- Economic Parameters
    - Gross Domestic Product (GDP) – Direct and Indirect/Induced Impacts; and
    - Capital Utilisation.
- Socio-economic parameters
    - Employment – Direct and Indirect/Induced Impacts; and
    - Payments to Households – Low Income and Medium/High Income.

The Limpopo Social Accounting Matrix (SAM) was used to synthesise appropriate multipliers to be used in the Macro-Economic Impact Model (MEIM) to calculate the macro-economic impact of the different baseline activities.

All economic models incorporate a number of “multipliers” which form the nucleus of the modelling system. The nature and extent of the impact of a change in a specific economic quantity, e.g. exports, on that of another economic quantity or quantities, e.g. production output or employment, is determined by a “multiplier”. A multiplier summarises the total impact that can be expected from a change in a given economic activity. The change in economic activity resulting from the change in one factor of production, such as water resources, is measured by different multipliers. Four multipliers are commonly used to assess the impacts of an initial increase in production resulting from an increase in sales, usually called final demand in multiplier analysis. The four multipliers are: (1) output, (2) employment; (3) income; and (4) value added.

The multipliers that were used in this study to determine the economic impacts are as follows:

- Economic growth, i.e. the impact on GDP.
- Employment creation, i.e. the impact on labour requirements.

- Income distribution, i.e. the impact on low income, poor households and total households.

A breakdown of the different effects of the agricultural sector multipliers used in this study is as follows:

- Direct Impacts: the effects occurring directly in the agriculture sector.
- Indirect Impacts: those effects occurring in the different economic sectors that link backwards to agriculture due to the supply of intermediate inputs, e.g., fertilisers, seeds, hunting professional services, transport, etc.
- Induced Impacts: the chain reaction triggered by the salaries and profits (less retained earnings) that are ploughed back into the economy in the form of private consumption expenditure.
- Total Impacts: Represents the direct, indirect and induced summed effect.

5.2.2 AREA SUB-DIVISION

The study area was divided in three sub-areas to be used in the calculations, namely:

- Area 1: The area covered by the farm The Duel includes the proposed The Duel Coal Project development that may be impacted upon by the mining activities. This includes the so-called "Resource Area and Infrastructure Footprint". The land belongs to a private company, is stocked with game and hunting is reserved for invited guests. The farm The Duel comprises approximately 2 076 ha.
- Area 2: The area within a 5 km radius of Area 1 in which the farms Nakab 184 MT, Nairobi 181 MT, Gray 189 MT, Telema 190 MT (with the village communities of Makushu, Mosholombi and Masekwa), Kondoa 191 MT, Salaita 188 MT, Martha 185 MT and Van Deventer 641 MS are either fully or partially located. These farms may be impacted upon to a lesser extent than the so-called "Resource Area and Infrastructure Footprint". The main agricultural activitiesare game farming; the farms are stocked with game used either for visiting hunters or concession hunting. The area comprises approximately 8 386 ha. Use will be made of secondary data to calculate the economic impact of the proposed project.
- Area 3: The area within a 10 km radius of The Duel Coal Project development which excludes Areas 1 & 2. The farms Stayt 183 MT, Bennie 571 MT, Riet 182 MT, Hughes 151 MT, Naus 178 MT, Schuitdrift 179 MT, Kranspoort 180 MT, Lotieus 176 MT, Persues 175 MT, Aerial 174 MT, Tribal Land, Tshitadi (with the village of Musekwa), Njelele Poort 193 MT (with the village of Maangani), Boas 642 MS, Lukin 643 MS, Kilimanjaro 192 MT, Coen Britz 646 MS, Phantom 640 MS, Fanie 578 MS, Wildgoose 577 MS and Chase 576 MS are either fully or partially located in ths area. The area comprises of approximately28 064ha. Also, these farms are stocked with game for visiting hunters or concession hunting. Accommodation for hunters is available on some of the farms. Citrus farming is practised on the farms Kranspoort 180 MT, Lotieus 176 MT, Schuitdrift 179 MT, Perseus175 MT and Mount Stuart 153 MT. Although a small area of citrus orchards on the farm Kranspoort falls within Area 2, these orchards have been included as part of Area 3. The citrus and vegetable cultivation in Area 3 also extends outside and to the north of the 10km radius area to include theorchards on the farms Lotieus, Persues and Mount Stuart. The vegetable farming at Mount Stuart is also included. The rationale being that any impact on citrus or vegetables will extend beyond the artificial 10km radius boundary.

The economic activities taking place in each area were identified and quantified applying accepted methodologies and then converted to economic and socio-economic parameters.

For analytical purposes, as mentioned, the farming activities in the project area were divided into three areas. The activities were grouped as follows:

- Area 1: The following farming practices were included in this group:
  - Game; and
  - Game lodges.
- Area 2: The following farming practices were included in this group:
  - Game; and
  - Game lodges.
- Area 3: The following farming practices were included in this group:
  - Game;
  - Irrigation farming (predominantly citrus);
  - Game lodges.

Table 92: Estimated Present Land Use in the Project Area (2015)

Land Use	Area 1		Area 2		Area 3		Total	
	Percentage	Hectares	Percentage	Hectares	Percentage	Hectares	Percentage	Hectares
Irrigation	0.0%	0	0%	0	0.7%	191	0.5%	191
Game	100%	2 076	100%	8 386	99.3%	27 453	99.5%	37 735
Total	100.0%	2 076	100.0%	8 386	100.0%	27 644	100.00%	37 926

The dominating land use activity in both of the areas is game farming representing approximately 99.5% of the total area, with the balance representing irrigation farming. A number of years ago beef farming was dominant but has now been replaced by game farming.

5.2.3 GAME FARMING

The majority of farms stock game and allow hunting on own accord or by means of concessions made to professional hunters. Some farms, classified as game farms, also have small herds of cattle.

The following sub-divisions of commercial farming enterprises in the study area were applied:

- Game farming: Live game sales; Trophy hunting; Biltong hunting.
- Hunting supporting services: Professional hunter; Skinner and tracker; Transport; Taxidermist; Game Catching; Other.
- Accommodation.
- Hunting.
- Other.

A game farm as an independent enterprise can present a “one stop” hunting venture by providing the hunting supporting services, the game and the accommodation for both the hunters and non-hunters. Such an enterprise may also have acquired hunting concessions from game farms in the area for specific game species not stocked or available on the farm where the supporting services and accommodation infrastructure is located. Also, a game farm (or cattle farm) may have no supporting services or

accommodation infrastructure available and only sell game by allowing hunting concessions. In some cases no hunting takes place on the farm as the game is caught and sold at auctions or to private individuals.

For purposes of this study the breeding of game and the eventual marketing of the animals are divided in to three groups:

- Sale of live animals at either game auctions or through private transactions (the supporting service of game catching is included);
- Trophy hunting, predominantly foreign tourists; and
- Biltong hunting, predominantly South African groups.

As the numbers per sale activity varies from game specie to specie the price also differs for the different outlet activities. It was therefore necessary to use a number of assumptions, which not necessarily applies to all the farms or game producers. The grazing norm applied is 12 ha/AU. The different AU to game number conversion rates are presented in the following table.

Table 93: Estimated Game Representation Used in the Project Area plus the Sex Ratio and Annual Growth Rate

Specie	Conversion Rate[#]	Animal Representation[##]	Number of Females per Male[###]	Annual Growth Rate[###]
	Number/AU	Percentage	Numbers	Percentage
Blesbuck	4.50	2.73%	10	30%
Bushbuck	7.50	0.71%	6	20%
Blou Wildebeest	2.40	11.03%	10	25%
Buffalo	1.00	1.20%	15	20%
Eland	1.00	5.92%	15	20%
Gemsbok	2.20	9.11%	10	25%
Giraffe	0.70	1.75%	13	15%
Impala	7.00	39.38%	10	35%
Kudu	2.20	16.56%	7	20%
Nyala	3.30	1.31%	10	20%
Hartebeest (Red)	2.00	2.19%	10	20%
Sable Antelope	1.67	1.15%	12	20%
Roan Antelope	1.56	0.95%	10	20%
Tsessebe	2.63	0.57%	10	20%
Reedbuck, Klipspringer, Duiker, Steenbuck	7.70	2.08%	4	20%
Warthog	5.00	1.86%	10	20%
Waterbuck	2.40	0.63%	10	20%
Zebra	1.60	0.87%	6	25%
Average	3.29	100.00%		

Note: The presence of rhinoceros and other bug five animals, except buffalo, have been ignored.
#Department of Agriculture.
##Mosaka Research and Interpretation.
###The SA Financial Sector Forum – HB Falkena: Profit and Honour in Game Ranching (2003).

Applying the above to the number of Animal Units (AUs) and then converting it to animal numbers the following numbers are available for trading or hunting purposes.

Table 94: Number of AU and Game Available for Sale or Hunting purposes

	Area 1	Area 2	Area 3	Total
Number of AU	173	698	2 288	3 159
Number of Animals	742	2 990	10 091	13 823
Annual Growth Animals	210	829	2 800	3 839

A decision was then made on the numbers of animals sold live, the number hunted as trophy animals and the number hunted for biltong. It was firstly decided that some of the species are too expensive for the "biltong" market and was allocated to the live sales and trophy hunting section, the animals treated this way are: Buffalo, Giraffe and Sable Antelope.

Of the male animals of the above group, 45% were mostly allocated to trophy hunting, 27% were allocated to live sales and 28% to biltong hunting; in the case of the females 34% to trophy, 30% were allocated to live sales and 36% to biltong hunting.

For the rest of the animals an analysis was performed in terms of the number of animals per specie that was sold and feedback on the preferences of biltong hunters and information received from professional hunters on the preferences of trophy hunters.

The prices of trophy game were sourced from Greater Kuduland Safaris - Rifle Hunters Price List 2015 (Trophy), the pricelist presents the prices in US$ which was converted by Mosaka to Rand using an exchange rate of ZAR11.5 = 1US$, eliminating decimals.

Table 95: Different Outlet Prices for Game as Used in the Calculations (2015 prices)

Specie	Male Offtake - Average Prices			Female Offtake - Average Prices		
	Game Sales	Trophy	Biltong	Game Sales	Trophy	Biltong
Blesbuck	R 2 300	R 7 475	R 1 500	R 3 600	R 7 475	R 1 500
Bushbuck	R 16 000	R 13 800	R 4 457	R 22 000	R 13 800	R 5 342
Blou Wildebeest	R 5 200	R 12 650	R 3 500	R 9 000	R 12 650	R 3 350
Buffalo	R 450 000	R 92 000	R 29 710	R 600 000	R 92 000	R 35 616
Eland	R 12 000	R 21 850	R 9 300	R 60 000	R 21 850	R 7 200
Gemsbok	R 5 500	R 13 800	R 5 900	R 7 000	R 13 800	R 5 500
Giraffe	R 15 500	R 27 600	R 14 000	R 18 000	R 27 600	R 12 000
Impala	R 3 000	R 4 888	R 1 250	R 5 500	R 1 150	R 1 000
Kudu	R 2 000	R 23 000	R 5 400	R 16 000	R 4 025	R 3 500
Nyala	R 35 000	R 25 300	R 10 900	R 28 000	R 25 300	R 8 300
Hartebeest (Red)	R 5 000	R 16 100	R 4 000	R 5 000	R 16 100	R 3 500
Sable Antelope	R 180 000	R 92 000	R 29 710	R 180 000	R 92 000	R 35 616
Roan Antelope	R 450 000	R 115 000	R 37 138	R 450 000	R 115 000	R 44 521
Tsessebe	R 14 000	R 32 200	R 15 000	R 26 000	R 32 200	R 15 000
Reedbuck, Klipspringer, Duiker, Steenbuck	R 8 000	R 7 855	R 1 500	R 8 000	R 7 855	R 1 250
Warthog	R 1 000	R 6 038	R 1 200	R 1 000	R 6 038	R 950
Waterbuck	R 14 000	R 23 000	R 4 300	R 4 300	R 23 000	R 3 500
Zebra	R 4 500	R 13 800	R 6 500	R 4 500	R 13 800	R 7 900

Using the above approach, the estimated game farming annual turnover is presented below.

Table 96: Annual Game Farming Turnover

	Area 1	Area 2	Area 3	Total
Annual Turnover (R.mil.)	1.03	3.19	14.04	18.26

With the game farming industry rapidly increasing in the area, investments have been made to establish new luxury accommodation or upgrading existing accommodation for the trophy hunting fraternity, simultaneously accommodating the eco-tourism segment.

The two types of hunters hunting in the area are divided into the so-called trophy hunters and biltong hunters.

The trophy hunters are mostly foreigners who are looking for specific game species for which they are prepared to pay a very high price. They are generally not interested in the meat of the hunted animals. They, however, support a number of supplementary activities grouped together and referred to as "Supporting Services".

Supporting services (usually included in the daily rates and package purchased) comprise the transport from the airport of arrival to the hunting camp and for the duration of the hunting expeditions, the services of a professional hunter, trackers and skinners, use of facilities such as cold room and salt, the field preparation of trophies, caping of trophies, laundry, accommodation and all refreshments.

Taxidermy, shipping of trophies and dipping and packing of trophies is for the account of the hunter and is not included in the daily rates and package quoted, although assistance is offered to deliver the trophy to the taxidermist.

5.2.3.1 Accommodation

5.2.3.1.1 Trophy hunter accommodation

The hunting camps and lodges used for trophy hunters and non-hunters (observers) accompanying the hunters and tourists range from very comfortable to luxurious with all modern amenities always available.

5.2.3.1.2 Biltong hunter accommodation

The biltong hunters decide, according to their budget, what accommodation is preferred. The average biltong hunter requires only basic accommodation with limited personal amenities such as sleeping quarters (single or shared), shower and facilities to prepare meals/coffee/tea (braai) all self-catering.

The number of available beds and tariffs was sourced from Naledi Development Restructured and the internet, and an estimation of the bed occupation was made. The trophy hunter group presented a special problem because included in their daily tariffs are not only the accommodation fee, but also the services of a professional hunter, skinners, trackers and vehicles. It is an all-inclusive package which also includes the transfer from the OR Tambo airport and only excludes the price of the animal and the taxidermy services.

The following number of beds could be traced per area:

- Area 1 – None;
- Area 2 – 109; and
- Area 3 – 72.

A 22% bed occupation was used to calculate the number of bed nights per annum.

Area	Number of Beds	Occupation	Average Day Bed nights	Annual Bed nights
Area 1: The Duel - Impacted Area	0	0%	0	0
Area 2: 5km radius	109	22%	23.98	8 753
Area 3: 10km radius	72	22%	15.84	5 782

After analysing the data obtained the accommodation turnover in the area was estimated and is presented in the following table.

Table 97: Annual Accommodation Turn Over in the Project Area (2015 prices)

Area	Accommodation (Rand mil.)
Area 1	0
Area 2	4.63
Area 3	4.00
Total	**8.63**

The total accommodation turnover in the project area is R 8.63 million.

5.2.3.2 Hunting Supporting Services

The professional hunter operates independently and is contracted by the hunting organiser for a specific safari. The professional hunter often resides in the Gauteng area and meets the hunting party at the airport on arrival. From arrival he/she will accompany the hunting party to the game farm with either his/her own transport or transport supplied by the hunting organiser or hired helicopter.

The trackers and skinners are the responsibility of the hunting organiser and are separately hired by the organiser for the specific safari. They do the field preparation of trophies and the caping of trophies. It could also be that the tracker(s) and skinners are in the full employment of the hunting organiser.

All transport and amenities on the game farm is the responsibility of the hunting organiser. Transport to visit local sights, souvenir hunting and entertainment is also supplied at additional cost.

The facilities such as cold room and salt, the field preparation of trophies, caping of trophies is provided by the hunting organiser. The arrangement and responsibility for taxidermy, the shipping of the trophies and the dipping and packing of trophies is the hunter's, although advice is given, and assistance is offered to deliver the trophy to the taxidermist.

A hunting trophy is an item prepared from the carcass of a game animal killed by a hunter and kept as a souvenir of the successful hunting expedition. Often the heads or entire bodies are processed by a taxidermist, although sometimes other body parts such as teeth, tusks or horns are used as the trophies.

The cost of hunting services was calculated separately from the money spent on taxidermist services. The taxidermy fees were obtained from the internet and the number of animals treated determined from discussions with individuals in the industry.

In the following table the support services and taxidermist costs are presented.

Table 98: Annual Value of Support Services and Taxidermy Costs (2015 prices)

Area	Support Services Rand mil.	Taxidermy Rand mil.	Total Rand mil.
Area 1	0.15	0.46	0.61
Area 2	1.10	1.53	2.63
Area 3	0.93	5.34	6.27
Total	2.18	7.33	9.51

The table shows that the value of the support services is R 2.18 per annum and the taxidermy costs are around R 7.33 million per annum for the project area.

5.2.4 IRRIGATION

As no detailed data on the exact crop varieties produced, other than citrus, was available, it was necessary that some assumptions be made to be used for the analysis:

- It appears as if the more accepted practice for the vegetable crops is three crops in a two year cycle period, although some farmers claim two crops per annum. A 67% double cropping factor for the vegetable crops was used for, a winter and summer variety.
- The area is predominantly producing citrus and the hectare areas were sourced from Google Earth measurements of orchards and will be revised when WSMLeshika (Pty) Ltd. data is received.

In the next table a breakdown of the physical hectares and crop hectares used in the calculation is presented based on the available information and the formulated assumptions.

Table 99: Irrigation Areas and Crops

Irrigation Crops	Area 3	
	Physical Area (ha)	Crop Area (ha)
Vegetables	59	80
Citrus	155	155
Total	214	235

The total physical irrigated hectares are estimated at 214, all in Area 3. The estimated orchard crop hectares are 155 ha citrus and 59 ha vegetable crops. The total vegetable area is estimated at 59 hectares, but with a 67% double cropping assumption 80 hectares are harvested per annum.

Enterprise budgets compiled for the Land Bank and Development Bank during 2012 were updated to 2015 values and applied to arrive at the total irrigation value per category.

Table 100: Enterprise Budgets (2015 Rand Values)

Current Situation (per hectare)	Brassicas (Winter)	Cucurbits (Summer)	Citrus
Gross Income	128 000	56 100	122 439
Variable Costs	56 017	32 040	79 147
-Marketing Costs	7 047	7 013	805
-Pre Harvest Cost			0
-Irrigation labour			
- Other – pre-harvest costs	37 545	12 726	29 301
-Harvest Cost	11 425	12 302	49 040
Interest on Working Capital	1 690	704	3 304
Gross Margin	70 293	23 356	39 988
Fixed Costs	3 594	2 910	7 412
-Depreciation			
- Irrigation equipment			
- Other	2 041	1 758	2 660.60
-Labour	184	115	736.00
-Insurance	311	269	572.40
-Repairs & Maintenance	596	511	1 287.90
-Administration Costs	184	85	975.20
-Fuel & Electricity	223	117	743.40
-Sundry	55	55	436.72
Net Farm Income	66 700	20 446	32 575

In the following table the estimated value of the irrigation activities per area is presented.

Table 101: Estimated Value of the Irrigation Activities (2015 prices)

Farm Category	Value (Rand million)
Area 3	26.28
Total	**26.28**

The table shows that the annual estimated value of the irrigation activities in the total project area is around R26.28 million.

5.2.5 ANNUAL TURN-OVER ESTIMATION

In the next table the total estimated annual value of the current activities in the project area is presented.

The figure shows that irrigation represents 42% of the monetary value of the current activities in the total impacted area, hunting 23%, the hunting services 15%, accommodation 14% and game sales 6%.

The annual total value of the current activities is estimated at R62.71 million, with irrigation contributing around R26.28 million, 42%, with game farming the second largest contributor at R18.27 million, 29%, with the rest the hunting activities.

Table 102: Annual Turn Over of the Activities in the Project Area (2015 prices)

Farming Activity	Annual Income (Rand mil.)			
	Area 1	Area 2	Area 3	Total
Game Farming – Animals (Turn Over)	R 1.03	R 3.19	R 14.04	R 18.27
- *Game Sales*	R 0.38	R 0.66	R 2.83	R 3.87
- *Trophy Hunting*	R 0.33	R 1.34	R 6.62	R 8.29
- *Biltong Hunting*	R 0.33	R 1.19	R 4.58	R 6.10
Hunting				
- Professional Hunting Services (including game	R 0.15	R 1.10	R 0.93	R 2.19
- *Taxidermy*	R 0.46	R 1.53	R 5.34	R 7.34
- *Accommodation*	R 0.00	R 4.63	R 4.00	R 8.63
Total	R 0.62	R 7.27	R 10.27	R 18.16
Eco-Tourism	R 0.00	R 0.00	R 0.00	R 0.00
Irrigation	R 0.00	R 0.00	R 26.28	R 26.28
Grand Total	R 1.65	R 10.46	R 50.59	R 62.71

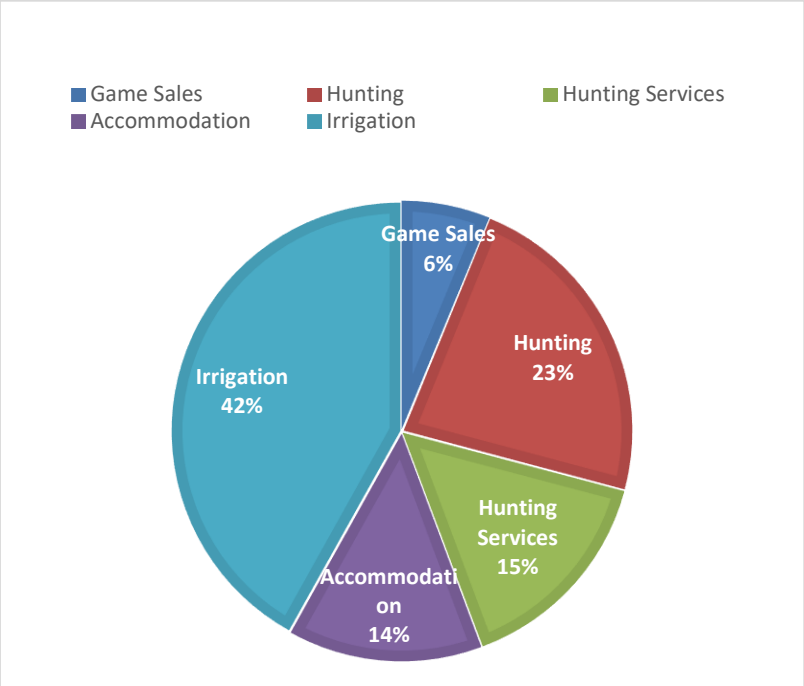


Figure 65: Monetary Value of Current Activities

5.2.6 SUMMARY OF MACRO-ECONOMIC ANALYSIS

5.2.6.1 Area 1 - The Duel

The following table presents the current economic and socio-economic parameters for The Duel.

Table 103: Current Economic and Socio-Economic Parameters for The Duel (2015)

Farming Activity	Gross Domestic Product			Employment			Payments to Households		
	Direct R mil.	Indirect/ Induced R mil.	Total R mil.	Direct Number	Indirect/ Induced Number	Total Number	Total R mil.	High/ Medium R mil.	Low R mil.
Irrigation	-	-	-	-	-	-	-	-	-
Game Farming	0.44	0.75	1.19	2	7	9	0.52	0.34	0.18
Hunting	0.37	0.36	0.73	-	1	1	0.34	0.23	0.11
Taxidermy,	0.26	0.26	0.52	1	1	2	0.16	0.12	0.04
Accommodation	-	-	-	-	-	-	-	-	-
Total	**1.06**	**1.37**	**2.43**	**3**	**9**	**12**	**1.03**	**0.69**	**0.33**

The total GDP generated is estimated at a total of R2.43 million per annum and the direct at R1.06 per annum. Only three direct employment opportunities are sustained by the farming activities on The Duel, with a total of 12 if the indirect and induced is added. The total payments to households are R1.03 million with R0.33 million, 32% to the low-income households.

5.2.6.2 Area 2 - 5 km Radius

The following table presents the current economic and socio-economic parameters for the area included in Area 2 (the 5 km radius area).

Table 104: Current Economic and Socio-Economic Parameters for Area 2 (2015)

Farming Activity	Gross Domestic Product			Employment			Payments to Households		
	Direct R mil.	Indirect/ Induced R mil.	Total R mil.	Direct Number	Indirect/ Induced Number	Total Number	Total R mil.	High/ Medium R mil.	Low R mil.
Irrigation	-	-	-	-	-	-	-	-	-
Game Farming	0.79	1.15	1.94	7	9	16	1.29	1.29	-
Hunting	1.80	1.76	3.55	10	7	17	1.67	1.13	0.54
Taxidermy,	1.45	1.47	2.92	8	5	13	0.92	0.69	0.24
Accommodation	2.10	2.45	4.56	14	10	24	2.38	1.61	0.77
Total	**6.15**	**6.82**	**12.97**	**38**	**31**	**69**	**6.26**	**4.71**	**1.55**

The total GDP generated is estimated at a total of R12.97 million per annum and the direct at R6.15 per annum. Only 38 direct employment opportunities are sustained by the farming activities, with a total of 69 if the indirect and induced is added. The total payments to households are R6.26 million with R1.55 million, 24.7% to the low-income households.

5.2.6.3 Area 3 – 10 km Radius

The following table presents the current economic and socio-economic parameters of the area included in Area 3 (the 10 km radius area).

Table 105: Current Economic and Socio-Economic Parameters for Area 3 (2015)

Farming Activity	Gross Domestic Product			Employment			Payments to Households		
	Direct R mil.	Indirect/ Induced R mil.	Total R mil.	Direct Number	Indirect/ Induced Number	Total Number	Total R mil.	High/ Medium R mil.	Low R mil.
Irrigation	15.18	12.80	27.97	266	61	327	13.03	10.96	2.07
Game Farming	13.62	3.65	17.28	23	19	42	2.45	1.93	0.52
Hunting	6.30	6.16	12.46	27	26	53	5.84	3.96	1.89
Taxidermy, Gamecatching, etc.	3.46	3.49	6.95	21	13	34	2.20	1.63	0.57
Accommodation	1.81	2.12	3.93	10	9	19	1.28	0.95	0.32
Total	**40.38**	**28.21**	**68.59**	**346**	**128**	**474**	**24.80**	**19.44**	**5.37**

The total GDP generated is estimated at a total of R68.59 million per annum and the direct at R40.38 per annum. The two largest contributors to the direct GDP is irrigation with R15.18 million and game farming R13.62 million. The contribution of irrigation to direct employment opportunitiesare 266 out of 346 sustained by the farming activities, with a total of 474 if the indirect and induced is added. The total payments to households are R24.80 million with R5.37 million, 21.6% to the low-income households.

5.2.6.4 Total All Areas

The following table presents the total parameters for all three the areas.

Table 106: Current Economic and Socio-Economic Parameters All Areas (2015)

Farming Activity	Gross Domestic Product			Employment			Payments to Households		
	Direct R mil.	Indirect/ Induced R mil.	Total R mil.	Direct Number	Indirect/ Induced Number	Total Number	Total R mil.	High/ Medium R mil.	Low R mil.
Irrigation	15.18	12.80	27.97	266	61	327	13.03	10.96	2.07
Game Farming	14.85	5.55	20.41	32	35	67	4.27	3.57	0.70
Hunting	8.46	8.27	16.74	36	34	70	7.85	5.32	2.53
Taxidermy, Gamecatching, etc.	5.18	5.21	10.39	31	19	50	3.29	2.44	0.85
Accommodation	3.92	4.57	8.49	23	19	42	3.66	2.56	1.09
Total	47.59	36.40	83.99	388	168	556	32.09	24.84	7.25

The total GDP generated is estimated at a total of R83.99 million per annum and the direct at R47.59 per annum. The two largest contributors to the direct GDP is irrigation with a R15.18 million contribution, followed by game farming with R14.85 million.

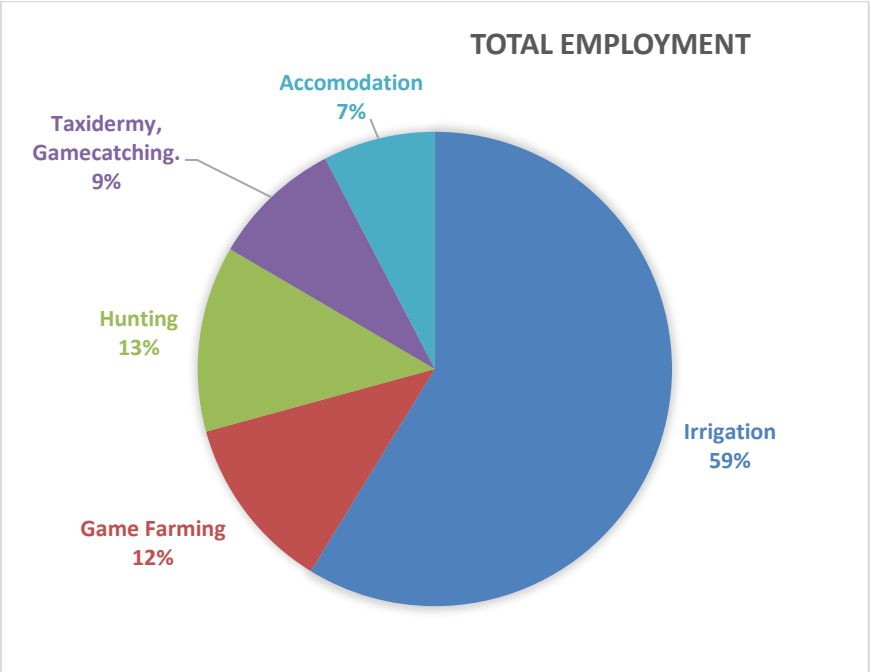


Figure 66: Employment per Current Activity

Irrigation represents 59% of the total employment, hunting 13%, game farming 12%, taxidermy and game catching 9% and accommodation 7%.

The contribution of irrigation to direct employment opportunities are 266 out of 388 sustained by the farming activities, with a total of 556 if the indirect and induced is added.

The total payments to households are R32.09 million with R7.25 million, 22.6% to the low-income households.

6 REFERENCES

Adamson, P.T. (1981). Southern African Storm Rainfall. Rep No T102. DWA. Pretoria.

Acocks, J.P.H. (1988) Veld Types of South Africa. Memoirs of the botanical survey of South Africa No. 57. Botanical Research Institute, South Africa.

Acocks, J.P.H. (1988) Veld Types of South Africa. Memoirs of the botanical survey of South Africa No. 57. Botanical Research Institute, South Africa.

Alexander, G and Marais, J. 2008. Second Edition. A guide to the reptiles of Southern Africa. Struik Publishers, Cape Town.

Astronomical Society of South Australia. 2012. Light pollution brochure.

Barnes, K.N. (Ed). 2000. The Eskom Red Data Book of Avifauna of South Africa, Lesotho and Swaziland. Avifauna life South Africa, Johannesburg, RSA.

Biltong hunting prices 2015: Cyferfontein URL http://cyferfontein.com/index.php?page=modules

BirdLife International. 2014. www.birdlife.org. In conjunction with the International Union for Conservation of Nature (IUCN).

Branch, B. 1998. Third Edition. Field Guide to Snakes and other Reptiles in Southern Africa. Struik Publishers (Pty) Ltd, Cape Town, RSA

Bromilow, C. (2001) Problem Plants of South Africa. Briza Publications, Pretoria.

Bromilow, C. 2010. Second Edition, Second Impression. Problem Plants of South Africa. Briza Publications, Pretoria, RSA.

Bureau of Land Management. Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands. First Edition 2013.

Bureau of Land Management, 1984, Visual Resource Management, BLM Manual Handbook 8400, Release 8-24, U.S. Department of the Interior, Washington, DC.

Bureau of Land Management, 1986, Visual Resource Contrast Rating, BLM Manual Handbook 8431-1, Release 8-30, U.S. Department of the Interior, Washington, DC, Jan.

Bureau of Land Management, 1986, Visual Resource Inventory, BLM Manual Handbook 8410-1, Release 8-28, U.S. Department of the Interior, Washington, DC, Jan.

Bureau of Land Management, U.S. Department of Interior. 2004. Bureau of Land Management Visual Resource Inventory Classes, Appendix C: Visual Absorption Capacity

Cachier H., Liousse P., Buat-Mernard P and Gaudichet A.(1995). Particulate content of savannah fire emissions. Journal of Amos.chem, 22,123-148.

CEPA/FPAC WORKING GROUP, 1998. National Ambient Air Quality Objectives for Particulate Matter. Part 1. Science Assessment Document, A Report by the Canadian Environmental Protection Agency (CEPA) Federal-Provincial Advisory Committee (FPAC) on Air Quality Objectives and Guidelines.

Chiapetta, F., A Van Vreden, 2000. Vibration/Air blast Controls, Damage Criteria, Record Keeping and Dealing with Complaints. 9th Annual BME Conference on Explosives, Drilling and Blasting Technology, CSIR Conference Centre, Pretoria, 2000.

Coal of Africa Projects in the Limpopo Province URLwww.coalofafrica.com/factsheets/makhado-factsheet-april2014.pdf

Coal of Africa Limited (August 2013), Greater Soutpansberg, Generaal Project, Scoping Report. Jacana Environmentals cc.

Coal of Africa Limited (January 2014), Greater Soutpansberg, Generaal Project, Environmental Impact Assessment and Environmental Management Programme. Jacana Environmentals cc.

Coal of Africa Limited (September 2012), Makhado Colliery Project, Environmental Impact Assessment and Environmental Management Programme. Jacana Environmentals cc.

Coates-Palgrave, K. (2000) Trees of southern Africa – second edition. Struik Publishers, Cape Town.

Conningarth Economists. (2007). A Manual for Cost Benefit Analysis in South Africa with specific Reference to Water Resource Development, Second Edition (Updated and Revised). Water Research Commission. TT305/07.

Conningarth Economists. (2007). Development and Construction of the South African and Provincial Social Accounting Matrix. (Updated 2013). Compiled under the auspices of the Development Bank of Southern Africa.

Cook, C.L. 1996. Aspects of the Ecology and Breeding Biology of the Giant Bullfrog Pyxicephalus adspersus. MSc. Thesis, University of Pretoria.

Dada R., Kotze D., Ellery W. and Uys M. 2007. WET RoadMap: A Guide to the Wetland Management Series. WRC Report No. TT 321/07. Water Research Commission, Pretoria.

Deacon, J. 1996. Archaeology for Planners, Developers and Local Authorities. National Monuments Council. Publication no. P021E.

Deacon, J. 1997. Report: Workshop on Standards for the Assessment of Significance and Research Priorities for Contract Archaeology. In: Newsletter No 49, Sept 1998. Southern African Association of Archaeologists.

Department of the Environment and Local Government, Ireland 2000. Landscape and Landscape Assessment. Consultation Draft of Guidelines for Planning Authorities.

Department of Water Affairs and Forestry (1993). Report No. P.A800/00/0793. Water Resources Planning of the Nzhelele River Basin - Study of the water resources.Water Systems Management (WSM).

Department of Water Affairs and Forestry (2002). Report No. P/01000/00/0101. Limpopo Water Management Area: Water Resources Situation Assessment. WSM (Pty) Ltd.

Department of Water Affairs and Forestry (2004). Report No. P WMA 01/000/00/0304. Limpopo Water Management Area: Internal Strategic Perspective Version 1.Tlou & Matjie EMS, Goba Moahloli Keeve Steyn, Golder Associates.

De Villiers, C., Driver, A., Clark, B., Euston-Brown, D., Day, L., Job, N., Helme, N., Van Ginkel, CE., Glen, RP., Gordon-Gray, KD., Cilliers, CJ., Muasya, M and van Deventer, PP. 2011. Easy identification of some South African Wetland Plants. WRC Report No TT 479/10.

DWA, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999. [Appendix W3].

DWAF (2005). A practical field procedure of identification and delineation of wetlands and riparian areas. DWA, Pretoria.

DWAF. 2007. Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Du Preez, L and Carruthers, V. 2008. A complete guide to the frogs of Southern Africa. Stuiker Nature, Random house, Cape Town, South Africa.

Du Preez, L and Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Struik Publishers (Pty) Ltd, Cape Town, RSA.

Endangered Wildlife Trust, 2004. (Conservation Breeding Specialist Group). 2004. Red Data Book of the Mammals of South Africa: A conservation Assessment.

Enterprise Budgets compiled for the Land Bank and Development Bank, 2012. Department of Agriculture.

EPA (1996). Users Guide for the Industrial Source Complex (ISC3) Dispersion Models., EPA-454/B-95-003a, US-Environmental Protection Agency, Research Triangle Park, North Carolina.

EPA (1996). Compilation of Air Pollution Emission Factors (AP-42), 6th Edition, Volume 1, as contained in the AirCHIEF (AIR Clearinghouse for Inventories and Emission Factors) CD-ROM (compact disk read only memory), US Environmental Protection Agency, Research Triangle Park, North Carolina.

Ezzati M., Kammen D.M,.(2002). The health impacts of exposure to indoor air pollution from solid fuels in developing countries: knowledge, gaps and data needs. Environmental health perspective, 110 (11): 1057-1068.

Falkena HB; The SA Financial Sector Forum - Profit and Honour in Game Ranching (2003).

Game and Cattle farming in the Soutpansberg – Verbal and electronic communication with farmers in the study area.

Game sales auction prices 2015: Vleissentraal - URL www.gamefarmnet.co.za

Henderson, L. (2001) Alien Weeds and Invasive plants – A Complete Guide to Declared Weeds and Invaders in South Africa. Plant Protection Research Institute, Agricultural Research Council Handbook No 12. Pretoria.

Henning, G.A and Henning, S.F. 1989. South African Red Data Book of Butterflies. South African National Scientific Programmes Report No. 158.

Hockey PAR, Dean WRJ and Ryan PG. 2005. Roberts - Birds of southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

Huffman, T.N. 2007. Handbook to the Iron Age. The archaeology of Pre-colonial Farming Societies in Southern Africa. University of KwaZulu-Natal Press.

ILP 2011. Guidance notes for the reduction of obtrusive light. GN01: 2011, Rugby: Institute of Lighting Professionals.

IUCN. 2014. International Union for Conservation of Nature http://www.iucnredlist.org/.

Jeffrey. L.S., The Characterization of the Coal Resources of South Africa. The Journal of the South African Institute of Mining and Metallurgy, February 2005.

Langer, R. H. M. and Hill, G. D. (1991) Agricultural Plants – second edition. Cambridge University Press, Cambridge.

Loubser, J.H.N. 1991. The Ethnoarchaeology of the Venda-speakers in Southern Africa. Navorsinge van die Nasionale Museum, Bloemfontein 7(8): 145 – 464.

Kleynhans C.J. 1999. A procedure for the determination of the ecological reserve for the purposes of the national water balance model for South African River. Institute of Water Quality Studies, Department of Water Affairs & Forestry, Pretoria.

Kleynhans CJ, Mackenzie J, Louw MD. 2007. Module F: Riparian Vegetation Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and DWA and Forestry report. WRC Report No.

Kleynhans C.J., Thirion C. and Moolman J. 2005. A Level 1 Ecoregion Classification System for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria.

Kleynhans, CJ, Thirion, C, Moolman, J and Gaulana, L. A Level II River Ecoregion classification System for South Africa, Lesotho and Swaziland. Report No.N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.

Kotze D.C., Marneweck G.C., Batchelor A.L., Lindley D.S., Collins. N.B., 2005 Wet Eco-services. A technique for rapidly assessing ecosystem services supplied by wetlands.

Kovaćs, Z. (1988). Regional maximum flood peaks in southern Africa. Rep No TR137. DWAF. Pretoria.

Kruger, E (ed) (2006). Drainage Manual. SANRAL. Pretoria.

Leeming, J. 2003. Scorpions of Southern Africa. Struik Publishers (Pty) Ltd, Cape Town, RSA.

Leroy, A. and Leroy, J. Second Edition. 2003. Spiders of Southern Africa. Struik Publishers (Pty) Ltd, Cape Town, RSA.

Limpopo SOER. 2004. Limpopo Department of Finance and Economic Development, Limpopo Province, State of the Environment Report (Phase 1).

Limpopo Department of Economic Development, Environment and Tourism, 2012. Five Year Strategic Plan for the Nzehelele Nature Reserve, Limpopo Province, South Africa.

Low, A.B. and Rebelo, A.G. (eds) (1998) Vegetation of South Africa, Lesotho and Swaziland. Department of Environmental Affairs & Tourism, Pretoria.

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D., Koopman V., Goodman P. and Goge C. 2008. WET-Health: A technique for rapidly assessing wetland health. WRC Report No. TT 340/08. Water Research, Commission, Pretoria.

MACVICAR, C.N. et al. 1991. Soil Classification. A taxonomic system for South Africa. Mem. Agric. Nat. Resour. S.Afr. No.15. Pretoria.

Marais, J. 2004. A complete guide to the Snakes of Southern Africa. Struik Publishers (Pty) Ltd, Cape Town, RSA.

Middleton, B.J.and A.K. Bailey (2009). Water Resources of South Africa, 2005 Study. WRC Rep No TT381. Pretoria.

Midgley, D.C., Pitman W.V. and Middleton, B.J. (1994). Surface Water Resources of South Africa 1990. (WR90 study). Vol V Appendices, WRC Report No 298/5.1/94. Pretoria.

Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J., & Kloepfer, D. (Eds). 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB Series #9. Smithsonian Institute, Washington, DC, USA.

Mucina, L. and Rutherford, M.C. (Eds). 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria, RSA.

Nel, JL, Driver, A., Strydom W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J, Nienaber, S., Van Deventer, H., Swartz, E. & Smith, Adao, L.B. 2011a. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. Water Research Commission Report No. TT 500/11, Water Research Commission, Pretoria.

NEMBA. National Environmental Management: Biodiversity Act (No. 10 of 2004).

Oberholzer, B., 2005. Guideline for involving visual & aesthetic specialists in EIA processes: Edition 1. CSIR Report No. ENV-S-C 2005 053 F. Republic of South Africa, Provincial Government of the Western Cape, Department of Environmental Affairs & Development Planning, Cape Town.

Ollis, DJ; Snaddon, CD; Job, NM & Mbona, N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Onderstall, Jo. 1984. Transvaalse Laeveld en Platorand insluitende Die Nationale Krugerwildtuin. Veldblomgids van Suid-Africa. Botaniese Vereeniging van Suid-Afrika, Kaapstad, RSA.

Persson, P. A., R. Holmberg and J. Lee, 1994, Rock Blasting and Explosives Engineering, Boca Raton, Florida: CRC Press.

Picker. M., Griffiths. C. and Weaving. A. 2004. New Edition. Field Guide to Insects of South Africa. Struik Publishers (Pty) Ltd, Cape Town, RSA.

Prendini, L. 2006. New South African Flat Rock Scorpions (Liochelidae: Hadogenes). American Museum Novitates 3502, 32pp.

Raimondo, D., von Staden, L., Foden, W., Victor, J.E, Helme, NA., Turner, R.C, Kamundi, DA., Manyama, PA. (eds) (2009). Red List of South African Plants Strelitzia 25. South African National Biodiversity Institute, Pretoria.

Roodt, F.2012. Phase I Heritage Impact Assessment: Proposed Makhado Colliery – Integrated report for the opencast mine & infrastructure; bulk power supply; off-site transport – railway line & siding. Vhembe District Municipality, Limpopo Province. For Jacana Environmental. Unpublished report.

Rowntree K.M. and Wadeson R.A. 2000. An Index of Stream Geomorphology for the Assessment of River Health. Field Manual for Channel Classification and Condition Assessment. NAEBP Report Series No. 13, Institute of Water Quality Studies, Department of Water Affairs and Forestry, Pretoria. Available: http://www.csir.co.za/rhp/reports/reportseries13.html.

SANBI (2007) The South African National Biodiversity Institute is thanked for the use of data from the National Herbarium, Pretoria (PRE) Computerised Information System (PRECIS).

SANBI - Biodiversity GIS (BGIS) [online]. URL: http://bgis.sanbi.org

SRK Consulting & Natural Scientific Services cc 2010 Faunal Assessment for the proposed Chapudi Coal Project near Waterpoort, Limpopo Province

SABAP2, 2013. The South Africa Bird Atlas Project 2 database. http://sabap2.adu.org.za/gap_analysis_spp_qdgc.php?qdgc=2430CA.

Siebert, S.J. (2001). Vegetation of the Ultramafic Soils of the Sekhukhuneland Centre of Plant Endemism, South Africa. Unpublished Ph.D. Thesis, University of Pretoria.

Siebert, S.J. Van Wyk, A.E. and Bredenkamp, G.J. 2001. (In press). The Physical Environment and Major Vegetation Types of Sekhukuneland. Journal of Botany (67). South Africa.

Sinclair, I., Hockey, P. and Tarboton, W. 2002. Third Edition. Sasol Birds of Southern Africa. Struik Publishers, Cape Town, RSA.

Sinclair, I. and Ryan, P. 2010. Birds of Africa south of the Sahara. Struik Nature, Cape Town, RSA.

Smit, N. 2008. Field Guide to the Acacias of South Africa. Briza Publications, Pretoria, RSA.

Smithers, R. H. N. 2000. Third Edition. Edited by Peter Apps. The Mammals of the Southern African. A Field Guide. Struik Publishers, Cape Town, RSA.

Stuart, C., Stuart, T. 2000. Third Edition. Track and Signs of Southern and East African Wildlife. Struik Publishers (PTY) Ltd, Cape Town, RSA.

Swanwick, C. and Land Use Consultants (2002). Landscape character assessment guidance for England and Scotland, Cheltenham: Countryside Agency and Battle by: Scottish National Heritage.

Tainton, N. (Editor) (1999) Veld Management in South Africa. University of Natal Press, Pietermaritzburg.

Taxidermy 2015 costs for Trophies: Taxidermy Africa - www.taxidermyafrica.com

The Landscape Institute, Institute of Environmental Management and Assessment, 2002. Second Edition Guidelines for Visual and Landscape Impact Assessment. E & FN Spon, London.

The Landscape Institute, Institute of Environmental Management and Assessment, 2013. Third Edition, Guidelines for Visual and Landscape Impact Assessment. E & FN Spon, London.

Threatened Species Programme (2005) Red Data List of South African Plant Species. Available online: http://www.redlist.org.

Trophy hunting for foreign hunters 2015 prices: Greater Kuduland Safaris (Tshipise)–Brochure.

Trophy hunting for local hunters prices 2015: Kudu Adventure Safaris – URL http://www.kuduadventuresafaris.co.za/trophy-pricelist/

Tyson P. D., Preston-Whyte R.A. (2002). The weather and climate of southern Africa. International journal of climatology, 22, pp 883-884.

Van Bladeren, D. and D van der Spuy. (2000). The February 2000 floods – the worst in living memory? Proc of Conf : Southern African floods of February 2000. Univ of Pretoria.

Van Der Merwe P. and Saayman, M.; Managing Game Farms from a Tourism Perspective – Published by the Institute for Tourism and Leisure Studies, North West University (2004).

Van Ginkel CE., Glen RP., Gordon-Gray KD., Cilliers CJ., Muasya M., Van Deventer PP. 2011. Wetland Plants. WRC Report No TT 479/10.

Van Oudtshoorn, F. 2004. Second Edition, Third Print. Guide to Grasses of South Africa. Briza Publications, Pretoria, RSA.

Van Oudtshoorn, F. (1999) Guide to Grasses of Southern Africa. Briza Publications, Pretoria.

Van Rooyen, N. 2001. Flowering plants of the Kalahari Dunes. Ecotrust cc, RSA.

Van Wyk, B. and Malan, S. (1998) Field Guide to the Wild Flowers of the Highveld. Struik Publishers, Cape Town.

Van Wyk, B., van Oudtshoorn, B. and Gericke, N. (1997) Medicinal Plants of South Africa. Briza Publications, Pretoria.

Van Wyk, B. and van Wyk, P. 1997. Field Guide to Trees of Southern Africa. Struik Publishers, Cape Town, RSA.

Van Wyk, B. van Wyk, P. and van Wyk, B. (2000) Photographic Guide to Trees of Southern Africa. Briza Publications, Pretoria.

Van Wyk, B., van Wyk, P. and van Wyk B.E. 2011. Photo Guide to Trees of Southern Africa. Briza Publications, Pretoria, RSA.

Walker, C. 2009. Twelfth impression. Signs of the Wild. Struik Publishers (Pty) Ltd, Cape Town, RSA.

WHO (2000). Guidelines for Air Quality, World Health Organisation, Geneva.

Wild en Jag dated July 2013 – "An Economic Outlook: The Wildlife Industry", by Bernard Groenewald and Richard York.

Wood Mackenzie -2012 – CoAL of Africa – Coking Coal Market Study.

Woodhall, S. 2005. Field Guide to Butterflies of South Africa. Struik Publishers (Pty) Ltd, Cape Town, RSA

WSM Leshika Consulting. (2012). Proposed Makhado Colliery Project Limpopo Province – Surface water assessment. Jacana Environmentals cc. Polokwane.

WSM Leshika Consulting. (2013). Generaal Coal Project: Groundwater flow impact assessment report. Jacana Environmentals cc. Polokwane.

Zietsman PC & Zietsman, LE. 2010. Department of Botany, National Museum. Bloemfontein Centre for Environmental Management, University of the Free State, Bloemfontein.