n

DEDET Ref: 17/2/3C NK31

Final Environmental Assessment Report

Part 2: Environmental Assessment

Proposed Eerstelingsfontein Mine, eMakhazeni (Belfast), Mpumalanga

Client: Exxaro Coal (Pty) Ltd

Date: November 2012

UNITED BY OUR DIFFERENCE

QUALITY MANAGEMENT

Issue/revision	Issue 1	Revision 1	Revision 2	Revision 3
Remarks	Draft Report for Public Consultation	Final Report for Public Consultation		
Date	March 2012	November 2012		
Prepared by	H Konigkramer J Fincham Surina Brink	J Fincham Surina Brink		
Signature				
Checked by	J McStay	J McStay		
Signature				
Authorised by	J McStay	J McStay		
Signature				
Project number	20023	20023		
File reference	2179ES_Exxaro_EF Mine_Final S24G Report_Part 2_2012-10			

WSP Environment & Energy
WSP House
1 on Langford
Langford Road
Westville 3629

P.O. Box 1442
Westville 3630, RSA

Tel +27 (0)31 240 8860
Fax +27 (0)31 240 8861
http://www.wspenvironmental.co.za

Reg. No: 1995/08790/07

CONTENTS

Part 2: Environmental Assessment

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION

Exxaro Coal (Pty) Ltd (Exxaro) is proposing to mine a coal resource at the Eerstelingsfontein site, south of eMakhazeni (formally Belfast), Mpumalanga. WSP Environment & Energy (WSP) was appointed by Exxaro to fulfil the role of independent Environmental Assessment Practitioner (EAP) in November 2010 to undertake the environmental assessment process.

The proposed Eerstelingsfontein Mine triggers a number of listed activities according to the Environmental Impact Assessment (EIA) Regulations of the National Environmental Management Act (107 of 1998) (NEMA). With the commencement of minor works on site, the project is the subject of a NEMA Section 24G application in order to obtain the necessary environmental authorisation from the Mpumalanga Department of Economic Development, Environment and Tourism (MDEDET).

An Environmental Assessment Report has been prepared to provide all the necessary information required by MDEDET to allow them to make a decision with regard to the proposed Eerstelingsfontein Mine. The report has been structured as follows:

Part 1: Introduction and Project Description

Part 2: Environmental Assessment (**this document**)

Part 3: Environmental Management and Closure Plan

This report represents the **final** Environmental Assessment Report and includes all updates made in red text to the draft Environmental Assessment Report following the 40 day consultation period. Any comments received on this final Report will need to be submitted directly to the Competent Authority, MDEDET for consideration in the determination of this Section 24G application.

1.1 PROJECT BACKGROUND

Exxaro operates a coal mining complex in the province of Mpumalanga, situated outside of the town of eMakhazeni. This complex is referred to as the North Block Complex (NBC) and consists of the Glisa and Strathrae coal mines as well as the proposed Eerstelingsfontein and Belfast Block projects. The NBC utilises both underground and opencast mining methods, and the coal mined is sold to various Eskom power stations.

The current coal supply from NBC's opencast and underground sections is expected to be exhausted within the next 3 to 4 years (end 2014). All the coal mined at NBC is blended to meet Eskom's quality specifications. Exxaro NBC is liable for substantial penalties in the event of under supply to Eskom. As the current coal reserves near the end of their lifespan, the quality (calorific value) of the coal reserve is deteriorating. The mining of Eerstelingsfontein site is required to provide the high quality coal required to blend with the coal from NBC's current operations. Without good quality coal to blend, Exxaro NBC would not be able to meet the contract requirements with Eskom and the substantial penalties may force the closure of the entire NBC operation.

The Eerstelingsfontein site, with a total lifespan of 2 years, will provide a short term bridge supply of coal necessary to allow NBC to remain operational until the proposed Belfast Block project comes on line. The Belfast Block is a significant coal resource (mining right area of ± 5820ha) approximately 10km southwest of eMakhazeni (Belfast).

A detailed project background and motivation, outlining the overall need for the Eerstelingsfontein Mine is provided in **Part 1: Introduction and Project Description**.

Investigations associated with the proposed Eerstelingsfontein Mine span in excess of 10 years. Submission of an Environmental Management Programme Report (EMPR) (GCS, 2004) resulted in the receipt of a mining right in terms of the Mineral and Petroleum Resources Development Act (MPRDA) (No. 28 of 2002) in June 2008. In addition, Exxaro received an integrated Water Use License in terms of the National Water Act (NWA) (No. 36 of 1998) in February 2010.

1.2 SITE LOCATION

The proposed Eerstelingsfontein Mine is located approximately 100km from Ermelo and 20km south of eMakhazeni on the farm Eerstelingsfontein 406 JT, Mpumalanga (**Figure 1**). The site lies within the Emakhazeni Local Municipality and the Nkangala District Municipality.

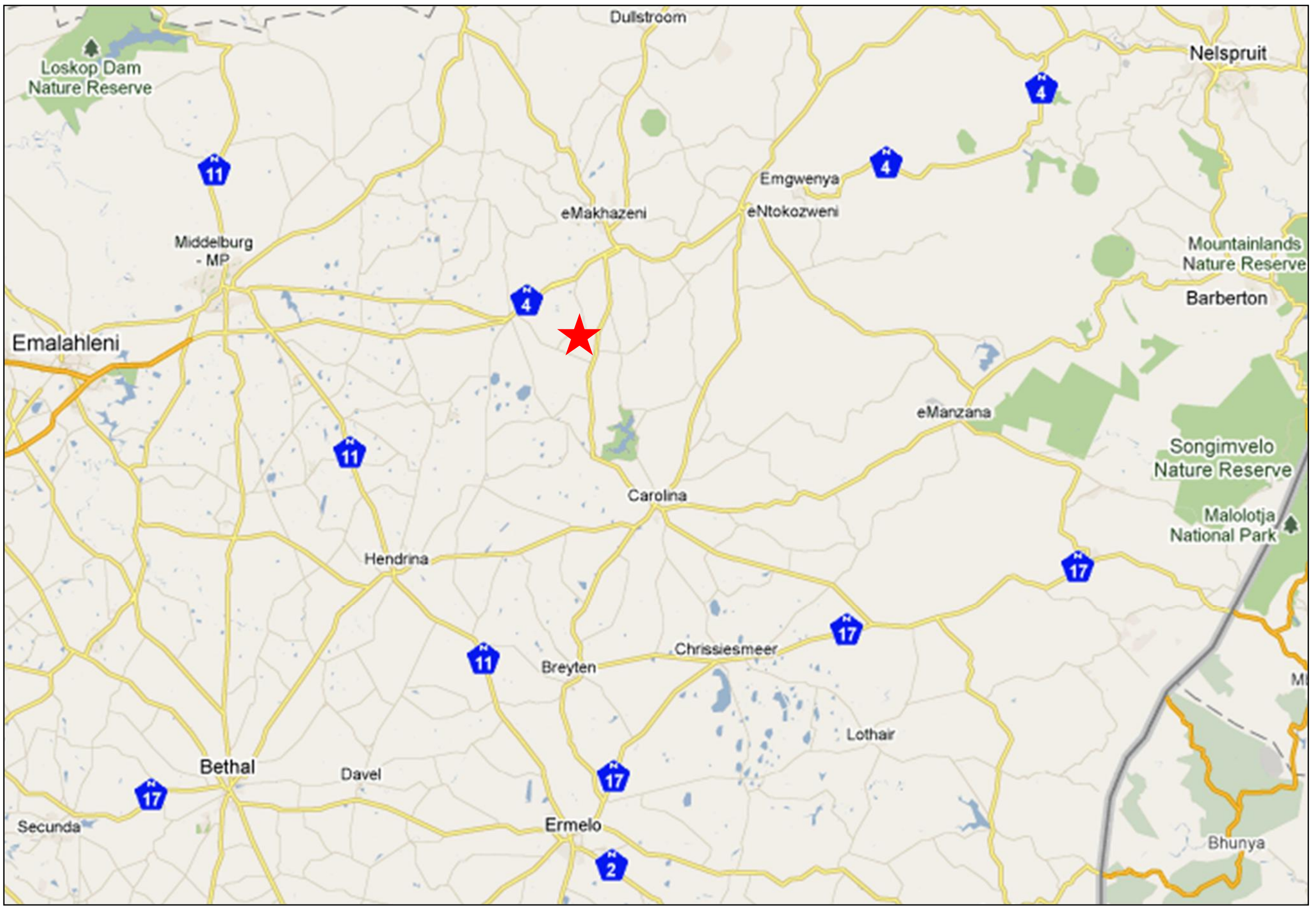


Figure 1 **Site Location and Regional Context (Google Maps, 2010)**

1.3 PROJECT OVERVIEW

The Eerstelingsfontein site will be an open cast mine, and will form part of Exxaro's NBC's Glisa Colliery, located just outside eMakhazeni. The site is intended to be mined using the open cast strip mining method. The coal reserve on site is a high quality, low sulphur coal with a single seam at a depth between 5m and 19m. It is estimated that a total of 2.4 million tons of coal will be mined during a period of 2 years. Coal mined at Eerstelingsfontein will be transported to Glisa Colliery, where it will be processed.

The proposed site comprises 8 portions of the farm Eerstelingsfontein 406 JT (Mpumalanga), totalling 314 hectares (ha) in extent.

1.3.1 Project Scope

The proposed coal mine will consist of:

- A total development footprint of approximately 227 ha, consisting of:
  - Open cast pit: 110 ha
  - Buildings and plant equipment: 64 ha
  - Other (i.e. road infrastructure; stockpile areas, etc.): 53 ha
- 2 x coal stockpiles of approximately 15 000m^3 each (30 000m^3 total volume);

- 2 x overburden stockpiles for temporary stockpiling of overburden prior to returning material to the pit (roll over method);
- 1 x pollution control dam with an area of 6 050m^2, volume of 12 332m^3, and height of 2.8m;
- Sewage septic tanks and associated treatment system with an estimated annual capacity of 2400 to 6000m^3,
- 11 KV power line; and
- on site road infrastructure.

A detailed project description is included in **Part 1: Introduction and Project Description**.

1.3.2 Commencement of Activities

Site establishment activities occurred on the Eerstelingsfontein site during the period March and June 2010. Commencement of activity on site was in the form of construction of the main haul road to service mining activities on site. The activity is characterised by an excavation across the site (on a north-west transect). The overall footprint of the excavation represents approximately 1 ha of disturbance.

<u>The Section 24G application (for which this report has been compiled as supporting documentation) is seeking approval for the activities which commenced in 2010, as well as overall approval of the proposed project as a whole.</u>

1.4 PROJECT APPLICANT

The applicant for the proposed Eerstelingsfontein Mine is Exxaro Coal (Pty) Ltd (**Table 1**).

Table 1 Applicants Details

Project Applicant: Exxaro Coal (Pty) Ltd	
Contact Person:	Simon Mkhonza
Physical Address:	Paardeplaats 406JT
Postal Address:	P O Box 321, Belfast, 1100
Telephone:	013 253 7321
Fax:	013 253 7360
E-mail:	simon.mkhonza@exxaro.com

1.5 ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)

WSP was appointed by Exxaro Coal (Pty) Ltd to fulfil the role of independent EAP to facilitate the environmental authorisation process (**Table 2**). WSP is a leading international environmental consultancy with a broad range of expertise in the environmental industry. WSP is a subsidiary of WSP Group plc, a global consultancy which is listed on the London Stock Exchange. WSP has successfully project managed a number of high profile environmental projects in South Africa over the past 20 years.

Table 2 EAP Details

Environmental Assessment Practitioner: WSP Environmental (Pty) Ltd	
Contact Person:	Hilary Konigkramer
Physical Address:	WSP House, 1 on Langford, Langford Road, Westville, Durban, 3629
Postal Address:	P O Box 1442, Westville, 3630
Telephone:	031-240 8860

Fax:	031-240 8861
E-mail:	hilary.konigkramer@wspgroup.co.za

2 ENVIRONMENTAL ASSESSMENT

2.1 SPECIALIST STUDIES

Due to the nature of the proposed activity, a wide range of specialist investigations have been undertaken (**Table 3**), the findings of which are described and assessed in **Part 2: Environmental Assessment (this document)**.

Table 3 Specialist inputs

Specialist Studies	Specialist Consultant
Terrestrial and Aquatic Ecology	Natural Scientific Services CC
Surface Water Assessment (including Water and Salt Balance)	WSP Environment & Energy
Groundwater Assessment	WSP Environment & Energy; in collaboration with the Institute of Groundwater Studies, University of Free State.
Air Quality Assessment	WSP Environment & Energy
Noise Assessment	WSP Environment & Energy
Heritage Impact Assessment	Archaetnos CC
Visual Impact Assessment	B Gebhardt
Socio-Economic Assessment	WSP Environment & Energy; in collaboration with Nomad Socio-Economic Consulting CC
Blast and Vibration Assessment	Blast Management & Consulting
Traffic Impact Assessment	WSP Environment & Energy
Agricultural Land-use Assessment	WSP Environment & Energy
Rehabilitation and Closure Assessment	WSP Environment & Energy

All specialist studies were initiated on the basis of the conceptual layout plan (**Figure 2**) indicating mine infrastructure associated with the proposed Eerstelingsfontein Mine, provided by Exxaro. A more detailed mine infrastructure plan (**Figure 3**) was produced by Exxaro in May 2011, which was made available to all specialists to inform their investigations.

All specialist studies conducted for the proposed Eerstelingsfontein Mine are summarised within **Chapters 3 and 12**, and appended to this report (**Appendix A to J**) with the exception of the Rehabilitation and Closure Assessment which is included in **Part 3: Environmental Management and Closure Plan**.

During the mining of the Eerstelingsfontein site, three mine stages will occur over a 2 year period (**Figure 4**). Many of the specialist studies have considering the impacts pre-mining, during the various mining stages, and post decommissioning in their investigations.

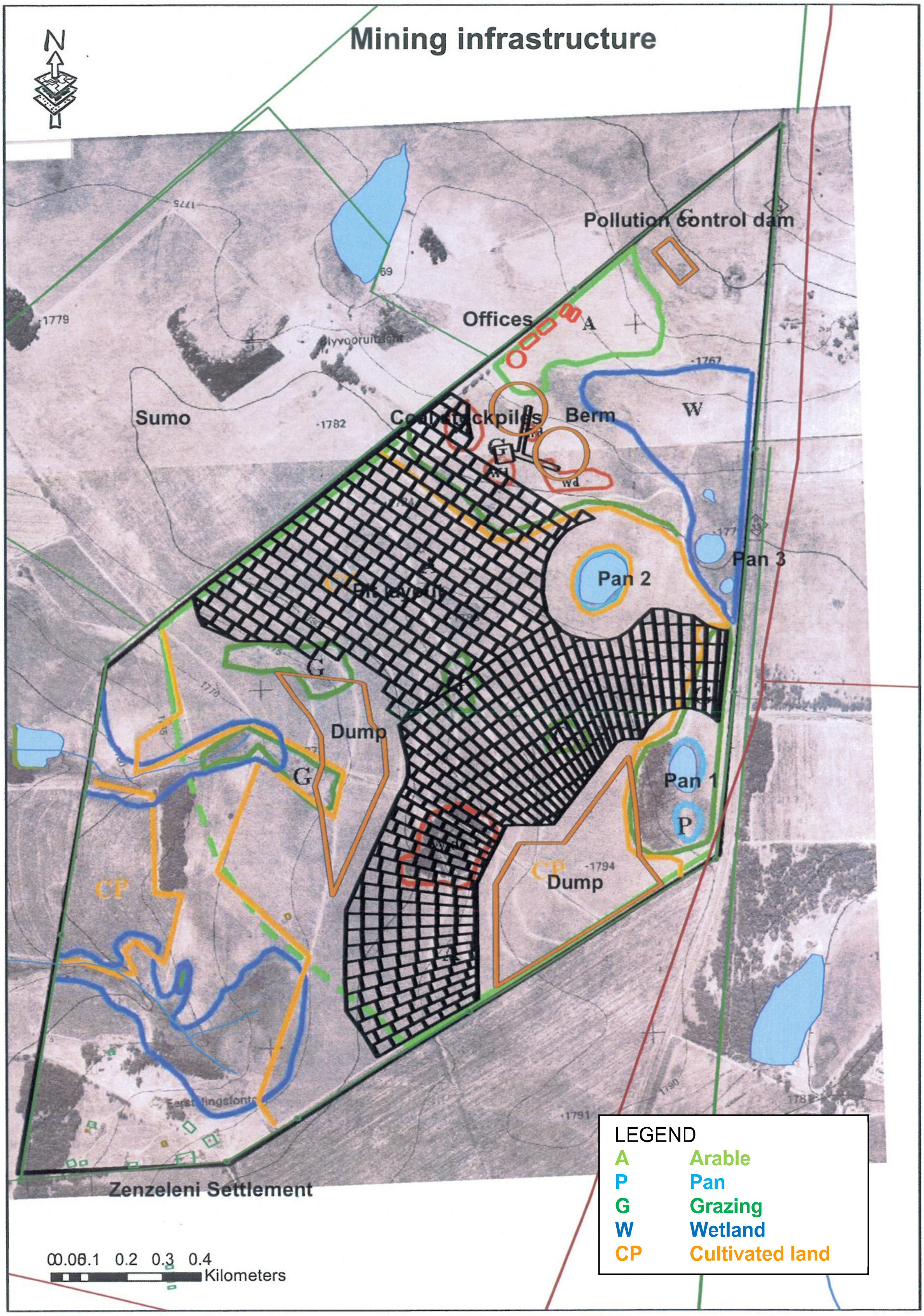

Mining infrastructure
Pollution control dam
Offices
Sumo
Coal stockpiles
Berm
Pan 2
Pan 3
Pan 1
Dump
Dump
Zenzeleni Settlement
LEGEND
A Arable
P Pan
G Grazing
W Wetland
CP Cultivated land
0 0.05 0.1 0.2 0.3 0.4
Kilometers

Figure 2 **Conceptual Layout Plan for Proposed Eerstelingsfontein Mine (Exxaro, 2009)**

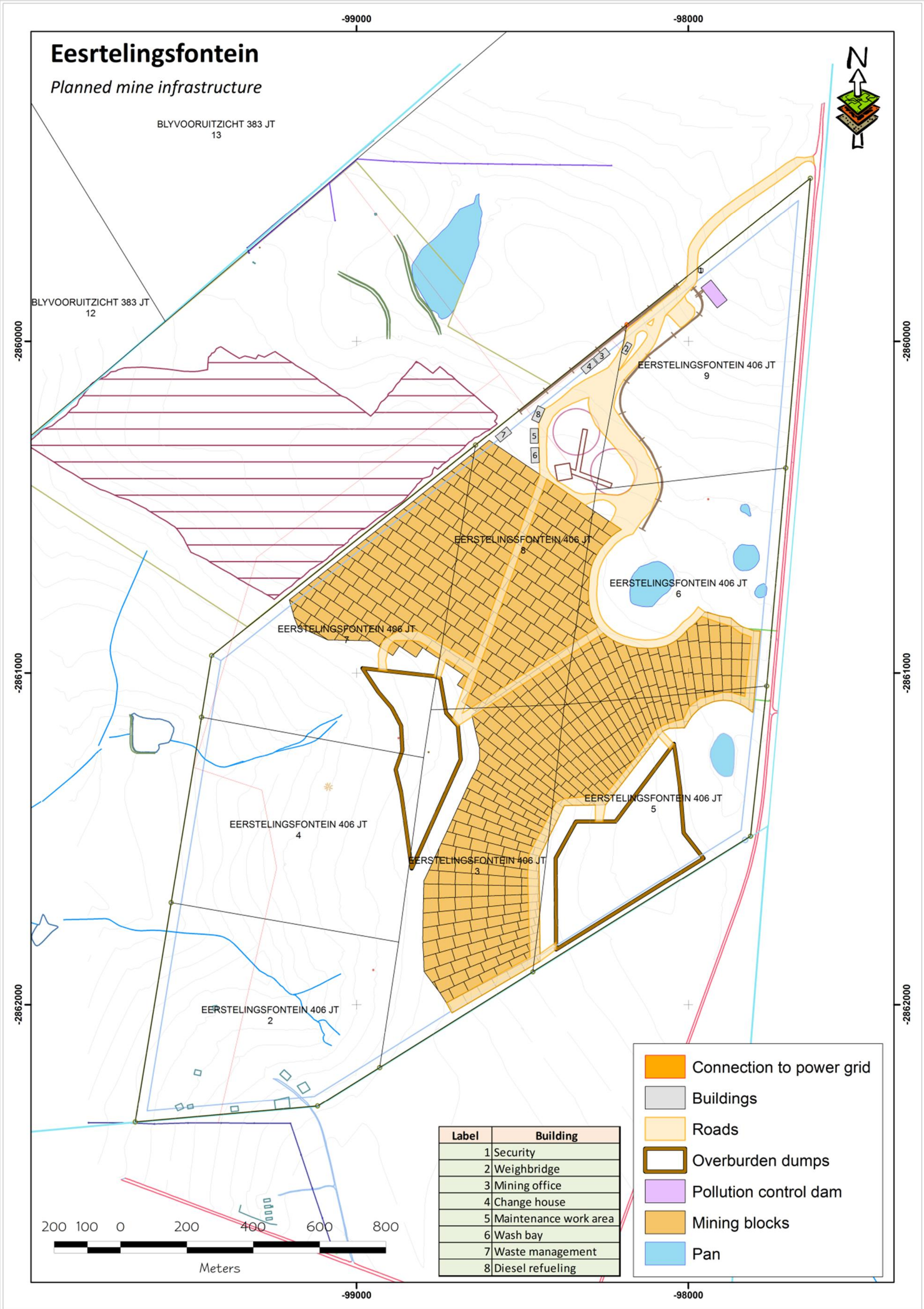


Figure 3 Infrastructure Plan for Eerstelingfontein Mine (Exxaro, May 2011)

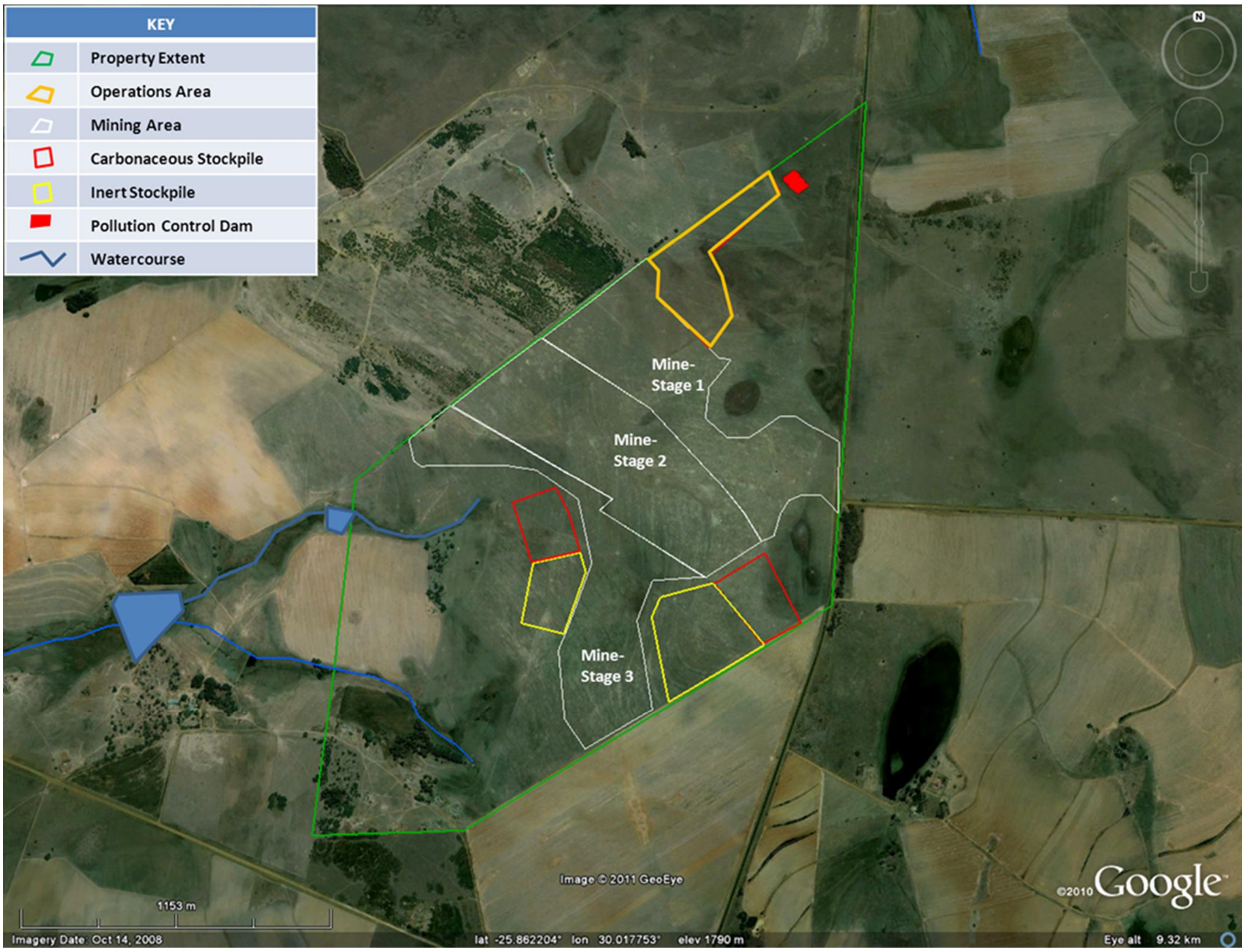


Figure 4 **Proposed Mine Stages (WSP, 2011)**

2.2 ASSESSMENT METHODOLOGY

Potential environmental impacts associated with the project have been evaluated using recognised semi-quantitative risk assessment methodology. This methodology has been developed to ensure all procedures for the investigation, assessment and communication of the potential consequences or impacts of activities on the environment as set out in NEMA 24(4b) are met. In addition, the impact assessment methodology must ensure that all information requirements of the EIA Regulations 22(2)(i) and 31(2)(l) are provided. In order to assess the significance as objectively as possible, the following criteria have been used:

- SEVERITY of the impact
- DURATION of the impact
- SPATIAL SCALE (EXTENT) of the impact
- FREQUENCY of the ACTIVITY
- FREQUENCY of the OCCURRENCE (PROBABILITY) of the impact

(Severity, Duration and Spatial Scale → **Consequence**; Frequency of the Activity and Frequency of the Occurrence → **Likelihood**; Consequence and Likelihood → **Significance**)

This system derives environmental significance on the basis of the consequence of the impact on the environment and the likelihood of the impact occurring**. Tables 4 to 9** describe the process in detail.

2.2.1 Determining Consequence

Consequence is determined based on the consideration of a combination of severity, duration and extent of the environmental impact.

Table 4 Assessment of the Nature of the Impact and its Severity

Number Reference for Impact Table	Description
1	Negligible / non-harmful / minimal deterioration
2	Minor / potentially harmful / measurable deterioration
3	Moderate / harmful / moderate deterioration
4	Significant / very harmful / substantial deterioration
5	Irreversible / permanent

Table 5 Assessment of Impacts Duration and degree to which the impact can be reversed

Number Reference for Impact Table	Description
1	Less than 1 month / quickly reversible
2	Less than 1 year / quickly reversible
3	More than 1 year / reversible over time
4	More than 10 years / reversible over time / life of project or facility
5	Beyond life of project of facility / permanent

Table 6 Assessment of Impacts Extent

Number Reference for Impact Table	Description
1	Within immediate area of activity
2	Surrounding area within project boundary
3	Beyond project boundary
4	Regional / provincial
5	National / international

2.2.2 Determining Likelihood

Likelihood considers the frequency of the activity together with the probability of an environmental impact associated with that activity occurring.

Table 7 Assessment of the Impacts Frequency

Number Reference for Impact Table	Description
1	Less than once a year
2	Once in a year
3	Quarterly
4	Weekly
5	Daily

Table 8 Assessment of the Impacts Probability

Number Reference for Impact Table	Description
1	Almost impossible
2	Unlikely
3	Probable
4	Highly likely
5	Definite

2.2.3 Determining Overall Impact Significant

Overall significance is determined using the professional judgement based on a clear understanding of the nature of the impact, its severity, the duration and degree to which the impact can be reversed as well as the extent of the impact. These aspects define the impacts consequence which must be considered against the likelihood of the impact occurring in order to assign an overall significance of the impact.

The status of the impact must be defined, and the impact can either be positive, neutral or negative. A positive impact is where an activity will have a social/ environmental/ economic benefit. A neutral impact is when an activity will have no effect. Finally, a negative impact is when an activity will be harmful socially/ economically/ environmentally.

Significance should be assigned according to the below definitions:

Table 9 Significance of Impact description

Significance	Description
No Change	A potential concern which was found to have no impact when evaluated
Very Low	Impacts will be site specific and temporary with no mitigation necessary
Low	Impact will have a minor influence on the biophysical and/or social environment, and will not have an influence on the decision.
Medium	Impact will have a moderate influence on the biophysical and/or social environment, and it should have an influence on the decision unless it is mitigated.
High	Impact will have a major influence on the biophysical and/or social environment, and would influence the outcome regardless of any possible mitigation

3 TERRESTRIAL AND AQUATIC ECOLOGY

3.1 TERMS OF REFERENCE

WSP Environmental and Energy contracted Natural Scientific Services (NSS) to conduct a detailed biodiversity assessment including terrestrial flora and fauna, aquatic and wetland components for the proposed new Eerstelingsfontein opencast coal mine site (**Appendix A**). The development of a Biodiversity Management Action Plan (BMAP) for the mine site was also included in the scope of work.

NSS undertook the first seasonal study in November 2010 which represented the drier season and took the form of an EcoScan. This survey was then supported by a further more detailed sampling survey undertaken in March 2011 which represented the wetter season. Following these two site surveys a draft report was produced (in August 2011). In October 2011, Exxaro commissioned Digby Wells and Associates to conduct a peer review of the wetland delineation component of NSS's investigation. The peer review resulted in a slightly modified wetland delineation. In addition, Digby Wells and Associates highlighted the presence of an IUCN Red Data plant species, *Khadia carolinensis* which is listed as Vulnerable (VU). The findings of the peer review were considered by NSS and a further site visit was arranged for both the NSS and Digby Wells and Associates specialists to discuss the wetland delineation. Where agreed, amendments were made to the wetland delineation and the assessment of the sensitivity of the vegetation on the site resulting in the finalisation of the NSS Biodiversity Assessment Report.

A summary of NSS's Biodiversity Assessment Report, dated February 2012 (**Appendix A**), covering the areas of (1) vegetation community structure; (2) fauna; (3) aquatic ecology; and (4) wetlands, is provided below.

3.2 VEGETATION COMMUNITY STRUCTURE

3.2.1 Methodology

Vegetation community studies incorporated two sampling seasons, the drier season in November/December 2010, and the wetter season in March 2011. A desktop study was conducted to generate a checklist of expected flora and to identify Conservation Important (CI) species in the region with reference to literature and various data bases.

Sample plots were used during the field survey to determine vegetation communities within the study area. These were established in representative areas of vegetation. TWINSPAN data analysis programme was used to analyse the community trends within the site. The full details on the methodology used are presented within the technical report included as **Appendix A**.

3.2.2 Baseline Findings

The proposed Eerstelingsfontein mine site falls predominantly within the Endangered Eastern Highveld Grassland (Mucina and Rutherford, 2006). This grassland biome is highly diverse and under threat through anthropogenic influences. This is observed in the study area, indicated by land-cover data, whereby agriculture has had an extensive impact on the study site and surrounding areas. Over 65% of the study area consists of transformed pasture grass fields. Natural grasslands and associated hydromorphic wetland areas constitute only 25% of the study area, with the total number of families and species present being 36 and 104 respectively. Wooded alien invasive bush clumps, crop fields and homestead make up the remaining 10% (**Table 10**). Alien infestations mainly occurred along the newly cleared areas for the road network. Vegetation communities associated with the Eerstelingsfontein site are illustrated in **Figure 5**.

Table 10 Vegetation units and approximate extent within the study area (NSS, 2012)

Code	Vegetation Units	National Vegetation Type	Size (ha)
A	*Eragrostis plana – Crepsis* Dryland Pasture Grassland	Eastern Highveld Grassland (EHG)	48.86
B	*Eragrostis plana – Lobelia flaccida Moist Pasture Grassland*	EHG	157.1
C	Themeda triandra – Chironia palustris Open Grassland *Diospyros lycioides – Tristachya leucothrix*	EHG	31.6

	C.1 Rocky Outcrops		
D	*Agrostis lachnantha – Andropogon eucomus Moist Grassland*	EHG	41.43
E	*Koeleria capensis - Centella asiatica* Moist Grassland		
F	*Leersia hexandra - Juncus oxycarpus* Wetlands	EHG	4.64
	Other land units (wooded alien invasive bushclumps, crop fields and homestead)		31.829
	TOTAL AREA		**315.41**

These vegetation units have been mapped across the site and are presented in **Figure 5** below.

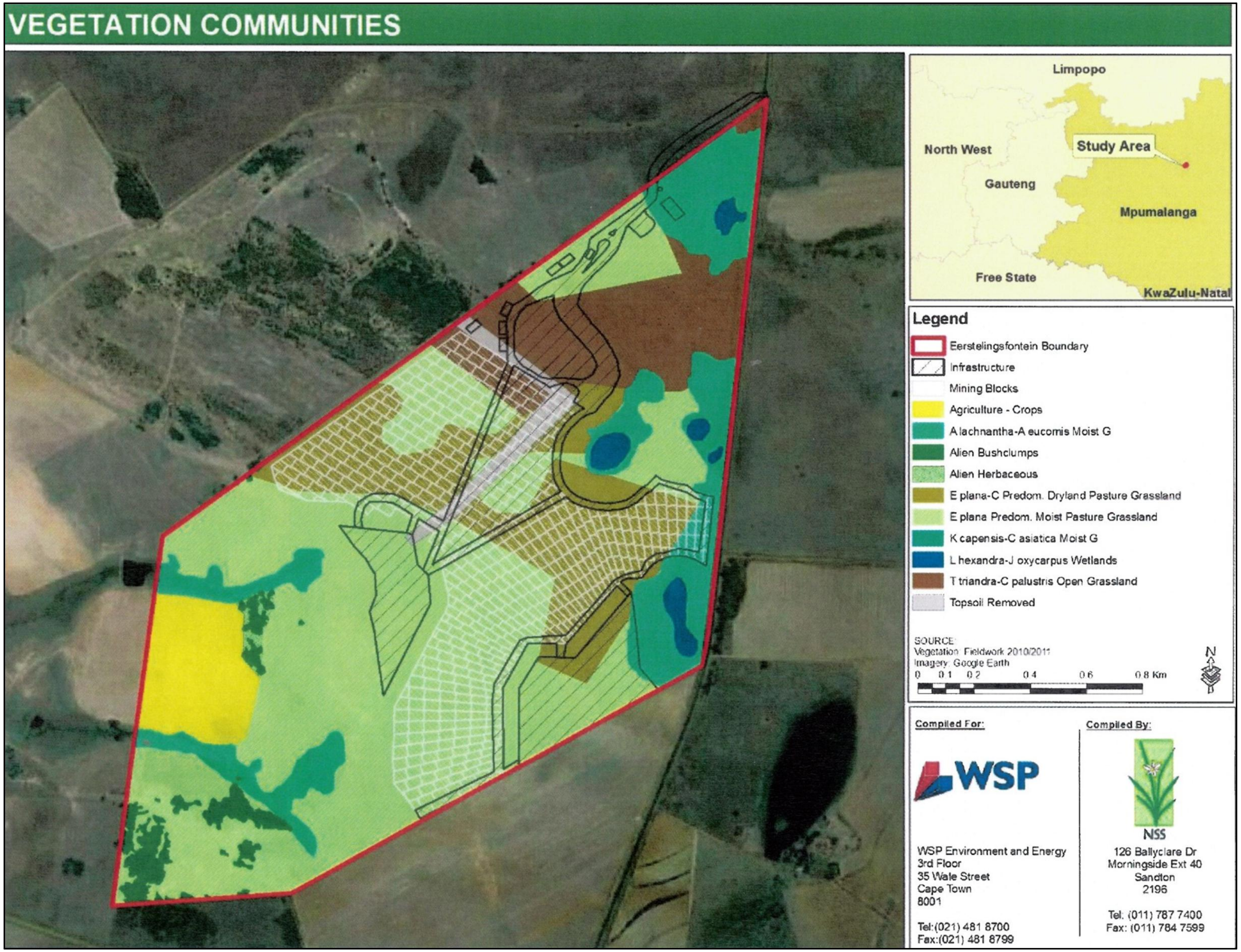


Figure 5 **Vegetation communities present within the proposed Eerstelingsfontein Mine site (NSS, 2012)**

- <u>Conservation Important (CI) Species</u>

There are 9 CI species identified in terms of The Red List of South African Plants (Raimondo et al, 2009) and Ordinance Listings in terms of the Mpumalanga Nature Conservation Act (57 of 1998), were found to be present within the study area (**Table 11**) (**Figure 6**). One of the CI species that is present within the study area is the **Vulnerable** species *Khadia carolinesis*.

Khadia carolinensis *Habenaria galpinii* *Watsonia bella* *Eucomis autumnalis*

Figure 6 Photographic representation of some of the CI species from the Eerstelingsfontein study area

Table 11 **Conservation Important Species found within the study area (NSS, 2012)**

Family	Scientific name	Common name	Status
AMARYLLIDACEAE	*Brunsvigia radulosa*	Candelabra Flower ***Flowering Time***	Protected *December-February*
HYACINTHACEAE	*Eucomis autumnalis*	Common Pineapple Flower ***Flowering Time***	Protected & Declining *December-February*
IRIDACEAE	*Dierama insigne*	Hair bell ***Flowering Time***	Protected Spring-Summer (particularly December)
IRIDACEAE	*Gladiolus crassifolius*	Thick-leaved Gladiolus ***Flowering Time***	Protected All Summer
IRIDACEAE	*Watsonia bella*	Bugle Lily ***Flowering Time***	Protected Summer-December
LILIACEAE	*Aloe ecklonis*	Ecklons Aloe ***Flowering Time***	Protected November-January
MESEMBRYANTHEMA CEAE	*Khadia carolinesis*	- ***Flowering Time***	Vulnerable & Protected Late Spring – Early Summer
ORCHIDACEAE	*Habenaria filicornis*	Terrestrial orchid ***Flowering Time***	Protected February-April
ORCHIDACEAE	*Habenaria galpinii*	Terrestrial orchid ***Flowering Time***	Protected February-March

- <u>Species with Medicinal or Cultural Value</u>

Plants that contain medicinal or cultural uses are considered as species with conservation importance. From NSS's field investigations, within hte boundaries of the study area almost 28% of the total species identified contained a form of medicinal or cultural use (**Appendix A**).

- Alien and Invasive Species

Alien species, especially invasive species, represent a significant threat to the ecological functioning of natural systems and to the productive use of land.

In terms of the regulations promulgated under the Conservation of Agriculture Resources Act, 1983 (Act No. 43 of 1983), landowners are legally responsible for the control of alien species on their properties. In accordance with the Act, declared weeds and invasive species have been divided into the following three categories:

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

The protection of our natural systems from invasive species is further emphasised in the National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004), whereby responsibility is apportioned to the owner of the land on which a listed invasive species occurs.

During NSS's field investigations 16 alien and invasive species were identified within the study area (approximately 17% of the total species recorded). Four Category 1 and six Category 2 listed alien invasive species were logged and the distribution of alien and invasive species within the study area was mapped by NSS (**Appendix A**).

Occurrence of alien wooded species is most severe in the wetland systems to the west. Within the pasture grass areas the Category 1 species *Solanum sisymbriifolium* and *Cirsium vulgare* were found wherever there was soil disturbance. The recently cleared area to the north of the site contained numerous clumps of the problematic plant, *Solanum sisymbriifolium.*

3.2.3 Areas of Conservation Concern

NSS assigned each vegetation community (**Table 10**) a rating based on sensitively and ecological significance (**Table 12; Figure 7**). The following communities obtained a high rating:

- *Koeleria capensis - Centella asiatica* Moist Grassland
- *Agrostis lachnantha - Andropogon eucomus* Moist Grassland
- *Leersia hexandra - Juncus oxycarpus* Wetlands
- *Diospyros lycoides – Tristachya leucothrix* Rocky Outcrops

These areas contain a unique array of species, including a number of Protected species as well as the Declining (Red listed) *Eucomis autumnalis* subsp *clavata*. These areas were also limited in terms of disturbance and transformation. These are the last remaining natural systems in the study area and are habitat for a number of threatened faunal species. These systems provide refuge and corridors for faunal movement and floral dispersal to areas outside the proposed mine site.

Although pressured upon by surrounding pasture communities, the *Themeda triandra – Chironia palustris* Open Grassland vegetation unit still contains a diverse number of floral species. Large communities of *Gladiolus* are present within this community as well as a population of *Khadia carolinensis* identified by Digby Wells and Associates (2011).This unit also contains the High rated *Diospyros lycoides –Tristachya leucothrix* Rocky Outcrops (**Table 12**).

Although the rating of the Eragrostis plana – Crepsis Dryland Pasture Grassland is regarded to be of medium significance it does contain a population of the Vulnerable species– Khadia carolinesis (Digby Wells & Associates, 2012). The proposed protection strategy currently proposed by Digby Wells & Associates is to provide a 400m around the identified plants until such time that a relocation strategy is approved by the relevant Departments (NSS 2012).

Table 12 Summary of Vegetation Communities and their status (NSS, 2012)

Vegetation Unit	National / Regional Status	Species Diversity	CI Floral Species	Providing habitat for CI faunal species	Extent of Disturbance	Rating
Koeleria capensis - Centella asiatica Moist Grassland	MGPS : EHG (3)	Moderate – High (5)	Yes (4)	Yes (5) Crowned Crane	Limited (4)	High
Agrostis lachnantha – Andropogon eucomus Moist Grassland	MGPS : EHG (3)	Moderate – High (5)	Yes, TSP Declining (5)	Yes (5) Crowned Crane; Bald Ibis	Limited (4)	High
Leersia hexandra - Juncus oxycarpus Wetlands	MGPS : EHG (3)	Moderate (4)	Yes (4)	Yes (5) *Metisella Meninx*	Limited (5)	High
Themeda triandra – Chironia palustris Open Grassland	MGPS : EHG (3)	Moderate (4)	Yes (4)	Probable (4)	Limited – Overgrazing; Clearing of vegetation for haul road (3)	Moderate - High
Diospyros lycioides – Tristachya leucothrix Rocky Outcrops	MGPS : EHG (3)	Moderate – High (5)	Possibly (3)	Probable (4)	Limited (5)	High
Eragrostis plana – Crepsis Dryland Pasture Grassland	MGPS : EHG (2)	Low (1)	Yes (4)	Possibly (3)	Transformed – Pasture Fields; Extensive Grazing; Clearing of vegetation for haul road (1)	Medium
Eragrostis plana – Lobelia flaccida Moist Pasture Grassland	MGPS : EHG (2)	Moderate – Low (2)	Unlikely (2)	Possibly (3)	Transformed – Pasture Fields; Extensive Grazing; Clearing of vegetation for haul road(1)	Medium - low

MGPS: SANBI Moist Grassland Priority Sites; EHG: Eastern Highveld Grassland
Rating 1-5 (5 = Top Priority / High Diversity / Least Disturbance; Maximum Score 25)

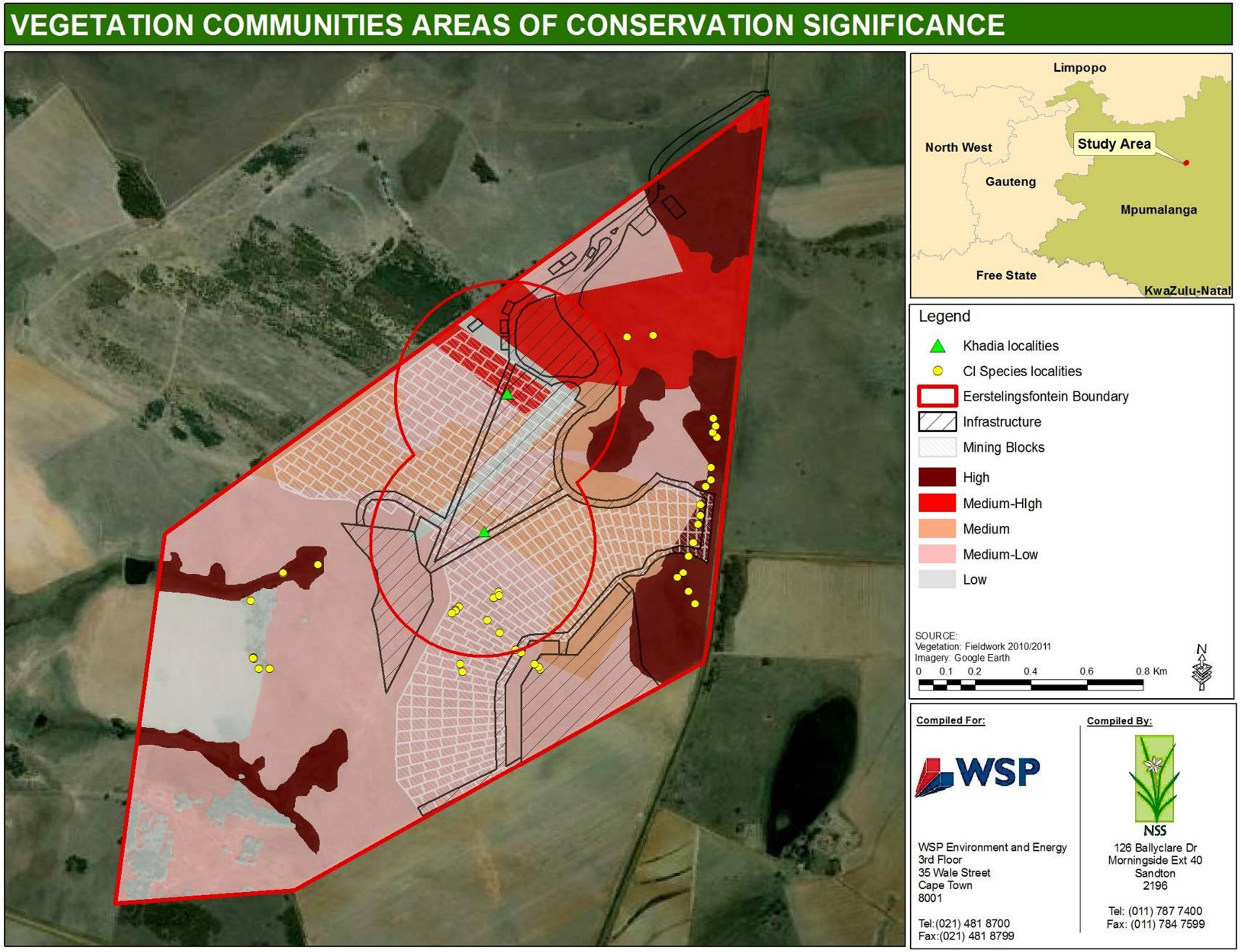
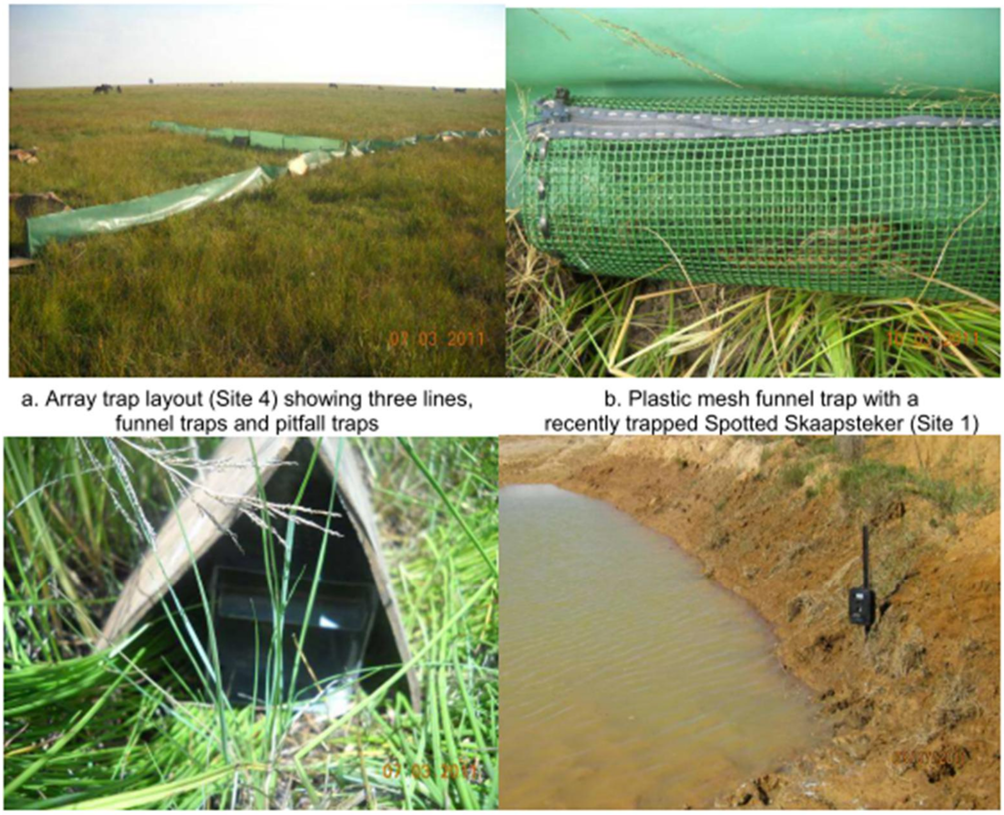


Figure 7 **Vegetation Communities – Areas of Conservation Significance (NSS, 2012)**

3.3 FAUNA

3.3.1 Methodology

Faunal studies incorporated two sampling seasons, the drier season in November/December 2010, and the wetter season in March 2011. Methods used for the study of faunal species included a desktop review and fieldwork, which included live trapping, active searching for species and setting of baited motion cameras (**Figure 8**) (**Appendix A**).



a. Array trap layout (Site 4) showing three lines, funnel traps and pitfall traps

b. Plastic mesh funnel trap with a recently trapped Spotted Skaapsteker (Site 1)

c. Sherman mammal trap with wooden covers (Site 1)

d. Motion-sensitive camera (NSS2)

Figure 8 Faunal sampling methods (NSS, 2012)

3.3.2 Baseline findings

The assessment of terrestrial fauna included five animal groups: mammals, avifauna, reptiles, amphibians and macro-invertebrates (**Table 13**).

Table 13 Numbers of faunal species identified on the Eerstelingsfontein site

Animal Group	Total
Mammals	16
Avifauna	79
Reptiles	2
Amphibians	6
Macro-invertebrates	31

3.3.2.1 Mammals

Research has demonstrated that the Mpumalanga Province supports a high faunal diversity, including 163 mammal species, of which 98 species fall into the small mammal category. Of these 163 mammal species, 16 mammal species have been recorded at the Eerstelingsfontein Mine site (**Appendix A**) from the following field visits: the 2004 EMPR (7 species), NSS's December 2010 Ecoscan (4 species) and NSS's March 2011 detailed field assessment (14 species). **Table 14** provides the full list of the mammal species recorded from the Eerstelingsfontein opencast project site.

Table 14 Mammals recorded from the Eerstelingsfontein site

FAMILY	SCIENTIFIC NAME	COMMON NAME	CONSERVATION STATUS	EMPR (2004)	NSS (2010)	NSS (2011)
BATHYERGIDAE	*Cryptomys hottentotus*	African mole-rat	LC	1		1
BOVIDAE	*Raphicerus campestris*	Steenbok	LC	1		1
BOVIDAE	*Sylvicapra grimmia*	Common duiker	LC	1		1
CANIDAE	*Canis mesomelas*	Black-backed jackal	LC			1
HERPESTIDAE	*Suricata suricatta*	Meerkat	LC			1
HYSTRICIDAE	*Hystrix africaeaustralis*	Cape Porcupine	LC	1	1	1
LEPORIDAE	*Lepus saxatilis*	Scrub Hare	LC	1	1	1
MURIDAE	*Rhabdomys pumilio*	Four-striped grass mouse	LC			1
MURIDAE	*Tatera brantsii*	Highveld gerbil	LC		1	1
ORYCTEROPODIDAE	*Orycteropus afer*	Aardvark	LC	1		
SCIURIDAE	*Xerus inauris*	South African ground squirrel	LC			1
SORICIDAE	*Crocidura cyanea*	Reddish-grey musk shrew	DD			1
SORICIDAE	*Myosorex sp.*	Forest shrew	DD			1
VESPERTILIONIDAE	*Neoromicia capensis*	Cape serotine bat	LC			1
VIVERRIDAE	*Atilax paludinosus*	Water Mongoose	LC			1
VIVERRIDAE	*Cynictis penicillata*	Yellow Mongoose	LC	1	1	1

3.3.2.2 Avifauna

Mpumalanga supports a highly diverse bird life, with over 567 birds recorded within the province, of which 71 are Red Data species. Of these 567 birds, 79 have been cumulatively recorded on the site during the 2004, 2010 and 2011 past surveys (**Appendix A**).

One of the CI bird species that was found at the Eerstelingsfontein Mine site, not previously recorded in the vicinity by the South African Bird Atlas Project, is *Crex crex* (Corncrake).

3.3.2.3 Reptiles

Reptiles are difficult to comprehensively detect during short field surveys, however reptile species recorded on site during the March 2011 assessment were *Philothamus hoplogaster* (Green water snake) and *Psammophylax rhombeatus* (Spotted skaapsteker).

Published data from the South African Frog Atlas (Minter et al. 2004) was used to compile a list of 30 amphibian species that could occur within the study area. Conditions during the baseline survey were favourable to frog activity and 6 (representing 35%) of the most likely expected diversity of frog species were encountered. These include *Amietia fuscigula* (Cape river frog*), Cacosternum boettgeri* (Common caco), *Strongylopus fasciatus* (Striped stream frog), *Xenopus laevis* (Common platanna), *Semnodactylus wealii* (Rattling frog) and *Amietophrynus gutturalis* (Guttural toad).

3.3.2.4 Terrestrial Macro-Invertebrates

At least 31 families of invertebrates have been confirmed from the study area during the NSS field visits (**Appendix A**). Some examples include the Opal butterfly, Skimmer dragon fly and the grass funnel-web spider. As South Africa supports an enormous diversity of insects and other macro-invertebrate fauna, the numbers of terrestrial macro-invertebrates identified within the study area is far from a representative list of the actual diversity present there (NSS, 2011).

3.3.3 Conservation Important (CI) Species

The most recognised criteria for categorising the level of threat that species are facing, is the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. The IUCN Red List categories were developed as a simple and widely understood system for classifying species which are at high risk of global extinction. The overall purpose of the system is to provide a clear, objective framework for the classification of the broadest range of species according to their extinction risk. The IUCN categories are as follows:

- Extinct
- Extinct in the wild
- Critically endangered
- Endangered
- Vulnerable
- Near threatened
- Least concern

South African Atlases and Red Data Books for mammals, birds, frogs and butterflies have recently been published by Friedman & Daly (2004), Barnes (2000), Minter et al. (2004) and Henning et al. (2009) respectively, while the Reptile Conservation Atlas is in progress (NSS, 2011). These National listings follow the IUCN system for categorising the conservation status of species. The National Environmental Management: Biodiversity Act (10 of 2004) provides a further listing of threatened and protected species that occasionally differs with the other listings.

NSS considered both the IUCN and National listings in order to determine the CI species relevant to the proposed mine site, the results of which are summarised under the relevant faunal groups below.

3.3.3.1 Mammals

The desktop review revealed 33 CI mammal species that could potentially occur within the study site. Two of these red data species have been confirmed as present within the study area, namely *Crocidura cyanea* (Reddish-grey musk shrew) and *Myosorex varius* (Forest shrew). A further 3 CI mammals were reported within the vicinity of the site (surroundings farms) by Mpumalanga Parks: the endangered *Ourebia ourebi* (Oribi), and the near threatened *Orycteropus afer* (Aardvark) and *Rhinolophus clivosus* (Geoffroy's horseshoe bat).

3.3.3.2 Birds

The desktop review identified 11 CI bird species, having been recorded by South African Bird Atlas Program (1 & 2) for the study area and surrounds, all having a Red Data classification. A further 2 CI birds (Botha's Lark and Wattled Crane) were reported on surrounding farms by Mpumalanga Parks and thus may be encountered on the mine site. These 2 birds have a high conservation status and are thus worth noting. Of the 11 CI bird species previously recorded on the site, 5 were confirmed to be observed. A summary of the CI birds confirmed on site is provided below.

- Southern Bald Ibis (*Geronticus calvus*) – The estimated South African population is less than 10000 birds, and this species is endemic to the region, making it a VULNERABLE species. There is a small breeding colony located 13km NE of the site, which may utilise the proposed site.
- Blue Crane (*Anthropoides paradiseus*) – This endemic species has an estimated South African population of between 15000 and 25000 birds, as such is listed as VULNERABLE. The proposed mining area appears to be only an occasional foraging site for Blue Cranes (based on fieldwork and records reviewed).

- Grey Crowned Crane (*Balearica regulorum*) – The estimated South African population is approximately 2800 to 3000 individuals, and is thus VULNERABLE. This species is likely to be utilising the site regularly for foraging in and around the seasonal pans and natural grasslands.

A distribution comparison map between SABAP 1 and SABAP 2 shows a significant decline in Grey Crowned Crane sightings (**Figure 9**). The project area is indicated by the black arrow. Red squares indicate where the species has disappeared and orange blocks indicate where it is declining. This reliable information strengthens the importance of the sightings at the Eerstelingsfontein site and the need for the protection of sites frequented by these birds.

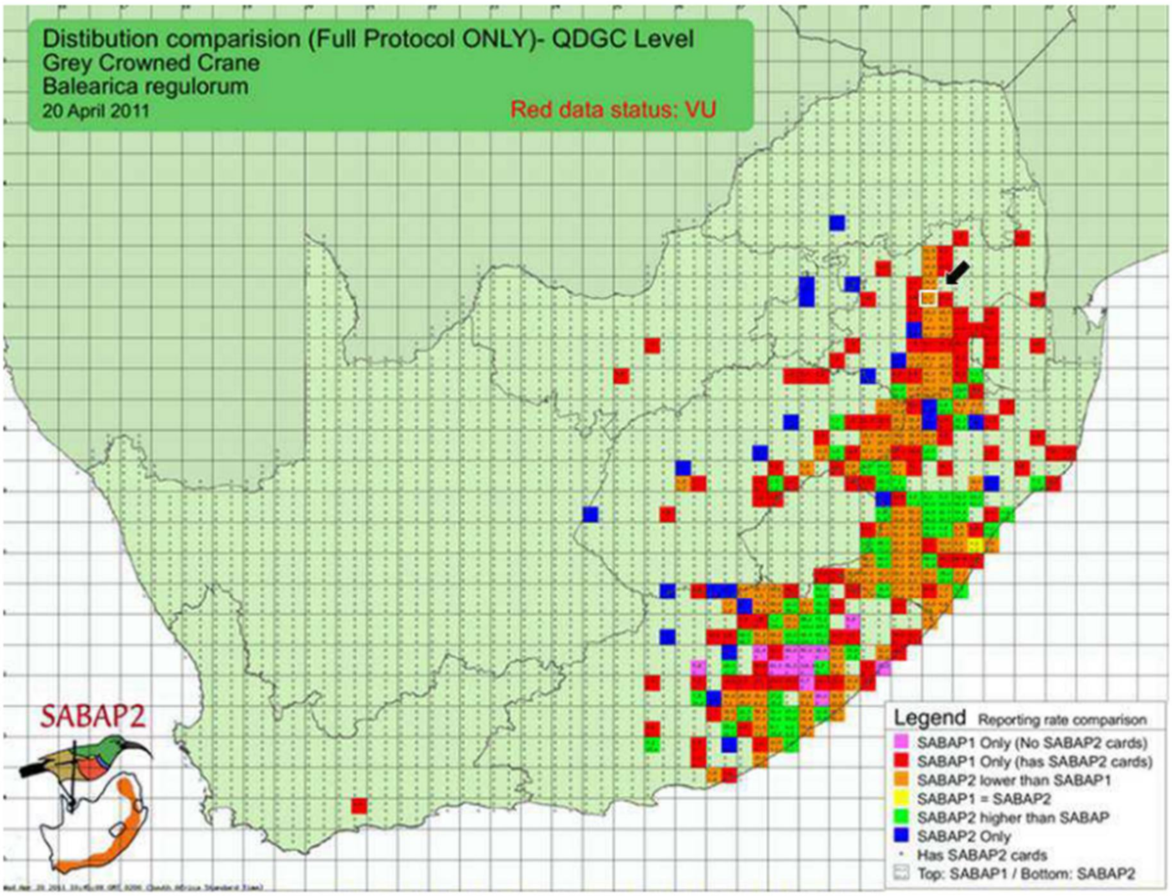


Figure 9 **SABAP Distribution Comparison Map for Grey Crowned Crane (NSS, 2012)**

- Corncrake (*Crex crex*) – The estimated South African population is between 2000 to 2500 individuals, as such the Corncrake is listed as VULNERABLE. A single bird was seen during NSS's fieldwork. It is unlikely to occur annually in the project area and the impact of mining on the conservation status of Corncrake is therefore likely to be limited.
- Martial Eagle (*Polemaetus bellicosus*) – The Martial Eagle is listed as VULNERABLE. An individual was observed flying high over the site during NSS fieldwork. Whilst, there is no habitat for this species on site, it is important to note the sighting due to the status of this bird.

3.3.3.3 Reptiles

The list of CI reptiles compiled is based on available information, which is considered to be inadequate (i.e. reptile atlas is pending). The 4 CI species identified to potentially occur in the study area have a medium to low likelihood of occurrence, based on NSS desktop review and the IUCN conservation status (**Table 15**).

Table 15 Conservation important reptiles potentially occurring in the study area

Species	Common Name	Status	Likelihood of Occurrence
Hormonotus swazicus	Swazi Rock Snake	NT	3
Python natalensis	African Rock Python	LC[0]	3
Lamprophis fuscus	Yellow-bellied House Snake	NT	4
Tetradactylus breyeri	Breyer's Long-tailed Seps	VU	4

Key: [0] Species listed as Protected in NEMBA (2008)
LoO (Likelihood of Occurrence): 1 – Present; 2 – Likely; 3 – Possible; 4 – Unlikely
Conservation status: NT – Near threatened; LC – Least concern; VU – Vulnerable
Sources: SARCA website (2010)

3.3.3.4 Amphibians

The desktop review revealed only 1 Red Data frog species, the Giant Bullfrog (*Pyxicephalis adspersus*), which has a low likelihood of occurrence. However, due to the seasonal pans on site, Giant Bullfrog presence cannot be ruled out.

3.3.3.5 Invertebrates

Based on distribution records, NSS's desktop review identified 2 CI butterflies with a high likelihood of occurrence on the proposed mine site, namely Swanepoel's Brown Marsh Sylph (*Pseudonympha swanepoeli)* and Marsh Sylph (*Metisella meninx*). Suitable habitat for both species exists on site, with the Marsh Sylph being recorded during the study periods. In addition, several Common Baboon spider (*Harpatcira sp*.) holes were encountered. These spiders are Protected Species according to the NEMBA (2008).

3.3.4 Discussion

Due to the confirmation of 9 CI faunal species present on site (**Table 16**), the majority of the proposed Eerstelingsfontein Mine site is considered sensitive from a faunal perspective, with particular reference to wetlands (**Section 3.6**).

Table 16 Confirmed CI faunal species for the Eerstelingsfontein site (NSS, 2011)

Species Name	Common Name	Conservation Status	Habitat Preference	Site Notes
Crocidura cyanea	Reddish-grey Musk Shrew	DD	Wetlands	Caught in the traps in the western wetlands
Myosorex varius	Forest Shrew	DD	Wetlands	Caught in the traps in the western wetlands
Geronticus calvus	Southern Bald Ibis	VU	Nests in cliffs and forages in wetlands	Foraging at the eastern pans
Polemeatus bellicosus	Martial Eagle	VU	Savanna and open woodlands	Fly over only
Crex crex	Corn Crake	VU	Rank grasslands	Flushed from the moist grassland near trap site 1
Balearica regulorum	Grey Crowned Crane	VU	Nests in tall vegetation near wetlands, forages in wetlands	A group of six foraging on site every day of the assessment and recorded by the farmer to occur regularly
Anthropoides paradiseus	Blue Crane	VU	Wetlands, grasslands and pastures	Fly over only
Metisella meninx	Marsh Sylph	VU	Wetlands, associated with the plant *Leersia hexandra*	Confirmed in the eastern pans
Harpactira sp.	Baboon Spider	PS	Varied habitats	Burrows in the high lying grass

Key: Conservation status DD – Data Deficient; VU – Vulnerable; PS – Protected Species
Sources: Barnes (2000), SABAP1 and SABAP2 (ADU website, 2010), SARCA website (2010)

A faunal sensitivity map has been produced based on the presence of IUCN Red Data listed species confirmed to be occurring on site (**Figure 10**). All the illustrated species rely on wetland habitats, mainly for foraging. The Southern Bald Ibis, Blue Crane and Grey Crowned Crane will be highly impacted should the mining go ahead as suitable foraging habitat for these species will be lost in the medium-to-long term or permanently (depending on the success of post-mining rehabilitation measures). A 200m buffer was added to the delineated wetlands for the protection of the Grey Crowned Crane. There are no published guidelines or legislation documents that provide buffer size recommendations for Grey Crowned Crane. The conservative 200m buffer is based on professional judgement and has been applied to protect the catchment of the wetland servicing the cranes, as well as to protect these vulnerable birds from noise, activity and pollution associated with open cast mining (NSS, 2012).

3.4 AQUATIC BIODIVERSITY

3.4.1 Methodology

Aquatic biodiversity studies incorporated two sampling seasons, the drier season in November/December 2010, and the wetter season in March 2011. Thirteen sites were selected along local rivers, tributaries, pans and dams, based on the position of the proposed mining area, accessibility and potential biodiversity that they would have (**Figure 11**). The Present Ecological State (PES) of the aquatic systems in the proposed mining area was measured by assessing water quality, habitat, macro-invertebrates and fish community integrity. The interpretation of the data was assisted by the use of Ecological Categories, which define the ecological condition of an aquatic system (**Table 17**). These categories range from natural (Category A) to critically modified (Category F) and are represented by characteristic colours (NSS, 2011). Refer to the complete technical report to obtain details on the methodology applied for the aquatic studies. Thirteen sites were primarily selected based on the position of the proposed mining area, accessibility and potential biodiversity that they would have. Four of these were on rivers where full bio-monitoring could be done (EF7 to EF10), three were farm dams (EF1, 2 and 5) and 5 were natural pans (EF3, 4, 11, 12, 13). Site EF6 was originally planned as a full bio-monitoring site, but as flow was minimal, it did not have the right characteristics to fulfil the requirements as per the sampling protocols of the indices used. Therefore, site EF6 is discussed under the pans and dams section.

Table 17 PES ratings and descriptions (based on NSS, 2012)

ECOLOGICAL CATEGORY	PES RATING	DESCRIPTION
A	5	**Unmodified, natural**.
B	4	**Largely natural with few modifications**. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	3	**Moderately modified**. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	2	**Largely modified**. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	1	**Seriously modified**. The loss of natural habitat, biota and basic ecosystem functions are extensive.
F	0	**Critically / Extremely modified**. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

Sources: Kleynhans (1996); Kleynhans (1999)

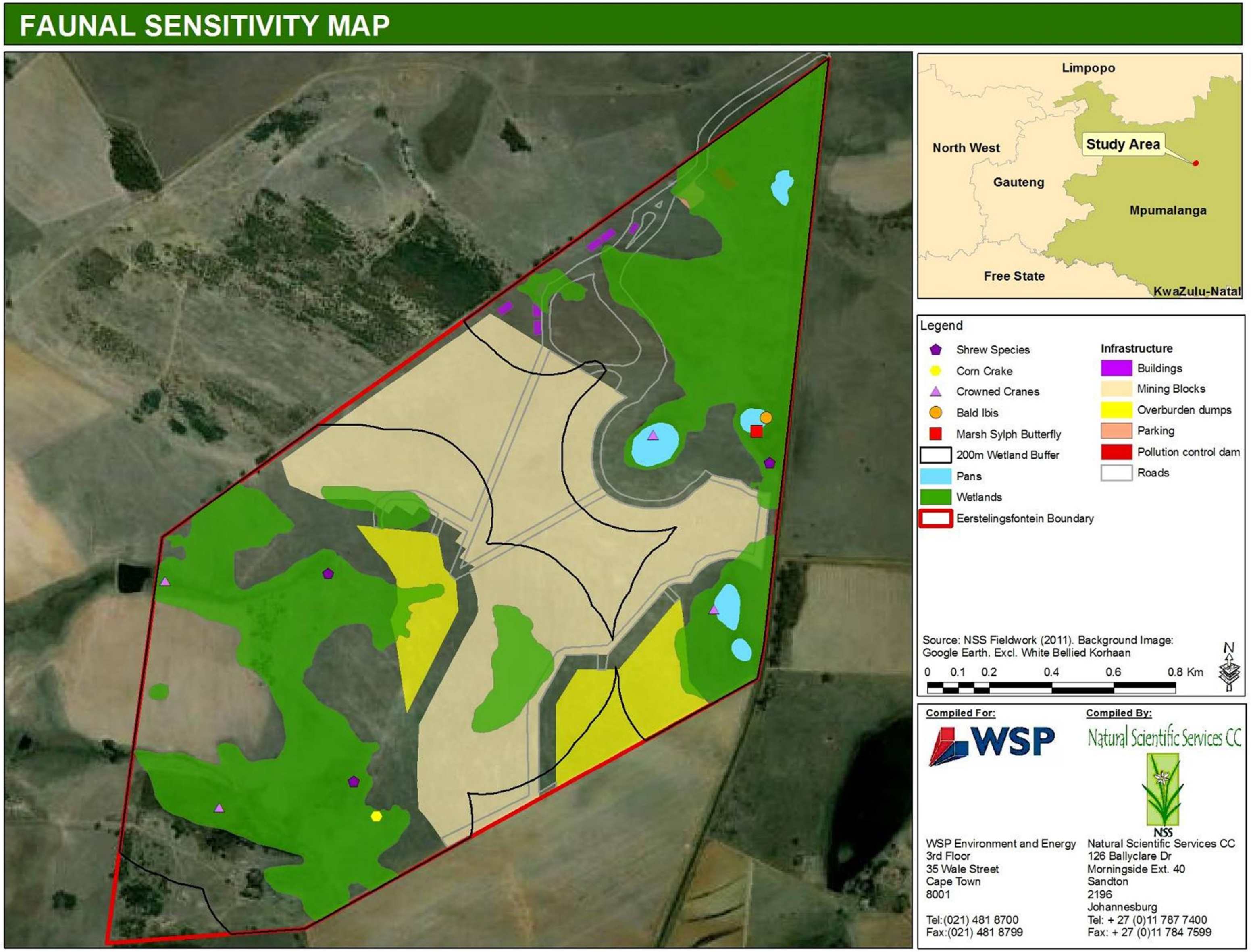


Figure 10 Faunal sensitivity Map (NSS, 2012)

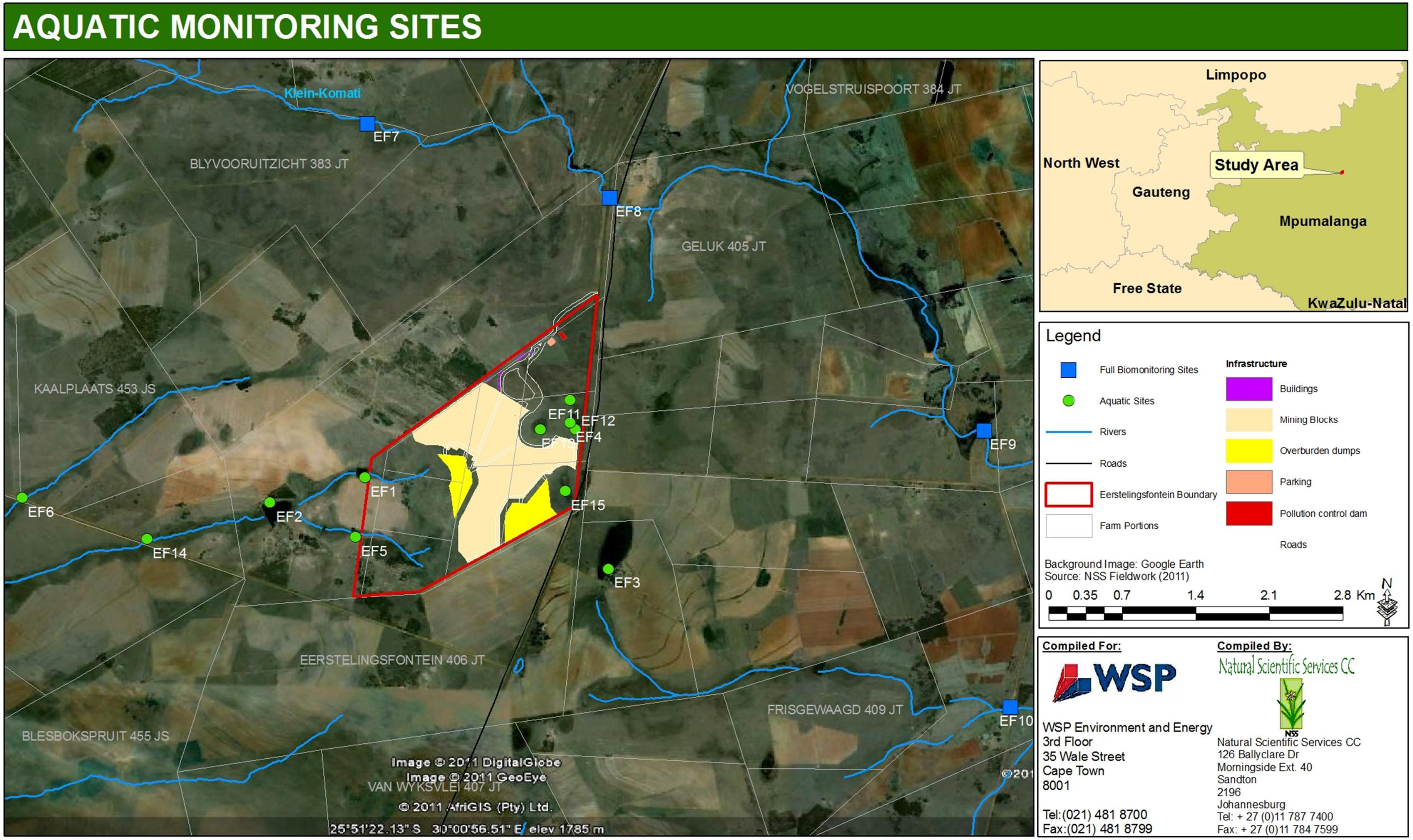


Figure 11 Aquatic biomonitoring, dam and pan sites selected to conduct bio-monitoring within and adjacent to the proposed Eerstelingsfontein Mine (NSS, 2012)

3.4.2 Baseline findings

The aquatic biodiversity has been transformed by almost 50% due to previous anthropogenic activities (primarily by cultivation, and to a smaller extent by plantations, mines, urbanisation and the building of dams). The ecological status of the surrounding water resources ranged from being **moderately impaired** to **critically modified**.

3.4.2.1 Water Quality

- Dams & Pans

Pan systems are generally seasonal and are standing, non-flowing systems. This means that their water levels fluctuate and that variables such as oxygen and temperature will fluctuate on a daily basis. Organisms within the pans are adapted to these extreme conditions. In most of the systems, there is an increase in metals, namely, aluminium and iron. These metals are associated with anthropogenic impacts such as coal mining. There is a correlation of high levels of Fe and Al with two dam sites at the upper reaches of the Witkloofspruit, and the Groundwater data. All borehole sites sampled had very low levels, with the exception of one except for the borehole site that is adjacent to the western boundary of the site. The Eerstelingsfontein area has no active coal mining in the immediate area, although there was historic mining adjacent to the site by Sumo colliery, however these fluctuations are considered to be natural. It must also be mentioned that Al can be sourced from certain pesticides, and this could be the source of the higher levels in the sites mentioned above.

In terms of nutrients, it is noted that in the majority of sites, there are high levels of ammonium and the chemical oxygen demand (COD) is high. These increases are generally associated with an increase in the amount of nutrients in the system, specifically through sewage waste and animal faeces. As the sites were on a livestock and agricultural farm, this is expected. The alkalinity at sites EF2, EF3, EF5 was high. The alkalinity increase can be attributed to an increase in algal content and aquatic vegetation, which produces more CO_2. In pan and dam systems, this is not of concern, as there will naturally be high levels of algae and aquatic vegetation which will cause an increase in the alkalinity.

- Klein Komati & Witkloofspruit Rivers

The pH and oxygen at all the sites were below the target water quality ranges (TWQRs). According to the South African water quality guidelines defined by DWAF (1996), a few metals, nutrients and organic components were above the guideline levels. These included Al, Fe, Alkalinity, COD, suspended solids (SS), and ammonia, at most/all sites. In general, these are usually associated with agricultural activities and sewage contaminants which are expected due to the presence of crop and livestock farming activities. SS were elevated at EF9 and EF10, which can be attributed to upstream agriculture which has accumulated downstream.

3.4.2.2 Habitat Integrity

- Klein Komati & Witkloofspruit Rivers

All of the sites monitored have reduced habitat integrity, the level of modification ranges from largely modified to moderately modified. Only one site was considered largely natural and this was the monitoring point furthest downstream of Eerstelingsfontein proposed mine area.

3.4.2.3 Macro-Invertebrate Integrity

- Dams & Pans

The macro-invertebrate diversity associated with the dam systems is low, and is dominated by tolerant taxa. There is also the presence of exotic largemouth bass (*Micropterus salmoides*) at EF2 and EF5. These species are well known for their predatory habits and could have an effect on the number of invertebrate taxa present, especially larger taxa such as the Odonata. The water quality within the dams is at an acceptable level, and as such is not thought to be the driver in decrease of taxa. It is rather attributed to the general reduction in habitat and specific conditions created when a dam is built.

The pan systems are different as they are natural systems with macro-invertebrate families present adapted to the seasonality of the pans. A very small number of sensitive families were sampled in addition to the tolerant families that dominated the community.

- Klein Komati & Witkloofspruit Rivers

The results of the SASS5 assessment highlight that all the sites are largely modified from the various anthropogenic impacts. For the macro-invertebrate communities to recover, it will take time and a reduction in the impacts such as agriculture and livestock farming.

The MIRAI scores for the site show the rivers to be **largely modified** to **seriously modified**. Communities are dominated by non-sensitive taxon, which reduces the MIRAI scores.

3.4.2.4 Ichthyofauna

- Dams & Pans

The dam sites sampled (EF1, EF2 and EF5) all fall within the uppermost tributaries of the Witkloofspruit River. These tributaries are very small systems with mainly subsurface flow. The only fish sampled within these systems were largemouth bass (*Micropterus salmoides*) at EF2 and EF5 and the Chubbyhead barb (*Barbus anoplus*) at EF1.

In terms of the fish biodiversity within the pans, only one species was sampled, P*. Philander*. This was at site EF5. This pan is well established, and holds water for most of the year, so it is not surprising that fish were sampled, albeit one species.

- Klein Komati and Witkloofspruit Rivers

Of the 6 fish species that were expected to occur within ecoregion 11.02 of the Klein Komati River and Witkloofspruit River, B*. anoplus*, C*. pretoriae* and *P. philander* were sampled. However, C*. pretoriae* and P*. philander* were only sampled at EF9. *B. anoplus* were sampled at all sites for both seasons except for EF10, which had no fish species present for both surveys. What is of concern is that M*. salmoides* (Largemouth bass) were sampled, at EF8 and EF9. It is well documented that this highly invasive and predatory species can negatively affect fish communities, especially in upper catchments (NSS, 2012). Fortunately, the weir at EF8 seemed to pose a migratory barrier, so above this site there were no bass sampled.

The reduced FRAI scores can therefore be attributed to a combination of habitat degradation and impacts from various anthropogenic sources. Water quality is moderate but the effect of agriculture and livestock can be seen, which will adversely affect sensitive fish species such as C*. pretoriae,* A*. uranoscopus* and A*. natalensis*.

3.4.2.5 Present Ecological Status

- Pans

All the pans on the site are seasonal in nature and as such the species within in them are adapted to survive harsh conditions. Copepods were sampled at two of the pans on site, but no amphipods were present. The biodiversity of the pan sites should be preserved due to the seasonal nature of all the pan sites. The biodiversity potential of the pans is very high and they play an important role in the ecosystem, as not only aquatic macro-invertebrates and fish (temporarily) use them as habitat, but birds and amphibians as well.

- Dams

No conservation status fish species were sampled, and the exotic Black Bass (*Micropterus salmoides*) was prevalent at 2 dam sites. These dams do however have a large biodiversity potential for other organisms, such as macro-invertebrates, amphibians and birdlife. In addition, they provide a buffer zone between the proposed mining area and the tributaries leading to the Witkloofspruit River, which will be important if mining commences.

3.4.2.6 River biomonitoring

All the aquatic sites have modified water quality, over both sampling periods, in terms of biological and physico-chemical parameters thus resulting in a low PES and 'critically endangered' conservation status. The parameters that are above Target Water Quality Ranges (TWQR) are pH, NH4, COD, Fe, Alkalinity, SS and O^2. This is of concern, as the water quality could be the main driver for the low PES of the biological communities. Water quality is poor due to anthropogenic sources, particularly the high degree of agriculture and livestock farming. The proposed coal mining of the Eerstelingsfontein site will further compound the impacts on water quality and consequently on biological communities.

The habitat integrity of all the sites has been modified to some extent. Macro-invertebrate communities have been impacted on at all sites, however using macro-invertebrate indices and in situ water quality measurements at 3 riverine sites, the author showed that there were no highly sensitive taxa sampled.

The Ichthyofaunal communities are all modified; Klein Komati River was at a medium degradation state and the Witskloofspruti River being critically modified. The remaining sites are all largely modified. Klein Komati River had the most species sampled as it was the least degraded of the river systems.

The drivers responsible for the poor PES ratings are; diminished habitat availability, poor water quality, exotic fish species and a reduction in flow. It must be highlighted that the presence of Black bass (*Micropterus salmoides*) is a concern, as these species are well known exotic predators that reduce indigenous fish populations. However, the fact that the sensitive C*. pretoriae* was sampled in the Klein Komati River shows that the system is still in a moderately healthy state.

It has been identified that the aquatic ecosystems within the vicinity of the proposed coal mine in Eerstelingsfontein are ***moderately-largely modified***. The majority of the impacts were largely associated with agriculture, livestock farming, farm dams and general anthropogenic activities and infrastructure.

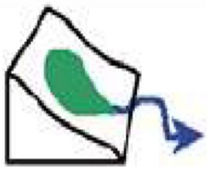
3.5 WETLANDS

3.5.1 Methodology

Wetland studies incorporated two sampling seasons, the drier season in November/December 2010, and the wetter season in March 2011. Wetland delineation and assessment incorporated a desktop survey, the hydro-geomorphic (HGM) classification of identified wetlands, determination of the PES (**Table 11**) of the wetlands, the identification of Ecoservices provided by the wetland and the determination of the Ecological Importance and Sensitivity (EIS) of the wetlands. The most popular wetland classification method used in South Africa is the classification of wetlands into hydro-geomorphic units developed by Kotze et al. (2007) in WET-EcoServices. This has been used to classify the wetlands found on the site. A summary of these wetland types is presented below (**Table 18**).

Table 18 Characteristic wetland hydro-geomorphic types supporting inland wetlands in South Africa (NSS, 2012)

Hydro-geomorphic (HGM) Wetland Types	Source Maintaining Wetland	
	Surface	Sub-Surface
Floodplain  Valley bottom areas with a well-defined stream channel, gently loped and characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs occur from the main channel (when the channel banks overspill) and from adjacent slopes.	***	*
Valley bottom with a channel  Valley bottom areas with a well-defined stream channel but lacking the characteristic floodplain features. May be gently sloped characterised by the net accumulation of alluvial deposits, or may have steeper slopes and be characterised by the net loss of sediment. Water inputs occur from the main channel (when channel banks overspill) and from adjacent slopes.	***	*/***

Valley bottom without a channel  Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs occur mainly from the channel entering the wetland and also from adjacent slopes.	***	*/***
Hillslope seepage linked to a stream channel  Slopes of hillsides which are characterised by colluvial (transport by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Isolated hillslope seepage  Slopes of hillsides which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through a diffuse sub-surface and/or surface flow, but no direct surface water flow connection to a stream channel.	*	***
Depression  A basin-shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/***	*/***

Key: * = Contribution usually small; *** = Contribution usually important; */*** Contribution may be small or important depending on circumstances
Source: Kotze et al. (2007)

3.5.2 Baseline findings

3.5.2.1 Wetland classification

According to the HGM classification (**Table 18**), four types of wetlands (HGM units) were identified within the study area (**Figure 12**), including:

- Valley bottom without a channel;
- Valley bottom with a channel;
- Hillslope seepage not linked to a stream channel; and
- Isolated depressions.

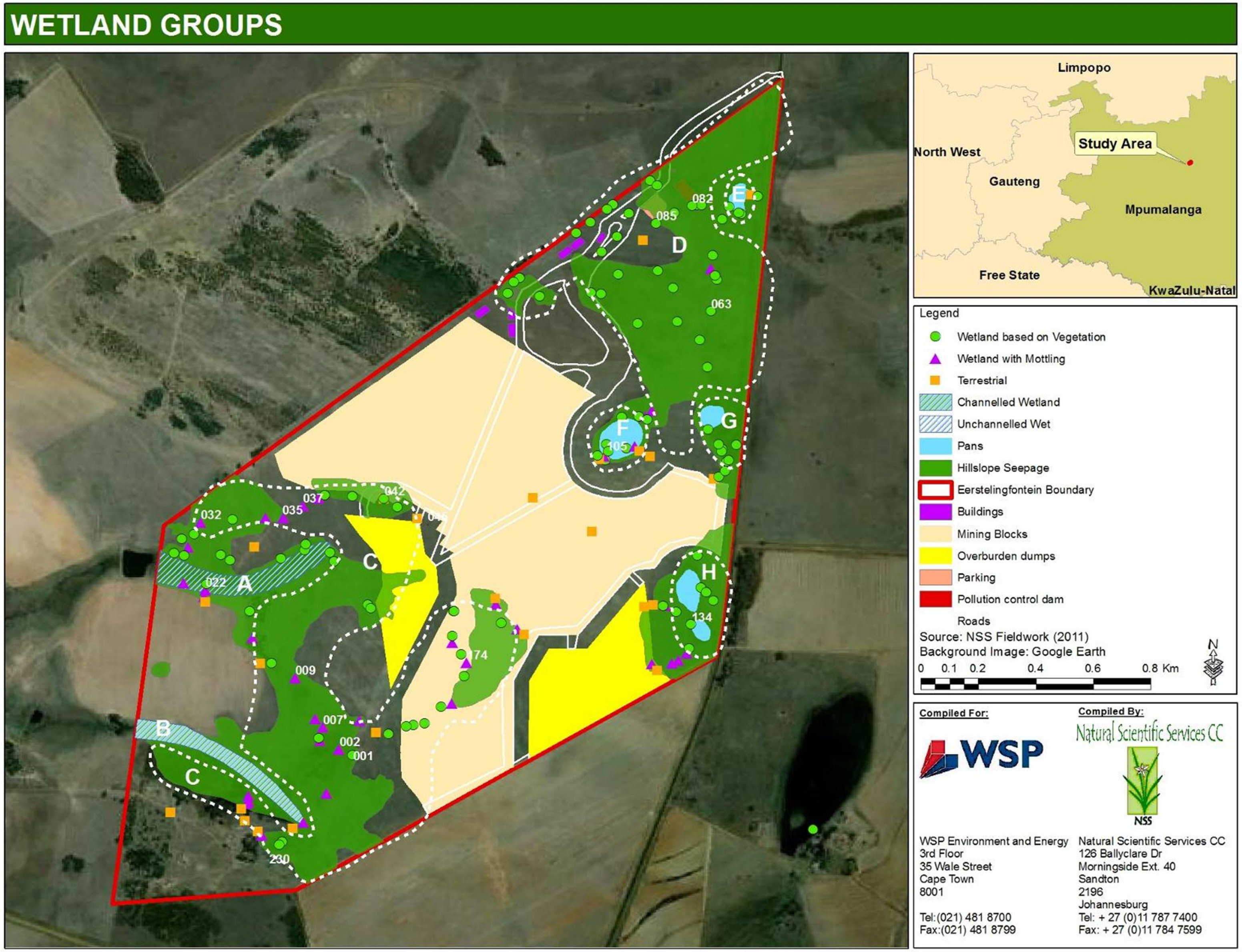


Figure 12 **Locations of wetland HGM units within the study area (NSS, 2012)**

3.5.2.2 Wetland delineation

The wetlands were delineated based on the combined results of the terrain units, signs of soil form and wetness, and vegetation indicators. This data, together with aerial imagery, was used to plot the outer boundary of the wetland. Buffers were then determined based on legislative requirements, Best Practice guidelines and the layout and extent of wetlands (NSS, 2011).

NSS, together with Digby Wells & Associates, visited the Eerstelingsfontein site on 21 November 2011. The main purpose of this visit was to discuss and visually observe locations where the two wetland delineations differed and to agree on a revised wetland delineation. All the data obtained, from the desktop review, the NSS survey and the follow-up visit in November 2011 was consolidated within the final wetland delineated.

- Wetland buffers

The legal requirement for buffer zones on wetland systems is unclear. There are a number of guidelines which recommend buffer widths ranging from 20 to 50m from the edge of a wetland area. From a national legislation perspective, NEMA specifies a buffer of 32m from the edge of a wetland. In addition, the pan systems on the eastern boundary of the site, are defined as "Wetland Clusters" in terms of the National Freshwater Ecosystem Priority Areas (NFEPA). The guidelines for these areas state that *"Mining in any form should not be permitted in wetland FEPAs, or within 1km of a wetland FEPA buffer"* (Driver et al, 2011). In terms of the wetland FEPA buffer the guidelines (Driver et al, 2011) state that at a minimum (i.e. whether desktop or site-based), the biodiversity requirements of FEPAs should be regarded as high and the buffer width should be adjusted to take this into account.

Draft guidance has been published by the Institute of Natural Resources in 2010 on buffer determination (INR, 2010). These guidelines however have taken a modified-fixed width approach, whereby each wetland is assessed independently on a number of risk based factors. There is no guideline provided for the preferred width of a buffer strip within this document, however there is guidance that suggests all wetlands within 500m of the proposed development are mapped where an application for a water use license is being applied for. This is draft guidance and since a water use license has already been issued for the site, only the wetlands within the site were mapped.

The current Water Use License (WUL) issued to Exxaro for the mining of the proposed Eerstelingsfontein site specifies that a 'no development' buffer of 100m be respected around the wetlands. As the WUL requirements are legally binding, 100m buffer around all wetland units has been applied (**Figure 14**). An overall buffer (excluding overlaps between adjacent buffers) covers an area of 95.90 ha representing 31.87% of the study site.

3.5.2.3 Wetland Present Ecological State (PES)

Assessment of the PES of wetland groups within the study area indicates numerous existing impacts on the wetlands mainly as a result of agriculture, topographic alterations by communities and alien invasive plant species. Results of the PES assessments of the wetland groups are graphically illustrated in **Figure 13**.

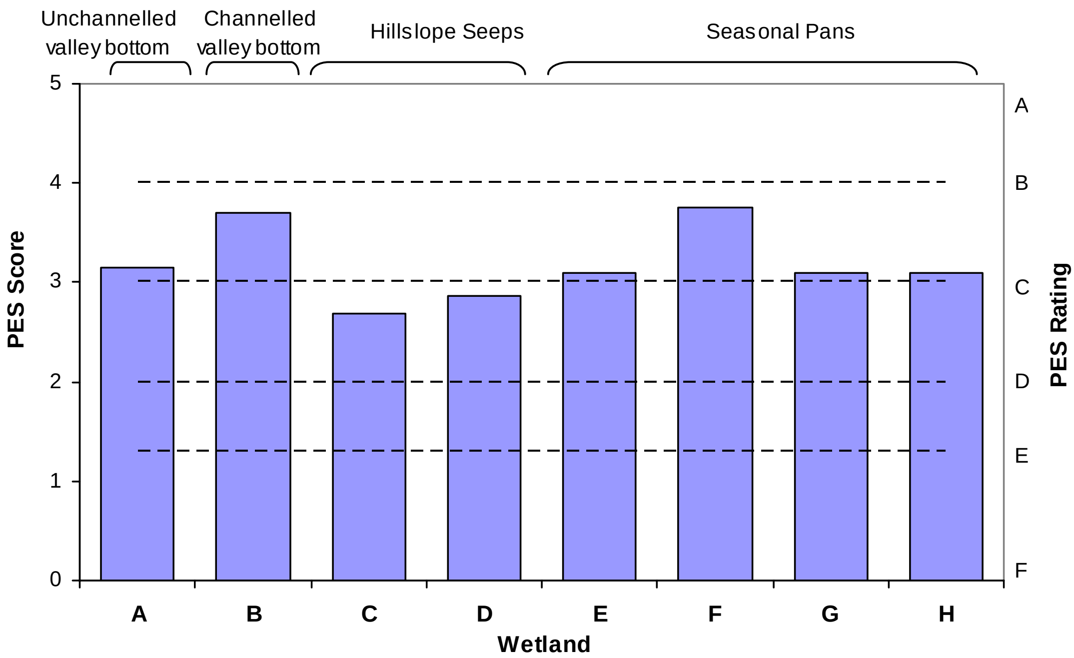


Figure 13 **Results of assessments of the Present Ecological State for the wetland groups in the study area**

The major impacts contributing to the PES of each of the wetland groups has been summarised in **Table 19**.

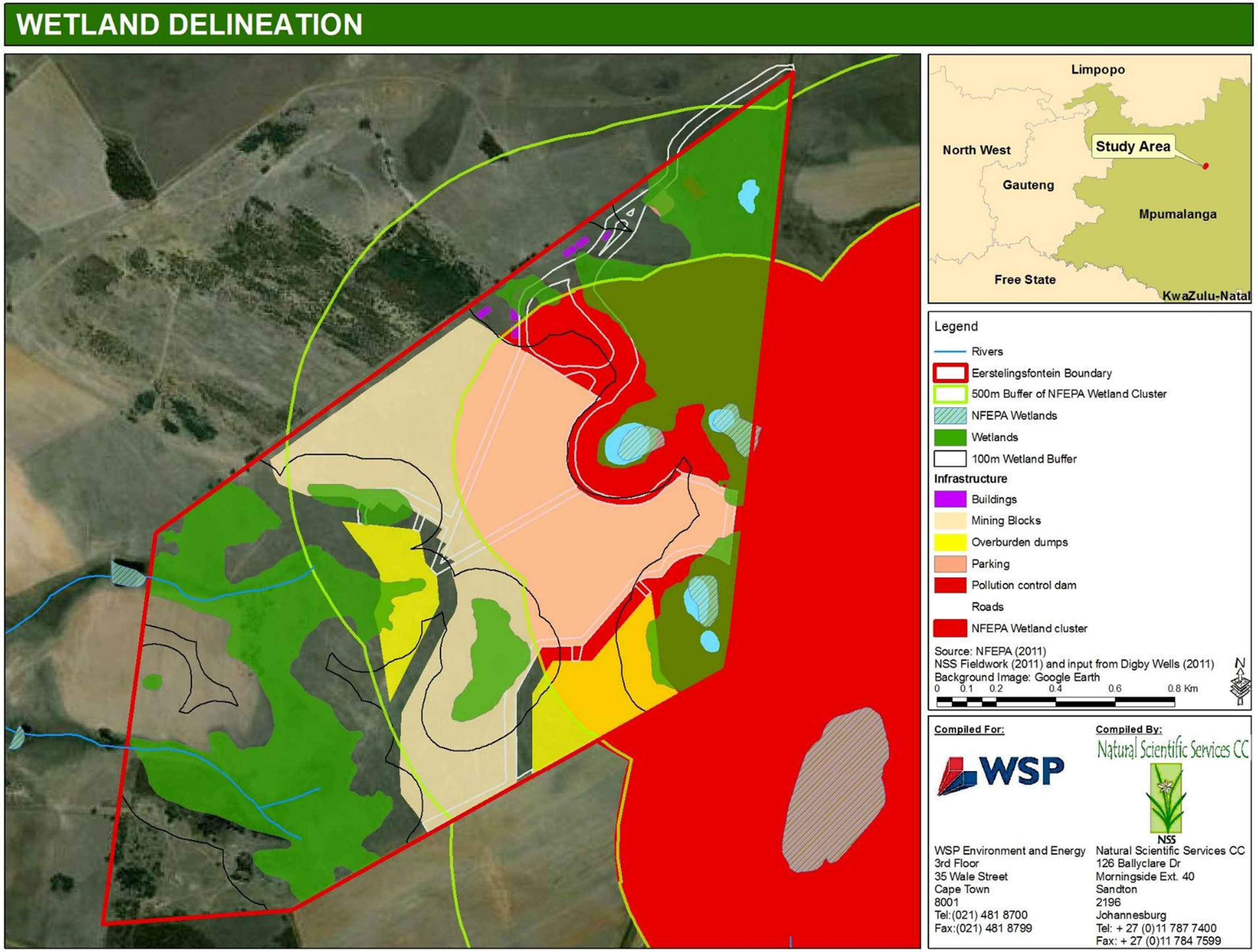


Figure 14 **Layout of the wetlands and buffers within the study site (NSS, 2012)**

Table 19 Summary of Major impacts affecting the PES of Wetland Groups (NSS, 2012)

WETLAND GROUP	MAJOR IMPACTS				Overall PES
	Hydrology	Water Quality	Geomorphology	Biota	
A (Unchannelled valley bottom wetland)	• Increased runoff from the agricultural fields • Change in inundation patterns due to farm dam	• Possible leaching of fertilizers and pesticides from adjacent cultivation • Sediment originating from adjacent annually ploughed field	• Topographical alterations caused by adjacent former tillage.	• Alien trees present • Loss of indigenous vegetation from overgrazing and marginal adjacent cultivation • Red Data birds seen.	**B Largely Natural**
B (Channelled Valley Bottom)	• Moderate reduction in base flow as a result of water abstraction from local communities.	• Effluent from adjacent cultivation and rural communities causing water contamination. • Invasive riparian vegetation (*Poplus x canescens*) is reducing water quality.	• Limited occurrence of erosion of the banks and instream channel • Geomorphology influenced by roads and footpaths for accessing the wetland.	• Alien plants and adjacent cultivation lead to loss of floral and faunal diversity.	**B Largely Natural**
C (Hillslope Seep)	• Change in flow patterns due to former tillage	• Manure accumulation from heavy livestock presence (cattle and horses) • Unstable sediment from former tillage and over-grazing.	• Topographical alterations such as terracing	• Overgrazing and former tillage has led to Increaser III grass species dominance (e.g. *Eragrostis plana*), and moderate floral diversity loss. • Presence of alien tree clumps • Red Data birds seen.	**C Moderately Modified**
D (Hillslope Seep)	• Change in flow patterns due to terracing and contour ploughing from former tillage	• Manure accumulation from heavy livestock presence • Unstable sediment from former tillage and over-grazing.	• Topographical alterations such as terracing	• Overgrazing and former tillage has led to Increaser III grass species dominance (e.g. *Eragrostis plana*), and moderate floral diversity loss. • Some shrub and herbaceous alien species present • Red Data birds seen.	**C Moderately Modified**
E	• Change in flow dynamics due	• Loss of water quality from litter, oils	• Topographical	• Loss of vegetation diversity	**B**

WETLAND GROUP	MAJOR IMPACTS				Overall PES
	Hydrology	Water Quality	Geomorphology	Biota	
(Seasonal Pan)	to road - increased runoff and limited flow obstruction	and other fluids in water runoff from adjacent tar road • Limited sediment accumulation from overgrazing and former tillage of adjacent seep wetlands • Possible high nutrient levels caused by livestock	alterations of adjacent seepage wetlands	caused by heavy grazing • Alien *Persicarya* species observed in the pan.	**Largely Natural**
F (Seasonal Pan)	• Limited flow modifications caused by terracing of adjacent areas	• Possible high nutrient levels caused by livestock • Limited sediment accumulation from overgrazing and former tillage of adjacent seep wetlands	• Limited topographical alteration from tillage of adjacent seepage wetlands	• Loss of vegetation diversity caused by heavy grazing • Alien *Persicarya* species observed in the pan. • Red Data birds (Grey-crowned Crane and Southern Bald-ibis)) seen	**B** **Largely Natural** (B – Golder, 2009)
G (Seasonal Pan)	• Limited flow modifications caused by adjacent tar road and terracing of adjacent areas	• Loss of water quality from litter, oils and other fluids in water runoff from adjacent tar road • Possible high nutrient levels caused by livestock	• Drainage alterations of the adjacent tar road affect inflows into this pan	• Loss of vegetation diversity caused by heavy grazing • Alien *Persicarya* species observed in the pan.	**B** **Largely Natural** (B – Golder, 2009)
H (Seasonal Pan)	• Limited flow modifications caused by adjacent tar road and terracing of adjacent areas	• Loss of water quality from litter, oils and other fluids in water runoff from adjacent tar road • Possible high nutrient levels caused by livestock	• Drainage alterations of the adjacent tar road affect inflows into this pan	• Loss of vegetation diversity caused by heavy grazing • Alien *Persicarya* species observed in the pan.	**B** **Largely Natural** (B – Golder, 2009)

3.5.2.4 Wetland Ecoservices

The EcoServices provided by the wetlands in the proposed mine site were assessed according to the four Hydrogeomorphic (HGM) units identified on site (refer to **Figure 12** for Wetland A to H locations). A summary of the wetlands Ecoservices associated with the site is provided below:

- Un-channelled Valley Bottom (Wetland A)

Wetland A provides important stream flow regulation services. Services of flood attenuation, toxicant and nitrate removal, phosphate trapping, erosion control and biodiversity maintenance are considered moderately important.

- Channelled Valley Bottom (Wetland B)

Wetland B is highly important in the provision of natural resources for the local community and for biodiversity maintenance. Flood attenuation, stream flow regulation and toxicant removal, including phosphate trapping and nitrate removal scored moderately-high.

- Hillslope Seep (Wetlands C and D)

Wetlands C and D provide an important service for biodiversity maintenance, but moderately important for the physical attributes such as flood attenuation, stream flow regulation and toxicant removal, including phosphate and nitrate trapping. Carbon storage scores very low importance due to the absence of naturally-occurring trees. The various anthropogenic services (education, tourism, cultural significance, cultivated foods, natural resources and water supply for human use) featured as having a low to very low importance.

- Isolated Depressions / Seasonal Pan (Wetland E, F, G and H)

The 4 pans (Wetlands E, F G and H) provide important biodiversity maintenance services but moderately important flood attenuation, phosphate, nitrate and toxicant removal services. The pans were however low providers for anthropogenic services.

3.5.2.5 Wetland Ecological Importance and Sensitivity (ESI)

The ESI assessment for all of the HGM units was determined to be of High ecological importance and sensitivity for the site (**Appendix A**). The site has a high ecological importance due to the significant Red Data bird species observations and 36% coverage of the study area by wetlands (excluding the buffer zones).

The wetlands within the Eerstelingsfontein study area scored a **HIGH** for Ecological Importance and Sensitivity (Category B) with the PES of the majority of the wetlands being **Largely Natural** and one of the main ecosystems services provided by all wetlands being biodiversity maintenance. For the study area, the NFEPA Project recognizes the pan systems on the eastern boundary of the site in an area defined as "Wetland Clusters" and the site also falls within a Rivers Priority Area (FEPA). According to the Mpumalanga Conservation Plan Handbook, these wetland clusters should be given a 1km buffer. Further to this the '*Implementation Manual for Freshwater Ecosystem Priority Areas'* states the following objectives for wetland FEPAs (which includes Clusters):

Wetlands FEPAs that are in a good condition (equivalent to an A or B ecological category) should remain so. Wetlands FEPAs that are not in a good condition should be rehabilitated to their best attainable ecological condition. This means that:

- Land-use practices or activities that will lead to deterioration in the current condition of a wetland FEPA are not acceptable.
- Land-use practices or activities that will make rehabilitation of a wetland FEPA difficult or impossible are not acceptable.

Based on the National legislative requirements, the Mpumalanga C-Plan data, the identification of the site has a NFEPA, with important wetland clusters, and the findings onsite, all wetlands within the Eerstelingsfontein opencast project site have been classified as having a HIGH significance.

3.6 POTENTIAL BIODIVERSITY IMPACTS

Due to the encroachment of the opencast mining and associated mine residue deposits, water management facilities and other infrastructure into the areas of high conservation significance, significant impacts to the biodiversity of the area will occur.

The potential impacts of the Eerstelingsfontein opencast mining can be divided into three categories, namely habitat loss and fragmentation, habitat disturbance and increase in anthropogenic activity. The potential impacts expected as a result of the Eerstelingsfontein mine have been described briefly below:

3.6.1 Habitat loss and fragmentation

3.6.1.1 Flora

Natural areas will be lost to the clearing of land for mining however the main impact will be the 'knock-on' effect of the development on the surrounding vegetation and the difficulty in rehabilitating the vegetation back to Eastern Highveld Grassland. The significance of the impact has been assessed based on the vegetation units being affected. The loss of *Centella asiatica* Moist Grassland and *Chironia palustris* Open Grassland is considered to be of **high** significance. The loss of the *Crepsis Dryland* Pasture Grassland is considered to be of **medium to high** significance, and the removal of the Vulnerable species *Khadia carolinensis* within this vegetation type is to be of **medium** significance. The loss of *Lobelia flaccida* Moist Pasture Grassland is considered to be of **low to medium** significance. Finally the loss of *Juncus oxycarpus* Wetland, *Andropogon eucomus* Moist Grassland and *Tristachya leucothrix* Rocky Outcrops is considered to be of **medium** significance.

The loss of *Crepsis Dryland* Pasture Grassland and *Lobelia flaccida* Moist Pasture Grassland is considered to be of **medium to high** significance. Finally the loss of *Juncus oxycarpus* Wetland, *Andropogon eucomus* Moist Grassland and *Tristachya leucothrix* Rocky Outcrops is considered to be of **medium** significance.

The loss of the natural vegetation will lead to the loss of flora conservation important (CI) species, such as *Eucomis autumnalis* and the **Vulnerable** *Khadia carolinesis.* Habitat fragmentation affects the dispersal of plant species within the surrounding areas and is considered to be of **high** significance.

3.6.1.2 Fauna

The loss of the natural vegetation will lead to the loss of fauna conservation important (CI) species, such as Grey Crowned Crane, which is considered to be of **high** significance. There are 3 species that will be highly impacted should the mining go ahead as suitable foraging habitat for these species will be lost in the medium-to-long term or permanently (depending on the success of post-mining rehabilitation measures). The loss of habitat and connectivity for faunal species is considered to be of medium to high significance. Finally, the potential increase in fatalities of the faunal species due to mining excavations and blasting is considered to be isolated with a moderate frequency and is therefore considered to be of **medium** significance.

3.6.1.3 Wetlands

Areas of high ecological importance such as wetlands and National Priority Areas will be highly impacted on whereby up to 36.9% of the wetlands and buffers will be lost and 58% of the wetland Freshwater Ecology Priority Areas. The impact of this is considered to be of **high** significance.

3.6.2 Habitat disturbance

3.6.2.1 Flora

Dewatering activities associated with the mine will have a major impact on the surrounding moisture dependant vegetation communities by changing the structure of these communities in the long term. This is considered to be of **medium to high** significance. In altering the vegetation, this will allow for the invasion of Category 1 Alien invasive species thus reducing the chances of reintroduction of the conserved species successfully. This is considered to be of **high** significance. As the site is relatively small in size, the remaining vegetation units will definitely be impacted upon by excessive coal dust which is considered to be of **medium to high** significance.

3.6.2.2 Fauna

The displacement of faunal species from the mine site can be as a result of the above change in vegetation communities or the increased production of noise associated with mining activities. The noise production will most likely lead to the dispersal of animals away from the mine site and immediate surrounds. This is considered to be of **medium** significance. This is a **high** significance in relation to CI species such as the Grey Crowned Cranes. Terrestrial communities are not the only communities to be affected, Aquatic biota community structures are also impacted on due to stream flow modifications and deterioration in water quality. This is considered to be of **high** significance.

3.6.2.3 Aquatic Biodiversity and Wetlands

Throughout the various mining stages, including post-closure, water base levels are altered and thus will result in the desiccation of wetlands and increased seasonality of the pans. This will put increased stress on the biological communities that rely on this wetlands and pans. Together with altered water flow, is the increased acidity (sulphuric acid), eutrophication, turbidity and fluctuating oxygen levels associated with coal mining. This will reduce the water quality of surrounding wetlands, rivers, pans and dams deeming the water unacceptable to support life. This is considered to be of **high** significance.

3.6.3 Increased Anthropogenic Activity

3.6.3.1 Flora

The natural flora of the Eerstelingsfontein mine and surrounding areas is the Eastern Highveld Grassland. Grassland communities exist in seasonal fire climates and thus have evolved strategies or life cycles to survive the effects of seasonal fires. However, the increase in anthropogenic interaction in the area may result in excessive and increased frequency of fires. This may lead to loss of seeds, degradation of soils, change in vegetation structure, loss of vegetation and associated fauna and erosion of soil thus increased turbidity of water sources. This is considered to be of **medium** significance.

Grasslands also comprise CI species used for medicinal and cultural medicines thus with increased human interaction in this area this will result in increased harvesting of such species. Species include *Brunsvigia radulosa; Gladiolus crassifolius; Aloe ecklonis;* and *Eucomis autumnalis.* This is considered to be of **high** significance.

Hunting and poaching of fauna inhabiting the grassland is another impact to be considered. This is considered to be of **high** significance.

The results of the ecological assessments have been used to develop a summary of areas of conservation significance which have been illustrated on **Figure 15** below.

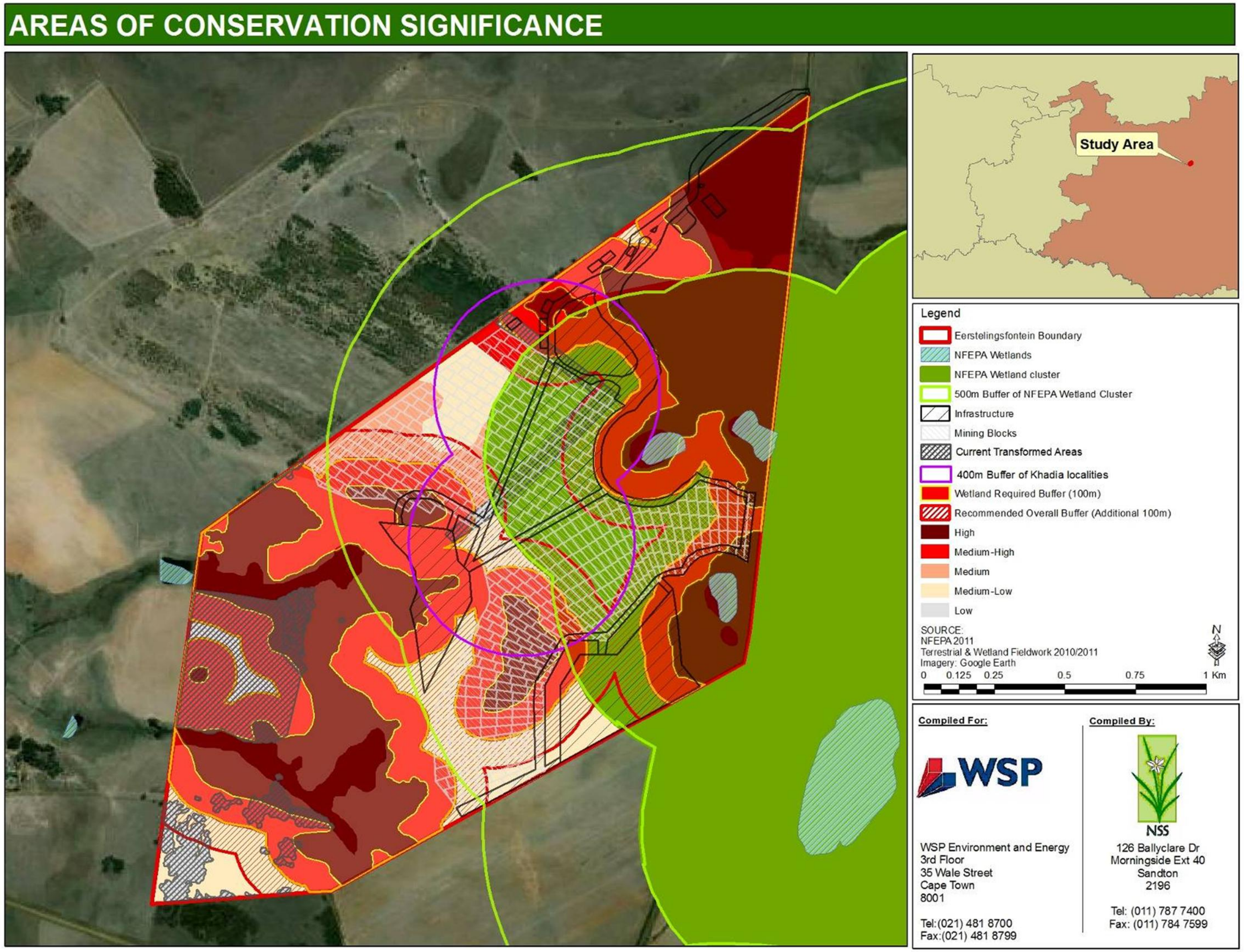


Figure 15 **Areas of conservation significance within the proposed Eerstelingsfontein mine site (NSS, 2012)**

3.7 RECOMMENDATIONS/MITIGATION MEASURES

The Impact Assessment has identified a number of High and Medium-High impacts, many of which cannot be mitigated due to the nature of the project and the type of impact. Based on these high rated impacts, the National and Regional importance of the site and the species identified as using the site, the overall effect of the Eerstelingsfontein mine will be of high significance from a biodiversity perspective.

In order to assist in the decrease of the impact's significance, the following general mitigation measures are advised, for more detailed mitigation measures, please refer to the attached specialist study (**Appendix A, Section F**):

- An Environmental Control Officer (ECO) should oversee and audit all activities associated with the Eerstelingsfontein mine.
- Project footprint area should be kept to the absolute minimum and clearly demarcated. The demarcations and barriers must be maintained in position until the rehabilitation phase.
- If mining is to occur, successful rehabilitation to a heterogeneous landscape is a necessity. In order to achieve this, top soils are to be correctly stockpiled in their different layers and not be higher than 2m (1 - 1.5m preferably).
- Implement the following monitoring programmes (refer to **Part 3: Environmental Management and Closure Plan**):
  - Bi-annual monitoring of the macro-invertebrate and fish communities for 5 years after the mining operation has ceased. Limit noise levels and light pollution. Create barriers and speed humps in areas of a high vehicle traffic to reduce fatalities of fauna.
  - Bi-annual monitoring of the PES of the wetland systems within the Eerstelingsfontein mine study area.
  - The wetlands were delineated for their protection. A 100m protective buffer on wetlands is required by legislation (WUL), however various guidelines recommend 200m, 500m and even 1km buffers which should be considered, but are not legislated. Guidelines are briefly discussed below:
    - Mining in any form should not be permitted in wetland FEPAs, or within 1km of a wetland FEPA buffer (Driver et al, 2011). A 100m buffer is to be placed on all additional wetlands. No development should occur within the wetlands and associated buffers. Since the mining area will overlap the NFEPA buffer a DWA license will be required.
    - A 200m buffer was also considered, as a guideline, to the wetlands for the protection of the Grey Crowned Crane. This is a conservative buffer that aims to protect the catchment of the wetlands servicing the cranes, as well as protecting the birds from noise, activity and pollution associated with open cast mining. Where possible a 200m buffer should be implemented.
  - Water quality monitoring should be conducted on a quarterly basis pre and post mining and on a monthly basis during mining (WSP, 2011). Efficient pollution dams must be erected and "clean" and 'dirty" water separated.
  - Vegetation monitoring (specifically those communities associated with the wetland systems).
  - CI Relocation Monitoring Action Plan (Permits and Botanists required).
  - Alien Invasive Control & Monitoring.
- Education and Awareness Training is essential with regards to biodiversity and the sensitivity of the systems.

3.7.1 Flora

- A botanist must be present just prior to land clearing activities (mid to end of the summer season) to assist in the identification, translocation or avoidance of any of the CI floral species identified during the survey or later. Permits will be required to remove, translocate or destroy protected species.
- All CI species that can be removed (mainly geophytic species), must be relocated to similar habitats within the area. This mitigatory measure does not greatly reduce the impact of CI loss as a number of species can be missed, some may not survive and some may then be harvested for medicinal purposes. A Relocation and Monitoring Action Plan for *Khadia carolinesis* as per Digby Wells & Associates (2012) recommendations must be incorporated into the BMAP on completion and implemented.
- The semi-transformed, but indigenous *Eragrostis plana – Crepsis* Dryland Pasture Grassland and *Eragrostis plana – Lobelia flaccida* Moist Pasture Grassland will be impacted upon by the opencast mining. The remaining areas, not immediately affected by surface infrastructure must be restricted and rehabilitated. Planting of additional species (specifically geophytes) as well as seeding with grass species sourced from the area will be required.
- The establishment of a small nursery within the office complex area could assist with long term rehabilitation of the site.
- The remaining Natural Vegetation Units must be avoided and NO traversing within these areas will be allowed;
- The design of the offices and associated infrastructure should be positioned within already transformed areas and not in any of the remaining natural vegetation.
- Monitoring Plots within each vegetation community must be set up with a long term monitoring programme implemented. If changes are detected within community structure, investigations into the reasons for this change will need to be carried out and measures to rectify applied.
- In order to achieve successful rehabilitation to a heterogenous landscape top soils are to be correctly stockpiled in their different layers and not be higher than 2 m (1 - 1.5 m preferably). This is highly recommended for successful vegetation rehabilitation, however, the trade-off between this and the increase in footprint and ultimately an impact of a greater area will need to be considered.
- A Rehabilitation Plan highlighting the process such as topsoil layering and use of an array of indigenous species must be a requirement for approval of the Environmental Process (the establishment and maintenance of a nursery must be included).

3.7.2 Fauna

- The primary recommendation is that any development in the wetlands and prescribed 200m faunal buffer is avoided. However, if the development proceeds, the mitigation recommendations for wetlands and vegetation apply to attempt to reduce the significance of the impacts on certain less sensitive faunal species. Sensitive fauna will still be affected.
- The Biodiversity Action Plan will include plans for a final biodiversity inspection of the site prior to mining commencing, for the removal of intact nests, juvenile animals or fossorial animals where possible.
- Together with Birdlife SA and the WWF, implement a monitoring programme for the CI bird species identified on site.
- Noise levels to be monitored and maintained within the Industry Norms and Standards.
- Security lighting to be avoided or kept to a minimum. Only high pressure sodium lights to be used and lights are to shine towards the ground and not into the night sky.
- Exxaro will commit to monitoring the road for signs of road kill along the road network adjacent to the mine operations. An independent junior individual will be trained to do weekly transects along the road to identify if there are any hot spot kill areas. All kills will be gpsed and identified to animal group, i.e.

mammal, bird, reptile, etc. where hot spots are identified mitigation barriers will be erected. The barrier will reduce faunal species such as herpetofauna (snakes and amphibian) from entering roads and being fatally injured. These edgings should have the vertical side facing the natural areas. Snakes and certain amphibian species often come across these barriers and will turn and run along the length rather than wasting energy going over. It is important to ensure that these barriers do no inhibit the movement of water.

- Incorporate the impact of hunting and poaching in the Education and Awareness Training Programme.
- Secure netting to be installed along the high wall to prevent faunal fatalities.
- Implement speed bumps to reduce speed and ultimately to prevent traffic colliding with faunal species.
- Keep a record of species seen on site and deaths occurring (Part of the BMAP). These records will need to be passed on to the ECO and measures re-investigated if numerous fatalities are recorded.

3.7.3 Wetland

- According to management guidance contained within the '*Implementation Manual for Freshwater Ecosystem Priority Areas*', mining in any form should not be permitted in wetland NFEPAs, or within 1km of a wetland FEPA buffer (Driver et al, 2011). A 100m buffer is to be placed on all additional wetlands. No development should occur within the wetlands and associated buffers.
- Should work be undertaken within a watercourse, or associated buffer (including the NFEPA buffer), it can only occur under the regulation of a DWA license.
- Access to wetland areas to be limited and only allowed upon authorisation from the Environmental Manager and under the supervision of the ECO.
- Prior to mining, investigate the volume of water feeding the downstream wetland system from the hillslope seep wetlands and the seasonal fluctuations in the pans. Investigate options of supplying clean water to these systems to maintain the natural fluctuations during mining.
- Ensure that clean and dirty water systems are separated and that no dirty water is discharged into the receiving environment.
- Do not dump waste of any nature, or any foreign material into any wetland or associated buffer.
- Ensure that no Acid Mine Drainage enters the downstream wetlands.
- Implement erosion protection measures to ensure that erosion of the watercourses does not take place.
- Due to the sensitive nature of the hydromorphic soils, ensure that compaction is minimised, for example utilise only existing roads where possible and minimise the road network.
- Adequate dust control strategies should be implemented to minimise dust deposition and reduce sedimentation within the wetland systems.
- Incorporate ecological input into the engineering design work for the rehabilitation of the wetland systems.
- Ensure that during the rehabilitation process the wet based soils are returned, in sequence, to the wetland areas.
- Investigate options to rehabilitate the hillslope seeps feeding the downstream wetland systems post mining to ensure the flow regime of the wetland is re-established.
- Ensure all management measures set out within the NFEPA management guidelines that are relevant to the Eerstelingsfontein project are met.
- Riverine buffers and wetland buffers and the vegetation between individual wetlands in prioritised wetland clusters should be maintained in a natural and healthy condition so as to support the movement of flora and fauna.

- Invasive alien plants (either terrestrial or aquatic) should be removed from wetland and river FEPAs, riparian areas and their buffers.

3.8 CONCLUSIONS

From an ecological perspective, 50% of future potential impacts receive a HIGH significance due to the current mine layout plan. The table presented below provides a summary of the anticipated impacts, their significance rating and how this will be reduced following mitigation. There are a number of impacts that will not reduce in significance following mitigation and this is generally when a natural habitat or species will be permanently lost or destroyed as a result of the proposed development. When considering the ecological impacts of the proposed Eerstelingsfontein mine alone it would appear that the impacts do outweigh the benefits.

The overall biodiversity impact assessment is presented in **Table 20**.

Table 20 Biodiversity Impact Assessment Table

ASPECT	IMPACT	NATURE OF IMPACT	Severity	Duration	Spatial Extent	Consequence	Frequency	Probability	Likelihood	Significance	SIGNIFICANCE
Habitat Loss and Fragmentation	Loss of vegetation communities										
	Koeleria capensis - Centella asiatica Moist Grassland	Negative & indirect	4	5	1	10	5	4	4.5	45	H
	With Mitigation		1	2	1	4	2	2	2	8	L
	Eragrostis plana – Crepsis Dryland Pasture Grassland	Negative & Direct	2	5	1	8	5	4	4.5	36	M-H
	(will be lost as in open cast footprint) With Mitigation		2	5	1	8	5	4	4.5	36	M-H
	Eragrostis plana – Lobelia flaccida Moist Pasture Grassland	Negative & Direct	2	5	2	9	5	3	4	36	M-H
	With Mitigation		2	5	1	8	5	3	4	32	M
	Themeda triandra – Chironia palustris Open Grassland	Negative & Direct	3	5	1	8	5	5	5	40	H
	With Mitigation		3	3	1	7	5	3	4	28	M
	Leersia hexandra – Juncus oxycarpus Wetland	Negative & Indirect	2	4	1	7	3	4	3.5	24.5	M
	With Mitigation		2	3	1	6	3	3	3	18	M-L
	Agrostis lachnantha - Andropogon eucomus Moist Grassland	Negative & Direct	3	4	1	8	3	4	3.5	28	M
	With Mitigation		2	4	1	7	3	2	2.5	17.5	M-L
	Diospyros lycoides – Tristachya leucothrix Rocky Outcrops	Negative & Indirect	2	4	1	7	3	3	3	21	M
	With Mitigation		1	3	1	5	5	2	3.5	17.5	M-L
	Removal of the Vulnerable and Declining TSP listed species	Negative & Direct	5	5	1	11	4	5	4.5	50	H
	With Mitigation		2	2	2	6	4	3	3.5	21	M
	Destruction of other CI plant species on site	Negative & Direct	2	5	1	8	4	5	4.5	36	M-H
	With Mitigation		1	2	2	5	4	3	3.5	17.5	M-L
	Loss of hillslope seeps and the EcoServices provided	Negative & Direct	5	5	3	13	5	5	5	65	H
	With Mitigation		5	5	3	13	5	5	5	65	H
	Loss of wetland buffer zones	Negative & Direct	4	4	2	10	5	5	5	50	H

ASPECT	IMPACT	NATURE OF IMPACT	Severity	Duration	Spatial Extent	Consequence	Frequency	Probability	Likelihood	Significance	SIGNIFICANCE
	With Mitigation		4	4	2	10	5	5	5	50	H
	Destruction of terrestrial faunal habitat	Negative & Direct	2	4	1	7	5	5	5	35	M-H
	With Mitigation		2	3	1	6	5	5	5	30	M
	Loss or displacement of faunal CI species	Negative & Direct	4	4	1	9	5	4	4.5	40	H
	With Mitigation		4	3	1	8	5	4	4.5	36	M-H
	Faunal fatalities	Negative & Direct	4	3	1	8	3	3	3	24	M
	With Mitigation		2	3	1	6	3	3	3	18	M-L
Habitat Disturbance	Change in vegetation structure within surrounding units	Negative & Indirect	3	4	3	10	4	3	3.5	35	M-H
	With Mitigation		2	3	2	7	4	2	3	21	M
	Introduction & Spread of Alien Species (increased competition with indigenous species)	Negative & Indirect	3	5	3	11	4	4	4	44	H
	With Mitigation		2	2	2	6	4	3	3.5	21	M
	Disturbance of wetlands and a reduction in EcoServices provided	Negative & Indirect	5	5	3	13	5	5	5	65	H
	With Mitigation		4	4	3	11	4	4	4	44	H-M
	Reduction in surrounding plant growth through excessive dust creation	Negative & Indirect	3	4	3	10	4	3	3.5	35	M-H
	With Mitigation		2	2	2	6	3	3	3	18	M-L
	Displacement of CI faunal species	Negative & Direct	4	4	2	10	5	4	4.5	45	H
	With Mitigation		4	4	2	10	5	4	4.5	45	H
	Displacement of faunal species	Negative & Direct	2	4	2	8	4	3	3.5	28	M
	With Mitigation		2	3	2	7	3	3	3	21	M
	Changes in the aquatic biota community structure due to stream flow modifications	Negative & Indirect	4	5	3	12	5	4	4.5	54	H
	With Mitigation		4	4	3	11	5	4	4.5	50	H
	Changes in the aquatic biota community structure due to water quality deterioration	Negative & Cumulative	4	5	4	13	5	4	4.5	59	H
	With Mitigation		4	4	4	12	5	4	4.5	54	H

ASPECT	IMPACT	NATURE OF IMPACT	Severity	Duration	Spatial Extent	Consequence	Frequency	Probability	Likelihood	Significance	SIGNIFICANCE
Increase in Anthropogenic Activity	Increase in surrounding fire frequencies	Negative & Direct	4	3	3	10	2	4	3	30	**M**
	With Mitigation		2	2	2	6	1	2	1.5	9	**L**
	Removal of CI plant species for cultural use	Negative & Direct	2	4	2	8	3	3	3	24	**M**
	With Mitigation		2	4	2	8	2	2	2	16	**M-L**
	Hunting or poaching of fauna	Negative & Indirect	3	3	2	8	4	2	3	24	**M**
	With Mitigation		2	3	2	7	3	2	2.5	17.5	**M-L**

4 SURFACE WATER ASSESSMENT

4.2 TERMS OF REFERENCE

WSP was commissioned by Exxaro to undertake a Surface Water Assessment (**Appendix B**). The objective of the study was to review the mine Stormwater Management Plan (SWMP), assess the mine impacts on the surface water quality and quantity, and develop a mine water and salt balance for the proposed new Eerstelingsfontein opencast coal mine.

4.3 METHODOLOGY

4.3.1 Storm Water Management Plan (SWMP)

A Stormwater Management Plan (SWMP) for the Eerstelingsfontein site was compiled by Virtual Consulting Engineers (Pty) Ltd in 2009 and approved by the Department of Water Affairs (DWA). WSP reviewed the SWMP in line with the DWAF GN704 Guideline Document, DWAF Best Practice Guidelines for Stormwater Management and the DWAF guidelines for the Water Management for Surface Mines. These guidelines set out the following requirements:

- Confine/divert any unpolluted water to a “clean” water system, and polluted water to a “dirty” water system;
- Both “clean” and “dirty” water systems should be designed and constructed in such a way so as to prevent cross contamination between the “clean” and ”dirty” water systems; and
- The “clean” and “dirty” water systems should be designed to contain the 50 year storm event, and should not lie within the 1:100 year floodline or within a horizontal distance of 100 m from any watercourse.

The SWMP includes the opencast mine area, the operations area and the overburden stockpiles.

4.3.2 Surface Water Assessment

The Surface Water Assessment included water quantity and quality analysis (**Appendix B**):

- Water quantity

Hydrological modelling (using the ACRU Agrohydrological modelling package) was utilised to determine the impacts of the mine stages on the water quantity of the receiving environment. Based on the modelling results, a comparative exercise was conducted to quantify and describe the impacts of the mining activities.

- Water quality

Monitoring has been conducted in the past within portions of the affected watercourses. These monitoring results were reviewed to determine the baseline water quality of the watercourses expected to be impacted on by the mining operations. Based on the review, recommendations for future monitoring have been made.

4.3.3 Water and Salt Balance

A water and salt balance is necessary as a management tool to quantify the impact of the mine on the natural environment and aid in the assessment of legislative compliance or management objectives. These balances facilitate the investigation and compiling of long term water quality treatment options and solutions.

- Water balance

In order for WSP have verified the water balance prepared by Exxaro in 2009, a baseline assessment was conducted. This assessment included the wet and dry season inputs and outputs of water from the mine and associated operations. Transfers of water within the mine area were included.

- Salt balance

Site specific salt concentrations will only be available once the mine is operational as such a conceptual salt balance was developed in order to guide future monitoring.

4.4 SUMMARY OF FINDINGS

4.4.1 Stormwater Management

The Stormwater Management Plan (SWMP) selected for use for the proposed mine was compiled by Virtual Consulting Engineers (Pty) Ltd (VCE) in 2009. VCE were appointed by Exxaro to conduct a zero-based assessment and review of surface water control procedures proposed for the opencast mine. This design was approved by DWA.

4.3.1.1 Operations Area

The operations area will contain the crushing plant and associated run of mine product stockpiles, roads, workshop, stores and refuelling areas. Pollution sources in this area include runoff from the stockpiles and roads, and spills of hydrocarbons and other chemicals within the workshops, stores and refuelling areas.

To limit the impact to surface water bodies, VCE proposed that "dirty" water flow from this area be directed through earth channels, berms and culverts towards a silt trap (to remove suspended solids) just upslope of a pollution control dam. The lined pollution control dam, to the north of the mine pit, will contain all polluted runoff which will be maintained in a closed system. Water contained within the dam will be used for dust suppression within the mine area, with the remaining water being continuously pumped into the opencast pit.

Clean surface run-off from outside the working areas will be diverted away from the 'dirty areas' and will flow into the natural drainage courses into a pollution control dam or open pit. Only water falling within the active mine operations areas will be contained and diverted away from the natural drainage courses into the pollution control dam.

Based on the peak flows and stormflow volume VCE calculated the required storage volume of the pollution control dam as 8042m^3. Based on a freeboard of 0.8m, and utilising the pond dimensions outlined in **Table 21** the pond capacity was calculated as 12 334m^3, with a depth of 3.6m. WSP's review of the flow and runoff calculations confirmed that the pollution control dam is adequate for the management of stormwater flow and meets the DWAF guidelines.

Table 21 Pollution Control Dam Dimensions (WSP, 2011)

Length	Width	Slope	Freeboard	Live Capacity
110m	55m	1 (v):2.5 (h)	0.8m	12 334 m^3

4.3.1.2 Overburden Stockpiles

VCE proposed the stockpiling of overburden within two areas, to the south-east and south-west of the mine. Containment berms will be created around stockpiles, as well perpendicular to ensure that "dirty" water coffers are created. Vegetation of the area between the berms and stockpile will promote evapotranspiration and reduce ponding. In addition, the construction of a 15m wide thickly vegetated "buffer" zone outside of the berms will contain sediment.

Overburden stockpiles will be separated as follows (**Appendix B**):

Carbonaceous stockpiles: will contain overburden, including shale and other potential carbonaceous materials. Surface water will be contained within the stockpile and berms. Groundwater contamination will be prevented by placing a 125mm clay liner at the bottom of the stockpile. Captured water will be lost through evapotranspiration.

Inert stockpiles: will contain mostly topsoil and soft overburden. "Dirty" water will be contained within the stockpile and berms. Water runoff from this area is expected to be contaminated only by suspended solids.

4.3.1.3 Mining Areas

The pit will be rehabilitated on an on-going basis. Rehabilitated areas will be re-vegetated and contour berms constructed to slow surface water and prevent erosion. Buffer zones, containing thick vegetation, will be established downslope of the rehabilitated areas to ensure erosion is minimised. Rehabilitated areas will be classified as "clean" water areas.

As the pit is mined-out and coal is removed a number of successive storage depression are created. This allows for storage of dirty water and reduces the reliance on the pollution control dam. Thus over time this eliminates the need for a large storage area for capturing the entire pits runoff, and facilitates continuous rehabilitation during the operational phase.

4.3.1.4 Haul Roads

Where pit access roads traverse rehabilitated areas, it is recommended that small coffer dams are constructed to contain potential pollution, and facilitate collection of sedimentation in order to facilitate the landscaping process and prevent contamination of newly rehabilitated areas.

4.3.1.5 Passive Water Treatment

Decanting is expected within 5 years after closure, at an expected rate of approximately 365 m^3/day and a worst case scenario of 456m^3/day. VCE concluded that passive treatment of AMD is achievable. The passive treatment system is proposed to consist of an anaerobic contact bed, anoxic limestone drain, sulphate reduction unit and polishing wetland. As the extent of AMD largely depends on the effectiveness of the rehabilitation, it was proposed the design of the treatment process be concluded following completion of the mining operations.

Decant from the EOP will be influenced by Pyrite oxidation with a decreased pH and dissolved salts, particularly sulphates and chlorides. The short duration of mining and progressive rehabilitation of the pit will reduce the impact of AMD and thus the chemistry of the decant waters will not be as seriously impacted as SUMO and thus a passive system of water treatment will be appropriate for maintaining an acceptable quality for natural discharge.

The proposed passive treatment system is a conservative generic system which can be modified to suit the final chemical characteristics of the AMD. The factors that influence the selection of treatment measures include the flow rate, the contaminant loadings, the pH and the dissolved oxygen content. Initial indications are that the pH of the decant will be moderately impacted but is unlikely to be lower than 4.5 (severe AMD results in pH that ranges from 2 to 4). Flow rates are likely to be low. Contaminants are likely to consist of raised levels of iron, aluminium, and manganese with increased sulphates and chlorides Therefore initial treatment via a constructed anaerobic wetland is likely to be effective for removal of metals and lowering sulphate concentrations. Given the variety of treatment steps available it is preferable to base final design measures on real data from monitoring during the life of the mine, in addition to predictive models, as pH, alkalinity and dissolved oxygen are key interrelated parameters that need to be understood. The short life of mine together with progressive rehabilitation are important factors that reduce the severity of AMD. For this reason the historic AMD associated with the old Sumo colliery is considered a poor analogue of the Eerstelingsfontein pit, although the chemistry of the rocks could be expected to be almost identical. The decant from Sumo has a pH in the range 4.7 to 5.9 and is noticeable in the visible staining associated with high iron and manganese contents. In the absence of mineralogical alkaline buffers it is the kinetics of the chemical weathering processes that drives AMD, i.e. the longer the waste rock is exposed to the atmosphere the more severe the problem can become. Rapid backfilling accompanied by flooding of the backfilled pit will reduce the rate of oxidation of the waste rock and although some acidic decant is seen as inevitable the scale of the impact can be mitigated without continuous chemical treatment.

There are no specific water quality requirements stated in the Water License. Depending on the final future use of the site will need to meet the relevant South African Water Quality guidelines.

4.3.1.6 SWMP Recommendations

WSP concluded that the overall SWMP was compliant. In order to meet the principles outlined in the DWAF guidelines for stormwater management, the following recommendations were made:

- Operations area:

Channels, berms and culverts used in the diversion of runoff to the pollution control dam are to be designed to contain the 1:50 year storm event, including a 0.8 freeboard.

- Overburden stockpile:

Stockpiles should be located outside the 1:100 floodline, and at least 100m from any watercourse. This is particularly relevant to the western stockpiles located in close proximity to the Blesbokspruit Tributary. Containment berms are to be designed to contain the 1:50 year storm event, including a 0.8 freeboard.

- Haul roads

Coffer dams (used to contain runoff and allow sediment to settle) should be sized to contain 1:50 year storm event, including a 0.8 freeboard.

4.4.2 Surface Water Assessment

4.3.2.1 Water Quantity Assessment

The ACRU Agrohydrological model was used to determine the runoff expected from the catchments during baseline conditions, and during each of the mine stages, and after mine rehabilitation. The resultant change in runoff from the baseline conditions was then used to determine the impact of the mining activities within each catchment. The catchments included were the Blesbokspruit Tributaries (1 and 2) which contribute to the Witkloofspruit tributary, as well as the Klein Komati tributary (**Figure 15**).

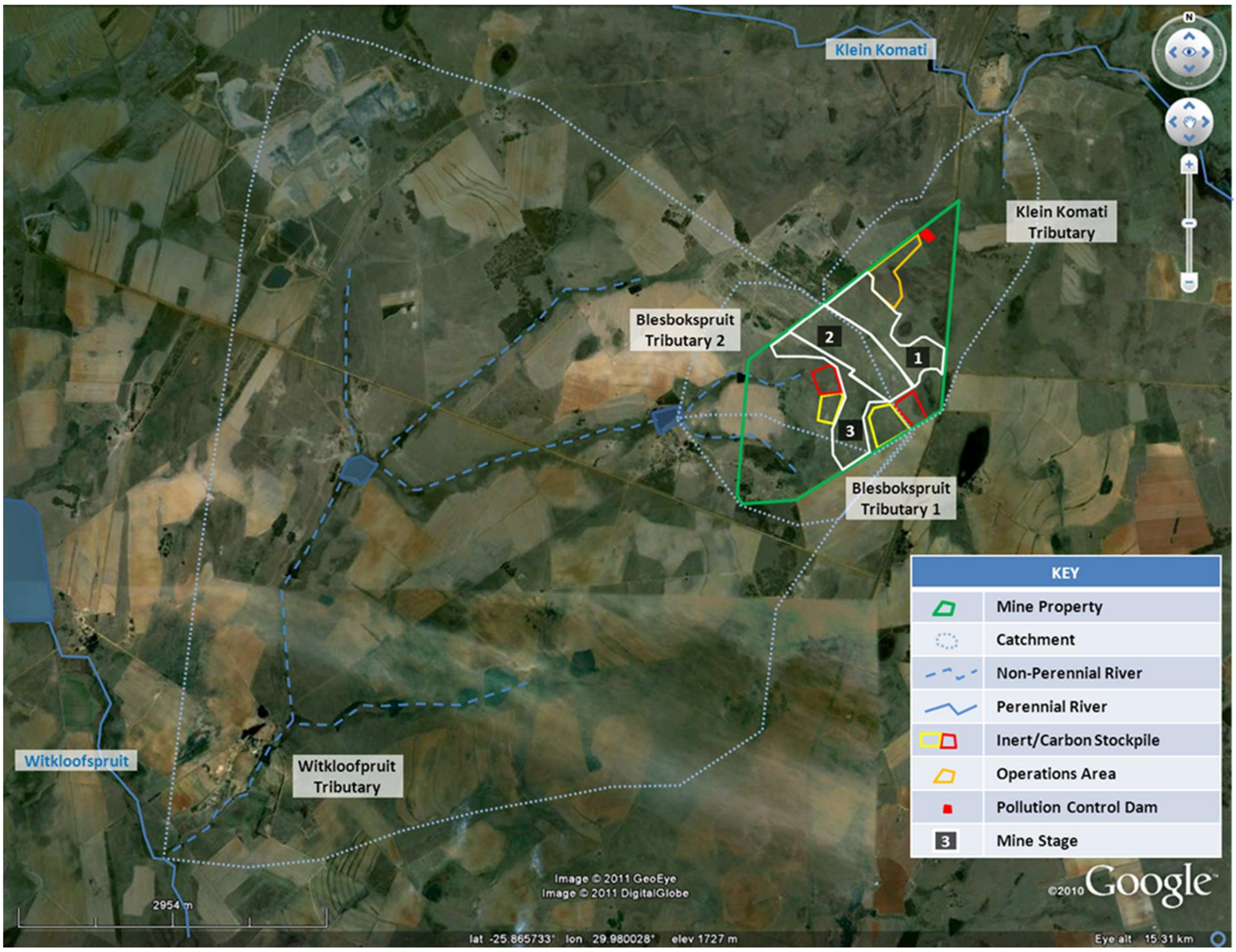


Figure 15 Mine hydrology and infrastructure (WSP, 2011)

The modelling results (**Appendix B**) are summarised as follows:

- Blesbokspruit Tributary 1:

The runoff from the Blesbokspruit Tributary 1 catchment is expected to be unchanged during mining Stage 1 and 2. During Stage 3 the runoff is expected to increase (by a maximum of 10.37% compared to baseline conditions) due to advancement of the mine pit. Post rehabilitation there is expected to be a reduction in flow from the catchment (by a maximum of 2.78%) due to increased infiltration. An increase in flow is likely to alter the physical characteristics of the channel due to erosion, while a decrease is likely to impact on the aquatic ecosystems.

The environmental significance of this impact is expected to be moderate (**Table 22**) due to the impact being limited to the short duration of the mining activities within this stage. Due to the moderate increase in flows, erosion protection (e.g. gabions) in sensitive river sections may be required. If properly implemented it is expected that this will lead to a low degree of impact to the physical river characteristics, but is unlikely to reduce the impact to aquatic ecosystems. This impact needs to be quantified by an aquatic ecologist.

Table 22 Blesbokspruit Tributary 1 Impact Summary (WSP, 2011)

Impact	Stage 1	Stage 2	Stage 3	Rehab
	None	None	Flow Increase	Flow Decrease
Severity	0	0	3	1
Duration	0	0	2	5
Extent	0	0	3	3
Consequence (sum)	0	0	8	9
Frequency	0	0	4	3
Probability	0	0	4	3
Likelihood (average)	0	0	4	3
Significance (consequence x likelihood)	**0**	**0**	**32**	**27**
Degree of impact	None	None	Medium	Medium
Mitigation measures	None	None	Erosion Protection	None
Degree of Impact Post Mitigation	**None**	**None**	**Medium**	**Medium**

- Blesbokspruit Tributary 2:

During Stage 1 and 2 of mining there is expected to be a general increase in runoff (by a maximum of 94.82%) due to an increase in impervious areas (including stockpiles) and a reduction in vegetation. Wet climatic conditions will, however, promote a decrease in flow, possibly due to a lower contributing catchment through the creation of the mine pit. There is expected to be a decrease in runoff during Stage 3 of mining (due to the advancement of the mine, and rehabilitation within the remainder of this catchment which promotes infiltration). Post mine closure the addition of decant water to this catchment has the potential to significantly increase the flows in this watercourse which is likely to alter the river geomorphology and aquatic health. It is recommended that this impact is minimised by enhancing evaporation and infiltration (e.g. through the use of constructed wetlands), and by limiting the erosion through the use of gabions.

Results of chemical tests on samples of the likely waste rock materials indicate that the sandstones and shales are likely to be moderately acid producing when exposed to atmospheric weathering. The rocks generally have a low carbonate content and a slightly elevated sulphate content which suggest that there is a potential for the rocks to leach to produce a low pH solution with elevated concentrations of chloride, sulphate, iron and manganese.

Simple chemical tests to screen rock materials for acid rock drainage potential do not consider the kinetic controls on chemical weathering. With the relatively short life of mine of approximately 24 months the extent of oxidation will be limited and of a superficial extent and thus the risk of a predicted pH of 4 being established and maintained is highly unlikely if the waste rock is used to backfill the pit progressively during mining.

This is likely to impact on the aquatic ecosystems and geomorphology within this reach of the watercourse. The environmental significance of this impact is expected to be high due to the high duration and frequency of the impact (**Table 23**). Based on these impacts it is proposed that the volume of decant water reaching the watercourse is limited to reduce the impact to the receiving watercourse. A possible option is the introduction of constructed wetlands which will serve a dual purpose of increasing evaporation and allowing for water infiltration to the groundwater store. Furthermore gabions within the downstream river reach may be required to limit the erosive energy of the flow. If properly implemented it is expected that this will lead to a medium degree of impact to the physical river characteristics, depending on the resultant flow. It should be ensured that the resultant flows do not have a significant impact on aquatic ecosystems.

Table 23 Blesbokspruit Tributary 2 Impact Summary (WSP, 2011)

Impact	Stage 1	Stage 2	Stage 3	Rehab
	Flow Increase	Flow Increase	Flow Decrease	Flow Increase
Severity	3	3	3	4

Duration	2	2	2	5
Extent	3	3	3	4
Consequence (sum)	8	8	8	13
Frequency	5	5	5	5
Probability	4	4	4	4
Likelihood (average)	4.5	4.5	4.5	4.5
Significance (consequence x likelihood)	**36**	**36**	**36**	**58.5**
Degree of impact	Medium	Medium	Medium	High
Mitigation measures	Erosion Protection	Erosion Protection	None	Flow reduction, erosion protection
Degree of Impact Post Mitigation	**Medium**	**Medium**	**Medium**	**Medium**

- Witklookspruit tributary (to which the Blesbokspruit tributaries contribute):

The mine will have an influence on this downstream catchment. During mining Stages 1 and 2 there will be an increase in flow (highest change of 1.83% during Mine Stage 2), except during the wet climatic conditions during Mine Stage 2 where there will be a marginal decrease. During Stage 3, the reduction in flows within the Blesbokspruit tributaries leads to reduction of flow (maximum of 1.06% compared to the baseline conditions). After mine closure, the addition of decant water to the upper tributary (Blesbokspruit tributary 2), there is expected to be a significant increase in flows (up to 100% change from baseline conditions). Should this not be addressed this is likely to alter the river geomorphology and aquatic health. The short life of mine together with progressive rehabilitation are important factors that reduce the severity of AMD as such the decant is not expected to significantly negatively affect the quality of water in this watercourse.

This impact can be minimised by enhancing evaporation and infiltration through the use of constructed wetlands, and by limiting erosion within affected river reaches through the use of gabions. This is expected to result in a medium impact to the watercourse physical characteristics and ecology (**Table 24**).

Table 24 **Witkloofspruit Tributary Impact Summary (WSP, 2011)**

Impact	Stage 1	Stage 2	Stage 3	Rehab
	Negligible	Negligible	Negligible	Flow Increase
Severity	0	0	3	3
Duration	0	2	2	4
Extent	0	1	1	4
Consequence (sum)	0	3	3	11
Frequency	4	4	4	5
Probability	4	4	4	4
Likelihood (average)	4	4	4	4.5
Significance (consequence x likelihood)	**0**	**12**	**12**	**49.5**
Degree of impact	None	Low	Low	High
Mitigation measures	None	None	None	Flow reduction, erosion protection
Degree of Impact Post Mitigation	**None**	**Low**	**Low**	**Medium**

- Klein Komati catchment:

There will be a reduction in flows during each of the mining steps. During Stage 1 of the mining activities this is due to the mining activities and stormwater management that reduces the size of the contributing catchment. During Stage 2 and 3 and after mine closure this is predominantly due to an increased infiltration due to rehabilitation activities. The decrease in flow is highest during Stage 1 of the mining activities (with a 34.1% change from baseline conditions). A decrease in flow is likely to impact on the aquatic ecosystems within this watercourse.

The environmental significance of this impact is expected to be moderate due to the high duration, frequency and probability of the impact. As no mitigation measures are expected to be implemented to increase these flows, this impact is not expected to be mitigated during this mining stage (**Table 25**).

Table 25 Klein Komati Catchment Impact Summary (WSP, 2011)

Impact	Stage 1	Stage 2	Stage 3	Rehab
	Flow Decrease	Flow Decrease	Flow Decrease	Flow Decrease
Severity	3	3	3	3
Duration	2	2	2	4
Extent	3	3	3	3
Consequence (sum)	8	8	8	10
Frequency	4	4	4	4
Probability	4	4	4	3
Likelihood (average)	4	4	4	3.5
Significance (consequence x likelihood)	**32**	**32**	**32**	**35**
Degree of impact	**Medium**	**Medium**	**Medium**	**Medium**
Mitigation measures	None	None	None	None
Degree of Impact Post Mitigation	**Medium**	**Medium**	**Medium**	**Medium**

4.3.2.2 Water Quality Impacts

Potential contaminants associated with coal mining include trace metals (iron, manganese, and arsenic), inorganics (sulphates, sodium, chloride, and fluoride), salinity and acidity. In order to assess the potential impacts of the mine on the receiving environment, it is necessary to know the baseline water quality conditions of the Blesbokspruit and Klein Komati tributaries. To determine the baseline water quality, historical water data was analysed, the results of which are summarised below:

- Blesbokspruit Tributary 1:

Monthly surface water sampling (between 2008 and 2010) at three points on this tributary, and within two dams on this length of watercourse indicated water quality unsuitable for use in irrigation (TDS), aquaculture (iron, aluminium, nitrite/nitrate), domestic use (iron, aluminium), aquatic ecosystems (aluminium).

- Blesbokspruit Tributary 2:

There are no surface water monitoring points on the river. A spring on site was sampled in March 2004, providing indicative results. This individual sample indicated calcium exceeded the guidelines for irrigation; total alkalinity is below the guideline for aquaculture; and nitrate exceeds the guidelines for aquaculture.

A sampling point at Dam 3 includes the contributions from both Blesbokspruit Tributaries (Tributary 1 and 2), and has been sampled monthly between February 2010 and November 2010. Results indicated that the water quality is typically unsuitable for use in irrigation (TDS), aquaculture (iron, aluminium, nitrite/nitrate, and alkalinity), domestic use (iron, aluminium) and aquatic ecosystems (aluminium).

- Klein Komati Tributary:

This tributary does not have any sampling points. Samples have previously been retrieved upstream and downstream of the point where the tributary joins the Klein Komati in March 2004, thus providing indicative results. The results indicate that the background water quality of the receiving watercourse is unsuitable for irrigation (TDS), domestic use (iron), and aquaculture (iron and nitrate). In addition, the upstream sampling location indicates that the water quality is unsuitable for domestic use and irrigation due to elevated manganese concentrations. This water quality is expected to have been influenced by agricultural inputs and soil erosion.

4.3.2.3 Water Quality Recommendations

Following review of the sampling program covering the watercourses expected to be impacted by the mine, the following recommendations were made:

- Additional monitoring points downstream of the mining activities to be included on Blesbokspruit Tributary 2, on the Blesbokspruit itself, and the tributary to the Klein Komati River.
- Sampling to include the parameters sampled previously by Exxaro on the Blesbokspruit tributary (including pH, trace metals, inorganics, and salinity). Arsenic (a known contaminant relating to coal mining), not previously monitored, should be included in the parameters to be sampled.
- Monitoring is to be conducted on a quarterly basis for at least a year prior to the commencement of mining activities, to determine baseline water quality. Thereafter, during mining activities monitoring should be conducted on at least a monthly basis, in order to determine impacts to the water quality through the mining activities. Post closure of the mine, monitoring should continue on a quarterly basis in order to detect residual contamination sources.

4.4.3 Water and Salt Balance

4.3.3.1 Water Balance

WSP conducted a baseline assessment of the mine water balance to determine the impact to the natural environment. The water balance indicated that in the wet season there is a net accumulation of 58,527m^3 within the mining area (**Figure 16**). Due to proposed transfers of water, this will be stored within the mine pit. In the dry season there will be a net loss of 38,483m^3 (**Figure 17**). As the pit is mined-out and coal is removed a number of successive storage depression are created. This allows for storage of dirty water and reduces the reliance on the pollution control dam.

Based on these results, there is expected to be a surplus of 20,044m^3 within the mine pit, which will need to be stored into the following year. As a result it needs to be ensured that the storage capacity of the mine pit takes into account this accumulation of water.

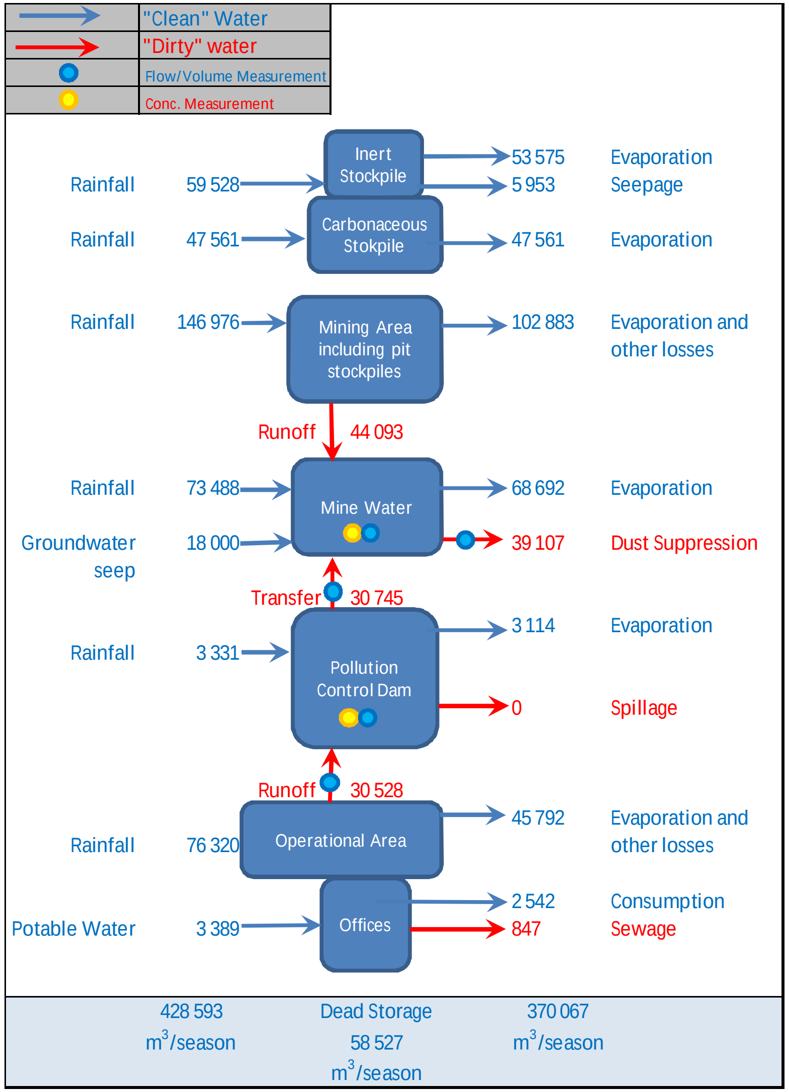


Figure 16 Water Balance for Eerstelingsfontein Mine: Wet Climatic Conditions (WSP, 2011)

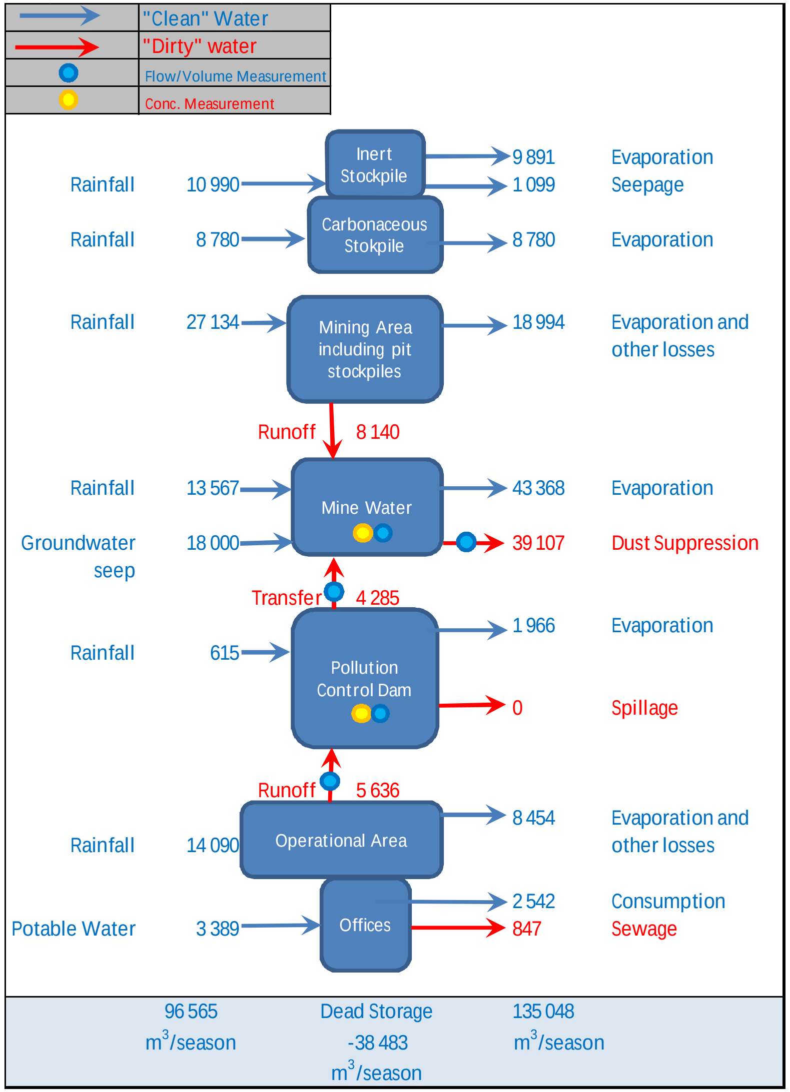


Figure 17 Water Balance for Eerstelingsfontein Mine: Dry Climatic Conditions (WSP, 2011)

4.3.3.2 Salt Balance

The salt balance is to be used in conjunction with the water balance to assist the mine in managing its waste in a responsible manner to limit the environmental impact. As a salt balance cannot be created until site specific salt concentrations are available, a conceptual model was developed to guide future monitoring (**Appendix B**).

The determination of salt load can be determined using the following equation:

$$Salt\ Load\ (kg/day) = Flow\ (m^3/day) \times 0.001 \times Salt\ Concentration\ (mg/l)$$

The measurement of flow and volume, and salt concentrations are recommended at the following locations:

- Volume of water utilised in dust suppression;
- Transfer volumes between pollution control dam and water storage within the mine pit;
- Flow volumes from the operations area to the pollution control dam;
- Volume stored within pollution control dam;
- Volume stored within the mine pit;
- Salt concentrations within the pollution control dam; and
- Salt concentration within the mine pit.

Since sulphate generation associated with the coal is expected at the mine it is recommended that sulphate is included as a salt within the salt balance.

A salt and water balance is dynamic and as the mine develops, the circuits, flows and concentrations within the water balance need to be updated to include all changes to the balance, and to include additional water, salt or pollutant sources. It is recommended that once operational, the mine water and salt balance is refined to include smaller management units to focus on specific circuits proven or expected to contribute to contamination loads. To achieve a balance with sufficient detail, any flows within the entire system contributing to more than 1-5% of the total flow should be considered **(Appendix B**).

The salt load is a factor of the water flow rate and salt concentration. In order to limit the salt impacts to the environment, two options are identified;

- Limit water flows to the receiving environment where possible; and
- Use suitable treatment systems to attenuate conservative salts (e.g. calcium, phosphate, nitrate, heavy metals, sulphate etc.) through mechanisms such as geochemical generation, precipitation and biological metabolism.

Although conservative salts can be attenuated, non-conservative salts such as sodium and chloride are expected to remain in the system. Hence, although the application of these water management measures can limit the environmental impacts to the receiving environment, the impact cannot be completely mitigated.

5 GROUNDWATER ASSESSMENT

5.2 TERMS OF REFERENCE

The Institute for Groundwater Studies (IGS), University of the Free State was appointed by WSP to undertake the groundwater component of the assessment for the proposed Eerstelingsfontein Mine. The focus of the Groundwater Assessment (**Appendix C**) was to:

- Update the existing hydrocensus data;
- Assess acid drainage potential and geochemical properties;
- Undertake steady state and transient state groundwater modelling;
- Identify and quantify groundwater impacts associated with the mining activities;
- Perform post-closure scenarios including decant volumes, qualities, localities and timing; and
- Compile a monitoring plan in compliance with best practice.

In addition, the indirect impact of changes in surface and groundwater regimes on wetlands was considered, in response to concerns raised during the specialist investigations.

5.3 SUMMARY OF FINDINGS

5.3.1 Baseline Characteristics

5.2.1.1 Geology

A summary of the generalised stratigraphy is summarised below (**Figure 18**).

Increasing with depth

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

Figure 18 Generalised Stratigraphy (IGS, 2011)

5.2.1.2 Geohydrology - Groundwater levels

Based on current available data, the aquifer displays fractured rock characteristics. The data pertaining to water level depth was obtained from monitoring borehole within and close to the mining area, and privately owned boreholes within the sites sub-catchments (**Appendix C**).

The positions of boreholes and springs together with groundwater levels are presented in **Figure 19**.

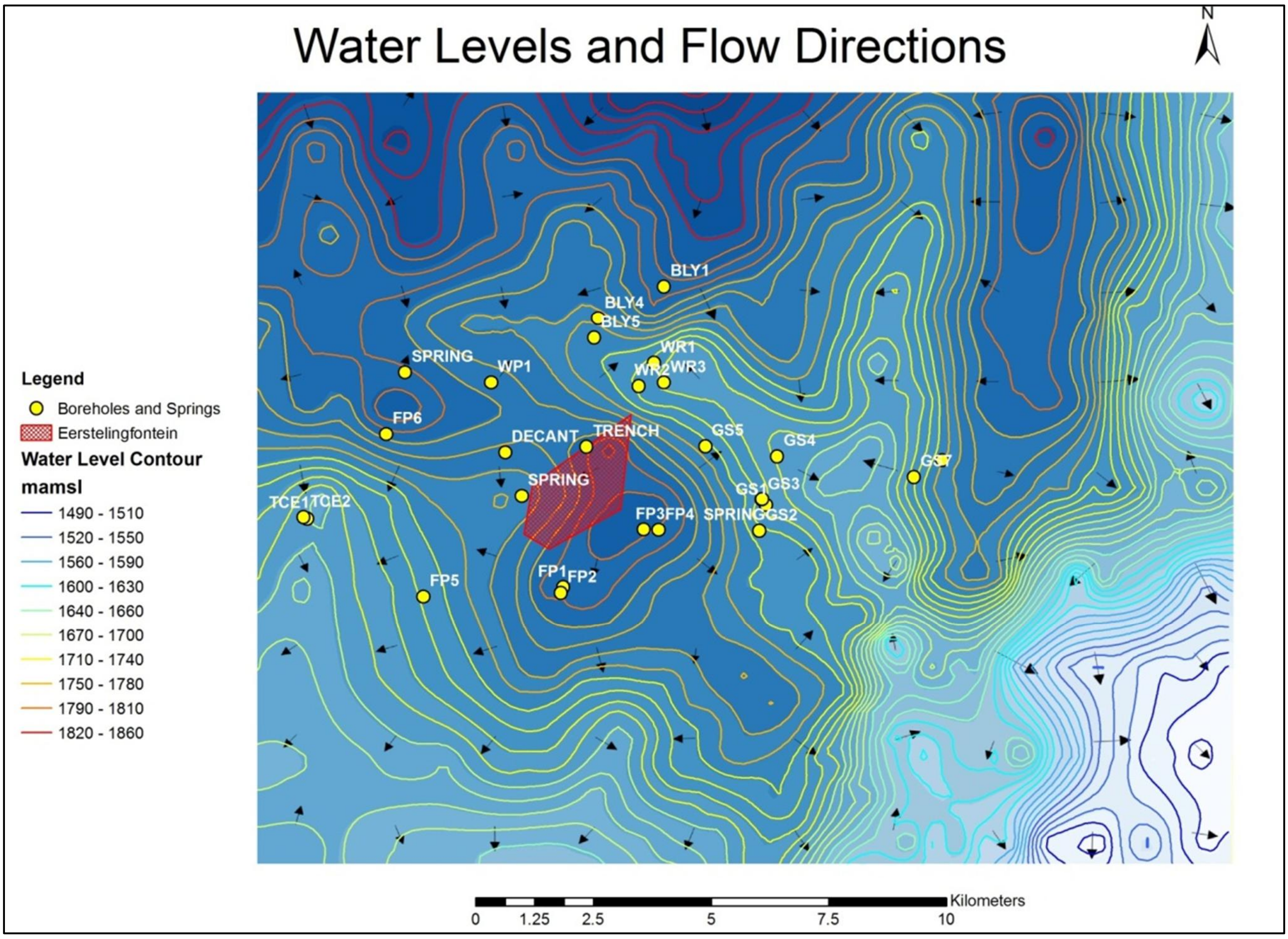


Figure 19 **Groundwater levels and positions of boreholes and springs (IGS, 2011)**

5.2.1.3 Chemistry

Existing monitoring data together with latest hydrocensus data were analysed using the WISH software. The available water quality data indicates the following (**Appendix C**):

- Total Dissolved Solids (TDS) and Electrical Conductivity (EC) are well below the SANS 241:2005 drinking water guideline (SANS 241:2005). EC is considered to be a good global indicator of possible water quality issues.
- Major cations and anions data indicate that all sites are well below the SANS drinking water guideline.
- pH values are within a relatively narrow band of neutral to slightly acidic. The pH levels in water are an important indicator of change in chemistry, and pH values limit the mobilisation of metals. If pH values remain in this band, metal content should remain low thereby limiting environmental impacts.
- Aluminium and iron levels are well below the SANS drinking water guideline, however historical elevated levels of aluminium and iron were present in a number of boreholes.

The Groundwater Assessment has made use of a number of methods (the Piper diagram and Expanded Durov diagram) to represent the chemistry associated with the groundwater sites (**Appendix C**).

Surface water monitoring positions relative to the Eerstelingfontein site are shown in **Figure 20**. Water quality data assessed indicates that:

- The pH values are within a relatively narrow band of neutral to slightly acidic with the exception of decant (from the decommissioned Sumo colliery).
- All sites are well below the drinking water guideline for EC. The decant site exhibits an elevated EC level, however this is still within acceptable limits.

Water qualities are well below the drinking guidelines with the exception of historic aluminium and iron concentrations.

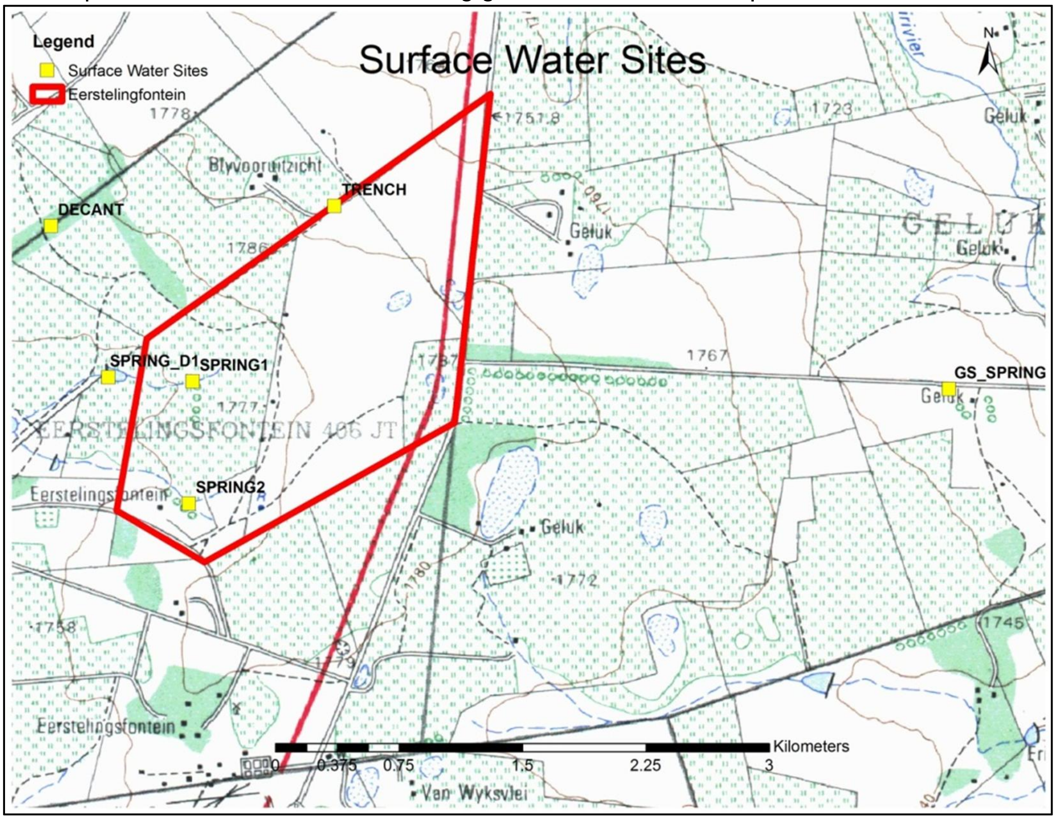


Figure 20 **Surface Water Monitoring Sites (IGS, 2011)**

5.2.1.4 Acid Base Accounting

Acid-based accounting is a screening procedure undertaken to determine the potential for acid mine drainage (AMD) from the overburden material (**Appendix C**). During the GSC study (2004) three composite samples (from the core exploration boreholes) were taken to determine the potential for AMD associated with the Eerstelingfontein opencast mining project. The samples analysed included sandstone, shale, and sandstone interbedded with shale.

All the samples indicate a low risk of acid generation (**Appendix C**).

5.2.1.5 Groundwater Use

Farmers and residents in the area rely solely on groundwater for domestic and agricultural use. It is estimated that the estimated 500 residents utilise approximately 20 000m^3 of water per annum from the identified boreholes and springs.

5.2.1.6 Aquifer Characteristics

Exploration borehole logs indicate a dolerite dyke, with an east-west orientation, in the central part of the mine. The contact between the dyke and the surrounding Karoo geology can act as a preferential groundwater flow pathway. Aquifer tests were performed on the monitoring boreholes. The aquifer underlying the Eerstelingsfontein site is considered to be a minor aquifer, but important for domestic and agricultural use.

5.2.1.7 Groundwater – Wetland Interaction

The wetland study undertaken by NSS (2011) identified wetlands on site, and that there is potential that their source is groundwater. Shallow cluster boreholes (to determine the thickness of the clay) were drilled in strategic positions to monitor water levels in order to calculate groundwater interaction with wetlands (**Figure 21**).

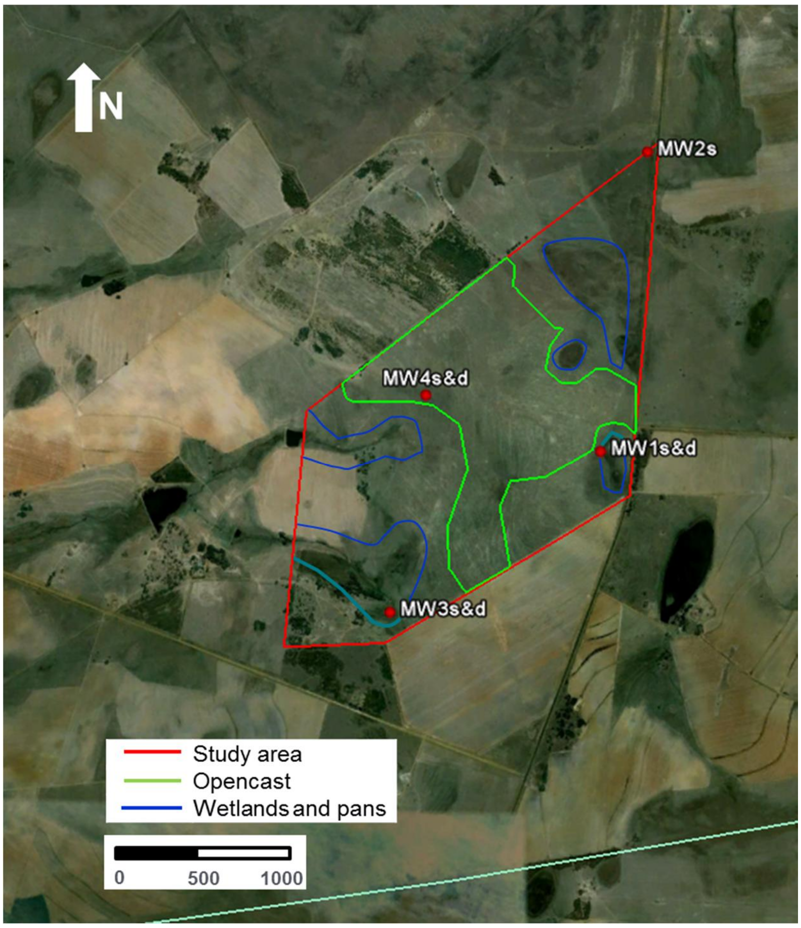


Figure 21 **New Boreholes (IGS, 2011)**

The groundwater quality in these boreholes was assessed and all data was within the SANS guideline. The groundwater found in the boreholes is calcium/magnesium bicarbonate in character and are considered to be unpolluted recharge waters.

5.3.2 Groundwater Modelling

5.2.2.1 Geochemical Model

A geochemical model was developed for the site using PHREEQC, in order to determine the acid generating potential for a series of boreholes. Initial and final pH indicate a low risk of acid generation (**Appendix C**).

5.2.2.2 Numerical Groundwater Model

Numerical models simulate groundwater flow and transport. The basic steps involved in modelling include:

- Collection and interpretation of field data;
- Calibration of data and validation of the reliability of the model to make predictions; and
- Modelling scenarios

MODFLOW, a three-dimensional simulation groundwater flow model, was used. Once all data had been inputted, a steady state calibration was conducted to ensure the flow model has the same behaviour as the actual system under investigation (i.e. undisturbed groundwater flow conditions).

Mass transport modelling to simulate water contamination or pollution was undertaken using MT3D software. The model takes into consideration a number of aspects or phenomena which affect concentration distribution of a contaminant as it moved through a medium (**Appendix C**).

5.3.3 Potential Impacts

5.2.3.1 Construction Phase

The construction of the box cut for mine stage 1 is the only activity which will have a significant impact on groundwater. It is assumed that the box cut will be approximately 10m in depth, over the northern section of the mining site. Groundwater seep into the excavated area at a rate of 35 to 50m^3/day is anticipated. The impact will occur when groundwater levels are approximately 2m below the surface, when the drawdown cone will develop (**Figure 22**).

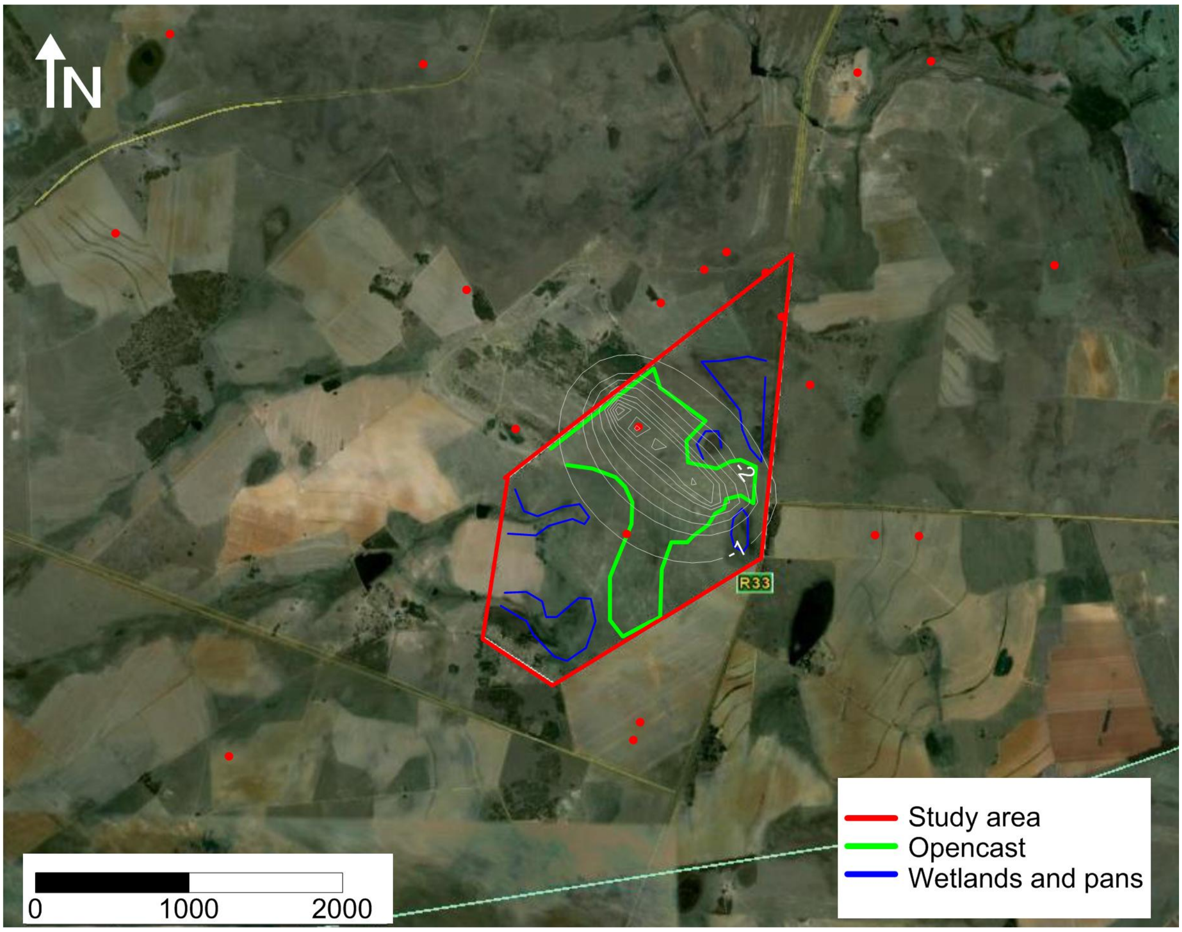


Figure 22 **Drawdown Cone (contour interval 1m): end of phase 1 (± 9 months after mining started (IGS, 2011)**

The groundwater gradient will be towards the opencast mine, preventing the spread of contamination into the surrounding aquifer. Water levels in borehole GCS6 and GCS5 will drop by 1.2 and 8m respectively.

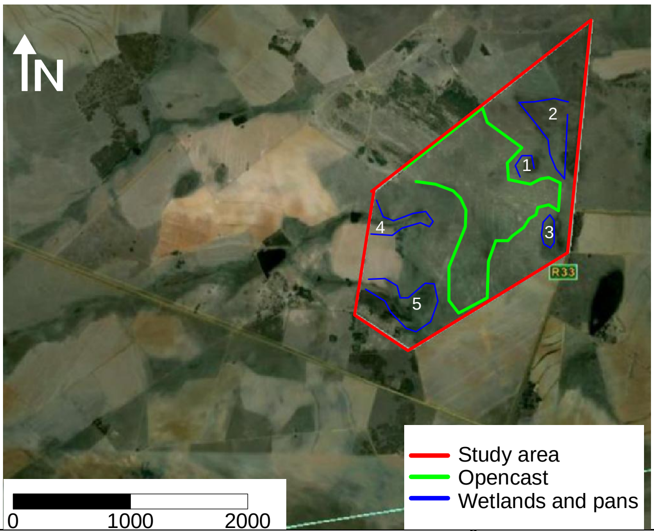
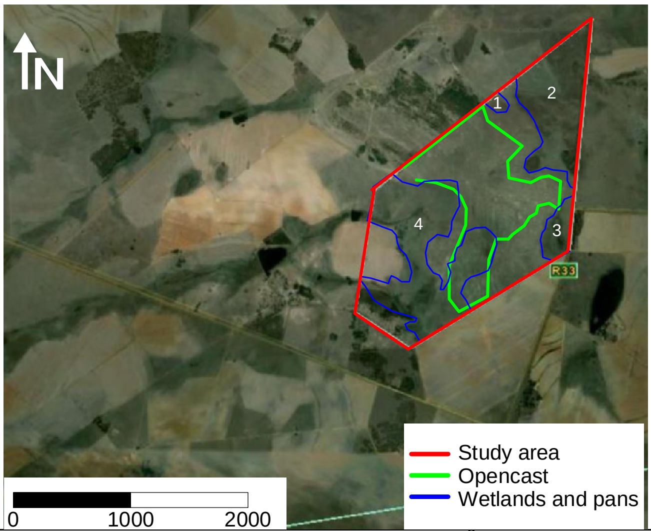
The groundwater model was adapted to address the impacts on wetland water levels when groundwater levels drop. Both wetland delineations for the site were included in the modelling exercise (**Table 26**).

The wetlands and pans receive their recharge via surface runoff and baseflow from a perched water table that develops above a low permeability layer of clay. The clay allows water to slowly permeate to the deeper sub-surface rock layers when fully saturated and fracture zones in the rock allow seepage and hydraulic connectivity to the deeper fractured rock aquifer. The regional aquifer also exhibits perching of groundwater particularly above coal and shale layers which act as 'leaky' aquitards and groundwater compartments can form where dolerite dykes intercept the groundwater flow paths. In general the wetlands are separated from the regional aquifer by over 10m of dry weathered rock. The clay is a plastic material and is thus not disturbed by mining induced stresses such as blasting vibrations.

During pit de-watering operations both the regional and the perched aquifers are affected as the vertical barriers to groundwater flow are removed by the excavation and thus a single radial cone of depression is created at the pit. An induced flow path develops towards the pit and the water table is lowered. Due to the lower volume of water in the upper perched aquifer compared to the regional fractured rock aquifer the effects of pit de-watering will be noticeable on surface water bodies closest to the pit after an initial time lag due to the lower permeability of the clay layer.

The impact on wetland areas has been modelled. The two scenarios below represent the seepage fluxes associated with wetland areas designated by the various studies. Scenario 1 represents the wetland delineation defined within the Water Use License and Scenario 2 represents the wetland delineation as defined by NSS in 2011.

Table 26 Construction Phase Impacts on Wetlands (IGS, 2011)

<table>
<tr><th>Scenario 1</th><th>Scenario 2</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Seepage to groundwater from wetland (m^3/d)</td><td>Seepage to groundwater from wetland (m^3/d)</td></tr>
<tr><td>Wetland 1: 0.63</td><td>Wetland 1: 0.19</td></tr>
<tr><td>Wetland 2: 0.13</td><td>Wetland 2: 0.64</td></tr>
<tr><td>Wetland 3: 0.35</td><td>Wetland 3: 1.01</td></tr>
<tr><td>Wetland 4: 0.00</td><td>Wetland 4: 2.79</td></tr>
<tr><td>Wetland 5: 0.00</td><td></td></tr>
</table>

The wetland areas have varying volumes of stored groundwater based on their hydrogeological properties. The rate of groundwater flow towards the pit is a function of the localised hydraulic conductivity and the volume of water in the wetland. The seepage fluxes prior to the commencement of de-watering are relatively low with no flow associated with the down-gradient riverine wetland areas in the western part of the site and minor contributions from the wetlands to the east.

5.2.3.2 Operational Phase

During the operational phase of the mine (approximately 2 years) groundwater will seep into the mining area. Inflow rates will vary, averaging from 50 to 100 m^3/day. This water will be pumped out of the mine, creating a cone of depression (**Figure 23**). The current groundwater quality is good and is considered suitable for discharge into the natural drainage paths as part of the ‘clean’ water management system during the initial phases of de-watering. Over time as the water table is lowered oxidation will results in a lowered pH and an increase in dissolved salts and heavy metals. The quality of the dewatering discharge should be monitored and if unsuitable for discharge to the ‘clean’ water system the discharge should be diverted to the pollution control dam

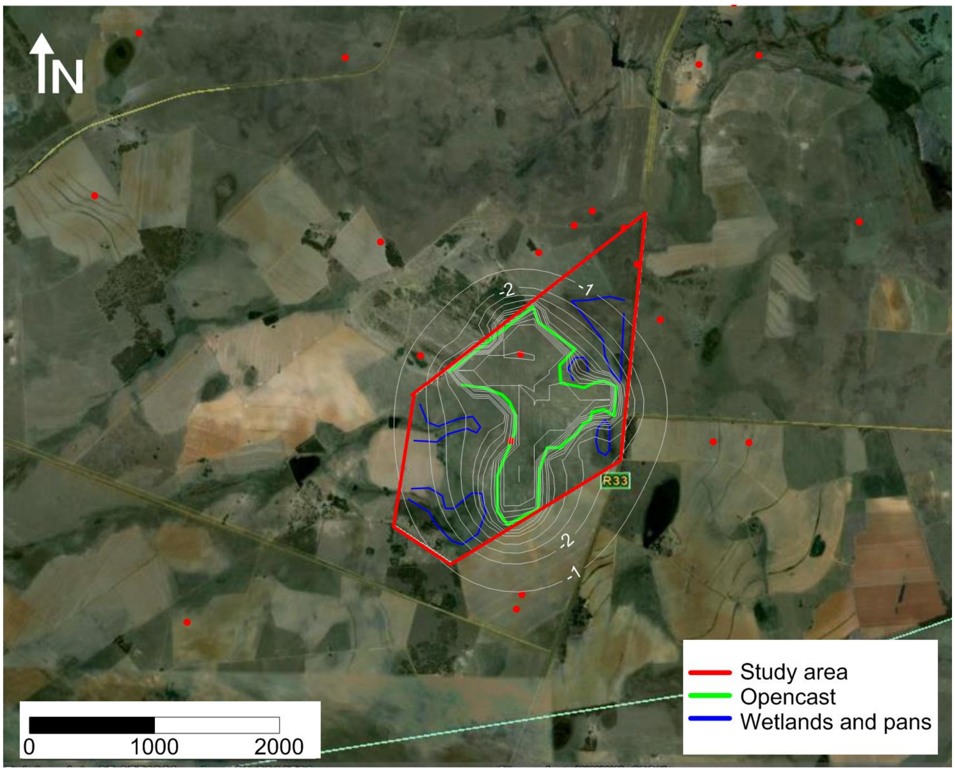


Figure 23 **Drawdown Cone (contour level 1m) – end of Phase 3 (2 year after mine started (IGS, 2011)**

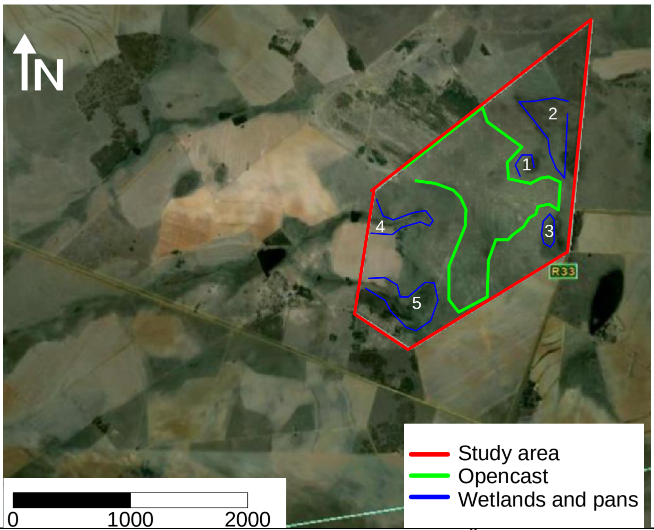
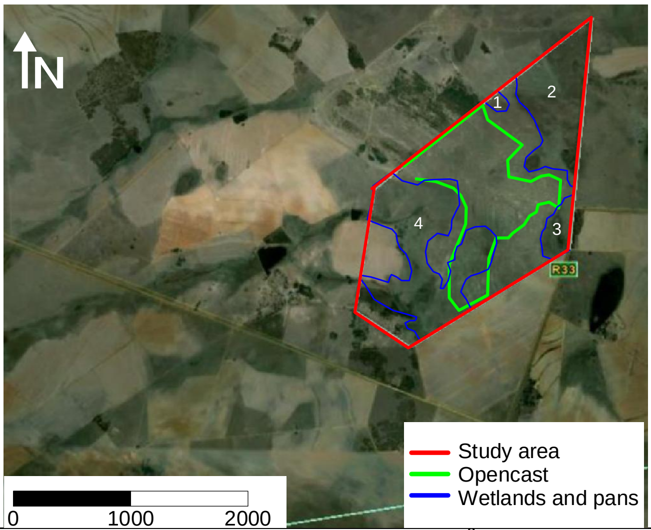
The expected impact on water levels in boreholes and springs are summarised in **Table 27** below.

Table 27 **Impacts on Groundwater Levels During Construction (IGS, 2011)**

Borehole / Spring	Drop in water level (m)
FP1	0.9
GCS5	11
GCS6	8.3
GCS7	0.5
Spring	1.6

The furthest measurable influence on groundwater (1m drawdown) from the mining area is anticipated to be within approximately 800m radius. Four boreholes and a spring will be impacted. The boreholes are monitoring wells within and adjacent to the proposed pit area. The influence on water supply wells in the surrounding community will be negligible. The increase in seepage from wetlands to the groundwater system was assessed (**Table 28**).

Table 28 **Operational Phase Impacts on Wetlands (IGS, 2011)**

<table>
<tr><th>Scenario 1</th><th>Scenario 2</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Seepage to groundwater from wetland (m^3/d)</td><td>Seepage to groundwater from wetland (m^3/d)</td></tr>
<tr><td>Wetland 1: 1.69</td><td>Wetland 1: 1.14</td></tr>
<tr><td>Wetland 2: 2.69</td><td>Wetland 2: 20.50</td></tr>
<tr><td>Wetland 3: 0.69</td><td>Wetland 3: 4.00</td></tr>
<tr><td>Wetland 4: 2.00</td><td>Wetland 4: 33.51</td></tr>
<tr><td>Wetland 5: 2.90</td><td></td></tr>
</table>

The increase in seepage from wetlands to the groundwater system was assessed (**Table 28**). The effect of pit de-watering is to increase the seepage flows from all the wetland areas. The natural hydraulic gradient is reversed and the eastern wetlands will be progressively de-watered. Depending on the volume of water in the upper perched water table at the commencement of de-watering it is considered likely that the groundwater baseflow component of the wetland water budget will be lost during the approximately two years of de-watering operations. The function of the wetlands will thus be controlled by stormwater flows only. The ecological impact of the de-watering process would be similar to a natural two year drought period. It is considered possible that the good quality groundwater can be discharged via the wetlands and thus the wetlands can be artificially maintained during the initial operational period when pit de-watering discharge quality is suitable for discharge to the 'clean' stormwater system.

5.2.3.3 Decommissioning (Closure) Phase

The decommissioning phase is too short to see significant impacts on groundwater levels.

5.2.3.4 Post Closure Phase

Groundwater levels will start to recover once mining activities cease, and groundwater will start to flow down gradient, away from the mining area. The groundwater levels will differ from pre-mining context due to the nature of the back-filled material. The mine area will take approximately 50 to 60 years to flood up, however within 10 years it will be close to the existing static equilibrium level (experience from Sumo Colliery indicates that water levels returned to close to the pre-mining condition after about 10 years). As the mine is located on a watershed divide, decanting us expected to commence within 5 years after closure, at a point on the south western boundary of the site (**Figure 24**). The decant rate expects to be between approximately 365m^3/day, with worse case calculated at 465m^3/day (**Appendix C**).

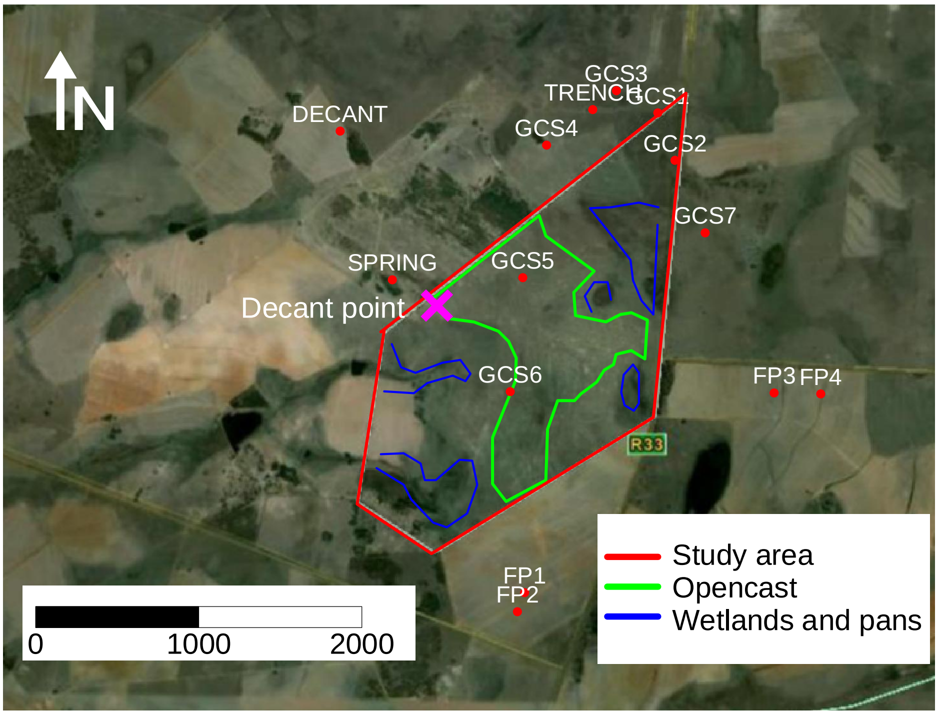


Figure 24 **Location of Decant Point (IGS, 2011)**

It is anticipated that more water will enter wetland post closure, as a result of changed groundwater level and aquifer characteristics.

Groundwater contamination will follow groundwater gradients, and the anticipate contamination plumes (10 and 20 year) have been calculated (**Figure 25 and 26**).

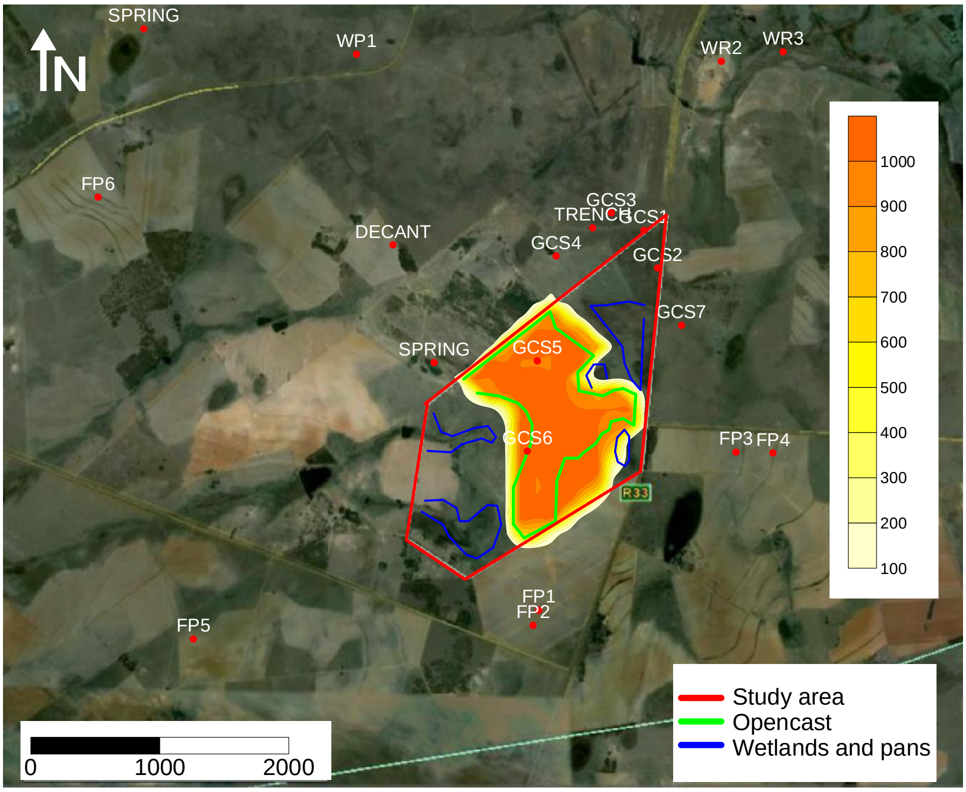


Figure 25 **Contamination Plume after 10 years (assuming source sulphate concentration of 1000mg/l) (IGS, 2011)**

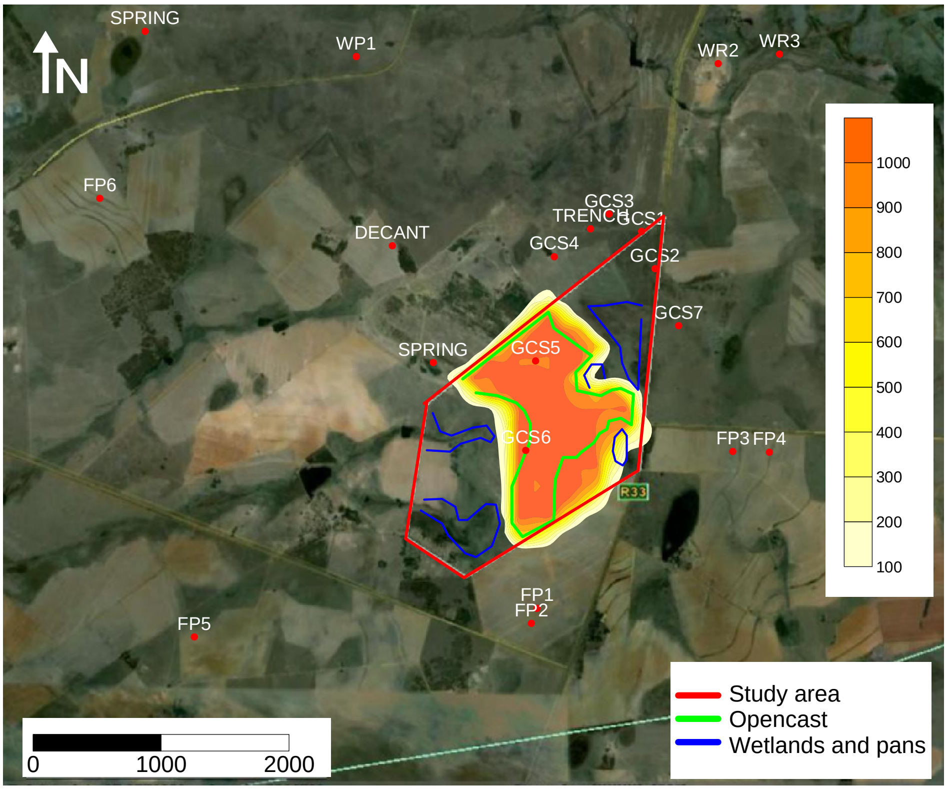


Figure 26 **Contamination Plume after 20 years (assuming source sulphate concentration of 1000mg/l) (IGS, 2011)**

5.4 CONCLUSIONS AND RECOMMENDATIONS

The groundwater impact assessment and summary of mitigation measures is presented in **Table 29**.

The relative shallow depth of open cast mining, short life of mine and relatively low hydraulic conductivities of the fractured rock aquifer indicates that impacts on groundwater levels, and groundwater quality are of a local extent with limited influence on water supply boreholes on adjoining land. A drop in water levels of approximately 10m will be experienced for two boreholes towards the end of the operational life of the mine with recovery to full equilibrium within 10 years. Impacts on wetlands areas will be significant during the operational phase as the shallow perched water table will be drained during pit de-watering, although this can be mitigated by draining the initial de-watering discharge through the wetland areas. The static water level will be expected to rebound to close to pre-existing levels within 10 years, although final equilibrium may take over 50 years. Groundwater quality will be impacted by interaction with the waste rock backfilling the mining void. Acid drainage will result in pH values in the range of 4.5 to 5.9 with significantly increased concentrations of sulphate, iron and manganese at the site boundary but these levels dissipate rapidly beyond the site boundary resulting in less contaminated groundwater being experienced off-site. Impacts will be localised and confined to the vicinity of the mine workings.

Table 29 **Impact Assessment and Mitigation Measures**

Potential Environmental Impact	Activity	Environmental Significance Score						Recommended Mitigation Measures
		S	D	E	FA	FO	ES	
Construction Phase								
Change in groundwater levels due to dewatering	Groundwater may start to seep into the excavation area at a rate of 35 -50 m^3/day. The impact on groundwater will start when the piezometric surface is intercepted (groundwater levels are approximately 2m below surface in the area). The drawdown cone will develop during the construction – however the radius of the cone will be less than 500 m.	Minor	More than 1 year	Within project boundary	Daily	Definite	Low	No mitigation is recommended
Impact of change in groundwater quality due to mining	Groundwater will initially be of good quality but will with time deteriorate. Included are the following: • Initially groundwater flowing into the mining operations should be of good quality. • The total dissolved solids in the groundwater will slowly start increasing due to groundwater contact with mining operations. Water quality in the mine will slowly start deteriorating, which can be magnified with the oxidation of pyrite. The initial acidification will be neutralized by the natural buffering capacity in the overlying rock. This can take place for years, until the neutralizing potential is depleted. Acidification of the groundwater can then increase. Water quality is expected to be more of a problem-post closure than during the construction phase of mining.	Moderate	More than 1 year	Within project boundary	Daily	Definite	Medium	No mitigation is recommended. However monitoring is recommended according to the monitoring plan
Increase in seepage from wetlands into the groundwater system	Due to the change is groundwater levels and gradient water in the wetlands can seep into the groundwater system. This can affect the ecological health of the wetlands.	Minor	Less than 1 year	Within project boundary	Daily	Definite	Low	Draining of the initial de-watering discharge through the wetland areas. Water levels within the wetlands must be monitored. The ecological integrity of the wetlands must be monitored.
Operational Phase								
Change in groundwater levels due to dewatering	Based on the mine plan, the life of mine will be approximately 2 years. During the operational phase of the mining project, groundwater will seep into mining area. This water will have to be pumped out of the mine creating a cone of depression. The inflow rates vary mainly according to mine floor depth below groundwater level and increased recharge from rehabilitated areas. However it is on average 50 – 100 m^3/d. It is expected that the	Moderate	Significant	Beyond project boundary	Daily	Definite	Medium	No mitigation is recommended. Groundwater levels must be monitored every two months.

	furthest measurable influence on the groundwater (1 m drawdown) from the proposed mining area will be within an approximately 800 m radius. Four boreholes and a spring will be impacted.							
Impact of change in groundwater quality due to mining	Groundwater will initially be of good quality but will with time deteriorate. Included are the following: • Initially groundwater flowing into the mining operations should be of good quality. • The total dissolved solids and other chemical parameters (such as sulphate) in the groundwater will slowly start increasing due to groundwater contact with mining operations. Water quality in the mine will slowly start deteriorating, which can be magnified with the oxidation of pyrite. The initial acidification will be neutralized by the natural buffering capacity in the overlying rock. This can take place for years, until the neutralizing potential is depleted. Water quality is expected to be more of a problem-post closure than during the operational phase of mining.	Moderate	More than 10 years	Beyond project boundary	Daily	Definite	Medium	No mitigation is recommended. However monitoring is recommended according to the monitoring plan.
Increase in seepage from wetlands into the groundwater system	Due to the change is groundwater levels and gradient water in the wetlands can seep into the groundwater system. This will affect the ecological health of the wetlands. .	Minor	Less than 1 year	Within project boundary	Daily	Definite	Medium	Water levels within the wetlands must be monitored. The ecological integrity of the wetlands must be monitored.
Post Closure Phase								
Impact of flooding and possible decanting of mine	The flooding of the mine is dependent on a number of factors including preferential flow zones such as geological lineaments. Not all preferential influx zones are known at this point, so the volumes might increase, as more information becomes available. At this point in time it is calculated that it is likely for the mine to decant. It is expected that poorer quality groundwater will be present on the mine horizon when total flooding is completed. Therefore the decanting water will can be of a poor quality. This will most probably impact on the streams and wetlands in the vicinity of the mine.	Minor	Permanent	Beyond project boundary	Daily	Definite	Medium	No mitigation is recommended. However increasing groundwater levels and groundwater quality must be monitored and the numerical models updated to predict decanting volumes and quality more accurately.
Impact of mine polluting groundwater and surface water	Contaminants from the mine (including coal stock piles, discard dumps and return water dams) can seep through the unsaturated zone into the groundwater system. Lateral groundwater movement will allow the spread of the contamination within the groundwater system. If this groundwater feeds surface water bodies such as streams and wetlands and these can also then be contaminated. However dilution is expected to occur.	Minor	More than 10 years	Beyond project boundary	Daily	Definite	Low	No mitigation is recommended. However, monitoring is recommended according to the monitoring plan, and water quality of the wetlands must be measured.

5.4.1 Monitoring Plan

The Groundwater Assessment (**Appendix C**) proposed a long-terms monitoring programme be developed based on DWA Best Practice Guideline G3: Water Monitoring Systems (2007). The overall objective of the monitoring plan (**Appendix C**) is to:

- Identify, quantify and monitor groundwater flow in the vicinity of the mine; and
- Identify, quantify and monitor all point and diffuse pollution sources and associated plumes on the mine.

The details of this monitoring plan (data requirements, monitoring regime, and reporting) have been included in the EMPr (**Part 3: Environmental Management and Closure Plan**).

6 AIR QUALITY ASSESSMENT

6.1 TERMS OF REFERENCE

WSP was appointed by Exxaro Coal (Pty) Ltd to undertake the Air Quality Impact Assessment (AQIA) specialist study for the proposed mining site in Eerstelingsfontein (**Appendix D**). The assessment included; site specific baseline air quality conditions, predicted impacts and proposed mitigation on air quality, the preparation of a site specific emissions inventory, the development of an air quality dispersion model and the compilation of an Air Quality Management Plan (AQMP).

6.2 METHODOLOGY

6.2.1 Relevant legislation

The AQIA and AQMP are conducted according to the following relevant legislation:

- National Environmental Management: Air Quality Act (Act 39 of 2004)
- South African National Standard SANS 1929:2009
- National Priority Areas

Particulate matter (PM_{10}) represents the key parameter of concern for the Eerstelingsfontein coal mine project. The legislated standard for PM_{10} has been used for the assessment of potential air quality impacts associated with the project (**Table 30**).

Table 30 National Ambient Air Quality Standards for Particulate Matter (PM_{10}) (WSP, 2011)

Averaging Period	Concentration	Compliance Date
24 hours	120 µg/m^3	Immediate - 31 December 2014
24 hours	75 µg/m^3	1 January 2015
1 year	50 µg/m^3	Immediate - 31 December 2014
1 year	40 µg/m^3	1 January 2015
The reference method for the determination of the particulate matter fraction of suspended particulate matter shall be EN 12341		

6.2.2 Baseline assessment

6.2.2.1 Meteorology

Meteorological data (from the 2010 period) was sourced from the South African Weather Service (SAWS) station located in Belfast. The data was processed using the AERMOD meteorological pre-processor, AERMET. Parameters used were temperature, wind speed, wind direction and cloud height.

6.2.2.2 Air quality

Baseline air quality data was sourced for the region surrounding the proposed mining activities. Baseline dust fallout data for 2010 was provided by Exxaro. Although no baseline particulate matter (PM_{10}) data was available for the purposes of this assessment, this was not a critical limiting factor in the assessment (**Appendix D**).

6.2.3 Impact monitoring and modelling

An emissions inventory established emissions quantities for on-site activities associated with Eerstelingsfontein coal mine, based on information provided by Exxaro Coal. In order to relate the on-site activities with emissions to air, appropriate Emissions Factors US-EPA AP-42 (1995) and (1998) were applied.

The Lakes Environmental AERMOD View was used to carry out the atmospheric dispersion modelling during both the construction and operational phases of the mine.

6.3 SUMMARY OF FINDINGS

6.3.1 Description of Baseline Findings

Meteorology

Belfast has a mild climate with average daily maximum temperatures ranging from 29.4˚C in October to 18.4˚C in July. The mean annual precipitation (MAP) is 325.6 mm, with most rainfall (98.34%) occurring during summer months from October to December and the highest rainfall in November.

Most winds occurring in Belfast are moderate (between 2.1 and 3.6 m/s) north-easterlies (45°). The average wind direction at Belfast is from the north east (42°) with the average wind speed being 2.2 m/s.

Air quality

Dust fallout monitoring data was obtained from Exxaro for the 2010 period. Data suggests that dust fallout levels have historically been in the moderate range for the area, with average values varying from 171 mg/m^2/day to 480 mg/m^2/day. These are well within the SANS residential threshold value of 600 mg/m^2/day (**Appendix D**).

6.3.2 Emission Inventory

The unit processes of blasting, bulldozing, loading of excavated material, truck loading, stockpiling and on-site vehicular activity were used to develop the emissions inventory (**Appendix D**).

A summary of the unit process emission estimates is presented below (Table 31). These estimates are based on no mitigation and predicted impacts based on these estimates represent a worst case 'unmitigated scenario'. It is standard practice, and indeed necessary, to undertake dust suppression for most mining operations. To assess the potential air quality impacts with mitigation measures in place, a total emission estimate for all processes was calculated assuming an overall 90% mitigation efficacy. This is considered to be an achievable mitigation efficacy for coal mining operations. Predicted impacts based on the mitigated emission estimates are referred to as the '90% mitigation scenario'.

Table 31 Exxaro Eerstelingsfontein coal mine emissions inventory (unmitigated) (WSP, 2011).

Parameter	Unmitigated scenario		90% Mitigation scenario		*Unit
	TSP	PM_{10}	TSP	PM_{10}	
Blasting	126.90	65.98	12.69	6.59	TPA
Bulldozing	95.69	25.57	9.56	2.55	TPA
Truck loading	44.81	6.89	4.48	0.68	TPA
Vehicular activity	151.36	64.69	15.13	6.46	TPA
Coal stockpiles	116.62	58.31	11.66	5.83	TPA
Total	535.38	221.44	53.53	22.14	TPA

*TPA tonnes per annum

The geometry of the area source was defined for the atmospheric dispersion modelling for the Exxaro Eerstelingsfontein coal mine (**Figure 27**). The emissions from all unit processes were averaged across the model source area. Cumulatively (all sources combined), it is calculated that dust will be emitted at a rate of 1.54 x 10-5 g/s/m^2 for the unmitigated scenario, and 1.54 x 10-6 g/s/m^2 for the 90% mitigation efficiency scenario. It is calculated that PM_{10} will be emitted at a rate of 6.38 x 10-6 g/s/m^2 for the unmitigated scenario, and 6.38 x 10-7 g/s/m^2 for the 90% mitigation efficiency scenario.

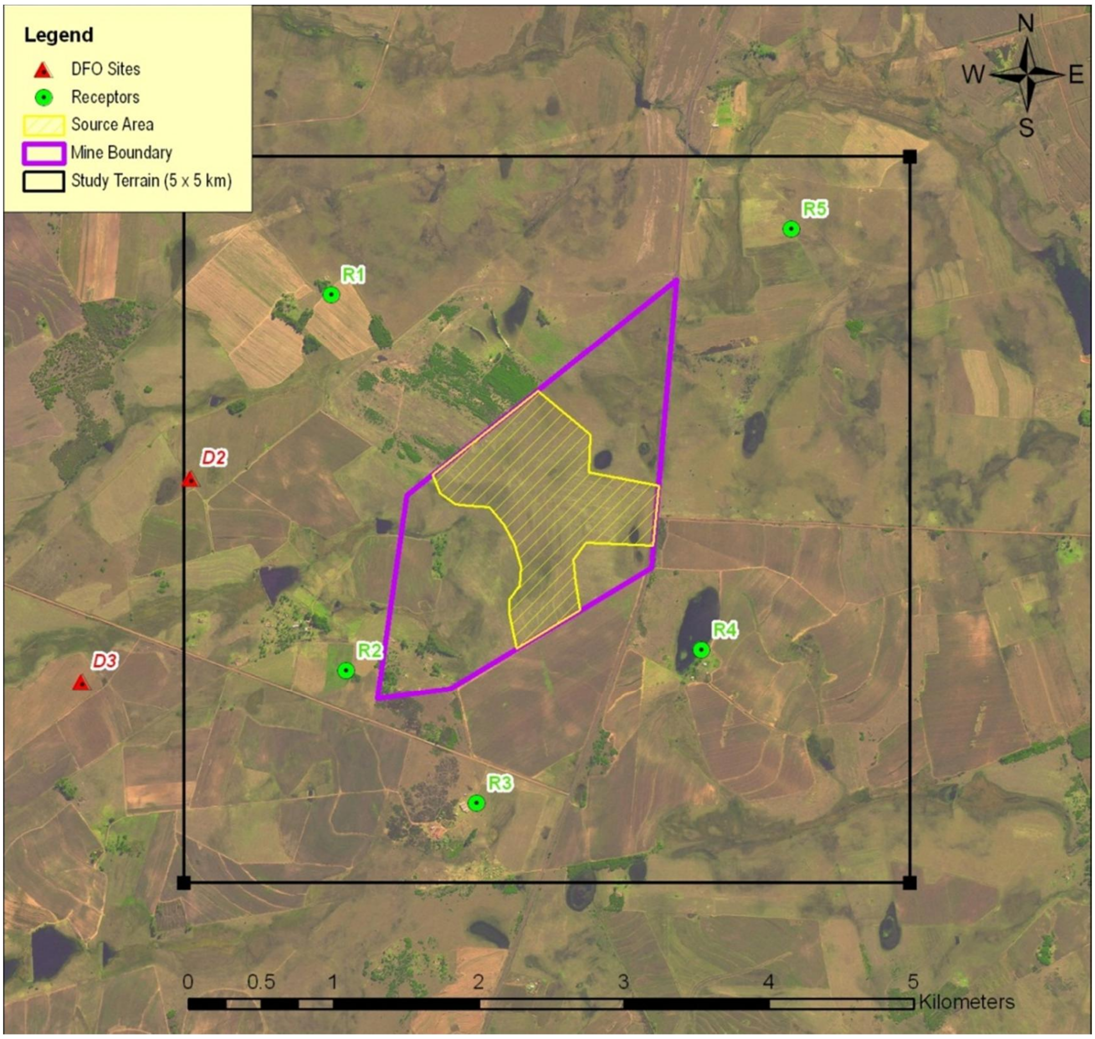


Figure 27 **Satellite image of the proposed Exxaro Eerstelingsfontein coal mine and surrounding area, including source geometry and adjacent receptors (WSP, 2011).**

6.3.3 Atmospheric Dispersion Modelling

Atmospheric dispersion modelling mathematically simulates the transport and fate of pollutants in the atmosphere once emitted from a source. Models can reliably predict the downwind concentrations of pollutants and determine the impact as a result of exposure to a particular pollutant at a specific concentration (**Appendix D**).

The Lakes Environmental AERMOD View was used to carry out the atmospheric dispersion modelling during both the construction and operational phases of the mine. The modelling took place using a study area of 5000m by 5000m whereby the Eerstelingsfontein mine was centred within. Receptors, comprising farmstead residents and labourers, were then identified in the immediate vicinity of the proposed mine site and discrete receptors identified adjacent to the site boundary (**Figure 27** above). Receptor 2 is directly downwind from the proposed Eerstelingsfontein coal mine, with Receptors 1, 3, 4 and 5 chosen at regularly spaced intervals around the site where farmsteads are located.

Predicted particulate matter concentrations and dust fallout rates were assessed against standards (NEM:AQA and SANS) to define the acceptability of the impacts in two key scenarios; without mitigation and with mitigation that reduces emission rates by 90%. Mapped output was also used to illustrate the dispersion of the plume footprint across the study area, with key isopleths for regulated standards plotted.

6.3.4 Potential impacts

6.3.4.1 Particulate matter (PM_{10})

- 24-hour averaging period

During the operation of the mine the predicted PM_{10} concentrations at the receptor locations ranged from 2.03 µg/m^3 to 206.78 µg/m^3 for the worst-case, unmitigated scenario, and from 0.20 µg/m^3 to 20.68 µg/m^3 for the worst-case, 90% mitigated scenario (**Table 32**).

Table 32 Predicted PM_{10} results, worst-case 24-hour averaging period for unmitigated and 90% mitigation (WSP, 2011)

Discrete Receptor	PM_{10} Concentration		
	Worst-case 24 hour Average, unmitigated (µg/m^3)	Worst-case 24 hour Average, 90% mitigation (µg/m^3)	NEM:AQA 24 hour Standard (µg/m^3)
Receptor 1	86.43	8.64	120
Receptor 2	111.59	11.16	120
Receptor 3	63.26	6.33	120
Receptor 4	206.78	20.68	120
Receptor 5	2.03	0.20	120

PM_{10} concentrations exceeding the 120 µg/m^3 standard are predicted to extend beyond the site boundary on the western, eastern and south eastern side of the site for the 24-hour averaging period (**Figure 28**) when no mitigation is implemented. With the 120 µg/m^3 isopleth for the unmitigated scenario extending well beyond the mine boundary, indicates the need for mitigation.

With 90% mitigation, PM_{10} concentrations are all predicted to be well below the NEM:AQA standard (120 µg/m$_3$) for the 24-hour averaging period (**Figure 29**).

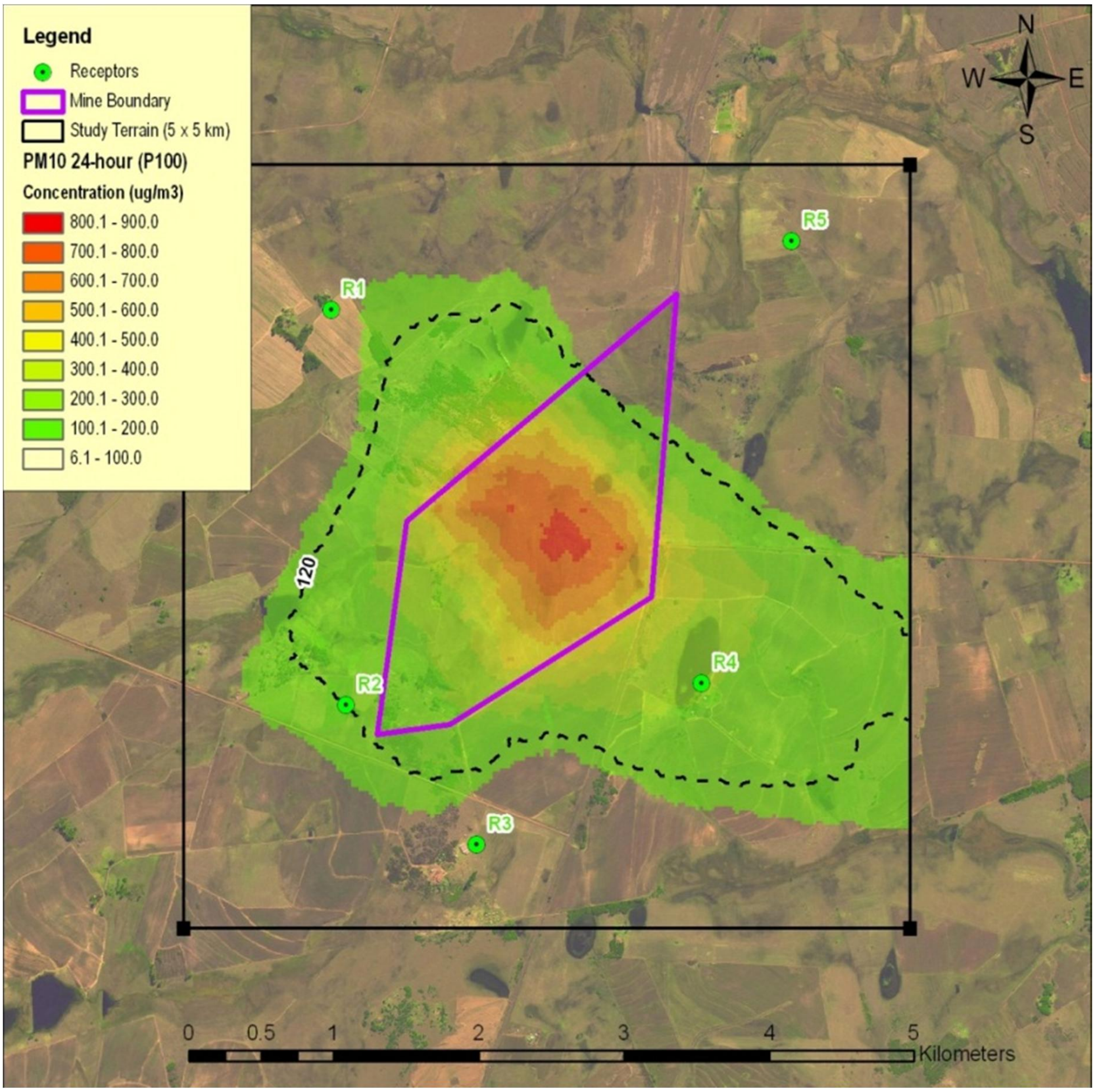


Figure 28 **Predicted PM_{10} results (24-hr averaging period): worst-case, unmitigated scenario (WSP, 2011)**

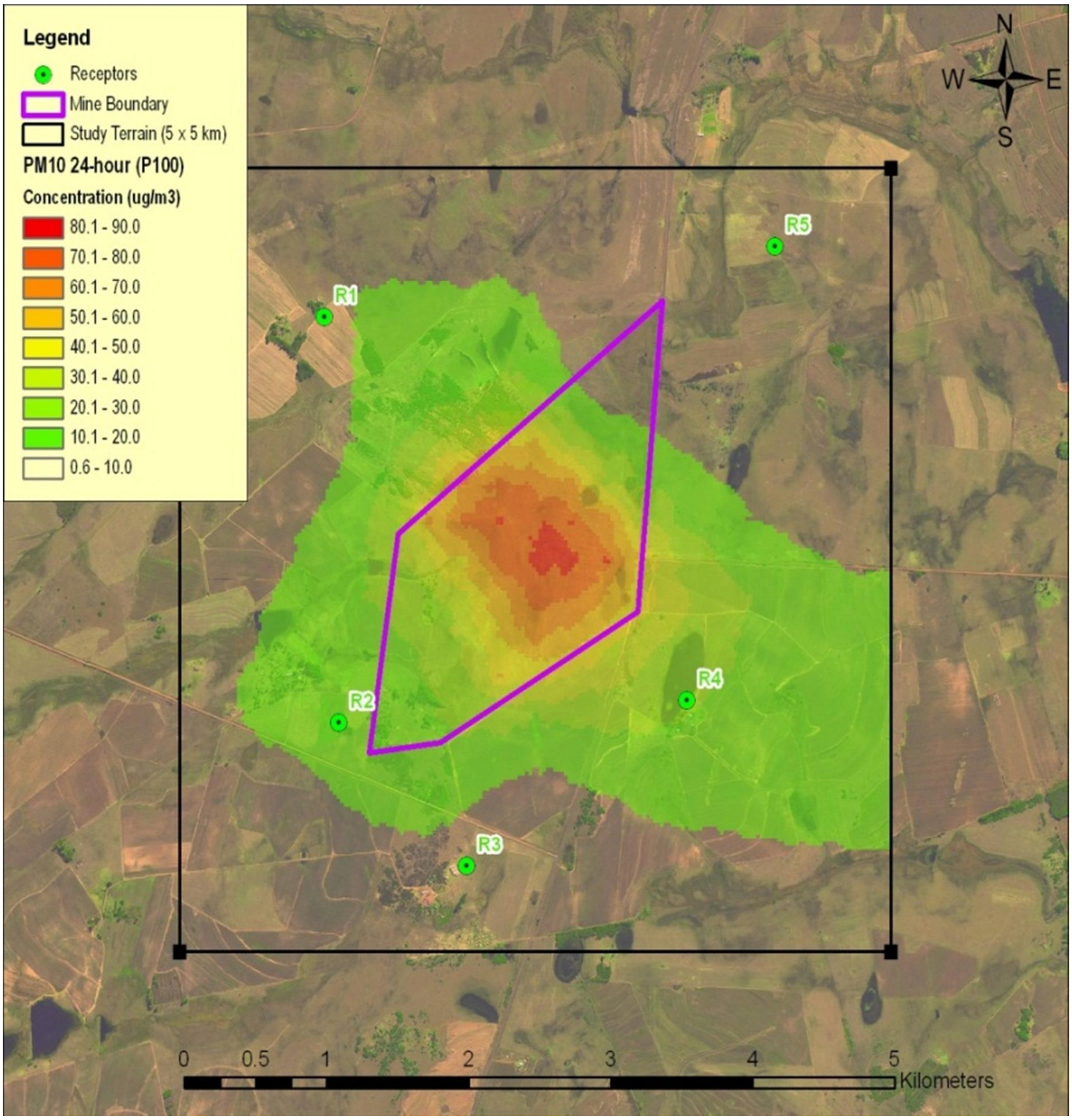


Figure 29 Predicted PM_{10} results (24-hr averaging period): worst-case with 90% mitigation (WSP, 2011)

- Annual averages

During the operation of the mine the predicted annual average PM_{10} concentrations range from 0.08 µg/m^3 to 40.81 µg/m^3 for the unmitigated scenario, and from 0.01 µg/m^3 to 4.08 µg/m^3 for the 90% mitigated scenario. Therefore for the annual average period all unmitigated and mitigated results for discrete receptors are well within the NEM:AQA standards of 50 µg/m^3 (**Table 33**). The results demonstrate that there are a limited number of meteorological conditions which combine on certain days of the year to create poor dispersion conditions.

Table 33 Predicted PM_{10} results, annual averaging period for unmitigated and 90% mitigation (WSP, 2011)

Discrete Receptor	PM_{10} Concentration		
	Worst-case Annual Average, unmitigated (µg/m^3)	Worst-case Annual Average, 90 % mitigation (µg/m^3)	NEM:AQA Annual Standard (µg/m^3)
Receptor 1	9.81	0.98	50
Receptor 2	40.81	4.08	50
Receptor 3	4.46	0.45	50
Receptor 4	16.85	1.68	50
Receptor 5	0.08	0.01	50

The mapped output (**Figure 30**), however, demonstrates that when viewed annually, the dispersive environment is inadequate to keep the impact within an acceptable range beyond the fenceline, without mitigation (the 50 µg/m^3 isopleth extends beyond the fenceline). As such, map proves to be more informative of the impact footprint than the receptor concentrations themselves. On the basis of the mapping, mitigation is required.

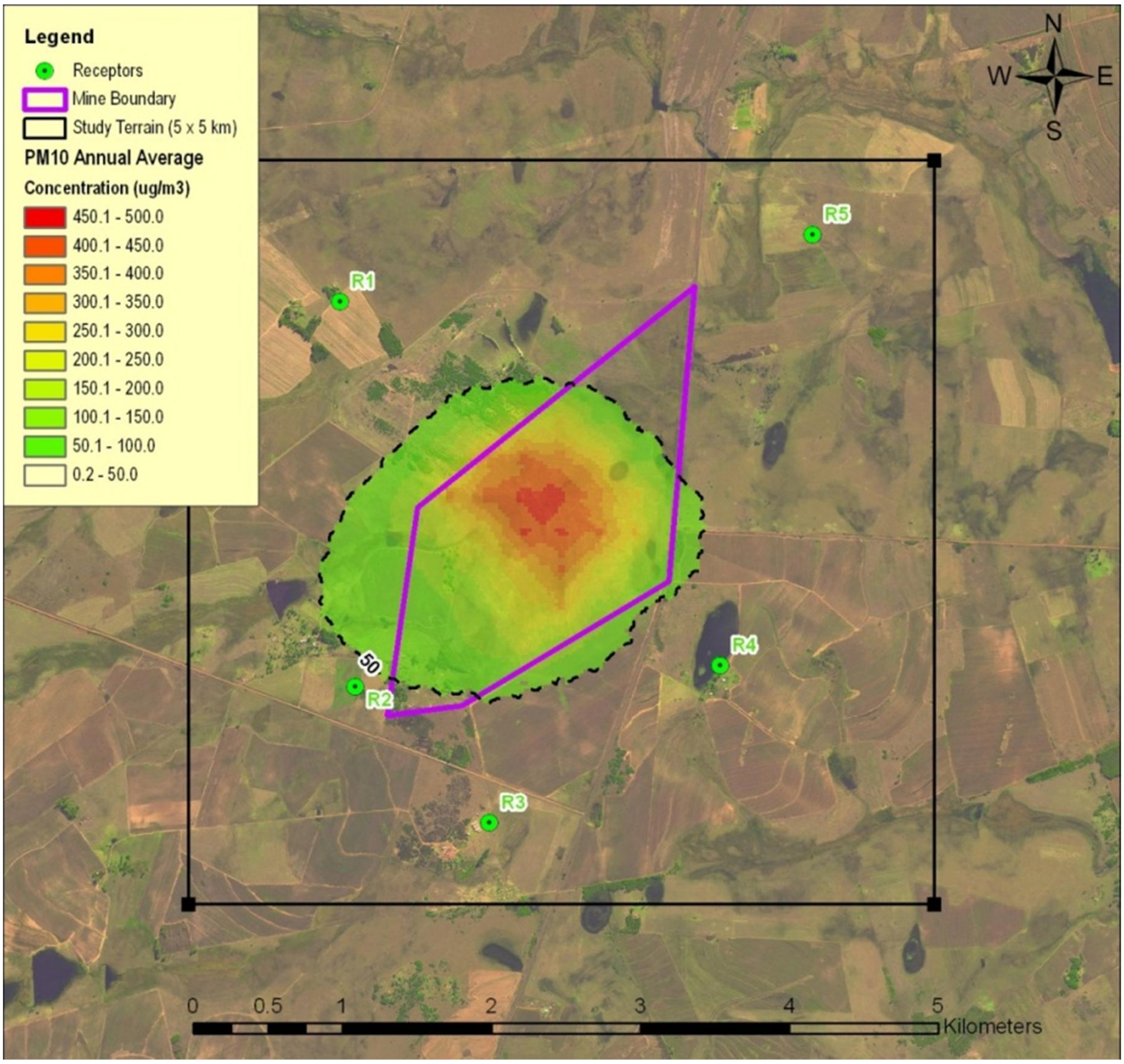


Figure 30 Predicted PM_{10} results for the annual averaging period for unmitigated (WSP, 2011)

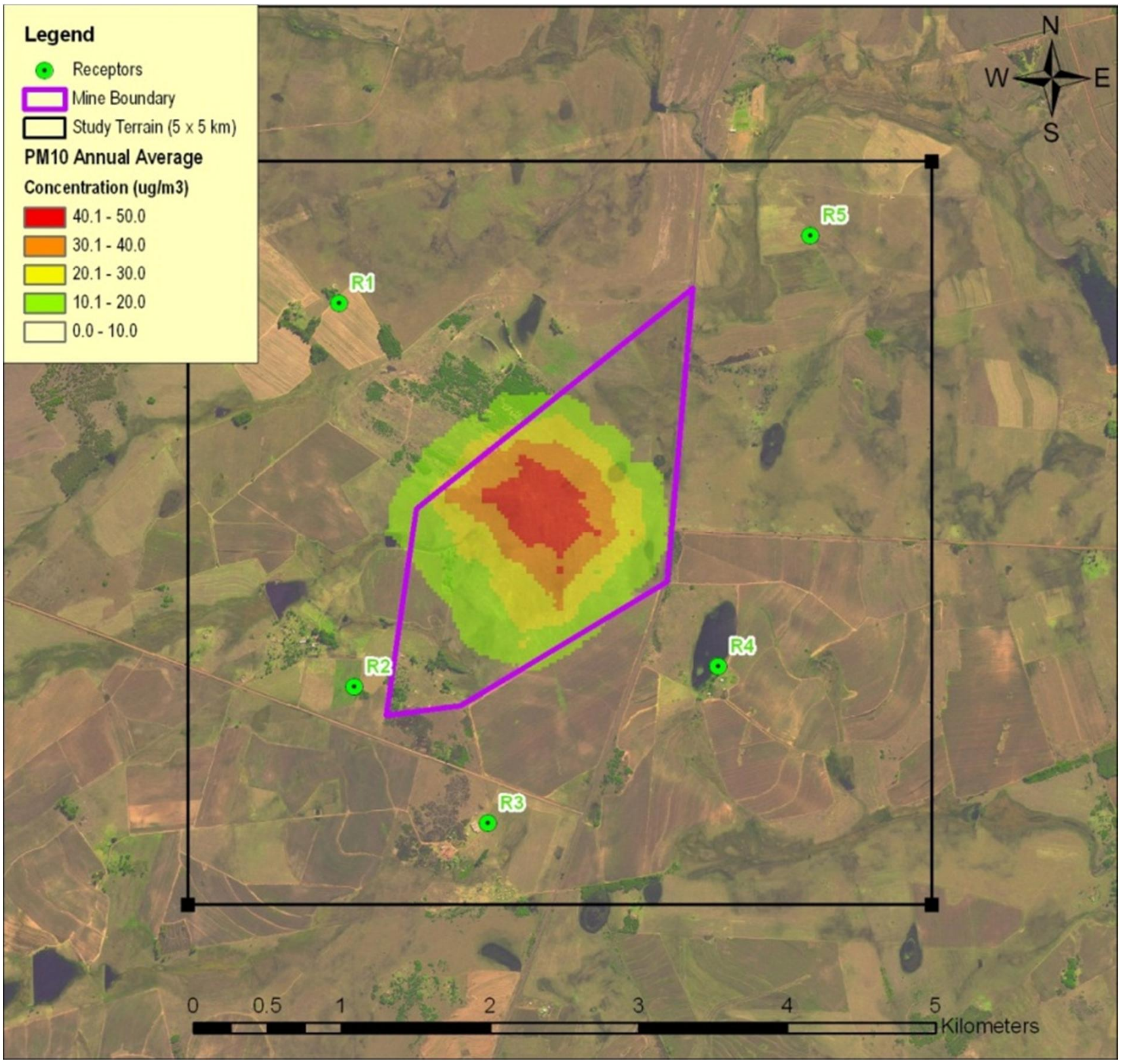


Figure 31 **Predicted particulate matter (PM10) results for the annual averaging period for 90% mitigation**

The 90% mitigation scenario is required (**Figure 31**) to achieve full compliance with both 24-hour and annual average PM_{10} concentrations in terms of the South African national ambient air quality standards (**Table 30**).

6.3.4.2 Dust fallout

The predicted dust fallout levels range from 13.23 mg/m^2/day to 7993.26 mg/m^2/day for the unmitigated scenario, and from 1.32 mg/m^2/day to 799.33 mg/m^2/day for the 90% mitigation scenario (**Table 34**). For Receptors 1, 2, 3 and 4 the predicted dust fallout levels without mitigation are well in excess of the SANS residential standard of 600 mg/m^2/day. Only Receptor 5 is predicted to be within the SANS residential standard. After mitigation is implemented, it is predicted that only Receptor 2 will receive dust fallout but at levels of 799.33 mg/m^2/day (**Table 34**).

Table 34 **Predicted dust fallout rates for unmitigated and 90% mitigation (WSP, 2011)**

Discrete Receptor	Predicted Dust Fallout Rate, unmitigated (mg/m2/day)	Predicted Dust Fallout Rate, 90 % mitigation (mg/m^2/day)	SANS Dust Fallout Residential Guideline(mg/m2/day)
Receptor 1	1932.41	193.24	600
Receptor 2	7993.26	799.33	600
Receptor 3	842.82	84.28	600
Receptor 4	3260.88	326.09	600
Receptor 5	13.23	1.32	600

The spatial footprint of dust deposition shows unacceptably high dust fallout rates across study area for the unmitigated scenario (**Figure 32**).

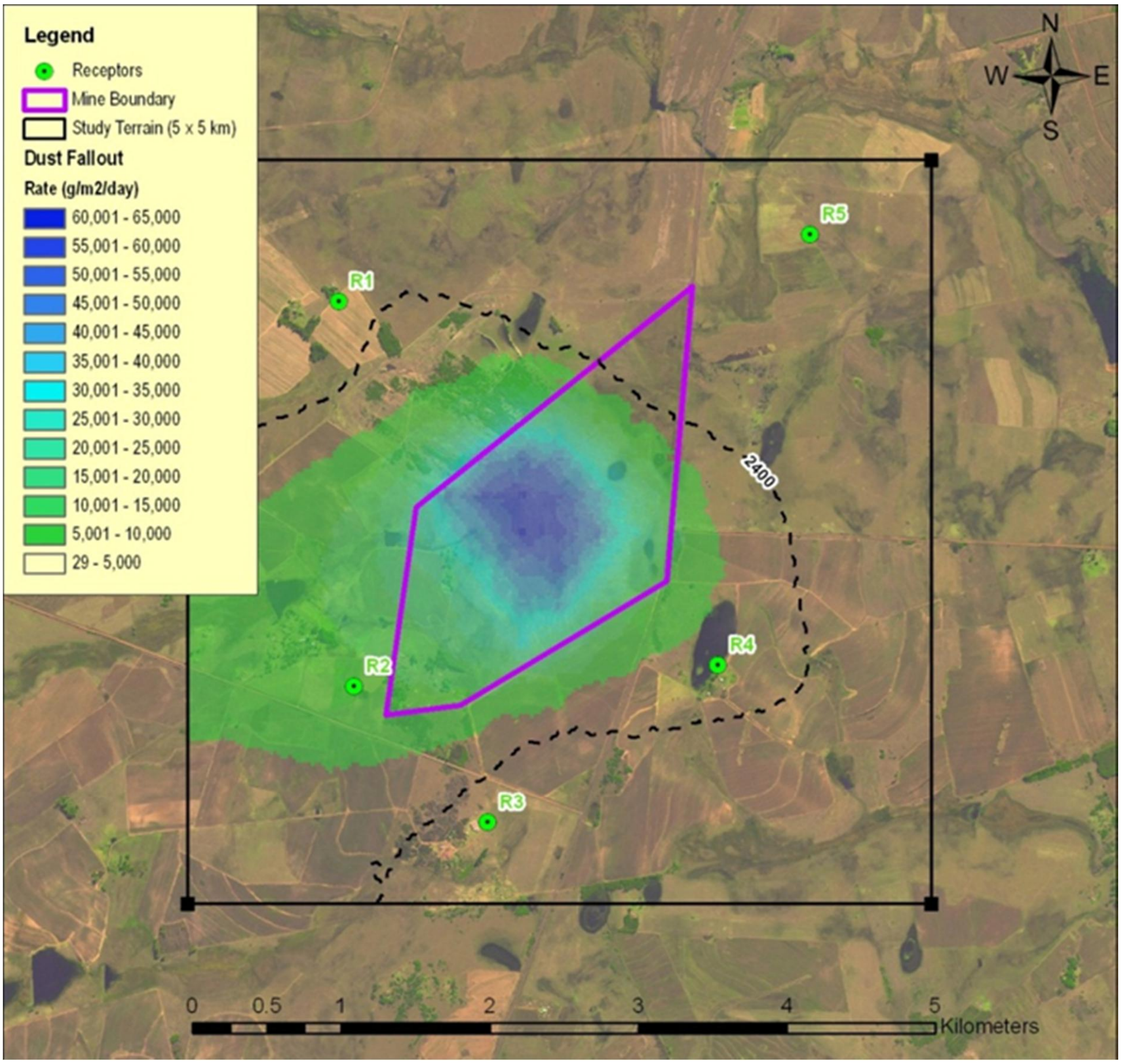


Figure 32 **Predicted dust fallout rates for unmitigated (WSP, 2011)**

A reduction of dust fallout rates for the mitigated scenario is predicted, whereby the 2400 mg/m^2/day isopleth covers a much smaller area. The 600mg/m^2/day isopleth, representing the SANS guideline threshold, still maintains a relatively large footprint after mitigation (**Figure 33**). The footprint occurs predominantly in a south-westerly direction, encompassing Receptor 2. This suggests that mitigation at source is required to achieve at least 90% reduction of emissions.

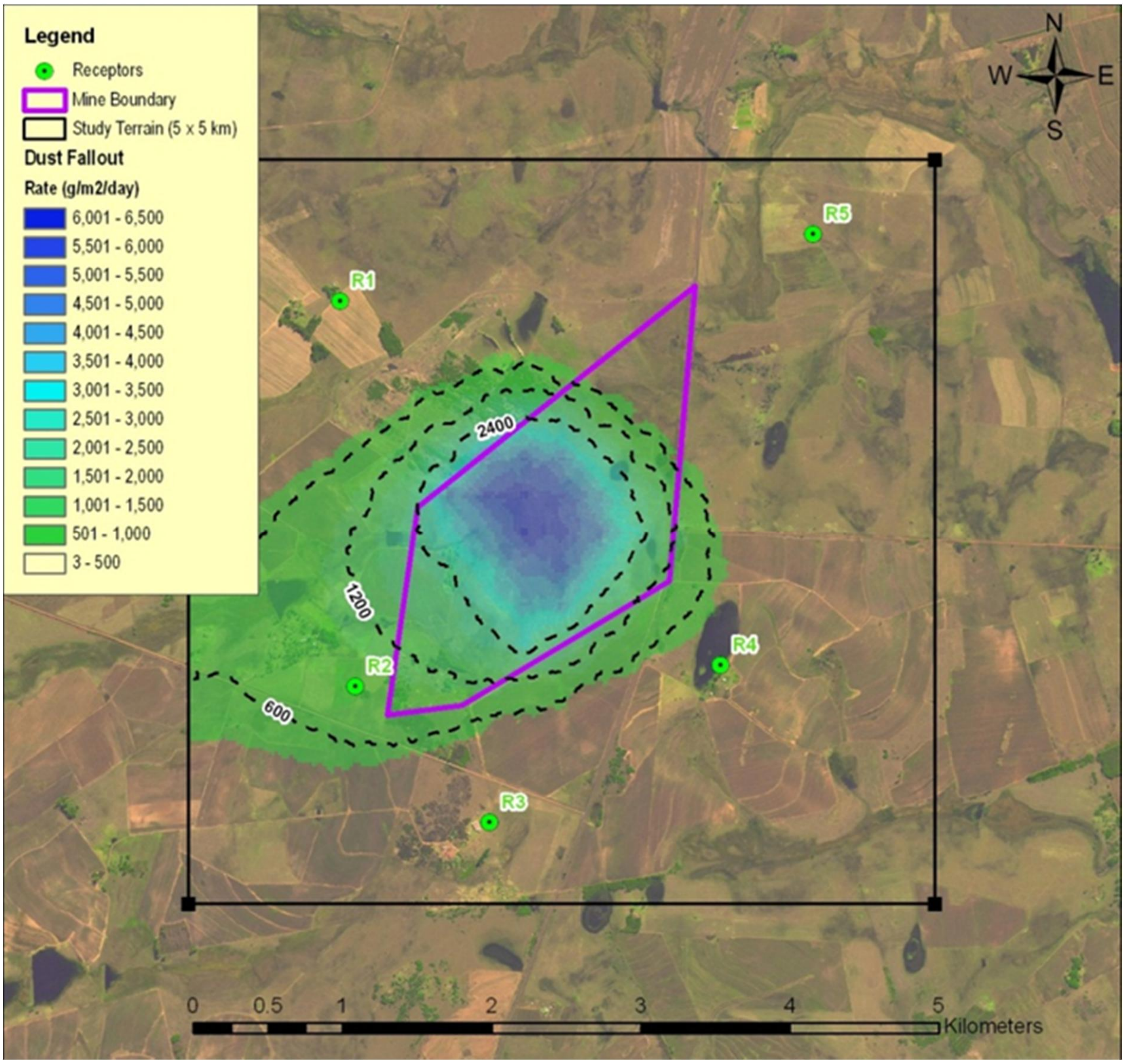


Figure 33 **Predicted dust fallout rates for 90% mitigation (WSP, 2011)**

The findings of the AQIA suggest that with targeted mitigation Exxaro should be able to achieve full compliance in respect of dust nuisance guidelines, but that monitoring would be required to verify the mitigation efficiencies achieved.

6.3.5 Impact assessment rating

The assessment of air quality impacts are presented **in Table 35 and 36** below.

Table 35 Impact assessment for PM_{10} during 'unmitigated' and '90% mitigation' scenarios (WSP, 2011)

Scenario	Severity	Duration	Extent	Frequency	Probability	Environmental Significance
Unmitigated	Moderate	>1 year / reversible with time	Beyond project Boundary	Daily	Highly likely	Medium
90% mitigation	Minor	>1 year / reversible with time	Beyond project Boundary	Daily	Highly likely	Medium

Table 36 Impact assessment for dust fallout during 'unmitigated' and '90% mitigation' scenarios (WSP, 2011)

Scenario	Severity	Duration	Extent	Frequency	Probability	Environmental Significance
Unmitigated	Significant	>1 year/reversible with time	Beyond project Boundary	Daily	Highly likely	Medium
90% mitigation	Moderate	>1 year/reversible with time	Beyond project Boundary	Daily	Highly likely	Medium

6.4 CONCLUSIONS AND RECOMMENDATIONS

Results indicated that when mitigation is applied to the dispersal of particulate matter and dust fallout, dispersion and quantities are reduced to below NEM:AQA and SANS standards.

In order to manage and monitor the air quality impacts associated with Eerstelingsfontein mine, an Air Quality Management Plan should be adhered to ensure impacts are reduced to a level of compliance. This can take place by implementing the following mitigation techniques:

- Air quality monitoring

Several on-site monitoring locations will be used to monitor PM_{10} and dust fallout. Dust fallout samplers should be located at all five sites, and either a roving PM_{10} unit or one unit stationed at Receptor 2 or 4 (for which the highest concentrations were predicted in the model over different averaging intervals).

- Dust suppression

The National Pollutant Inventory (NPI, 2001) provides control factors for each mining activity presented as a pollutant source (**Appendix D**)

- Traffic management

Vehicle movement along unpaved roads is a key source of dust entrainment. Reducing vehicle speed and weights, and limiting the amount of traffic using the roads would contribute to mitigation measures. Vehicle speed on site can be managed by means of road signage and speed humps.

- Wet suppression

The use of water carts to moisten road surfaces should be employed, possibly containing chemical binding agents and other dust suppressants.

Routine monitoring should be undertaken as a means to assess mitigation performance and identify when additional dust suppression is required.

7 NOISE ASSESSMENT

7.1 TERMS OF REFERENCE

WSP was appointed by Exxaro to undertake the environmental noise impact specialist study (**Appendix E**) for proposed mining of the Eerstelingsfontein site. The study investigated the potential noise impact the proposed opencast mine will have on the surrounding environment.

7.2 METHODOLOGY

The approach used in the noise investigation and impact assessment included:

- Determination of the current land use and sensitive receptors in the region, which might be affected by the proposed construction and operational phases of the project;
- Measurement of the baseline noise levels at each of the identified receptor points;
- Identification of all potential noise sources during the construction and operation phases that could result in a significant noise impact at the identified sensitive noise receptor sites;
- Calculation of the total noise that would possibly be generated from the site;
- Calculation of the noise level that would be generated from the different phases of development;
- Assessment of all noise receptors to the relevant standards and terms;
- Rate the intensity, extent and duration of the impact on the surrounding environment; and
- Investigation of alternative noise mitigation procedures, if relevant.

7.2.1 Baseline Determination

The baseline conditions were determined with noise monitoring equipment specified in SANS 10103:2008 using a prescribed sound level meter (CEL Instruments – CEL480). A series of eight receptor locations were monitored (**Figure 34**). The monitoring period for each of the different samples was 15 minutes per measurement.

Figure 34 Noise monitoring points at Eerstelingsfontein (WSP, 2011)

7.2.2 Monitoring Procedure

The noise prediction model utilises applicable formulas associated with the rating levels for noise (in terms of various land uses) provided within SANS 10103:2008 (**Table 36**). The Eerstelingsfontein site and surrounding area would fall within the rural land use type reflected below.

Table 36 Typical rating levels for noise in districts (adapted from SANS 10103:2008) (WSP, 2011)

Type of District	Equivalent Continuous Rating Level for Noise ($L_{Req,T}$) (dB(A))					
	Outdoors			Indoors (with windows open)		
	Day-Night ($L_{R,dn}$)	Daytime ($L_{req,d}$)	Night-time ($L_{req,n}$)	Day-Night ($L_{R,dn}$)	Daytime ($L_{req,d}$)	Night-time ($L_{req,n}$)
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 Districts	70	70	60	60	60	50

L_{Leq}; (The equivalent sound pressure level). This is in essence a time-averaged sound measurement. Sound continuously fluctuates as a function of time. In order to effectively assess the effect of sound or noise on human beings it is very often necessary to obtain a measure of the average exposure to the sound or noise.

L_{Aeq}; (The equivalent A-weighted sound pressure level). This is internationally the most often used parameter to measure noise in relation to human responses.

The model calculated all noise source emissions for each source and scenario, adding them together to generate a single point of emission. The single source point was located at the centre of the proposed mine area. At each of the receptors, the noise level was calculated and combined with the baseline noise level of the region to determine the impact the proposed mining would have on the environment. The model calculated 65 receptor points spread out over the study area and calculated the noise levels at each receptor for the background noise level.

7.2.3 Noise Emission Sources

The project will introduce new noise sources into the region during construction and operation of the mine. The main sources of noise identified for each of these two phases are summarised below (**Table 37**).

Table 37 Summary of Noise Sources (WSP, 2011)

Construction Phase	Operational Phase
Construction activity	Open cast mining equipment
On-site vehicle movement	Transport of the material within the site
Road traffic noise	Crushing and screening of the coal
	Loading and off-loading transport truck
	Road traffic noise

The total cumulative noise (i.e. all sources on the site) for the construction and operational phases, as well as the worst-cast scenario was considered (**Table 38**). A centralised source point was adopted due to the nature of activities on-site and relatively small distances between the different sources from a noise source perspective. As the mining activity will continuously shift throughout the project lifetime, the generalised point source best simulates an environmentally conservative prediction of the noise generated by the proposed mine.

Table 38 **Source noise emission levels, measured 1m away, for each scenario (WSP, 2011)**

Scenario	Day-time noise level	Night-time noise level
Construction	91.7 dB(A)	---
Operation	106.6 dB(A)	57.1 dB(A)
Worst-Case (during operation)	130 dB(A)	---

7.3 SUMMARY OF FINDINGS

The baseline monitoring results, followed by the modelling of predicted increases in noise level during construction and operation are summarised below.

7.3.1 Baseline Results

The daytime baseline noise levels (measured in terms of SANS: 10103:2008) ranged from 28.7 to 47.7 dB, and the night-time baseline noise levels from 35.1 to 46.5 dB (**Figure 35**). The night-time measurements were generally higher than the daytime results (**Figure 36 and 37**) due to the elevated nocturnal insect activity in rural areas. The baseline noise is classified as very quiet, between a whisper and normal conversation, during the daytime.

There were measurements recorded during both daytime and night-time that exceeded the relevant SANS guidelines for rural areas of 45 dB(A) and 35 dB(A), respectively.

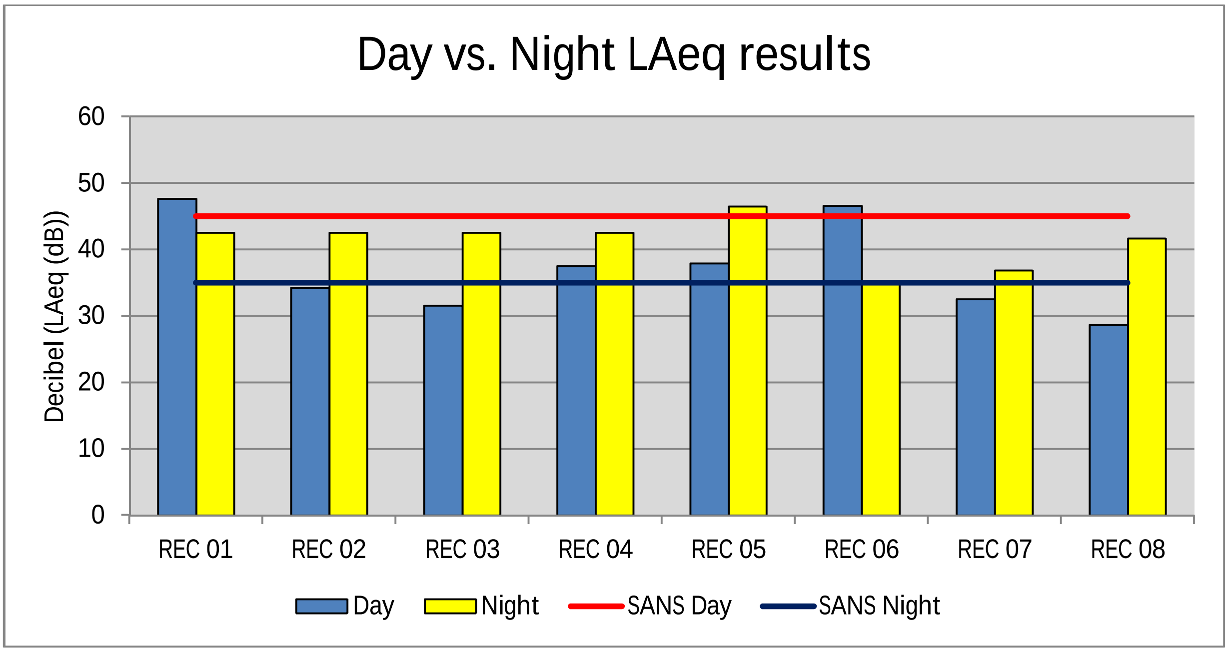


Figure 35 **Graph illustrating the comparison between daytime and night-time results at the different receptor points (WSP, 2011)**

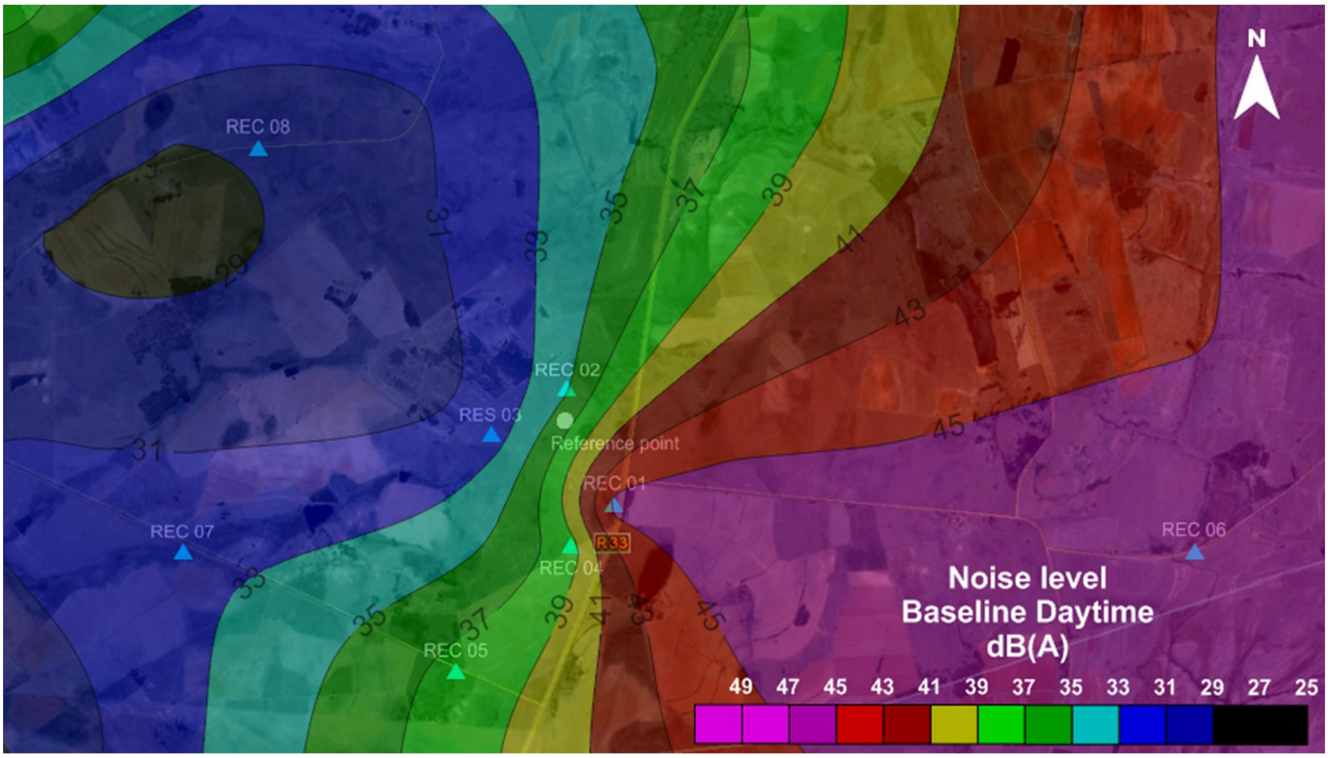


Figure 36 **Daytime background noise level (WSP, 2011)**

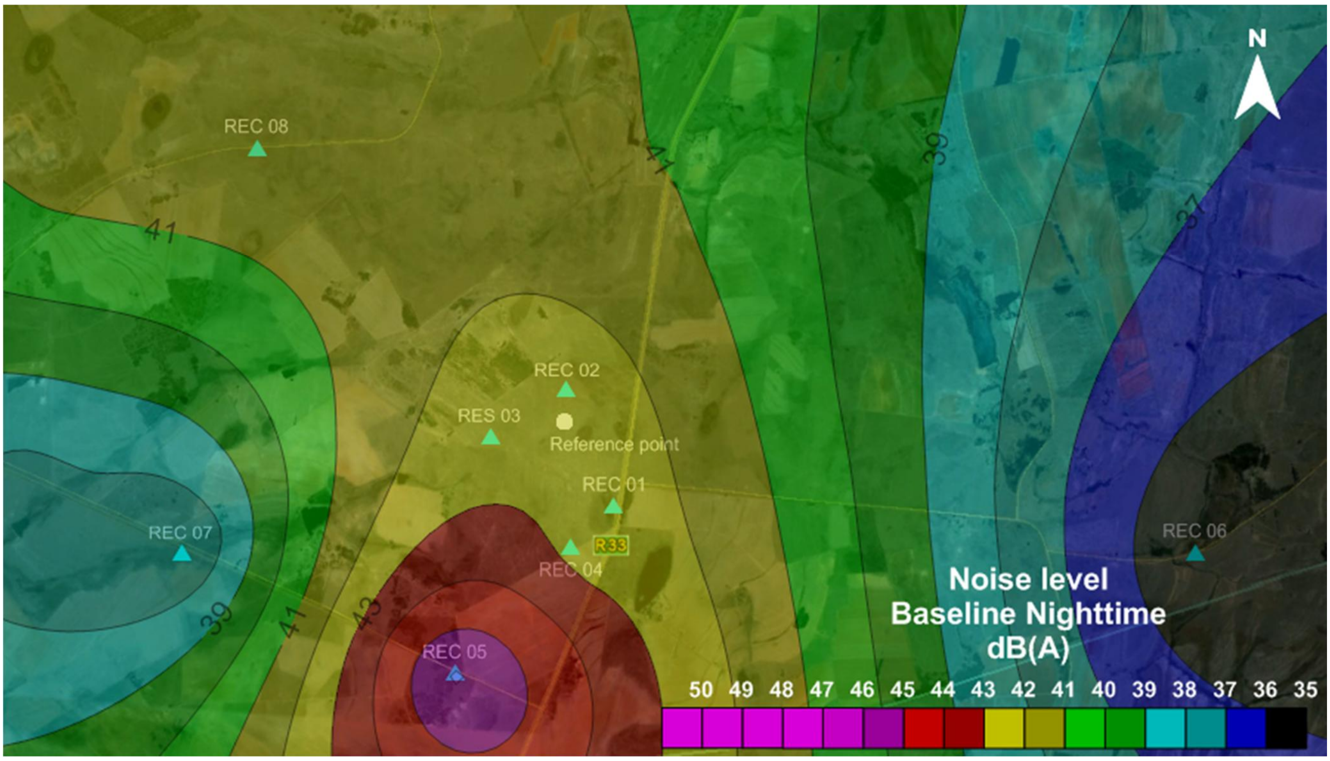


Figure 37 **Night-time background noise level (WSP, 2011)**

7.4 POTENTIAL IMPACTS

Elevated noise levels are expected to take place during the construction and operation phases, together with the increased traffic. Noise level predictions are available for both phases and the worst case scenario are summarised below.

7.4.1 Construction phase

The predicted noise levels on the site boundary during construction ranged from 37.53 to 63.70 dB, while the predicted noise levels for off-site receptor points ranged from 28.71 to 46.60 dB. The predicted on-site noise levels exceed SANS Rural – Daytime limit of 45 dB(A), while off-site receptor point noise levels are within the limits. The receptor (REC 01) on the south-eastern boundary of the site received the highest noise level possibly due to the combination of on-site and adjacent R33 traffic noise sources at this location (**Figure 38**).

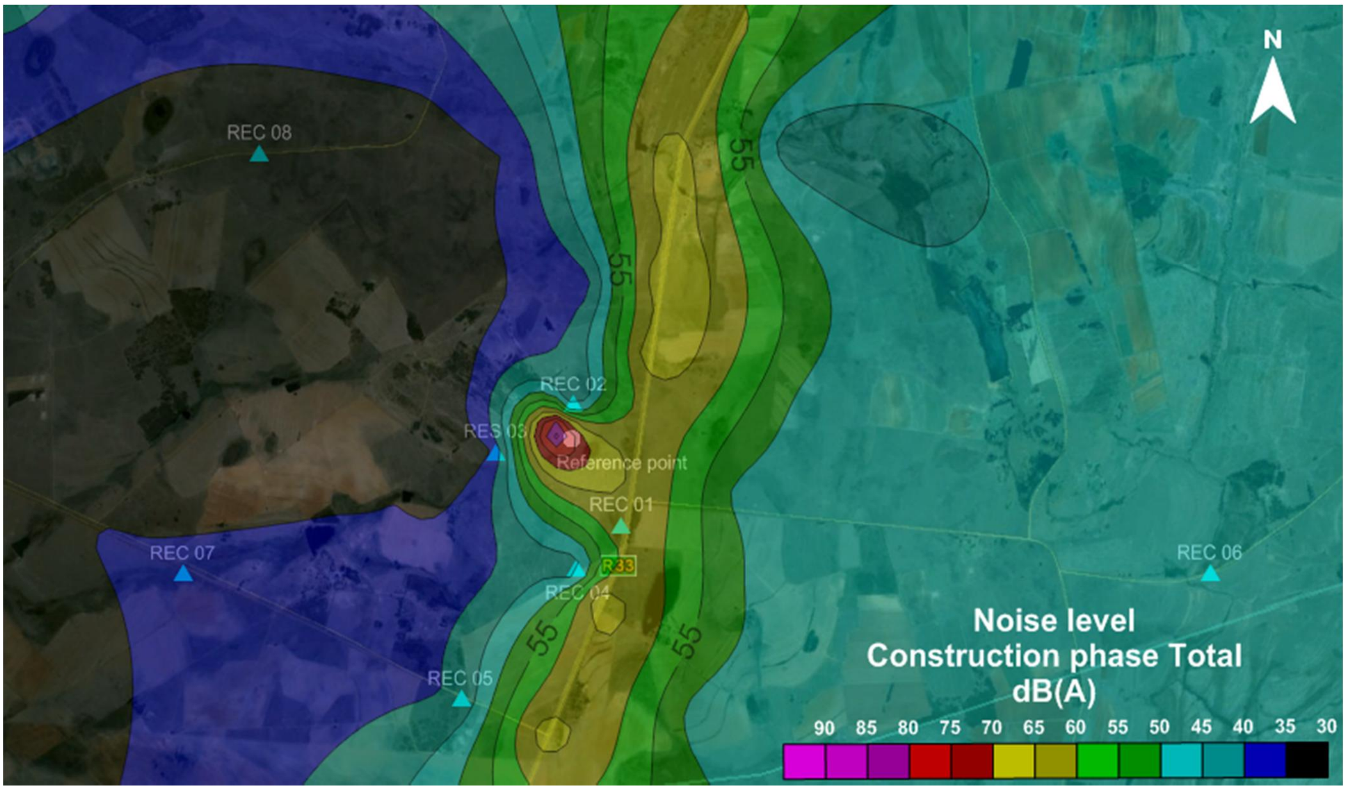


Figure 38 **Construction phase – Combined sources (Point, Line and Background) (WSP, 2011)**

7.4.2 Operation Phase

- Daytime

The predicted noise levels on the site boundary during daytime operations of the mine ranged from 36.85 to 85.09 dB, while the predicted noise levels for off-site receptor points ranged from 28.63 to 46.60 dB. The predicted on-site noise levels exceed SANS Rural – Daytime limit of 45 dB(A), while off-site receptor point noise levels were generally within the limits. The receptor (REC 01) on the south-eastern boundary of the site received the highest noise level as occurred during the construction phase (**Figure 39**).

- Night-time

Night-time activities on-site will be at a minimum with employees working from 06:00 in the first shift and the second shift ending at 22:00. Mining activities will be limited to loading and haulage of coal during the night-time period.

The average on-site noise level during the night-time activities is 42.6 dB(A), this is above SANS standards – 35 dB (**Figure 40**). There is predicted to be no significant increase in noise levels above current baseline at any of the off-site receptor points. It is anticipated that the cumulative noise sources from the mine will produce a low level 'humming' noise that may be audible beyond the site boundary to off-site receptors. This is also dependant on prevailing wind direction, receptor sensitivity and distance from site.

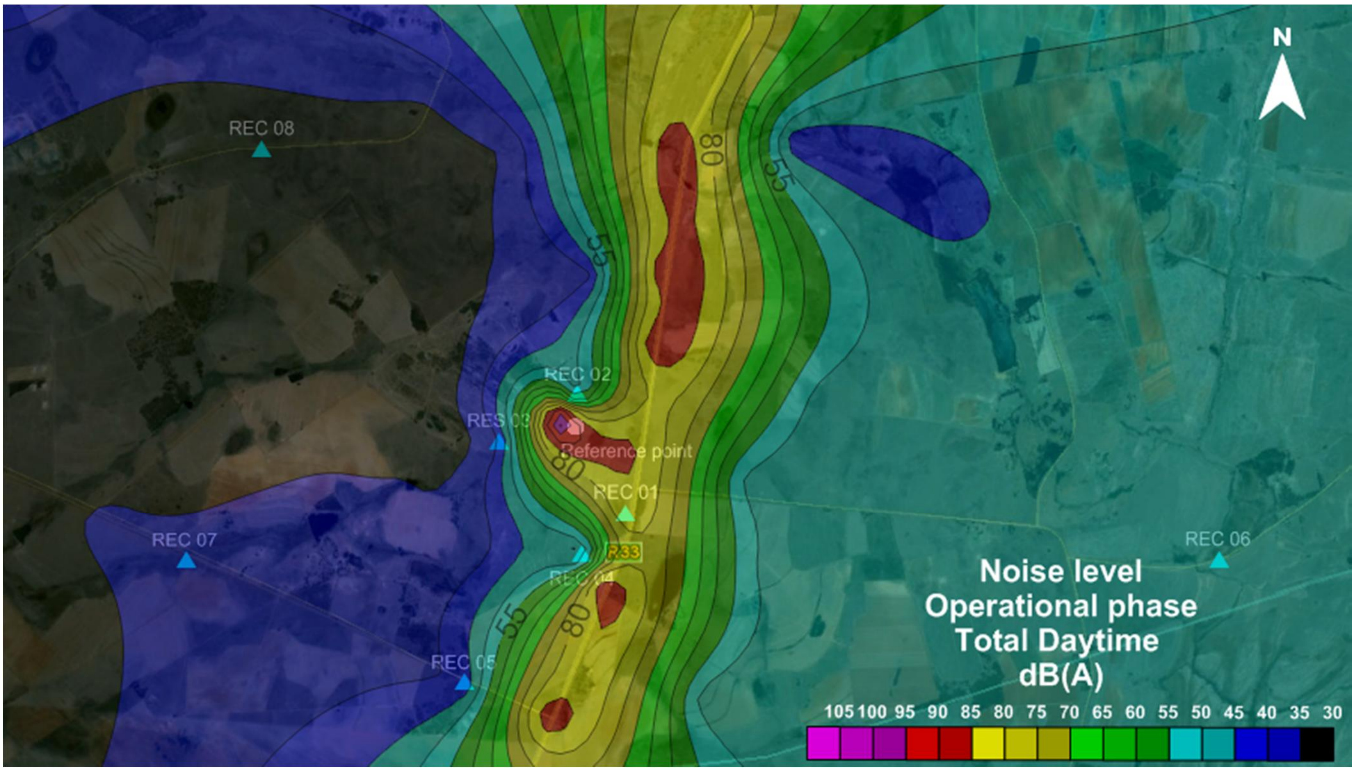


Figure 39 Operational phase combined noise sources for daytime (WSP, 2011)

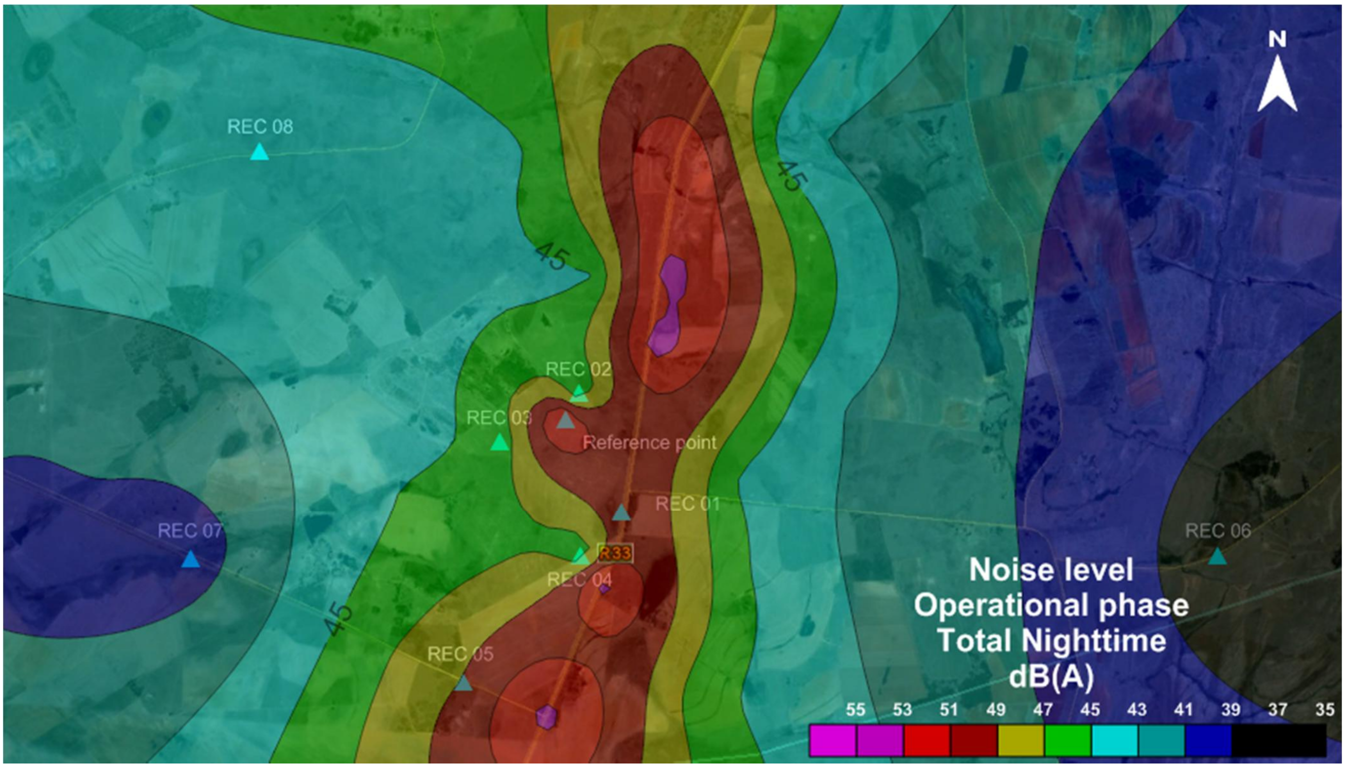


Figure 40 Operational phase combined noise sources for night-time (WSP, 2011)

7.4.3 Worst case scenario

The worst case scenario represents a short term instantaneous noise event (<10 seconds) that might occur onsite (blasting activities, falling equipment, etc.). The worst case scenario is not a long term noise event. The assessment provides an indication of the extent that noise could potentially spread from the site over the study region. A 130 dB(A) maximum onsite noise level is used and provides a plausible estimate of a peak source noise level from an unconfined blast event on site.

As expected the combined worst case noise from the two sources indicated that the spread in noise over the region will result in offsite receptors experiencing a significant, short term, increase in noise level of around ±10 dB(A) (**Figure 41**). However predicted offsite noise levels even under this extreme scenario, were within acceptable urban noise levels.

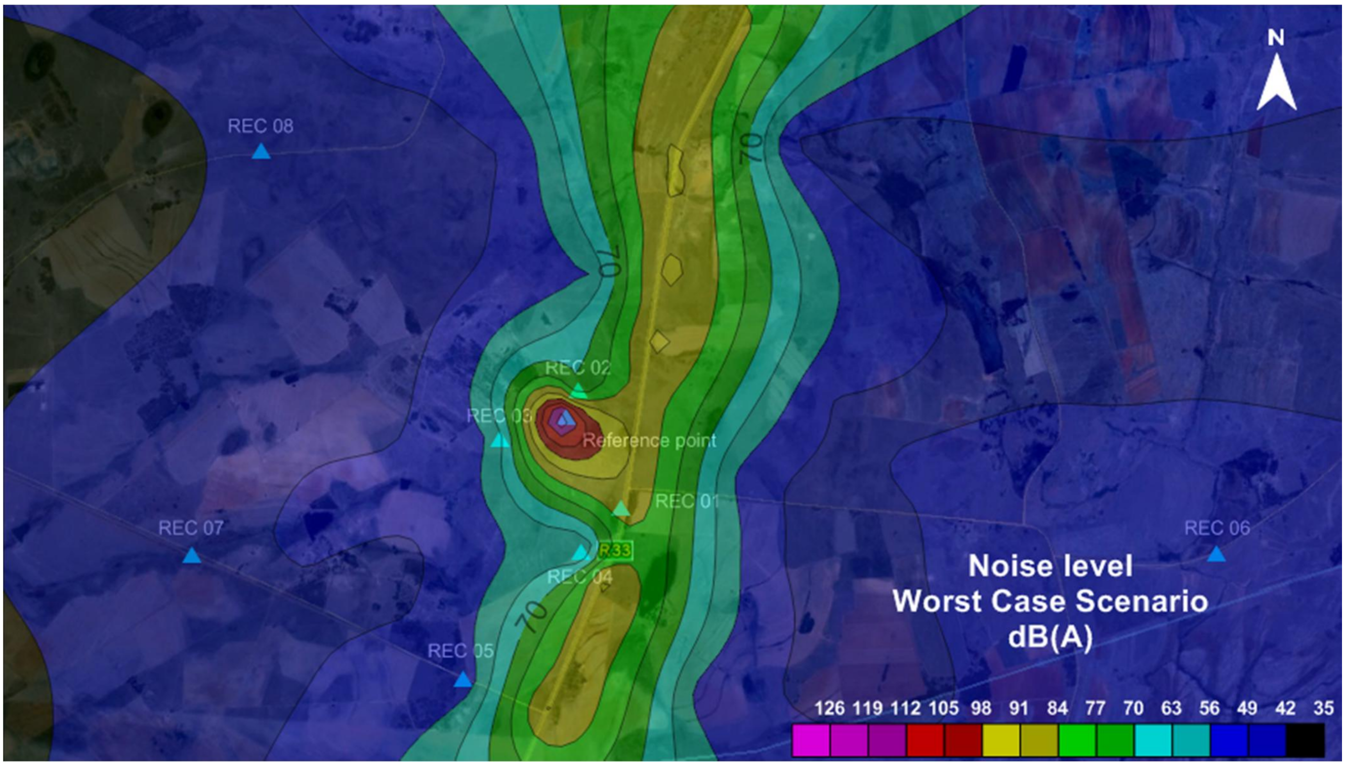


Figure 41 **Worst-case – Combined sources (Point, Line and Background) (WSP, 2011)**

7.4.4 Impact Assessment

Table 39 Impact assessment for noise levels during construction and operational phases (WSP, 2011)

Phase	Scenario	Severity	Duration	Extent	Frequency	Probability	Significance
Construction	Unmitigated	Low	3months / reversible with time	Beyond project Boundary	Daily	Highly likely	Low
Operational Daytime	Unmitigated	Moderate	>2 year / reversible with time	Beyond project Boundary	Daily	Highly likely	Medium
	Mitigated	Moderate	>2 year / reversible with time	Beyond project Boundary	Daily	Probable	Medium
Operational Night-time	Unmitigated	Moderate	>2 year / reversible with time	Within the project boundary	Daily	Highly likely	Low
	Mitigated	Low	>2 year / reversible with time	Within the project boundary	Daily	Highly likely	Low

7.4.5 Recommendations and Mitigation

Community sensitivities towards different noise will vary therefore conservative approaches are adopted in these predictive studies. Mitigation includes:

- Implementation of best practicable attenuation measures (irrespective of predicted nose levels) to minimise noise pollution;
- High-intensity impulse sounds at night should be avoided, however where reverse movements are required it is accepted that all vehicles driving on a mining site should make an audible noise when reversing to avoid injury;
- Attenuation on more constant sources through regular maintenance and sound reducing enclosures will ensure that noise is not a significant impact from the proposed operations; and
- Noise monitoring should be undertaken when the mine is operational to assess the validity of the model predictions and confirm the acceptability of actual noise levels. In the event that unacceptable noise levels are identified suitable mitigation measures will need to be considered.

7.4.6 Conclusions

The Eerstelingsfontein coal mine will have a noise impact on the surrounding environment, but with differing magnitude, primarily dependent upon distance of specific receptors from the operations.

The results of the noise modelling indicate that construction related noise impacts beyond the property boundary will be low. Operation related noise impacts (day time period) beyond the property boundary will occur, however, predicted levels are mostly below SANS Rural guideline. The predicted operational (night time) noise impact is primarily limited to on the site, although it is expected that a low level 'humming' noise may be audible beyond the site boundary depending on prevailing wind direction, receptor sensitivity and distance from site. Should the noise monitoring results indicate that unacceptable noise levels are present, suitable mitigation measures will need to be considered.

8 HERITAGE ASSESSMENT

8.1 TERMS OF REFERENCE

Archaetnos cc was appointed by WSP to conduct a Phase 1 Heritage Impact Assessment (**Appendix F**) for the proposed Eerstelingsfontein opencast coal mine. The purpose of the assessment was to identify and document objects, sites and structures of cultural heritage importance located on the property, and propose appropriate mitigation measures and applicable legislative requirements.

8.2 METHODOLOGY

The methodology included the following activities:

- Literature survey to obtain background information on the area; and
- Field survey, conducted according to heritage impact assessment practices, to locate objects, sites and structures of archaeological significance. A Global Positioning System (GPS) and photographs were used during this survey.
- Identification of objects, sites and structures (and locations of such) were documented according to the general minimum standards accepted by the archaeological profession.

8.3 SUMMARY OF FINDINGS

8.3.1 Baseline Description

During the field survey two sites of cultural heritage significance were located in the proposed mine site (**Figure 42**).

Figure 42 Location of the two sites identified within the mining area (Archaetnos, 2011)

8.3.1.1 Site 1: Graveyard

The graveyard included graves with dates of death varying between 1907 and 1976 (**Figure 43**). The graveyard appears to have been divided into black and whites people's graves. Graves are regarded as having a high cultural significance, with those graves older than 60 years considered as heritage graves.

Figure 43 Site 1: Graveyard (Archaetnos, 2011)

8.3.1.2 Site 2: Farmstead

The farmstead consists of the ruins of a house and outbuildings. It was built from stone and dates to ca. 1890-1910 (**Figure 44**). It is therefore older than 60 years, but is not very unique and therefore it has a medium cultural significance.

Figure 44 Site 2: Remains of Homestead (Archaetnos, 2011)

8.3.2 Potential Impacts

The graveyard and the farmstead fall within the boundary of the mine but not within the area that will be directly affected by the mining operation. If mining were to commence, with no protection of the sites, the potential indirect impact on identified heritage sites would be considered of low significance (**Table 40**).

Table 40 Assessment of Impacts on Heritage Resources (Archaetnos, 2011)

Impact	Severity	Duration	Extent	Frequency	Probability	Significance
Site number 1	Moderate	>10 yrs	Within the project boundary	Quarterly	Definite	Low Significance
Site number 2	Minor	>1 year	Within the project boundary	Quarterly	Definite	Low Significance

8.3.3 Recommendations/Mitigation measures

8.3.3.1 Site 1: Graveyard

- The site should be fenced. The fence should be erected at least 20m from the perimeter of the site in order to ensure that possible graves that cannot be seen (due to it not having any dressing) are included.
- Blasting should not take place within 50m of the graveyard. Blasting experts have advised that blasting closer than 50m will undoubtedly lead to damage to headstones and grave dressing. Although different circumstance will affect the distance, providing 50m is seen as a best practice minimum safe distance.
- A management plan is to be prepared for the preservation and maintenance of this area. This plan will have to be approved by the Burial Grounds and Graves Unit (BGG) of the South African Heritage Resources Agency (SAHRA) and should be monitored annually by an independent heritage specialist. A protocol, arrangements, security and safety measures, for allowing descendants to visit the graves should be included in the management plan.

8.3.3.2 Site 2: Homestead

The farmstead is not unique and thus does not need to be preserved; it may be demolished if necessary. A permit from SAHRA would be required before demolition can take place, however the farmstead falls outside the area of direct impact and thus should be left as is.

Impacts still prevalent on both heritage sites after mitigation are summarised below in **Table 41**. Although the probability of the impact occurring is definite, the severity of the impacts are both rated as minor and has a low significance rating.

Table 41 Impacts of the proposed mining activity after mitigation (Archaetnos, 2011)

Impact	Severity	Duration	Extent	Frequency	Probability	Significance
Site number 1	Minor	>10 yrs.	Within the project boundary	Quarterly	Definite	Low Significance
Site number 2	Minor	>1 year	Within the project boundary	Quarterly	Definite	Low Significance

8.3.4 Conclusion

It was determined that there will be a secondary impact from the mining activity on two heritage sites. This refers firstly to the mining debris and dust from blasting and, secondly the families will have hindered access to the graves. However with the mitigation measures in place the overall significance thereof will be low. A management plan, as indicated above should suffice relating to the graves. The farm yard should be left as is and be left to deteriorate naturally. However, should it pose a safety risk it may be demolished, but only after obtaining the necessary permit from SAHRA.

9 VISUAL ASSESSMENT

9.1 TERMS OF REFERENCE

Belinda Gebhardt was appointed by WSP to prepare a Visual Impact Assessment (**Appendix G**) for the proposed new Eerstellingsfontein opencast coal mine. The purpose of the assessment was to describe the existing visual character, identify and assess visual impacts, and to provide practical mitigation measures to reduce negative visual impacts.

9.2 METHODOLOGY

The methodology included both qualitative and quantitative techniques including:

- Data collection (including topography, visual character and quality, and mine layout plans);
- Field work and visual sampling was undertaken using photography and a Global Positioning System (GPS);
- Determination of the zone of visual influence (viewshed) using SRTM Digital Elevation Model (DEM); and
- Assessment of visual and landscape impacts.

9.3 SUMMARY OF FINDINGS

9.3.1 Baseline

The landscape in the vicinity of the site is predominantly rural comprising out of cultivated fields alternating with open grassy fields, occasional homesteads and clusters of trees set against gently undulating topography. Mountains are present to the north and east of the region. The topography and colours of the landscape provide pleasing rural scenery.

Westwards towards Witbank and directly north of the site visually prominent mining activities and towns are present creating an urban, industrial character. Additionally visual elements in the landscape such as partially rehabilitated rock dumps and areas of degraded land detract from the visual character of the region in certain areas.

In terms of sense of place, the general landscape in the vicinity of the study area has elements of the peaceful, rural Highveld and of the industrial mining activities (**Figure 45**). However, the general area immediately surrounding the site cannot be said to be easily distinguishable from the rest of the region and does not have a uniquely different character.

Figure 45 General visual character of the study area (old Sumo Colliery dumps north of site) (WSP, 2011).

9.3.2 Evaluation of Magnitude of Visual Impacts

Various factors were considered in the assessment including; visual quality, visual absorption capacity, visibility, integrity with the existing landscape and sensitivity of viewers (**Appendix G**).

9.3.2.1 Visual quality

Visual quality is an estimation of the composition of landscape elements and their resulting scenic excellence. The overall visual quality of the site and surrounding landscape is rated as being moderate.

9.3.2.2 Visual absorption capacity

Visual absorption capacity (VAC) is the potential for an area to conceal additional human intervention (activities and structures) without significant loss of character or visual quality. Visual absorption capacity of the site is rated as being moderate**,** primarily due to undulations in the topography, maize fields and clusters of trees

9.3.2.3 Visibility and Visual Exposure

Visibility is determined by the viewshed i.e. the topographically defined area, including all the major observation sites, from which proposed structures/activities will be visible. Viewshed calculations were based on worst-case scenario using 360o line-of-sight calculations on a Digital Elevation Model (at 30m contour intervals). It is important to note that the proposed mining activities may not be visible from all points within the viewshed, as views may be obstructed by visual elements such as built structures, minor local variations in topography and vegetation.

Viewsheds were determined for the overburden dumps (maximum height of 8 m), the coal stockpiles (maximum height of 10 m) and the pollution control dam (2.5 m high). These were overlaid to present a composite viewshed of the proposed mine. As the site is situated within a shallow valley, the viewshed in the area immediately surrounding the site is relatively contained, even though the site is situated on a small plateau. The viewshed primarily extends in fragmented pieces to the north and west of the site. The top of the ridges to the east of the site are also included within the viewshed (**Figure 46**).

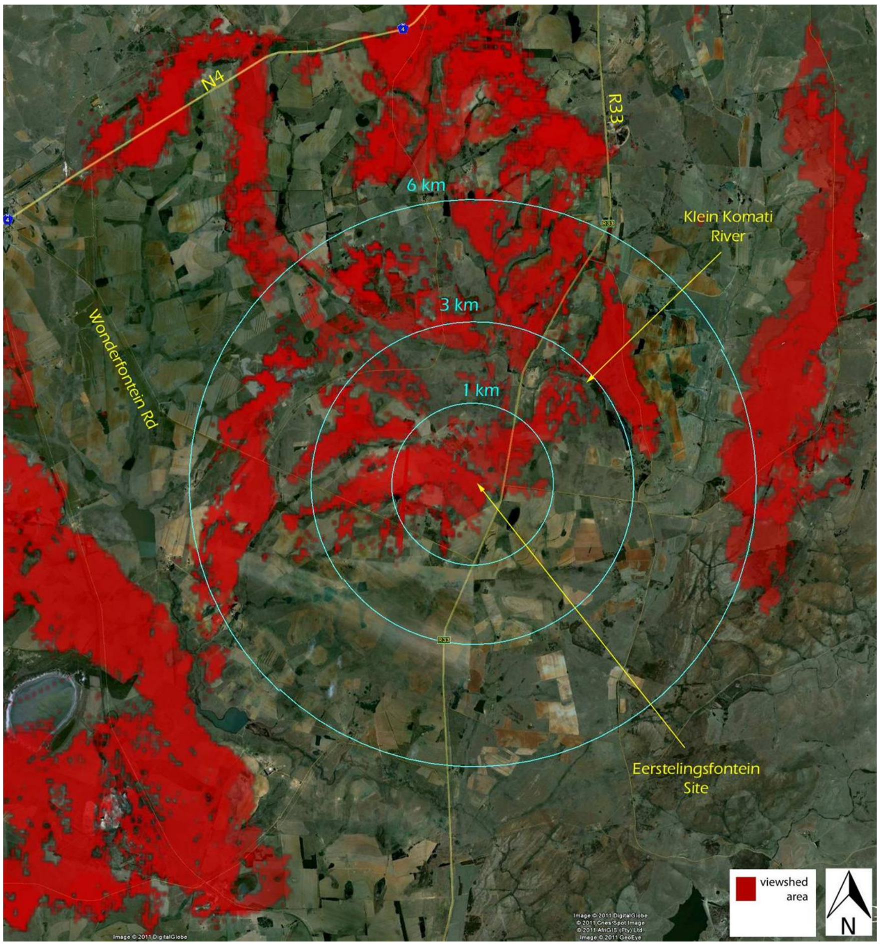


Figure 46 **Viewshed for proposed Eerstelingsfontein Mine (B Gerharbt, 2011)**

Overall visibility of the site is considered to be regional (extends beyond the immediate surrounds) but with generally low visibility and high visibility from a limited number of significant viewpoints.

9.3.2.4 Visual integrity

Visual intrusion refers to the compatibility of the proposed activities with the existing landscape and/or townscape. Due to their size, scale and visual character, mining activities are generally not considered to be visually congruent with a rural landscape or with tourism, conservation or residential activities. However, the stockpiles and overburden dumps on the Eerstelingsfontein site will not exceed 10 m in height. This is low and of a size and scale that will reduce the mine's intrusion on the landscape. Additionally the existence of other mining activities in the area reduces the proposed mine's visual impact i.e. it will contribute to an existing impact in the greater region.

Overall the visual integrity is considered to be moderate, with the crushing plant, stockpiles and overburden dumps being the most incongruent.

9.3.2.5 Viewer sensitivity analysis

The level of visual impact considered acceptable is depended to some degree on the sensitivity of the visual receptors. Potential viewers included in the study are residents, tourists and motorists. Generally the immediate residents are considered to be highly sensitive viewers, but numbers are low as homesteads are sparse. Occasional tourists are also considered to be sensitive viewers, but again numbers are low, with most tourists travelling to Dullstroom or along the N4.

Overall the sensitivity of the visual receptors is considered to be moderate to low, with the immediate residents being the most sensitive (of primary concern).

9.3.3 Potential Impacts

9.3.2.1 Visual landscape impacts: Construction Phase

A deterioration of the visual quality of the landscape will occur during the construction and operational phase. The main landscape impact during the construction phase will be the deterioration on visual quality due to the construction activities such as land clearing, cut and fill and road establishment. Only landforms within the site boundaries will be impacted on. This is rated as a medium impact without mitigation (**Table 42**).

- Mitigation
  - Natural vegetation must be retained as far as possible, thereby keeping the construction footprint to a minimum.

Mitigation during the construction phase will reduce the significance of visual landscape impacts from medium to an overall significance of low (**Table 42**).

Table 42 Assessment of Visual Landscape Impacts: Construction Phase (B Gebhardt, 2011)

	Severity	Duration	Extent	Overall Consequence	Frequency	Probability	Significance
Without mitigation	Minor	More than once a year	Within the project boundary	Medium	Daily	Definite	Medium
With mitigation	Negligible	More than once a year	Within the project boundary	Low	Daily	Definite	Low

9.3.2.2 Visual landscape impacts: Operational Phase

Deterioration of the visual quality of the landscape during the operational phase includes the formation of stockpiles, dumps, excavation pits and dams. These impacts are contained within the site and will be experienced for the duration of the project up until when the site is fully rehabilitated. These activities are rated as having a medium impact without mitigation (**Table 43**).

- Mitigation
  - Natural vegetation must be retained as far as possible.
  - A detailed plan for re-vegetation and design of future land use must be compiled.
  - The decommissioning plan should include the removal of all equipment and structures.

The operational phase impacts are rated as medium before mitigation and as low with mitigation (Table 43).

Table 43 Assessment of Visual Landscape Impacts: Operational Phase (B Gebhardt, 2011)

	Severity	Duration	Extent	Overall Consequence	Frequency	Probability	Significance
Without mitigation	Significant	More than once a year	Within the project boundary	Medium	Daily	Definite	Medium
With mitigation	Minor	More than once a year	Within the project boundary	Low	Daily	Definite	Low

9.3.2.3 Visual impacts on viewers: Construction Phase

Activities causing deterioration of the visual quality and sense of place include land clearing, earthworks, construction equipment /plant and temporary construction of camps/offices. The impacts are limited to the site but viewed from beyond the site boundaries. These impacts are thus rated as a medium without mitigation (**Table 44**).

- Mitigation
  - Natural vegetation must be retained as far as possible (construction and operational phase)
  - Construction footprint to be kept to a minimum and facilities placed where they will be least visible from key viewpoints
  - Implementation of proper visual screening as well as dust and litter control (construction phase).

With the mitigation measure the overall significance of impacts will be reduced to low (**Table 44**).

Table 44 Assessment of the Visual Impact of Construction Activities on viewers (B Gebhardt, 2011)

	Severity	Duration	Extent	Overall Consequence	Frequency	Probability	Significance
Without mitigation	Moderate	Less than once a year	Beyond project boundary	Medium	Daily	Definite	Medium
With mitigation	Minor	Less than once a year	Beyond project boundary	Low	Daily	Definite	Low

9.3.2.4 Visual impacts on viewers: Operational Phase

Operational activities and structures resulting in the significant visual impacts on viewers include the coal stockpiles, overburden dumps, pit/excavations, the crushing plant and equipment. The overall visibility, however, is limited by the visual absorption capacity of the site, relatively low height of the proposed mining operations and the relatively short life-span of the mine. Visual impacts occurring on the site will be experienced beyond the site boundaries in the surrounding area. These activities and structures are rated as a medium-high impact without mitigation (**Table 45**).

- Mitigation
  - Maximum height of stockpiles must be limited to 10 m above current ground level and overburden dumps to 8m above current ground level.

- If possible, buildings should not go above single storey height
- Involve affected viewers in the mitigation measures (future decommissioning and rehabilitation plans) that are going to be implemented.
- A detailed plan for re-vegetation and design of future land use must be compiled.
- The decommissioning plan should include the removal of all equipment and structures.

The impact rating before mitigation is rated as medium to high and can be reduced to medium with mitigation measures put in place. The impact of can be rated as insignificant of the site is fully rehabilitated after the decommissioning of the mine (**Table 45**)

Table 45 Assessment of the Visual Impact of Operational Activities on viewers (B Gebhardt, 2011)

	Severity	Duration	Extent	Overall Consequence	Frequency	Probability	Significance
Without mitigation	Significant	More than once a year	Beyond project boundary	Medium - High	Daily	Definite	Medium - High
With mitigation	Minor	More than once a year	Beyond project boundary	Medium	Daily	Definite	Medium

* this rating may be reduced to insignificant after the decommissioning phase if the site is fully and effectively rehabilitated.

9.3.2.5 Visual impacts on viewers: Increased night lighting

Increased night lighting is likely to deteriorate the visual quality for viewers. The intensity of the lighting impact will be reduced by the relatively moderate visibility of the site in the immediate area, relatively low viewer numbers as well as the limited life-span of the mine. Lighting is rated a medium impact without mitigation (**Table 46**).

- Mitigation
  - Directional lighting techniques and screening must be used where practicable.
  - The removal of lighting must be included in de-commissioning plans.

Although using only essential lighting for operations and safety during the night, it is not likely to significantly alter the impact (**Table 46**).

Table 46 Assessment for the Visual Impact of Night-Lighting on viewers (B Gebhardt, 2011)

	Severity	Duration	Extent	Overall Consequence	Frequency	Probability	Significance
Without mitigation	Moderate	More than once a year	Beyond project boundary	Medium	Daily	Definite	Medium
With mitigation	Minor - moderate	More than once a year	Beyond project boundary	Medium - Low	Daily	Definite	Medium - Low

*****this rating may be reduced to insignificant after the decommissioning phase if all lighting is removed.

9.3.2.6 Visual impacts on viewers: Dust and increased traffic

Dust and increased traffic will further deteriorate the visual quality and sense of place. Dust impacts on the visual quality of the scenery and will be experienced beyond the boundaries of the site on a daily basis. The increased number of haul trucks will have an impact on the sense of place in the area. These impacts will be experienced beyond the site boundaries within the surrounding area and will be daily impacts for the duration of the mine. Dust and increase traffic are rated as a medium impacts without mitigation (**Table 47**).

- Mitigation
  - Implementation of dust suppression measures on site.
  - Coal transport trucks conveying coal to Glisa must be covered and adhering to the speed limits on unpaved roads.

The visual impact of dust and increased traffic has a medium significance rating before mitigation and a medium to low after mitigation (**Table 47**).

Table 47 Assessment for the Visual Impact of Dust and Increased Traffic on viewers (B Gebhardt, 2011)

	Severity	Duration	Extent	Overall Consequence	Frequency	Probability	Significance
Without mitigation	Moderate	More than once a year	Beyond project boundary	Medium	Daily	Definite	Medium
With mitigation	Minor - moderate	More than once a year	Beyond project boundary	Medium - Low	Daily	Definite	Medium - Low

9.3.3 Conclusion

The visibility of the proposed works is relatively limited, primarily due to the low height of the mining activities, undulations in the topography and low viewer numbers. If mitigation measures are properly implemented and decommissioning and rehabilitation plans are followed, visual impacts would be reduced to acceptable levels of medium-low rating.

10 SOCIO-ECONOMIC ASSESSMENT

10.1 TERMS OF REFERENCE

WSP, in collaboration with Nomad Socio-Economic Consulting (Nomad) were appointed to undertake the Social Impact Assessment for the proposed Eerstelingsfontein Mine. The primary objective of the SIA was to assess or estimate the social consequences of the proposed project. The terms of reference for the SIA investigation included consideration of the socio-demographic and socio-economic profile of the study area; land use and socio-economic activities; impacts of potentially affected communities and the significance thereof (**Appendix H**).

10.2 METHODOLOGY

The SIA included a qualitative assessment of existing documentation, as well as primary data collection. In addition, a quantitative assessment of the economic assets of the adjacent community, the Zenzeleni Settlement, was undertaken to determine the socio-economic profile of this community. The SIA sought to understand the extent to which the Zenzeleni Settlement and adjacent landowners may be affected by the proposed mining activities, and the potential benefits that could be accrued to them.

The key activities undertaken during the SIA study are summarised below:

- Desktop investigation

A comprehensive review of existing information provided background information for the SIA study. Other specialist studies conducted have provided insight into the potential social impacts and mitigation measures. Specialist studies of particular relevance were the Surface Water, Ground Water, Air Quality, Noise, Blast and Vibration, Visual and Traffic Impact Assessments.

- Primary Data Collection and Assessment

The collection of accurate information pertaining to the surrounding communities and land users, several stages of consultation were undertaken. This included consultation with and survey of the Zenzeleni community and neighbouring farmers. In addition, consultation was undertaken with the relevant local authorities.

The data collected from the community survey and questionnaires was coded and captured so as to consolidate the information. The data was assessed with consideration of the local context associated with the project. This exercise contributed to the process of identifying and evaluating the potential socio-economic impacts.

- Assessment of potential socio-economic impacts

The assessment of the potential impacts of the proposed mine on the socio-economic environment made use of the information gained from the community and land users surveys, authority consultation, existing reports, and other relevant specialist studies conducted during the overall investigation of the project. This information was assessed based on the likelihood of occurring and relevance to the proposed project, and potential likely impacts identified. The overall significance of the potential impacts was evaluated. Potential impacts of the project, as well as the implications of the project not going ahead (i.e. the no-development option) were considered.

- Development of Social Management Strategy

Recommendations and mitigation measures were determined during the SIA in order to develop a management strategy for the social environment, which is included in the EMPr.

10.3 SUMMARY OF FINDINGS

10.3.1 Description of the baseline

Understanding the nature of the receiving social environment is essential in terms of identifying the potential socio-economic impacts associated with the proposed Eerstelingsfontein Mine. The SIA describes the socio-economic profile of the regional, local and site level (**Appendix H**).

10.3.2 Socio-Economic Profile

The regional and local socio-economic profile is described in the SIA report (**Appendix H**).

In terms of contextualising the site and immediate surrounds, the Eerstelingsfontein area has a long history of farming and coal mining. The site is strongly linked to the town of eMakhazeni, for both political and geographical reasons, as Emakhazeni is the seat of the local municipality, the key coal processing centre in the area.

The farming activities immediately surrounding the site include maize and soy cultivation, cattle (dairy and meat) and horse breeding. Mining in the area is dominated by coal. The Eerstelingsfontein 406JT site was purchased by Exxaro in 2001 from the farmer who currently owns the adjacent land. The sale agreement indicates that the when the land is sold by Exxaro the former landowner will have first option on the land.

The Eerstelingsfontein site has not had any land claims, however the local communities (both black and white) have a strong connection to the land, spanning over a century, with graves and historical structures present on and in the vicinity of the site (**Appendix F**).

- Zenzeleni Community

The Zenzeleni Community is well established, as it has reportedly existed for almost a century. The settlement is comprised of 9 low-income, rural homesteads. There are 61 residents (both permanent and intermittent) who speak a range of African languages. The footprint of the settlement is approximately 10 ha. The houses are either individual or multi-roomed, "wattle and daub" type structure.

The community lease land from Exxaro for housing and subsistence stock farming. Provision of municipal services is limited. Water is sourced from a borehole on the property (in the south-east corner of the community). Waste is managed internally, mainly through recycling and reusing products, and for animal feed. Wood (sourced from the surrounding area) and coal are the main sources of heat for households.

Zenzeleni is relatively young community, comprising predominantly of individuals between the ages of 10 to 34 years. The community is characterised by relatively large family groups with both male and female headed households. The education levels within the community vary; with the older generations having little or no education, while a number of the younger members have a matric, but no tertiary education. The majority of children, younger than 18, are currently enrolled in schools within the area.

This low income community relies predominantly on cash wages, usually earned by a few members of each household, and pension grants. Total household income rages from approximately R400 to R4000 a month. The majority of the employed individuals within this community work as farm workers on neighbouring farms and domestic workers in the town of eMakhazeni. Other occupations include mine workers, truck drivers, and construction workers.

- Surrounding Farmers

The neighbouring farms cultivate a variety of agricultural products, including maize, lucerne, soy, fruit (e.g. cherries), cattle (meat and dairy), sheep and horse breeding. A number of these farmers are long-term residents within the area and multiple generation farmers. Two of the farmers have purchased their farms more recently and have only farmed in the area for past 10 to 30 years. There appears to be a strong sense of community. There are a number of family owned farms (under trusts), however a number of individuals have acquired land over the past few decades, and become an integral part of the community.

10.3.3 Key Stakeholders

A summary of the key stakeholders (i.e. those likely to be affected by the proposed project) include:

- Zenzeleni Community

The Zenzeleni Community, located on the Eerstelingsfontein site, will be directly affected by the proposed mining of the property. The community falls outside of the immediate mining footprint, but lies in close proximity to the proposed mining area (~500m at the closest point). As this community could potentially be directly affected by the mining activities, they were the primary focus of the SIA.

- Neighbouring farmers

There are five farmers utilising the land directly adjacent to the proposed mining site. These farmers, their crops and stock could potentially be directly and indirectly affected by the mining activities. These farmers also provide a key role in employment and community support for the immediate area.

- eMakhazeni Local Municipality

The Local Municipality plays a key role in economic and social development and maintenance in the region.

- Mpumalanga Department of Agriculture, Rural Development and Land Administration

This department plays a role in ensuring that the land tenure rights of farm workers are upheld and work closely with the farming communities in the area. They were therefore consulted to provide local knowledge and insight into the land tenure process.

- Representatives of the Escarpment Environment Protection Group (EEPOG)

The EEPOG is an active Non-Governmental Organisation (NGO), which acts in the interest of environmental protection of the greater escarpment area, with a particular interest in mining activities.

10.3.4 Potential Impacts of the Proposed Mine

The identification and evaluation of the potential impacts of the proposed mine on the socio-economic environment made use of the information gathered during the SIA as well as existing reports and other relevant specialist studies conducted during the overall investigation of the project (**Table 48**). The review of other specialist studies focuses only on the potential impacts that could affect the social environment, and the recommended mitigation measures required to minimise the social impacts and maximise social benefits of the mine.

10.3.4.1 Surface Water

One of the key aspects raised by authorities and adjacent communities and farmers was the issue of potential surface water contamination as a result of the mining activities on the site. A number of farmers in the area use the Klein Komati River as a primary source of water for their cattle and other animals. The impacts of AMD, particularly impacts further downstream of the Klein Komati River, as the water flows into the lower reaches of the Komati River, were also raised.

The following potential impacts identified in the Surface Water Assessment (**Appendix B**) are relevant to the social environment:

Water Quality:

- Alteration of water quality due to decanting of mine water into tributaries. This is not considered significant in the short to medium term (construction and operational phase). The long-term impacts post closure show that decant from the EOP will be influenced by by Pyrite oxidation with a decreased pH and dissolved salts, particularly sulphates and chlorides. The short duration of mining and progressive rehabilitation of the pit will reduce the impact of AMD and thus the chemistry of the decant waters will not be as seriously impacted as SUMO and thus a passive system of water treatment will be appropriate for maintaining an acceptable quality for natural discharge.
- Low level of contamination from sediment washed off the site into the catchments. Although this impact is considered low as the Surface Water Management Plan will ensure that "dirty" water flow from the mine working area will be directed through earth channels, berms and culverts towards a silt trap (to remove suspended solids) just upslope of a pollution control dam. The lined pollution control dam, to the north of the mine pit, will contain all polluted runoff which will be maintained in a closed system.
- Contamination due to the failure of a pollution control dam within the mine site. This has the potential to impact immediate downstream users, specifically along the Klein Komati, as farmers utilise the river water as the sole means of watering their cattle.

Water Quantity:

Potential increases in runoff in the Blesbok Tributary 1 during mining operations, due to removal of vegetation.

Potential decrease in the Blesbok Tributary 2, due to increased filtration and activities on site.

- Potential decrease in flow of the Klein Komati Tributary during mining operations due to mining activities and stormwater management reducing the size of the contributing catchment, and post closure due to an increased infiltration from rehabilitation activities on site.

- Post rehabilitation there is likely to be a significant increase in flow of all four catchments, as decant water from the mine is released into surface water features.

Recommendations and Mitigation Measures:

- The recommendations for water quality monitoring and emergencies contained within the Surface Water Assessment (Appendix B) must be followed. The recommendations of the Surface Water Assessment are likely to mitigate the significance of the surface water impacts to an acceptable level.

- In the event of accidental release of contaminated water from the control dam into the adjacent catchment and rivers, Exxaro must provide stock water to the directly affected farmers for the period that the water remains contaminated.

- Exxaro's long term commitment to rehabilitate and monitor the site through the Rehabilitation and Mine Closure Plan will ensure on-going monitoring of surface water, and prevention of contamination of surface water resources.

If the mitigation measures are followed, the potential contamination of surface water resources is considered to be of **low to medium significance**, from a social perspective.

10.3.4.2 Ground Water

The farmers and residents in the area are solely dependent on groundwater. The water is used for domestic and agricultural use. Concerns have been raised that the mining of the site may affect the community and farmers' access to a clean source of domestic and agricultural water. The dewatering of the mine during the excavations could impact on the quality and quantity of ground water supply to these and other surrounding land users.

The Groundwater Assessment (**Appendix C**) indicated that the shallow aquifer underlying the proposed Eerstelingsfontein site is considered to be a minor aquifer, but with local significance to the farming community. The hydrocensus conducted illustrated that there would be a draw down on the shallow aquifer within the mining area, as water will be pumped out of the area during the operational phase. The Groundwater Assessment confirmed that whilst mining activity may impact on borehole water levels, this would be relatively low. The closest modelled groundwater level to the Zenzeleni site is potentially going to decrease by 0.9m. This will have a negligible impact on the community. Although the aquifer cannot be used for large-scale agriculture or supply, it is likely to be sufficient for supply to the local communities during the operational phase. Considering the findings of this assessment, the overall implication on water supply is considered to be of **medium significance** from a social perspective.

The Groundwater Assessment (**Appendix C**) states that there is a low risk of acid generation associated with the site, as such the potential impact of acid mine drainage (AMD) is considered to be of **low significance**.

Recommendations and Mitigation Measures:

- Exxaro are to ensure the sustainability of water supply to the community and neighbouring farms during the operational phase. The existing boreholes in the vicinity of mining operations should be monitored throughout life of the mine. If borehole water supply is reported to be affected by mining operations, this is to be investigated and addressed as a priority. A contract should be agreed upon and signed by Exxaro and members of the community to ensure a sustainable and usable source of water supply to any I&APs that might have their water supply interrupted during and after the mining operations.

- The recommendations contained in the Groundwater Assessment are to be adhered to.

If groundwater mitigation measures are applied, the overall significance of this issue is considered to be **low**.

10.3.4.3 Noise

Noise is likely to directly affect the immediate neighbours of the site, namely the Zenzeleni community, and surrounding farmers, during blasting activities.

The Environmental Noise Impact Assessment (**Appendix E**) found that there is not likely to be noise levels above acceptable noise for a rural land use. The only incidents of higher than acceptable noise levels would occur during brief (<10 seconds) blasting activities, falling equipment or similar incidents. The worse-case scenario considered in the study indicated that, only on rare circumstances for a very short duration, would the community experience a significant increase in noise levels i.e. an increase above background levels by around 10dB(A). The impact could potentially have a moderate negative impact. Night time noise is likely to have a greater impact on surrounding receptors, due to the rural nature of the area.

Recommendations and Mitigation Measures:

- The recommendations contained in the Environmental Noise Impact Assessment (**Appendix E**) are to be followed, and blasting should not be undertaken at night.
- Complaints must also be investigated and resolved within 7 days so as to minimise these impacts. This should be resolved via a Grievance Referral and Redress Mechanism (GRRM).

These mitigation measures are likely to reduce the social impact of noise to a **medium significance**.

10.3.4.4 Dust

Dust generated during the operational phase of the mine has the potential to:

- Impact on crops and stock: dust settling of crops may inhibit growth as it prevents photosynthesis. This could impact on crop yields and have an economic impact on neighbouring farmers. Dust settling on animal feed (grass, Lucerne, etc) may impact on cattle farming in the area, as cattle will not eat feed covered in dust. If Lucerne production is reduced, farmers will be forced to purchase feed. The overall viability of some farming activities may be impacted upon which is considered to be of medium significance.
- Impact on communities: Dust could cause health and nuisance impacts. Health impacts are of a specific concern, in relation to vulnerable, low-income communities. Dust, if unmitigated is likely to have a significant impact on immediately surrounding communities, especially the Zenzeleni community, and therefore has a **high social significance**.

The Air Quality Impact Assessment (**Appendix D**) indicated that dust emissions associated with the operations at the Eerstelingsfontein are likely to be **moderate to significant** (without mitigation).

Recommendations and Mitigation Measures:

- The recommended dust suppression and monitoring needs to be implemented (**Appendix D**).
- If complaints of agricultural impact received, these are to be properly investigated.

If the dust abatement measures are effectively implemented at 90% efficiency, the dust fall out will be reduced to a level of **medium significance**.

10.3.4.5 Visual and Aesthetic Implications

A change in landscape as a result in the mining operations, and possibly longer-term changes, could further impact on the sense of place.

The area north of Emakhazeni, the Dullstroom greater area, is known for its fly fishing and scenic tourism value. The Eerstelingsfontein and Carolina areas do not have as strong a tourism industry; however, the potential impact on tourism was raised. This is mainly due to the aesthetic impacts of the mine on the landscape adjacent to the R33 between the town of Emakhazeni and Carolina. The implications of this impact could be more regional than local.

A Visual impact Assessment (**Appendix G**) indicates that there are several potential sources of visual impacts which will alter the landscape physically and impact on visual quality during both the construction and operational phases, such as land clearing, cut and fill, roads, stockpiles, dumps, pits and dams. These are considered to be of **high significance**. Night lighting, dust and increase traffic will also have an impact on the local landscape. These impacts could lead to the secondary impact of loss of tourism income. This is considered to be of **medium significance**, as tourism is more prominent north of Emakhazeni town, towards Dullstroom, and the majority of road users passing this site (along R33) are farmers and labourers.

Recommendations and Mitigation Measures:

The recommendations provided in the Visual Impact Assessment (**Appendix G**) must be properly implemented so as to mitigate any potential impacts on the surrounding land users and passing traffic. These recommendations are likely to reduce most potential negative aesthetic impacts; however these cannot be avoided all together. With mitigation, the overall visual impact is likely to remain of **medium significance** for some key receptors, namely neighbouring farmers and the tourism sector.

10.3.4.6 Blast and Vibration

There is a possibility that blasting activities could impact structures on adjacent properties. The Blast and Vibration Assessment (Appendix I) identified two key potential impacts of blasting that could affect the social environment surrounding the Eerstelingsfontein site:

- Damage to Structures

There is a potential for structures up to 1028m away from the mining pit boundary to be affected by ground vibration. This is likely to impact structures differently depending on the material they are constructed of. The "wattle and daub" type structures have the potential to be affected less than those made of brick and mortar, as they are more flexible and are able to absorb the vibrations. The nearest Zenzeleni structure to the mine pit area is approximately 500m.

- Borehole collapse

There is the potential for boreholes located on the site (less than 250m from the pit edge) to collapse as a result of ground vibrations from blasting. Although not considered within the specialist study, there may be a potential for ground vibrations to impact the borehole within the Zenzeleni community (located ~450m from the pit edge). If this were to occur, it would have a significant impact on the community, as this is their sole source of water. The likelihood of this occurring is low however, if the borehole were to collapse, the significance of the impact would be high without any mitigation (i.e. another source of potable water).

Both the above potential impacts of blasting are considered to be of **high significance**, given vulnerability of the Zenzeleni community, and proximity of structures to the mine.

Recommendations and Mitigation Measures:

Recommendations contained within the Blast and Vibration Assessment (**Appendix I**) must be adhered to.

It is recommended that a full independent structural audit is undertaken, so as to establish the pre-existing condition of structures within 2km of the mining area, so as to ensure all potentially affected structures are included.

In addition, good communication networks must be set up with neighbouring land users so as to communicate blasting times and any potential complaints. The implementation of these mitigation measures is likely to reduce the potential of noise and safety related impacts of blasting on immediately surrounding land users. Impacts on building structures are likely, and can be partially mitigated during the operational phase, as such the social impact of this is considered to be of **medium significance**.

Exxaro have confirmed that once the operational phase of the mine is complete, they will repair and / or replace community structures affected by the mining operations. In addition, a contract should be agreed upon and signed by Exxaro and members of the community to ensure a sustainable and usable source of water supply to any I&APs that might have their water supply interrupted during and after the mining operations.

10.3.4.7 Employment Opportunities

The issue of employment opportunities was raised by various stakeholders, in relation to the economic development of the area and the economic gains for the immediate unskilled and semi-skilled labour force. This is seen as a key issue due to a number of historical precedents where mining companies, within the area, have often promised that a number of jobs will be generated from a new mining operation. The perception is that these promises are often not fulfilled.

The mine will not offer any new permanent jobs as Exxaro will utilise the existing staff from the Glisa Colliery for the operation of Eerstelingsfontein mine. There may however be scope for a number of temporary, medium-term employment opportunities to emerge from the Eerstelingsfontein mine. These could include unskilled opportunities such as cleaners, security guards and labour for rehabilitation and landscaping. These opportunities offer the possibility of economic gain (and the associated social support) for the immediate community.

Cumulatively, there is not likely to be any significant impact on unemployment in the area, as very few new jobs are likely to be generated from this activity. Expectations as to the number of jobs likely to be created need to be properly managed. The likely impact, prior to mitigation to maximise the social benefits of the mine, is therefore of **low positive significance**.

Recommendations and Mitigation Measures:

In order to enhance the potential positive impacts of employment opportunities on the local community, Exxaro needs to employ local residents for any available unskilled and semi-skilled jobs. The priority source of employment (skills dependent) is to be Zenzeleni community and then consideration of residents within the immediate local area. A skills audit of the local communities must be undertaken during the project initiation phase. If possible, Exxaro will initiate this audit earlier in order to identify opportunities for skills training to occur in advance of the mining operations that would enable the local community to be employed for positions that are available. This would improve the positive impact on employment opportunities in the local area from low to **medium significance**.

10.3.4.8 Historical and Cultural Value

The Heritage Impact Assessment (**Appendix F**) included the assessment of two sites of heritage significance on the Eerstelingsfontein site. The first site is the existing graveyards which lie in the centre of the Zenzeleni community, which is of high cultural significance. The second site is a farm yard also located within the community. This is of medium cultural significance, but may be demolished if necessary if a permit is obtained (**Appendix F**).

As the mining will not be taking place within the Zenzeleni settlement area, there is not likely to be significant direct impacts on the graves or the farm yard. The social impact is therefore of a **low negative significance**.

Recommendations and Mitigation Measures:

The Heritage Impact Assessment (**Appendix F**) recommends that a comprehensive management plan for the graves within the community should be developed. This must include the fencing of the site 20m from the boundaries and the preservation and maintenance of the site.

The potential impact of the mine on cultural and historical resources is not likely to be high; however the implementation of the management plan could have a **low positive impact** on the identified sites.

10.3.4.9 Distrust of mining companies and their activities

Neighbouring farmers raised the issue of a lack of trust of mining companies based on previous experience. The perception is that mining companies do not consider the local communities and the impacts of the mine on them. Coupled with this, was the perceived lack of commitment by mines to mitigate impacts on the environment.

If this impact is not mitigated, there is the potential for the mistrust of the mining companies and their activities to increase, which is likely to impact on the developer's social license to operate the mine. This is therefore a social impact of **high significance** without mitigation.

Recommendations and Mitigation Measures:

In order to reduce the distrust within the community, Exxaro must ensure:

- Good communication between themselves and the local and greater community;
- Complaints and issues are properly investigated and mitigated as far as possible; and
- A functional and active community forum is in place prior to the start of mining processes.

The implementation of these recommendations could reduce the impact to one of **medium significance**.

Table 48 Assessment of socio-economic impacts associated with the proposed Eerstelingsfontein Mine (WSP, 2011)

Aspect	Impact	Severity	Duration	Extent	Frequency	Probability	Significance without mitigation	Significance with mitigation
Surface water	Water Quantity: Decrease during operations	Moderate	More than 1 year	Beyond project boundary	Daily	Highly likely	Medium	Medium
	Water Quantity: Increase during rehabilitation (decant water release)	Significant	Life of the project	Regional	Daily	Definite	High	Medium
	Water Quality: Groundwater decant water	Significant	Life of the project	Regional	Daily	Probable	Medium	Low
Groundwater	Acid Mine Drainage	Moderate	Beyond the life of the facility	Regional	Daily	Unlikely	Medium	Low
	Reduced ground water supply	Moderate	Life of the project	Beyond project boundary	Weekly	Probable	Medium	Low
Noise	Construction Phase blasting, machinery & excavations	Moderate	More than 1 year	Beyond project boundary	Weekly	Highly likely	Medium	Low
	Reduced agricultural productivity	Moderate	More than 1 year	Beyond project boundary	Quarterly	Probable	Medium	Low
Dust	Nuisance	Minor	More than 1 year	Beyond project boundary	Weekly	Probable	High	Medium
	Health	Moderate	More than 1 year	Beyond project boundary	Weekly	Probable	High	Medium
Visual and Aesthetics	Change in landscape and sense of place	Significant	More than 1 year	Beyond project boundary	Daily	Definite	High	Medium
	Loss of scenic views and associated impacts on tourism	Significant	More than 1 year	Beyond project boundary	Daily	Definite	High	Medium
	Property devaluation	Moderate	More than 1 year	Beyond project boundary	Daily	Probable	Medium	Low

Blast and Vibration	Damage to Structures	Significant	Beyond the life of the facility	Beyond project boundary	Quarterly	Highly likely	High	Medium
	Borehole collapse	Significant	Beyond the life of the facility	Surrounding area with project boundary	Quarterly	Unlikely	High	Low
Employment	Unskilled employment opportunities	Moderate	More than 1 year	Beyond project boundary	Daily	Highly likely	Low (+)	Medium (+)
Cultural and heritage	Impact on graves	Minor	Quickly reversable	Surrounding area with project boundary	Less than once a year	Unlikely	Low	Low (+)
Distrust	Distrust of mining companies	Significant	Beyond the life of the facility	Beyond project boundary	Daily	Highly likely	High	Medium

10.3.5 Potential Impacts of the No Development Option

Should the Eerstelingsfontein site not be operational by 2012, it is likely that Exxaro will be forced to close the NBC operations. The socio-economic implications of not mining the Eesterlingsfontein mine centre on the issues of employment, social upliftment, financial viability and national income loss (**Appendix H**). A summary of these potential impacts and their significance is provided below (Table 50).

10.3.5.1 Employment

Exxaro's NBC currently employs 159 people and intends to employ another 40 by 2014, totally 199 people. In addition, there are approximately 14 separate contractors, who rely significantly (if not solely) on Exxaro's mining and processing activities within NBC (**Appendix H**). These contractors currently employ 776 people, which are likely to be directly or indirectly affected by the closure of Exxaro NBC, potentially affecting R 774 million in turnover over the period 2012 to 2014.

If the Eerstelingsfontein site is not mined, all 199 employees are likely to be affected, which amounts to a R194 million loss in salaries over the period 2012 to 2014. Table 49 provides a breakdown of the projected financial budget for Eerstellingsfontein employees from 2012 to 2014. It must be noted that the salary costs includes the cost to company including bonuses, employee share schemes, medical, pension, safety bonuses etc.

Table 49 Breakdown of projected financial budget for Eerstelingsfontein employees from 2012 to 2014

Description	2012	2013	2014	Total
Salary Budget	R 57 028 300	R 64 500 000	R 73 857 905	R 195 386 205
Nr. Of employees	161	179	199	180
Cost per employee per annum	R 354 213	R 360 335	R 371 145	R 1 087 492
Months	12	12	12	36
Cost per employee per month	R 29 517	R 30 027	R 30 928	R 30 208

The knock-on effect of the loss of these jobs is likely to impact a significant number of households within the area, and further afield, as many low-income households rely on skilled members to provide domestic income. The potential job losses and indirect economic effects are likely to be of **high significance**.

10.3.5.2 Social Upliftment

Exxaro NBC is currently committed to social upliftment projects as part of its license to mine Eerstelingsfontein. These projects include housing, provision of electricity to existing houses, an agricultural cooperative and an alien plant eradication project. The total value of these projects is estimated at R3 million, and will generate approximately 30 jobs in the construction, agriculture and manufacturing industries within the area. These projects, therefore, represent a significant opportunity to improve the quality of life of local communities.

In addition, Exxaro has contributed over R1.5 million to improving education through the Waterval Boven Saturday school project, which has resulted in a 22% improvement in matric pass rates. Exxaro has also been able to provide bursaries to individuals who have performed in the programme, providing additional upliftment for the local community.

Exxaro have stated that should the NBC operations be terminated, the completion of the Social and Labour Plan projects will be jeopardised.

If the NBC operation is closed down, as a result of Eerstelingsfontein, the implementation of social upliftment project will be impacted upon. In addition, the closing of the Glisa operations will put the Glisa Social and Labour Plan in jeopardy, having further significant social and economic implications for the local communities.

Due to the fact that the mining of the Eerstelingsfontein site will ensure a continued supply of coal from Exxaro's Glisa operations to Eskom, Eerstelingsfontein is intrinsically linked to Glisa's operations. Therefore, the Social and Labour Plan of Glisa will also be impacted on should coal supply diminish. The Social and Labour Plan of Glisa for 2010/2013 includes the construction of 20 houses, a brick making project, a bakery project, and cleaning materials and tissue project. The total value of these projects is estimated to be around R6 million. The closing down of the Glisa operations will therefore have further significant social and economic implications for the local communities benefiting from the Gisa SLP.

The loss of contribution to social upliftment and education projects is considered to be of **high significance**.

10.3.5.3 Exxaro Financial Implications

With the decrease in viable quality coal supply from the Glisa mine, Exxaro will not be able to meet the requirements of their supply agreement with Eskom. The terms of the agreement state that there is a significant financial penalty if Exxaro continuously supplies less than the required volume and / or quality of coal product per month. This amount is currently approximately R271 per ton, which amounts to R650 million over a year.

Failure of Eerstelingsfontein not starting in 2015 at the latest will lead to shortage of contractual delivery to Eskom being 50Kt in 2015, 240Kt in 2016 and 460Kt in 2017. Penalties will be in the region of R13.5m in 2015, R72m in 2016 and R152m in 2017. These penalties will lead to the mine making losses. If the mine closes then the annual penalty will be around R650 million as noted above.

The financial implications of these penalties for Exxaro are substantial, and would likely result in substantial loss of profit, and indirectly on employment and other aspects of the business. It is this financial pressure which would be the primary driver which would force the closure of Exxaro's NBC operation, and is therefore considered to be of **high significance**.

10.3.5.4 National Income Loss

There are potential implications for state income should the Eerstelingsfontein mine not commence. The 2010 Exxaro NBC business plan estimates that an amount of R392.9 million is to be paid in corporate tax and mining royalties to the South African Revenue Services over the 2012 to 2014 period.

The loss of the revenue generated by the NBC is not likely to have a significant impact on the state, as the net revenue for 2010 was almost R600 billion, with mining revenue comprising 0.1% of this (SARS, 2009/10). The impact is therefore considered to be of **low significance**.

Table 50 Assessment of socio-economic impacts associated with the no-development option (WSP, 2011)

Aspect	Potential Impacts	Consequence			Likelihood		Significance
		Severity	Duration	Extent	Frequency	Probability	
Employment	Loss of employment due to close of NBC operations	Significant	Permanent	Regional	Daily	Definite	High
Social Upliftment	Loss of contribution through social and labour plan for Eerstelingsfontein and Glisa, and additional community projects	Significant	Permanent	Regional	Daily	Definite	High
Exxaro Financial Implications	Loss of income and business opportunities	Irreversible	Permanent	National	Daily	Definite	High
National Income Loss	Loss of tax and royalties income for the state.	Minor	Permanent	National	Once a year	Definite	Low

10.3.6 Recommendations/Mitigation measures: Social Management Strategy

There are opportunities to mitigate the negative impacts and maximise the positive impacts of the mine on the local and regional socio-economic environment. It is recommended that the following aspects be included in the EMPr. The following aspects:

10.3.6.1 Grievance Referral and Redress Mechanism (GRRM)

It is recommended that a GRRM is put in place to ensure that there is continuous communication between the stakeholders and Exxaro throughout the mining process. This should be implemented In line with the International Finance Corporation (IFC) performance standards, which maintain that a GRRM must be:

- Accessible;
- Appropriate;
- Advertised; and
- Able to be used without fear of prejudice.

The GRRM should take form of a number of communications systems, including:

- A site box: where written complaints and issues can be deposited
- Complaints register: onsite register for complaints reported directly to the site manager
- Information boards: onsite boards displaying contact information for the site manager (and/or Exxaro), to facilitate communication between stakeholders and Exxaro.

10.3.6.2 Community Forum

A community forum should be set up to facilitate dialog between Exxaro and the local stakeholders. This aim of the forum will be provide the land users with information about the mining process, and for land users and other stakeholders to communicate with Exxaro on issues such as dust, noise, access to land, structural damage, and employment opportunities. This forum should include:

- Exxaro Environmental Manager (Eerstelingsfontein site)
- Exxaro community liaison/Estate Manager
- Emakhazeni LM representative/s (technical services/environmental/housing)
- Zenzeleni community representative
- Other land users & stakeholders (including neighbouring land users and owners)

The forum should be established prior to the commencement of activities on site, and the terms of reference of the forum defined and agreed. This should include the dates, venue and times of regular meetings.

10.3.6.3 Defined Roles & Responsibilities

It is necessary to define the specific roles and responsibilities of the various parties associated with the proposed mining in order to minimise the potential negative social impacts and to facilitate good communication (**Table 51**).

Table 51 Recommended Roles and Responsibilities of Key Parties (WSP, 2011)

Group / Organisation	Role / Responsibility
Exxaro	Implement the SEMP Monitor all actions and mitigation measures Feedback on progress made in terms of actions and mitigation measures
Eerstelingsfontein Community Forum	Draft and ratify a constitution for the forum. Ensure all stakeholders are represented on the forum Establish effective mechanisms to ensure communication and feedback between parties
eMakhazeni Local Municipality	Ensure that mining processes and related issues and mitigation measures are in agreement with local policies and plans
Mpumalanga DEDET	Ensure Exxaro is undertaking the necessary measures committed to in the EMP

Zenzeleni Community	Engage through representation on the community forum
Farmers	Engage through representation on the community forum

10.4 CONCLUSION

The social impacts that could result from the construction, operation and decommissioning of the Eerstelingsfontein mine include visual, aesthetic, noise, dust, blast and vibration impacts, as well as potential ground and surface water impacts. These impacts are considered to be of **low to a medium significance** if the specialist recommendations and socio-economic mitigation measures are effectively implemented. Potential positive impacts considered include employment opportunities and, and cultural and heritage aspects. If the relevant mitigation measures are put in place, opportunities exist to enhance these opportunities. The Grievance Referral and Redress Mechanism and on-going communication with the community are essential to improve the current situation of distrust of mining companies.

Should the Eerstelingsfontein mine not proceed, it is likely that the NBC will cease to operate due to significant financial penalties. The closure of NBC's operations will result in significant loss of employment and economic revenue, and would jeopardise the completion and future implementation of social upliftment projects in the local area. Due to the Eerstelingsfontein operations being primarily driven forward to offer a high quality coal to the Glisa operations in order for Exxaro to meeting Eskoms supply requirements it is reasonable to assume that the social upliftment projects being implemented under the Glisa's Social and Labour Plan projects are at jeopardy.

The Zenzeleni community and immediate neighbours will be directly impacted upon by mining operations. There are opportunities to minimise some of the potential negative impacts, which will require commitment from Exxaro to operate the site in a responsible manner and complete rehabilitation of the mining area. On-going communication with key local stakeholders throughout the mining process is essential.

11 BLAST AND VIBRATION ASSESSMENT

11.1 TERMS OF REFERENCE

Blast Management and Consulting was appointed by WSP to undertake a Blast and Vibration Assessment for the proposed new Eerstelingsfontein Mine (**Appendix I**). The objective of the assessment was to assess aspects of blasting operations such as ground vibration, air blast, fly rock and fumes of the mine.

11.2 METHODOLOGY

The methodology associated with the Blast and Vibration Assessment included:

- Site scan using aerial imagery (Google Earth) to identify the surface structures present within a 3500m radius from the proposed mine boundary that will require consideration during modelling of blasting operations.
- Review of proposed drilling information to calculate the required blasting designs. Blast designs are required to define the expected ground vibration, air blast and fly rock influences and levels.
- Monitoring of actual blasts (according to charge mass per delay, and distance, delay period and geometry of the blast) in order to determine the effective control measures of ground vibration.
- Calculation and modelling of ground vibration and air blast from the edge of the pit outline.
- Review of the type of structures around the mine operations
- Assessment of other factors associated with opencast mining and blasting including fly rock, noxious fumes, effects of ground vibration on adjacent communities and farm animals, cracking of houses and consequent devaluation, and water well influence.
- Evaluation of blast and vibration impacts.

The study included consideration of:

- The United States Bureau of Mines (USBM) criterion for safe blasting (applied where private structures are of concern). There is no South African Standard available; therefore the USBM Guidelines are applied. These guidelines include a wide range of structures, and most structures found in South Africa have natural frequencies that are covered by the frequency span of the USBM Guidelines. The USBM Guidelines includes a recommendation for air blast levels to remain below 134dB. Research has shown that windows break at levels higher than 134dB, but below 134dB impacts include rattling of windows, doors or large roof structures which will be perceived by the occupier. As such a best practice limit of 120dB is applied, this should limit complaints.
- Human perception, as the legal limit for structures is greater than the comfort zone for humans. Ground vibration is experienced as “Perceptible”, “Unpleasant” and “Intolerable” at different vibration levels for different frequencies.

11.3 SUMMARY OF FINDINGS

11.3.1 Ground Vibration

The minimum charge mass per delay is expected to yield levels within the boundaries for safe blasting with regards to the nearest structures and points of interest considered except one water measuring hole (WMH) (**Figure 47**).

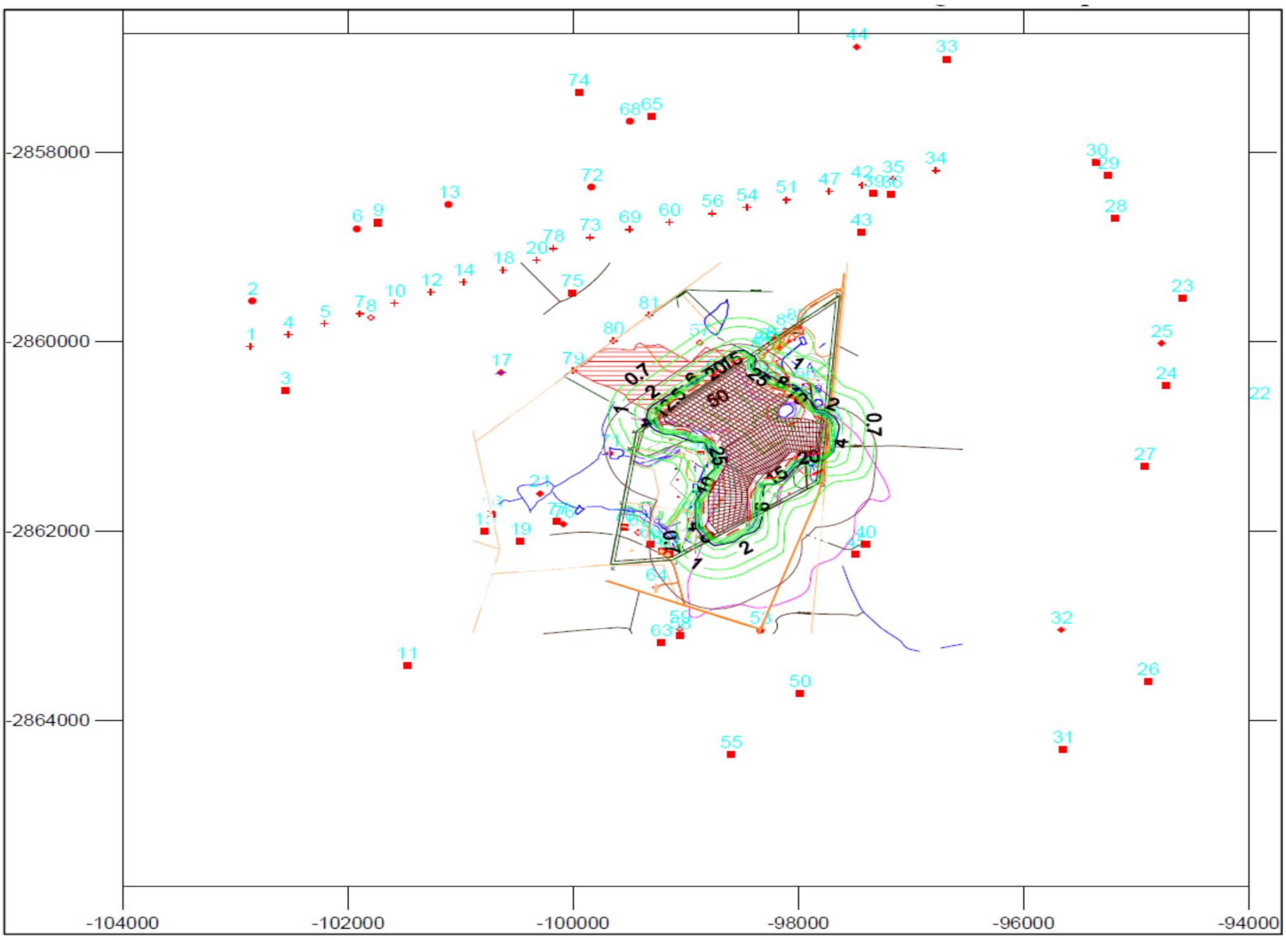


Figure 47 Ground vibration influence on site and surrounding areas: minimum charge of 29kg (BMC, 2011)

The levels obtained from modelling of the medium and maximum charge mass do however indicate concerns (**Figure 48 and 49**). Medium charge modelling shows mainly the R33 on the eastern side of the pit to be a possible problem. The crushing plant and again the WMH closest to the pit could be problematic. Ground vibration levels are greater than expected safe blasting levels. The crushing plant level is currently regarded as 150mm/s. This level will however be dependent on the type of crushing plant that will be used. It is certain that the WMH will be damaged due to blasting.

The maximum charge mass modelling shows a significant number of installations that could be affected (**Figure 49**). Most of the structures inside the mining area are bound to be influenced. The R33 on the eastern side is located such that levels of ground vibration expected are greater than specific limits. No private structure is located at such distance that levels are greater than the safe blasting limits but at levels which could create disturbances that will upset people. Mitigation will be required to maintain safe operations on the eastern side.

The adjacent farmer has an Arab Stud Farming enterprise and uses the current site to graze his horses, under agreement with Exxaro. When mining commences the horses will move to the adjacent farm. There is limited documentation available detailing the effect that blasting has on horses, however based on professional experience a distance of more than 1000m will limit adverse effects on the stud enterprise. It is not uncommon that horses are exposed to loud noises.

Considering the possible effects with regards to human perceptions it is clear that a significant quantity of points of interest will experience ground vibration. Five houses will experience ground vibration levels as unpleasant. Even though ground vibrations are less than structural damage levels it may lead to possible complaints.

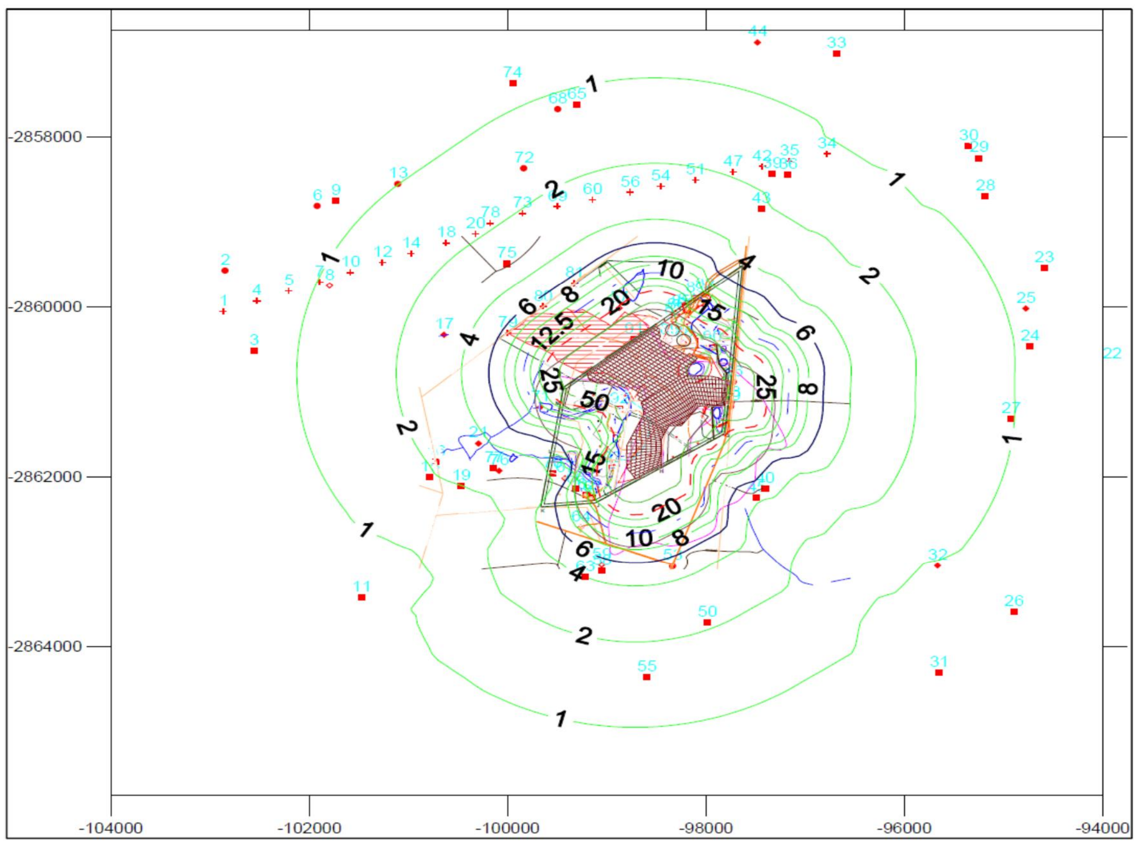


Figure 48 **Ground vibration influence on site and surrounding areas: medium charge of 420kg (BMC, 2011)**

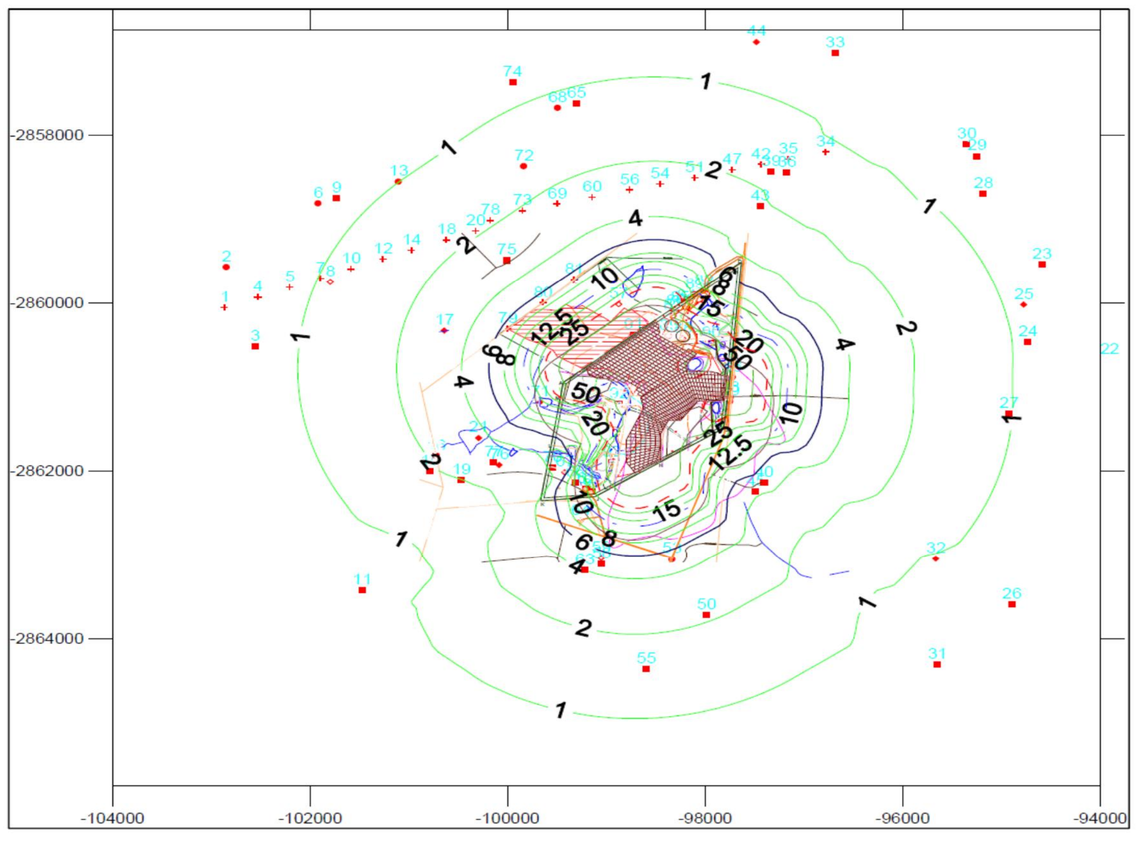


Figure 49 **Ground vibration influence on site and surrounding areas: maximum charge of 1679kg (BMC, 2011)**

11.3.2 Air Blast

The effect of air blast, if not controlled properly, could be problematic. Not in the sense of damage being induced but having an impact – even at low levels of roofs and windows that could result in complaints from people. However the prediction models for the three different charges used shows mainly the areas inside the mining area to be problematic (**Figure 50, 51, and 52**). The air blast levels anticipated at the Zenzeleni community located in the south western corner of the site was 126dB and less for the maximum charge. This is below the guideline level of 134dB however it is above the recommended level of 120dB above which the effects will be perceived by the community. It is recommended that monitoring be done using at least three monitors per blast, one of these monitors should be located in close proximity to the Zenzeleni community.

There is no specific concern for the privately owned structures.

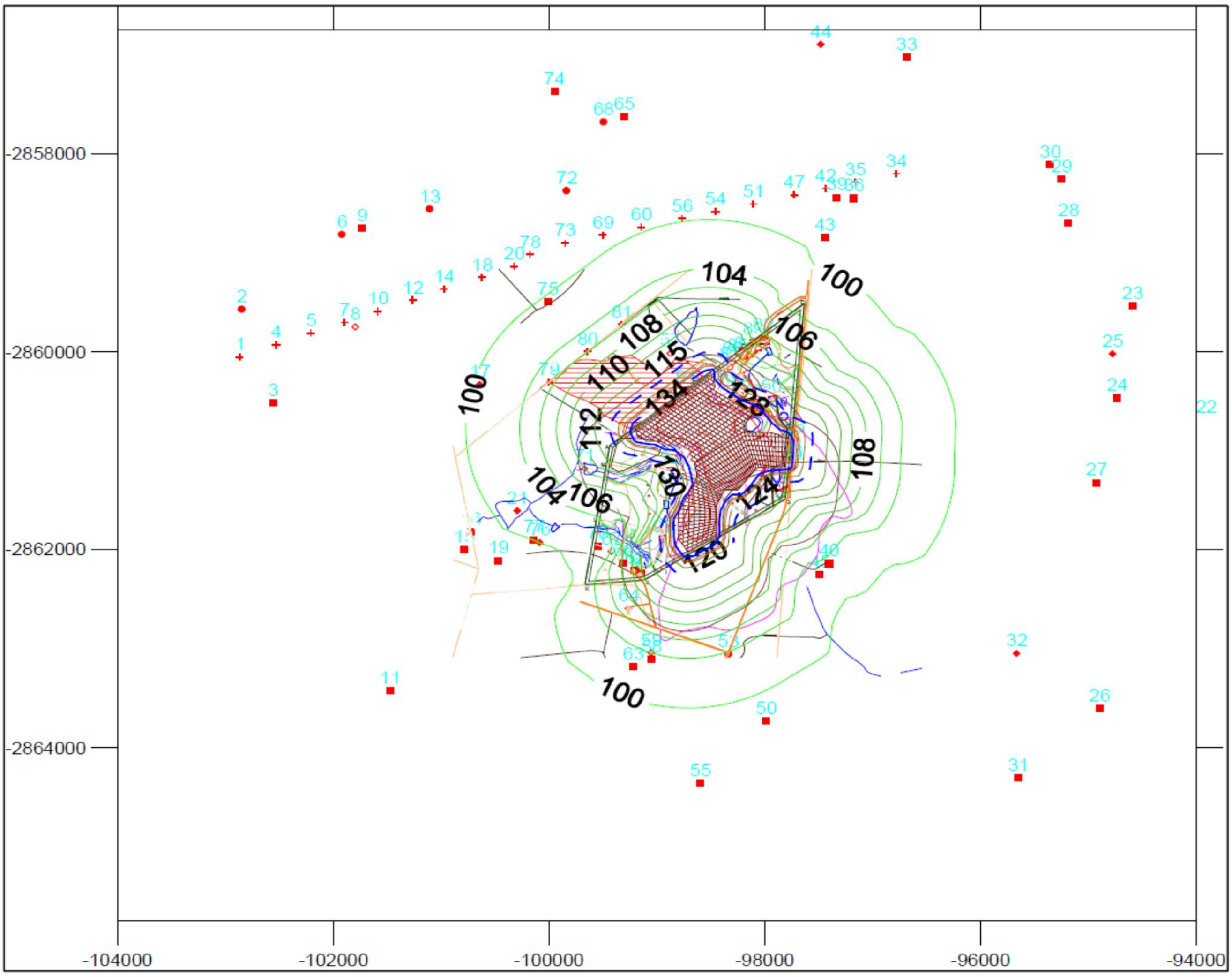


Figure 50 **Air blast influence on site and surrounding areas: minimum charge of 29kg (BMC, 2011)**

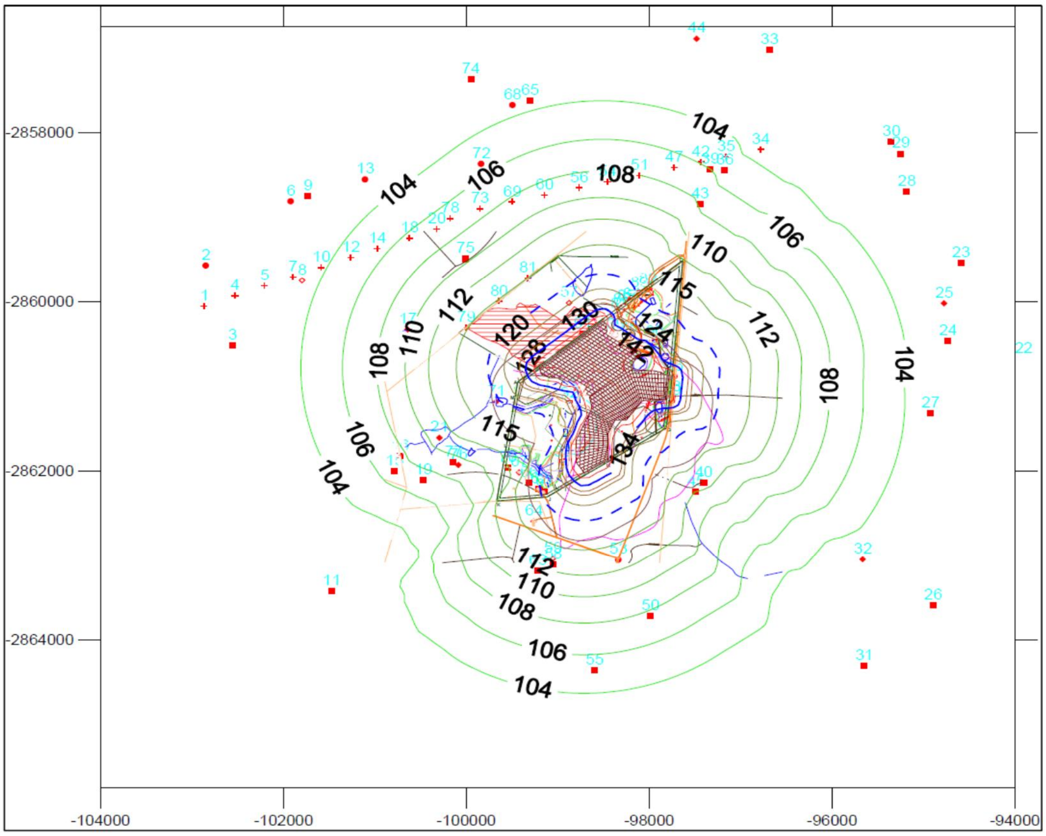


Figure 51 Air blast influence on site and surrounding areas: medium charge of 420kg (BMC, 2011)

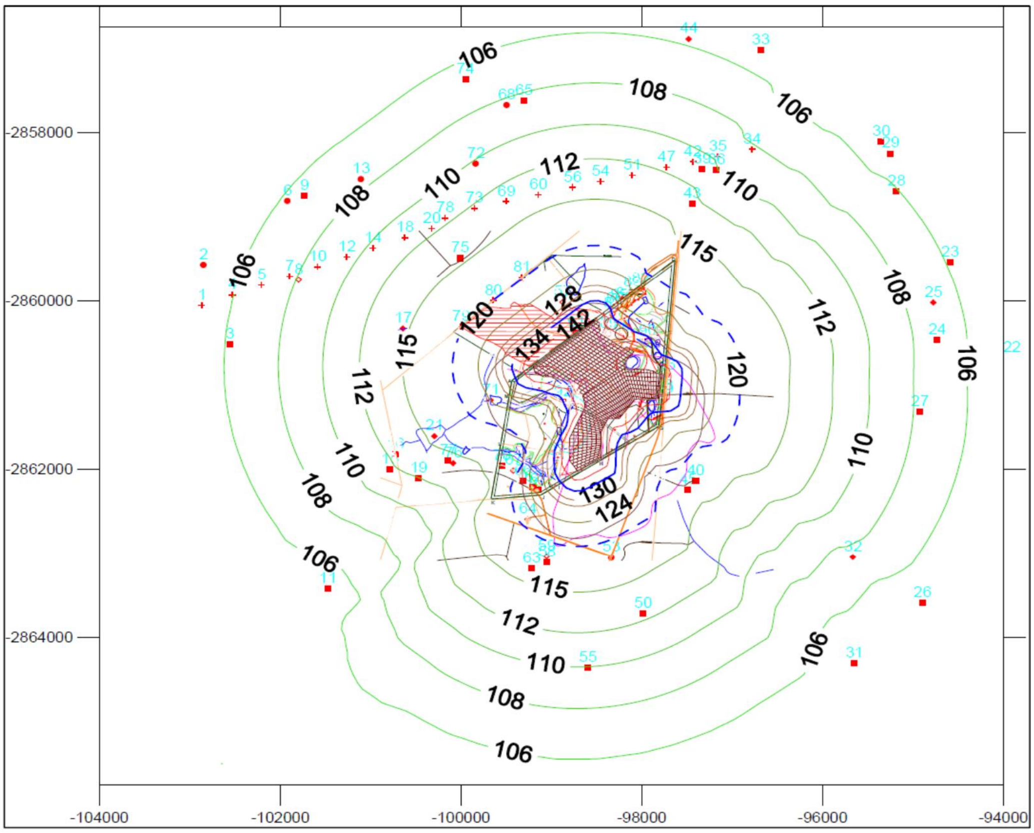


Figure 52 Air blast vibration influence on site and surrounding areas: maximum charge of 1679kg (BMC, 2011)

11.3.3 Fly Rock

Reviewing factors that contribute to fly rock it is certain that if no stemming control is exerted there will be fly rock. Possible reduction of stemming length to 2m for the blast configuration applied could see fly rock up to almost 900m possible travel for hard rock material. This distance will certainly reach neighbouring areas which will have far reaching consequences as fly rock could be detrimental to animals and people. The main concern is houses south west of the mine area and the R33 provincial road on the eastern side. The labourer's cattle that will remain within the south western corner of the site will be over 500m away from the blasting activities and will be at risk of effects from fly rock. Concern is also for mine structures inside the mining area.

11.3.4 Noxious Fumes

Production of noxious fumes such as nitrous oxides and carbon monoxide may be caused by poor quality control on explosive manufacture, damage to explosive, lack of confinement, insufficient charge diameter, excessive sleep time, and specific types of ground can also contribute to fumes. The impact can vary from undesirable to lethal.

11.4 IMPACT ASSESSMENT

The overall assessment of blast and vibration impacts associated with the proposed Eerstelingsfontein mine is present in **Table 52** below. Refer to the Appendix for more detail.

Table 52 Assessment of Blast and Vibration Impacts (BMC, 2011)

Blasting Impact	Severity	Duration	Extent	Frequency	Probability	Overall Significance
Ground Vibration	Moderate	Life of the project	Beyond the project boundary	Daily	Probable	Medium
Air Blast	Moderate	Life of the project	Beyond the project boundary	Daily	Probable	Medium
Fly rock	Moderate	Life of the project	Beyond the project boundary	Daily	Probable	Medium
Fumes	Moderate	Life of the project	Beyond the project boundary	Daily	Probable	Medium

11.4.1 Recommendations and Mitigation Measures

Ground vibration predictions have shown that distances at 400m have the possibility of inducing damage. All structures closer than 400m from the mine boundary or inside mine boundary will require mitigations. To reduce the influence of ground vibration the charge mass per delay must be reduced. This is achieved by changing the drill and blast parameters, changing initiation systems i.e. electronic initiation to obtain single hole firing.

Air blast levels are not as concerning as ground vibration. It has more influence on human perception than actual damage to structures. All attempts should be made to keep air blast levels generated from blasting operations well below 120 dB to reduce public disturbance and limit the possibility of complaints. Reduction of charge mass will have specific influence but controls during designs and charging will have to be in place to ensure air blast levels remain controlled. An aspect that is not quantified exactly as yet is the control on stemming length. Stemming length will require definite addressing. The rules for air blast control will also address fly rock control. In view of current operations there will be a requirement for separate addressing of applicable stemming.

Control actions on fumes will include the use of proper quality explosives and proper loading conditions. Excessive sleeping of charged blastholes will add to fumes generation and should be prevented. The checking of blastholes for water will ensure that charging crew charges blasthole from the bottom (which should be a standard practise) and displaces the water. This will also ensure proper initiation of the blasthole.

Required recommendations for the operations phase are summarised below and detailed within (**Appendix I**):

- Blasting at a minimum safe distance of 500m from communities;

- Ensuring all person and animals within 500m from the blast are cleared and where necessary evacuation must be conducted with all the required pre-blast negotiations;
- Roads must be controlled and closed for period of blast if road is closer than the 500m from the blast;
- All private boreholes in radius of 1000m from mine boundary must be recorded;
- A process of monitoring the blasting operations to qualify the expected ground vibration and air blast levels. This will also contribute to proper relationships with the neighbours.
- A further consideration of blasting times is when weather conditions could influence the effects yielded by blasting operations. Blasting should not occur:
  - too early in the morning when it is still cool or the possibility of inversion is present or too late in the afternoon in winter;
  - in fog or when there are low overcast clouds;
  - in the dark; and
  - when wind is blowing strongly in the direction of an outside receptor.
- It is recommended that a standard blasting time is fixed and blasting notice boards setup at various entrance routes informing the residents of blasting dates and times.
- Third party consultation and monitoring should be considered for all ground vibration and air blast monitoring work.

It was concluded that, should the specific mitigation measures be implemented the mine will operate in a safe and effective manner (**Table 53**).

Table 53 Assessment of Blast and Vibration Impacts with Mitigation (BMC, 2011)

Blasting Impact	Severity	Duration	Extent	Frequency	Probability	Overall Significance
Ground Vibration	Non-harmful	Life of the project	Beyond the project boundary	Daily	Unlikely	Low
Air Blast	Non-harmful	Life of the project	Beyond the project boundary	Daily	Unlikely	Low
Fly rock	Non-harmful	Life of the project	Beyond the project boundary	Daily	Unlikely	Low
Fumes	Non-harmful	Life of the project	Beyond the project boundary	Daily	Unlikely	Low

11.5 CONCLUSION

The evaluation of the impacts of blasting operations covered a wide variety of structures in the area, with a 3500m radius from the mining area. The structures observed ranged from typical rural type buildings to brick and mortar structures, cement brick structures, to industrial structures.

Results from the evaluation show that the predicted influence at the surrounding structures with regard to ground vibration will be significant up to distances of approximately 1028m from pit boundary. At distances of 571m from pit boundary levels are reaching point of excess of allowed limits. Levels may not always be damaging but the human perception is also considered. The main concerns with regards to ground vibration are the levels expected at the R33 on the eastern side and within the Zenzeleni community. There are also structures south west of the pit that may be influenced. These levels were calculated taking proposed blasting practices into account. The levels that will be experienced in the southwest portion of the site will be greater than the allowed limit for the type of structures and mitigation has been recommended to reduce charge mass per delay to ensure levels are lower than the limit. Ground vibration will have to be monitored and controlled with regards to this community. Exact locations for the three monitors have not been specified but it is recommended that one be placed at the Zenzeleni Community. Structural monitoring has also been recommended. Firstly structural inspections and second crack gauges for continuous check on cracks.

Fly rock could be experienced at a distance of 900m from the blasting face, as such it would be necessary to increase stemming length for the blast configuration. The main concern is for the houses in the south west of the mine area and the R33 provincial road. Mitigation measures such as ensuring:

- all blasting occurs at a minimum safe distance of 500m from communities;
- all person and animals within 500m from the blast are cleared; and
- roads are controlled and closed for period of blast if road is closer than the 500m from the blast.

If these measures are taken into account the predicted impact can be suitably mitigated and the impact significance will be low.

Cumulatively the impact of blasting would not be considered to be any worse. The main reason for this is that a blast lasts normally a few seconds and if there is no blast there is no ground vibration or air blast. The impact of blasting is related to the charge mass per delay and stemming lengths of the blast and not the number of the blasts. If there are a significant number of blasts which remain within the limits there will be no induced damage regardless of the number of events. Impact from a blast in the form of ground vibration and air blast does not always relate to damage of structures. The significance of the impact is therefore related to the intensity of impact experienced.

.

12 TRAFFIC ASSESSMENT

12.1 TERMS OF REFERENCE

WSP Civil and Structural Engineers (Pty) Ltd was appointed by WSP to undertake a Traffic Impact Assessment for the proposed new Eerstellingsfontein opencast coal mine (**Appendix J**). The purpose of the assessment was to evaluate existing traffic, analyse traffic operating conditions and comment on road improvements, safety and maintenance of roads in the vicinity of the mine.

12.2 METHODOLOGY

The Traffic Impact Assessment employed the following methodology:

12.2.1 Traffic Counts

Traffic data was obtained from manual and electronic traffic counts conducted at two intersections (Intersection 1 and 2), the truck entrance to Glisa mine and at two locations on P81-2 and P2-8 (**Figure 53**).

Figure 53 **Locality Plan showing main roads and intersections (WSP, 2011)**

12.2.2 Trip Generation, Distribution and Assignment

Trip generation rates were determined based on from information provided by the resident engineer at Glisa mine. Information was considered in terms of the different phases of the proposed development. A 3% annual growth rate for background traffic was applied.

12.2.3 Operational Assessment

Operating conditions for peak hours were assessed in terms of:

- Level of Service (LOS) – operating conditions are defined on a scale of A (best) to F (worst) (Appendix I);
- Volume to capacity ratios (v/c); and
- Average delay.

SIDRA Intersection Software (Version 4.0) was used to determine the impact of trips generated by the proposed Eerstelingsfontein mine during the morning (am) and afternoon (pm) peak. Intersection 1 and 2 were analysed in terms of the following scenarios:

- Scenario 1: Existing (2011), weekday am and pm peak hour
- Scenario 2: Horizon Year (2013), including generated trips.

In addition, the Glisa mine access and Eestelingsfontein mine access was assessed.

12.2.4 Road Safety Issues

The Traffic Impact Assessment (**Appendix J**) considered the following in terms of road safety:

- Should sight distance;
- Heavy vehicle turning movements;
- Dust; and
- Road surface conditions.

12.2.5 Road Pavement Management

Problem areas were identified and consideration given to current traffic loading and potential additional loading.

12.3 SUMMARY OF FINDINGS

12.3.1 Traffic Data

Traffic counts were undertaken at the following two locations (**Figure 53**):

- E-1: on the P2-8 between Glisa access and Intersection 1;
- E-2: on the P81-2 between Eerstelingsfontein and Intersection 2.

Data collected indicated that, in the vicinity of both mining sites, the current daily traffic volumes over are relatively low (**Table 54**).

Table 54 Seven-day Average Volumes (24 hours) (WSP, 2011)

Station	Vehicles Classification	Eastbound	Westbound	Both directions
E-1	Light	298	314	609
	Heavy	200	192	390
	All	497	506	1003
E-2	Light	199	322	521
	Heavy	261	152	414
	All	462	471	935

12.3.2 Trip Generation, Distribution and Assignment

12.3.2.1 Trip Generation

A summary of the anticipated trip generation for each of the mining phases is summarised as follows:

- Construction Phase

As no mining plant or permanent buildings will be constructed, the impact of the construction on the surrounding road network is considered to be negligible.

- Operating Phase (2 years)

Trip generation will be based on:

  - Daily transport of labour: considered to be negligible (as employees will be transported by bus/minibus); and
  - Transport of coal from the mine (**Table 55**).

Table 55 Generated Trips from Eerstelingsfontein (WSP, 2011)

Year	Produced Coal (tons)	Truck Loads[1]	Truck/day[2]	Trucks/hour[3]
2012	1 068 000	35 600	102	9
2013	1 058 000	35 267	101	8

1 Based on worst case scenario of 30t capacity trucks
2 Based on 350 days per year i.e. excluding public holidays only
3 Assuming that transportation will happen from 06:00 (am) to 18:00 (pm) i.e. 12 hours per day

The analysis is considered to be conservative. The cumulative traffic impact on the road pavement would be the same whether transportation occurs for 12 or 24 hours each day.

- Rehabilitation Phase

As the machinery and vehicles used will remain on site for the duration of the rehabilitation phase, the traffic impacts on the surrounding network are considered to be negligible.

12.3.2.2 Trip Distribution and Assignment

All new trips generated will use the R33 between the Eerstelingsfontein mine, via Intersection 2 and 1, to the truck entrance at Glisa mine (loaded), and back (unloaded) (**Figure 53**).

12.3.3 Operational Assessment

The SIDRA results (LOS and v/c ratio) indicated that the additional trips from Eerstelingsfontein and the 3 % growth in background traffic will not have a significant impact of the level of service of Intersection 1 and 2, and the Glisa mine access. Operating conditions at the intersections will be acceptable.

With respect to the Eerstelingsfontein mine access, SIDRA indicated that the intersection currently operates at a good level of service. The intersection is anticipated to continue to operate at acceptable levels during the mining activity.

12.3.4 Road Safety Issues

The Traffic Impact Assessment highlighted the following with regard to road safety:

- Should sight distance: anticipated to be approximately 375m which is acceptable.
- Heavy Vehicle Turning Movements: warning signs are present however additional signs are required at the required intersections.
- Dust: is not considered to be an issue if dust control measures are implemented.
- Road Surface Conditions: there is a section of road between Eerstelingsfontein and Intersection 2 which shows signs of failure, which is a road safety concern

12.3.5 Road Pavement Management

The additional loading calculated above is likely to accelerate the deterioration of the existing surfacing, causing more potholes and surface breakages.

12.3.6 Summary of impacts

The traffic impact assessment identified limited potential impacts on traffic and surrounding road networks during the mining operations. Minor impacts that were identified include an increase in trip generation rates and road safety.

- Trip generation rates: will increase annual traffic growth, but this is anticipated to be negligible (**Table 56**).

Table 56 Assessment of Increase in Trip Generation Rates

Impact	Severity	Duration	Extent	Frequency	Probability	Overall Significance
Without mitigation	Negligible	More than 1 year	Beyond project boundary	Daily	Definite	Low
No mitigation required						

- Road safety: dust needs to be managed and road surface conditions are currently of concern and are likely to further deteriorate with the predicted increase in traffic load (**Table 57**).

Table 57 Assessment of Road Safety Impacts

Impact	Severity	Duration	Extent	Frequency	Probability	Overall Significance
Without mitigation	Minor	Life of the project	Beyond project boundary	Daily	Definite	Medium
With mitigation	Negligible	Life of the project	Beyond project boundary	Weekly	Likely	Low

- Transportation at night: the transportation of coal will occur over a 24 hours period as such there are likely to be noise impact on sensitive areas along the transport routes (**Table 58**).

Table 58 Assessment of Transportation at Night

Impact	Severity	Duration	Extent	Frequency	Probability	Overall Significance
Without mitigation	Minor	Life of the project	Beyond project boundary	Weekly	Unlikely	Negligible
No Mitigation Required						

12.3.7 Recommendations/Mitigation measures

- According to the Manual for Traffic Impact Studies, it is proposed that a developer mitigate the traffic impact of the proposed development if the LOS drops below and D and the V/C ratio increases above 0.95.
- Road safety:
  - Dust mitigation (i.e. wetting of road and site surface) needs to be implemented to reduce the potential for this to affect driving visibility
  - It is recommended that replacing the existing road surface at the identified problem areas will reduce further deterioration. As a minimum requirement, to ensure no significant deterioration, a surface treatment should be applied.
  - A Road Maintenance Management Plan to facilitate on-going management and maintenance is also recommended.
  - Heavy vehicle warning signs on the approaches to the new mine access are required.

12.4 CONCLUSION

Taking into account the above analysis, it is clear that the proposed mine will have no discernible impacts on the peak hour traffic operating conditions in the vicinity of the new or existing mine or along the transportation route (R33). The effects of coal dust on visibility and replacement or treatment of the road surface are the main issues identified, and needing mitigation measures, in the traffic impact assessment.

13 AGRICULTURAL LAND USE ASSESSMENT

13.2 TERMS OF REFERENCE

The objective of the study was to review the Agricultural Land Use Capability of the Eerstelingsfontein site to address concerns associated with the change of land use from the present predominantly agricultural use to mining and then back to agricultural use in a post mining land use scenario.

Soils mapping was originally undertaken by Ken Smith Environmental Services in 2004 as part of the EMPR studies for the site and later updated and revised by Viljoen and Associates in 2011.

13.3 DESCRIPTION OF THE STUDY AREA

The site of the proposed Eerstelingsfontein Mine is situated 20km southwest of Belfast within the Emakhazeni Local Municipality. The general area is characterised by its agricultural and coal mining activities. The Emahkhazeni area experiences cold winters which coupled with its high altitude (1100m – 2200m) make it suitable for a variety of agricultural activities which include crops such as maize, soya beans, wheat, sunflowers and sorghum but also include more niche market horticultural crops such as cherries. Livestock farming including beef, dairy and sheep are also common in the area.

13.4 LAND CAPABILITY

Land capability is defined by Schoeman *et al*. (2002) as *'the extent to which land can meet the needs of one or more uses under defined conditions of management'*. The Agricultural Research Council (ARC) have defined eight different land capability classes based on simple physical and chemical soil characteristics, terrain and climatic criteria (Table 59). Land capability classes 1 to 4 are considered to be suitable for cultivation.

Table 59 Land capability criteria

Criterion	Indicator/measure
Terrain	Flood hazard. erosion hazard
Soils	Depth, texture, erodibility, internal drainage, mechanical limitations, acidity
Climate	Moisture availability, length of moisture season, length of temperature season, frost hazard, hail

Source: Schoeman *et al*, 2002

The proposed mining area at Eerstelingfontein has been subject to a number of soil mapping exercises. The results of the most recent survey completed by Viljoen and Associates in 2011 are indicated below.

The site is dominated by five major mappable soil types with some minor sub-units. The general soil properties and suitability for agricultural land use post mining are summarised in Table 60 and Figure 54, overleaf.

Table 60 Soil units present on the Eerstelingfontein site and their associated land capability

Soil Unit	Area	Erodibility (slopes <3%)	Internal Drainage	Natural Fertility	Suitability for rehabilitation post-mining
Avalon (Av)	205 ha	Low	good	Low to moderate	high
Glencoe (Gc)	26 ha	Low	good	Low to moderate	high
Dresden (Dr)	29 ha	Low	good	Low	moderate
Constantia (Ct)	26 ha	Low	imperfect	Low to moderate	moderate
Pans and wetlands	19 ha	Na	poor	na	Very low

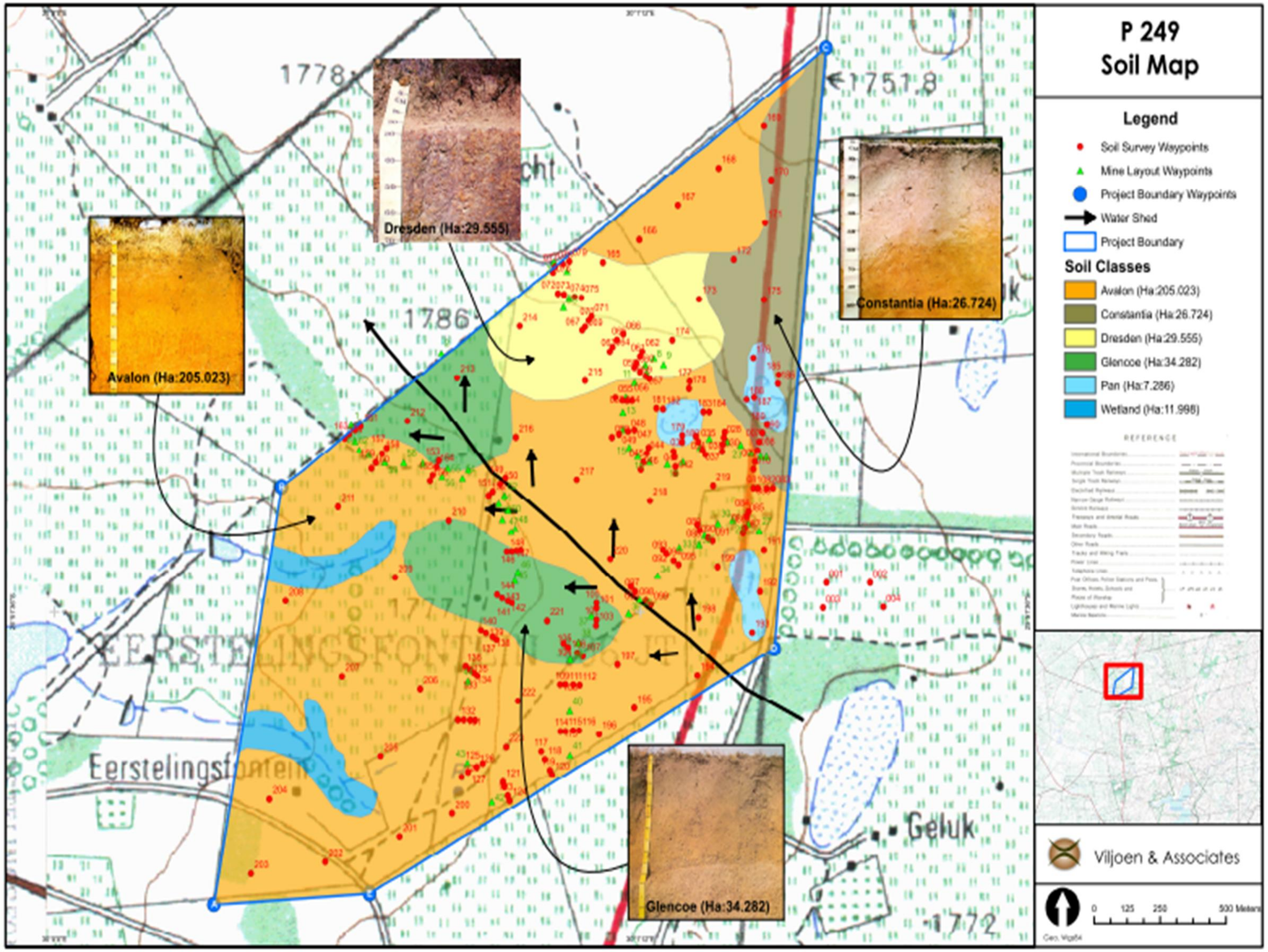


Figure 54 Soil Map of the property (produced by Viljoen and Associates, 2011)

The Avalon and Glencoe soil units make up a total area of approximately 230ha and are considered to be suitable for use as arable land or grazing. In terms of generic agricultural land classes much of the land is classified as Class 2. This means that the land is generally suitable for cultivated crops but with some limitations on the choice of crops and the land management and conservation measures required for sustainable agricultural use (ie a lower class than Class 1 Agricultural Land). Class 2 land is considered to have a high agricultural potential capable of consistently producing acceptable expenditure of energy and economic resources and minimal damage to the environment. If a land portion is, however, of high agricultural potential legislation provides for the protection of such areas. Some limitations to the site are seen as susceptibility to wind and water erosion, less ideal soil depth, occasional damage from flooding with wetness present that is correctable by drainage but exists as a permanent moderate limitation.

13.5 SOIL CHEMISTRY

The soils are slightly acidic with pH between 4.9 and 6, with a moderate cation exchange capacity and a fairly stable clay mineralogy. The natural fertility is low to moderate in terms of nutrients with relatively low calcium, potassium and magnesium. In order to achieve high crop yields addition of nutrient and trace element fertilisers would have to be considered.

The simple Agricultural Land Use assessments of land class differ substantially from the ecological studies undertaken on the site which tend to emphasise the wetland habitats on the site. According to the specialist studies undertaken by Natural Scientific Services in 2011 and others the total area of wetland and associated conservation buffer areas is approximately 32% of the total area of the site. In comparison the total area of pans indicating permanently saturated ground unsuitable for agricultural use is only 3% and their closely associated seasonal wetland areas are approximately 19% of the site area. There is thus considerable overlap of potentially useful agricultural land with areas which are considered to have a high ecological sensitivity as wetland and wetland buffer zones. The impacts of livestock grazing on the wetland areas are noted in the ecological baseline reporting, and recommendations are made that would restrict access of livestock to the more sensitive wetland areas.

At first glance the large discrepancy in the land classification using contrasting methodologies would appear to be inconsistent. However in recent years there has been no cropping on the site only grazing of livestock, mainly horses. The recent history of low intensity agricultural usage reflects the status of the land as having been sold for the intention of mining. In addition rainfall figures from the last ten years indicate that the site has become progressively wetter due to the effects of climate change. A re-establishment of natural vegetation and an increase in seasonal wetland areas may have improved the ecological status of the site and although its agricultural value remains similar it may require drainage measures in the lower lying parts of the site to enable the cultivation of certain crops sensitive to waterlogging.

13.6 PRESENT LAND USE

According to information supplied by the owner of the adjoining farm, Part 1 of Eerstelingsfontein 406 JT (and the former owner of the site), the land provides grazing and watering for 300 cattle and 200 horses during winter months. The high stocking rate is favoured by the wet conditions in the lower lying sections of the site. From observations the grazing of horses was frequently observed and the use by cattle less obviously. The horses are mainly produced for endurance riding and have a high value. The Arab horse stud business is one of the largest in South Africa and has won a number of awards. The present agricultural land use thus has an economic value not normally associated with similar farming land in the area and is considered to reflect a transient use because of the intention to mine the area. Although there are economic advantages in the raising of high value horses the land is not fully utilised at present in the production of food. There are farm labourers and their families that have some dependency on the land for grazing a herd of approximately 47 cattle. Neighbouring farms are producing extensive areas of maize, soybeans and seed potatoes. The area being used for grazing by the farm labourers cattle is outside the proposed mine footprint.

13.7 POST-MINING LAND USE

Given the agricultural capability of the land and its ecological status the future re-use of the land in a post mining scenario needs to be evaluated. Mines have traditionally had little success in returning prime agricultural land to its former mining productivity. This is largely due to destruction of topsoil which performs poorly once stripped and stockpiled with disruption of soil properties such as porosity, moisture retention and pH which may impact soil erodibility and reduce fertility. Land degradation due to poorly controlled rehabilitation measures is likely to reduce crop yields and increase the risk of crop failure. Soil improvement may be necessary to provide a viable agricultural potential and it may restrict the types of crop that may be grown, i.e. crops with a greater salt tolerance such as wheat may give better yields than maize.

It is understood that the original owner has the option to buy-back the land after the mined area has been rehabilitated and thus the most likely post mining land use scenario is likely to see a return to livestock grazing.

It is anticipated that rehabilitated grassland on the rehabilitated area will be able to support a livestock enterprise and the area can be returned to some form of agricultural production.

13.8 POTENTIAL IMPACTS

The overall assessment of agricultural land use impacts associated with the proposed Eerstelingsfontein mine is present in **Table 61** below. Refer to the Appendix for more detail.

Table 61 Overall impacts on land use

Impact	Severity	Duration	Extent	Frequency	Probability	Overall Significance
Crop Production post mining	Moderate	Permanent	Immediate Area	Daily	Definite	**High**
With mitigation	Minor	Permanent	Immediate Area	Daily	Unlikely	Medium
Grazing post mining	Minor	Reversible over time	Immediate Area	Daily	Definite	Medium
With mitigation	Negligible	Reversible over time	Immediate Area	Daily	Likely	Low

The affected land is currently being used as grazing for horses which does not represent the best and highest productive use of this Class 2 land from an agricultural perspective. In order to support crops currently the site would require intervention. Due to the sites current wet status it will require management from a water logging point of view and the soils would need enrichment in the form of fertilisers. As such, the impact on crop production post mining has been considered moderate. The overall significance is considered high since, once mining has ceased and the water table has returned to is former state, approximately 4 to 5 years post mining, the site is unlikely to be returnable to crop production without significant cost or limitations to the farming activities such as the implementation of variable rotational farming techniques.

The significance of the overall direct impact of the mining on the grazing use of the site post mining is considered to be medium without mitigation, largely due to the short duration of the mining and rehabilitation period. It is anticipated that rehabilitated grassland on the rehabilitated area will be able to support a livestock enterprise and the area can be returned to some form of agricultural production.

13.9 RECOMMENDATIONS AND MITIGATION MEASURES

Disturbance of the soil profile and loss of seasonal ponds may reduce the grazing carrying capacity, this can be mitigated by careful attention to:

- *The mine rehabilitation measures by applying progressive rehabilitation measures*: The continuous roll over method allows the mined areas to begin early rehabilitation and reinstatement of grazing potential making the earlier sections of the mining area available as grazing land following two wet seasons post mining.
- *The mine engaging in field trials with preferred vegetation types*: Investigate value of planting of the rehabilitated area using hardy shrubby legumes such as *Lespedeza*. This could potentially improve the grazing capacity of the mined area, however this initiative should be aligned with objectives set out for the site within the biodiversity action plan.

- *The mine should limit the footprint of the mine*: Keep total area of site to be affected by the mining operations to a minimum, it is possible that should mining not directly impact on certain arable portions of Eerstelingsfontain, these portions could return to pre-mining levels of productivity.

13.10 CONCLUSION

It is anticipated that rehabilitated grassland on the affected area will be able to support livestock enterprises and the area will be able to return to some form of agricultural production. The grazing carrying capacity is, however, likely to be affected as the growth of grasslands is likely to decline due to disturbance of the soil profile and water table as a result of the proposed mining activities.

14 SUMMARY ASSESSMENT AND DISCUSSION

14.1 IMPACT ASSESSMENT MATRICES

14.1.2 Impacts of the proposed Eerstelingsfontein Mine

The impact assessments undertaken for each specialist aspect (with respect to significant without and with mitigation) have been consolidated into a summary table below in order to allow consideration of the cumulative impacts associated with the proposed project (**Table 62**)

Table 62 Consolidated Impact Assessment for the proposed Eerstelingsfontein Mine

Aspect	Potential Impact	Phase	Significance without mitigation	Significance with mitigation
Terrestrial and Aquatic Ecology	**Habitat Loss and Fragmentation:**			
	Loss of vegetation communities: Moist Grassland (Koeleria capensis - *Centella asiatica*)		High	Low
	Loss of vegetation communities: Pasture Grassland (*Eragrostis plana – Crepsis*)		Medium - High	Medium – **High**
	Loss of vegetation: Moist Pasture Grassland (*Eragrostis plana – Lobelia flaccida*)		Medium - High	Medium
	Loss of vegetation: Open Grassland (*Themeda triandra – Chironia palustris*)		High	Medium
	Loss of vegetation: Wetland (*Leersia hexandra – Juncus oxycarpus*)		Medium	Medium – Low
	Loss of vegetation: Moist Grassland (*Agrostis lachnantha – Andropogon eucomus*)		Medium	Medium – Low
	Loss of vegetation: Rocky Outcrops (*Diospyros lycoides – tristachya leucothrix*)		Medium	Medium – Low
	Removal of the declining TSP listed species		High	Medium
	Destruction of other CI plant species on site		Medium - High	Medium – Low
	Loss of hillslope seeps and the EcoServices provided		High	**High**
	Loss of wetland buffer zones		High	**High**
	Destruction of terrestrial faunal habitat		Medium - High	Medium
	Loss or displacement of faunal CI species		High	Medium - **High**
	Habitat Disturbance			
	Change in vegetation structure within surrounding units		Medium - High	Medium
	Introduction and spread of alien species		High	Medium
	Disturbance of wetlands and a reduction in		High	Medium –

	EcoServices provided			**High**
	Reduction in surrounding plant growth through excessive dust creation		Medium – High	Medium – Low
	Displacement of CI faunal species		High	**High**
	Displacement of faunal species		Medium	Medium
	Changes in aquatic biota community structure due to stream flow modifications		High	**High**
	Changes in aquatic biota community structure due to water quality deterioration		High	**High**
	Increase in Anthropogenic Activity:			
	Increase in surrounding fire frequencies		Medium	Low
	Removal of CI plant species for cultural use		Medium	Medium – Low
	Hunting or poaching of fauna		Medium	Medium – Low
Surface Water	Increase in flow within the Blesbokspruit Tributary 1 during the final phase of operations	Operational phase	Medium	Medium
	Decrease in flow in the Blesbokspruit Tributary 1 during the final phase of operations	Post closure (rehabilitation)	Medium	Medium
	Increase and decrease in flow within the Blesbokspruit Tributary 2	Operational phase	Medium	Medium
	Increase in flow within the Blesbokspruit Tributary 2	Post closure (rehabilitation)	High	Medium
	Increase and decrease in flow on the Witkloofspruit Tributary	Operational phase	Low	Low
	Increase in flow on the Witkloofspruit Triburary	Post closure (rehabilitation)	High	Medium
	Decrease in flow on the Klein Komati Catchment	Operational phase	Medium	Medium
	Increase in flow on the Klein Komati Catchment	Post closure (rehabilitation)	Moderate	Medium
Groundwater	Change in groundwater levels due to dewatering	Construction Phase	Low	Low
	Impact of change in groundwater quality due to mining	Construction Phase	Medium	Low
	Increase in seepage from wetlands into the groundwater system	Construction Phase	Low	Low
	Change in groundwater levels due to dewatering	Operational Phase	Medium	Low
	Impact of change in groundwater quality due to mining	Operational Phase	Medium	Medium

	Increase in seepage from wetlands into the groundwater system	Operational Phase	Medium	Medium
	Impact of flooding and possible decanting of mine	Post Closure	Medium	Low
	Impact of mine polluting groundwater and surface water	Post Closure	Low	Low
Air Quality	Particulate Matter (PM_{10})	Operational phase	Medium	Medium
	Dust fallout	Operational phase	Medium	Medium
Noise	Construction phase noise impacts	Construction phase	Low	Low
	Operational daytime noise impacts	Operational phase	Medium	Medium
	Operational night-time noise impacts	Operational phase	Low	Low
Heritage	Site 1: Graveyard	Operational phase and post closure	Low	Low (+)
	Site 2: Farmstead	Operational phase and post closure	Low	Low
Visual	Visual impact of construction activities on viewers	Construction phase	Medium	Low
	Visual landscape impacts	Construction and operational phase	Medium	Low
	Visual impact of operational activities on viewers	Operational Phase	Medium - High	Medium
	Visual impact of night-lighting on viewers	Operational Phase	Medium	Medium - Low
	Visual impact of dust and increased traffic on viewers	Operational Phase	Medium	Medium - Low
Social and Socio-Economic	Decrease in water quantity and associated impacts on neighbouring farmers and community	Operational phase	Low-Medium	Low
	Increase in water quantity (decant) during rehabilitation phase, and associated impacts on surrounding properties and residents	Post closure	Low-medium	Low
	Water quality impacts on neighbouring farmers and community	Operational phase and post closure	Low-Medium	Low
	Acid mine drainage and associated impacts of	Operational phase and	Medium	Low

	water quality for a social perspective	post closure		
	Impact of reduced groundwater supply on social environment	Operational phase	Medium	Low
	Noise (nuisance and damage to structures)	Operational phase	Medium	Medium
	Social implications of reduced agricultural productivity as a result of dust	Operational phase	Medium	Low
	Dust related nuisance and health impacts	Operational phase	High	Medium
	Change in landscape and sense of place	Operational phase	High	Medium
	Loss of scenic views and associated impacts on tourism	Operational phase	High	Medium
	Property devaluation	Construction & operational phase	Medium	Low
	Damage to structures (as a result of blast and vibration)	Operational phase	High	Medium
	Borehole collapse (as a result of blast and vibration) and associated social implications	Operational phase	High	Low
	Employment opportunities	Operational phase	Low	Medium (+)
	Impact on cultural heritage resources	Construction & operational phase	Low	Low (+)
	Distrust of mining companies	Construction & operational phase	High	Medium
Blast and Vibration	Ground vibration	Operational Phase	Medium	Low
	Air blast	Operational Phase	Medium	Low
	Fly rock	Operational Phase	Medium	Low
	Fumes	Operational Phase	Medium	Low
Traffic	Increase in trip generation rates	Operational Phase	Low	-
	Road safety	Operational Phase	Medium	Low
	Transportation at night	Operational phase	Negligible	-

Agricultural Land Use	Crop Production Post Mining	Post closure	**High**	Medium
	Grazing Post Mining	Post closure	Medium	Low

14.1.3 Impacts of the No Development option

With the exception of the socio-economic environment, the status quo would remain unchanged with respect to the implications of the project not going ahead. The socio-economic impacts of the no development option are summarised below (**Table 63**).

Table 63 Consolidated Impact Assessment for the No development option

Aspect	Potential Impact	Significance
Socio-Economic impacts	Loss of employment: due to close of NBC operations	**High**
	Social upliftment: loss of contribution to community projects (though social and labour plan for Eerstelingsfontein and Glisa)	**High**
	Exxaro financial implications: loss of income and business opportunities	**High**
	National income loss: loss of state tax and royalties income	Low

14.2 DISCUSSION

The majority of the impacts of the proposed project can be mitigated to an acceptable level i.e. low to medium significance.

Those impacts which have been assigned a significance of HIGH are the impacts which cannot be mitigated to an acceptable level and the implications of these impacts need to be considered in the decision making process. The high significance impacts associated with the proposed project and no development alternative are summarised below (**Figure 55**). Essentially the key consideration associated with this project comes down to the challenge of balancing ecological and social impacts.

Significant impacts of the Eerstelingsfontein Mine

Biodiversity Impacts

Habitat loss and fragmentation:
- Loss of pasture grassland
- Loss of hillslope seeps and the EcoServices provided
- Loss of wetland buffer zones
- Loss or displacement of faunal CI species

Habitat Disturbance
- Disturbance of wetlands and reduction in EcoServices provided
- Displacement of CI faunal species
- Change in aquatic biota community structure due to water quality deterioration and stream flow modification

VS

Significant impacts of the no development option

Social Impacts

- Loss of employment due to closure of NBC operations
- Loss of social upliftment contributions
- Loss of income and business opportunities for Exxaro.
- Loss of crop production capability of the land post mining

Figure 55 Summary of Impacts of Significance

14.2.2 Synopsis of Biodiversity Standpoint

The NSS (2012) impact assessment identified a number of high and medium-high impacts, many of which cannot be mitigated due to the nature of the project and the type of impact. The potential impacts received a high significance due to footprint which will be covered by the opencast mining operations (i.e. the current mine layout plan). Impact of high ecological significance are those which cannot be mitigated and are those impacts that generally relate to when a natural habitat or species will be permanently lost or destroyed as a result of the proposed development. When considering the ecological impacts of the proposed Eerstelingsfontein mine alone it would appear that these impacts would make the proposed mine layout unacceptable from a biodiversity standpoint. However, the biodiversity impacts need to be contextualised in a broader regional setting and cumulative impacts of the project need to be considered holistically (**Section 13.2.2**). In addition careful consideration needs to be given to the impacts of the project not going ahead (**Section 13.2.3**).

13.2.3.1 Summation of ecological protection guidelines (buffers)

The designation of FEPAs across South Africa is aimed at protecting and conserving wetland, pan or river systems in terms of water quality and biodiversity aspects. FEPA maps themselves have no formal legal status. The primary means of giving effect to FEPA maps is through the classification of water resources in terms of the National Water Act. Other legal processes that should be informed by FEPA maps include publication of bioregional plans and listing of threatened ecosystems in terms of the Biodiversity Act, declaration of protected areas in terms of the Protected Areas Act, environmental impact assessments in terms of the NEMA, and development of Spatial Development Frameworks in terms of the Municipal Systems Act.

The mandate for managing and conserving freshwater ecosystems is shared between the DWA and the Department of Environmental Affairs (DEA). Therefore the conservation of inland water resources and freshwater biodiversity can only be realised effectively through proper interfacing of strategic objectives between these two departments.

In general, confidence in the FEPA maps at a national level is high but decreases at more local levels of planning. Given the relatively new status of the FEPA maps, with the 'Implementation Manual for Freshwater Ecosystem Priority Areas' only being published in August 2011 these maps have not yet influenced local level planning. Therefore, for the purposes of the Eerstelingsfontein project the application of the FEPA maps is at the local level through the EIA. The guidance given in Section 5.4.1 of the 'Implementation Manual for Freshwater Ecosystem Priority Areas' indicates that FEPA maps should ideally be ground-truthed by someone with aquatic ecological knowledge of the area concerned to refine the maps with additional local data and knowledge. This was undertaken by NSS in November 2010 and March 2011.

With specific reference to Eerstelingsfontein, the proposed mining area overlaps a nationally defined FEPA 'wetland cluster'. The pan systems, on the eastern boundary of the site, are defined as 'wetland clusters' in terms of the National Freshwater Ecosystem Priority Areas (NFEPA). The wetland features included in this designation are, specifically, wetland F, G and H with 50% of wetland feature D overlapping the FEPA wetland cluster according to the map. All of these wetlands, with the exception of D, have been defined as having a Present Ecological Status of B (Largely Natural) (NSS, 2012).

The implementation manual states that, '*any activity that will have an overall residual impact on wetland or river FEPAs and their immediate surrounds greater than a low negative significance, is not acceptable from the point of view of managing and conserving freshwater ecosystems, and must be avoided*.' However, it does go on to state that, *'unavoidable development requires special mitigation measures that would reduce the overall impact of the activity or development to low negative significance, or must require a biodiversity offset. Wetland FEPAs that are in a good condition (equivalent to an A or B ecological category) should remain so. Wetlands FEPAs that are not in a good condition should be rehabilitated to their best attainable ecological condition.*' (Driver et al, 2011).

The manual also indicates that a generic 100m buffer should be established around river and wetland FEPAs. This 100m buffer is considered adequate from a water quality perspective in providing functional filtering capacity to the river or wetland (Driver et al, 2011). However, additional biodiversity information should be taken into consideration to ensure that the buffer adequately addresses risks to the receiving environment, as a 100m is not necessarily sufficient (Driver et al, 2011).

The NSS assessment identified the presence of the two Red Data birds, namely, the Grey-crowned Crane and Southern Bald-ibis and has suggested a 200m buffer be applied to wetland areas on the site for the protection of the Grey-crowned Crane. On this basis it is recommended that a 200m buffer be applied to the wetlands located within the FEPA (wetlands F, G and H) as well as those wetlands on the site that are considered to be of a similar ecological status, namely wetlands A and B. However, since wetland C has been defined as having a Present Ecological Status of C (Moderately Modified) and is not located within the FEPA, it is suggested that the buffer at this location be maintained at 100m as per the recommendation of the WUL and the FEPA implementation manual.

The designation of a FEPA does not prohibit development per se, however it is necessary to ensure suitable and realistic mitigation measures are developed, a rehabilitation plan is collated and a monitoring programme is designed that aims to track the impacts associated with the development and how these affect the condition of the FEPAs.

Furthermore, the designation of a FEPA is significant when considering the granting of a Water Use License (WUL). The current Water Use License (WUL) for the Eerstelingsfontein site will need to be considered with respect to the FEPA status of a number of the wetlands on the site. A water use license should give effect to protecting FEPAs.

14.2.3 Contextualisation of Biodiversity Impacts

NSS have highlighted the site specific biodiversity impacts that would occur should the mine proceed. It is necessary to take a pragmatic approach and contextualise these local impacts in terms of the overall regional biodiversity impact. Key considerations are:

- Size of the site: 314ha – whilst a number of the biodiversity impacts are rated as highly significant, the ecological losses need to be considered in terms of the regional biodiversity and water catchment area context. The site is relatively small and the loss of ecological function will not greatly impact on surrounding areas.
- Lifespan of the proposed mining operation: 2 years – which represents a short term operational phase, however a longer term rehabilitation phase will follow.
- Current land use of the site – largely disturbed by agricultural activity and thus the conservation status quo is not guaranteed by the no-mining operation unless management intervention is applied.

14.2.4 Synopsis of Socio-Economic Standpoint

Exxaro NBC faces substantial penalties in the event of under supply of coal product to Eskom. If Exxaro are unable to meet their contractual obligations to Eskom, the penalties which under supply would carry will render the NBC unprofitable and result in the closure of this operation. The closure of the NBC operation will have significant financial implications of Exxaro and this will result in significant socio-economic impacts (employment and social upliftment losses).

The consequence of mining on the agricultural value of the land will be a function of the rehabilitation measures applied. The ability of the rehabilitated land to support high productivity of food crops is limited and thus productive agricultural land will be lost. However, the rehabilitation of the site to the current land use as pasture is more achievable and thus future use as grazing for high value livestock is a viable option and thus the economic impacts of reduced agricultural potential ae of local and limited scale. There is evidence on the site of historical contour ploughing and past tillage which indicates that the site has been used for crop production in the past and is likely to have already significantly limited the potential of the site to sustain future crop production.

The current Arab horse stud business utilising the site represents an economic value not normally associated with similar farming land in the area and is considered to reflect a transient use because of the intention to mine the area. Although there are economic advantages in the raising of high value horses the land is not fully utilised at present in the production of food. There are farm labourers and their families that have some dependency on the land for grazing a herd of approximately 47 cattle. The agricultural land use assessment has concluded that the site can be successfully rehabilitated to grassland and will support livestock enterprises. The grazing carrying capacity is, however, likely to be affected as the growth of grasslands is likely to decline due to disturbance of the soil profile and water table as a result of the proposed mining activities.

14.2.5 Contextualisation of Socio-Economic Impacts

The socio-economic impacts will be experienced a local and regional level. Employment losses will have cumulative impacts on families and households which rely on income from those employed. Social upliftment projects provide local employment and improve the livelihoods and services provided to communities in the local area. The current climate of economic recession, both worldwide and in South Africa, emphasises the need to secure economic growth and associated job security where possible.

There will be no impact on the farm labourers cattle grazing usage on the site. The horses currently using the site will need to be relocated to alternative pastures to facilitate the proposed mining activity. However, it is understood that the original owner of the Eerstelingsfontein site is the owner of the stud business and does have the option to buy-back the land after the mined area has been rehabilitated. As such the impact of the loss of this grazing land has already been compensated through the land sale agreement.

14.3 CONCLUSION AND OVERALL PROJECT RECOMMENDATION

Exxaro's challenge is to secure a short term supply of good quality coal to blend with the coal remaining within the Glisa reserve. The need for supplementary source of good quality coal is a short term requirement (2 years), until such time as the Belfast Block (a significant coal resource with an expected mine lifespan of 20 years) becomes operational in 2015.

The mining of the Eerstelingsfontein site will ensure continued supply of coal from Exxaro's Glisa operations to Eskom. The Eerstelingsfontein Mine will ensure continued job security for the current labour force at Glisa Colliery and sustaining the local economic growth generated from Exxaro's mining operations, until such time as the Belfast Block project is implemented.

The decision as to whether the proposed Eerstelingsfontein opencast mining project should be authorised hinges on the obtaining the rational balance between ecological preservation and protection of socio-economic livelihoods. The site specific ecological losses are significant however the social losses will have a significant impact on both a local and regional scale.

In addition, it should be noted that the ecological assessment has already highlighted that the current grazing use of the site is having negative impacts on the ecological value of the wetlands present on the site. Should the proposed mining activity not take place the site would probably continue to operate as grazing pasture. As such, the ecological value of the wetlands will continue to be impacted upon and is inconsistent with the recommendation of the biodiversity plan for the site.

Should the project be authorised, WSP's overall recommendation for the protection of wetlands (and associated ecological integrity) present on site, in relation to the areas identified as being of conservation significance (**Figure 56**) is that a 100m buffer be applied to the protection of wetland areas as per the WULA requirements.

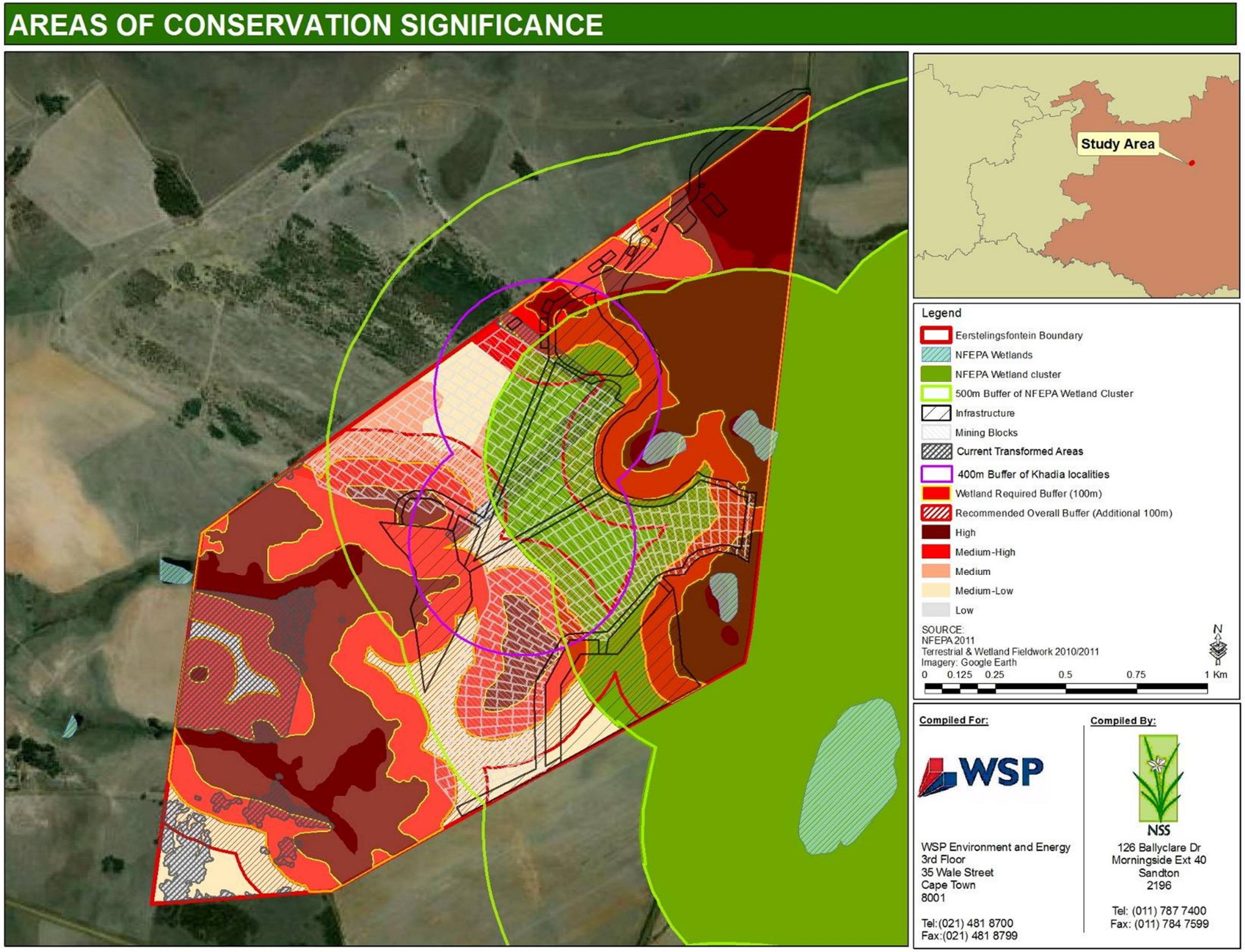


Figure 56 **Areas of conservation significance within the proposed Eerstelingsfontein mine site (NSS, 2012)**

15 REFERENCES

- Approved reserve and recommended conditions for the protection of the Klein Komati River and the Eerstelingsfontein wetlands in the quaternary catchment X11D to support the evaluation of the Water License application by Exxaro Coal, Department of Water Affairs, Chief Director Resource Directed Measures, 2009.
- Biodiversity Baseline Impact Assessment – Eerstelingsfontein Mine, Section F: Biodiversity, Natural Scientific Services, 2011.
- Eerstelingsfontein Specialist Soil Wetland Assessment, Report 249, Viljoen and Associates, 2011.
- Eertelingsfontein Colliery: Groundwater Specialist Study, Institute for Groundwater Studies (IGS), University of the Free State, 2011.
- Eerstelingsfontein – Peer Review of Specialist Reports in order to determine the accuracy of the wetland delineation and description, Digby Wells Environmental, 2011
- Environmental Management Programme Report (EMPR) for the proposed Eerstelingsfontein Opencast, a Section of Glisa Colliery, Belfast Magisterial District, Eastern Mpumalanga, Ken Smith Environmental Services, March 2004.
- Eyesizwe Coal (Pty) Ltd Glisa Colliery: Eerstelingsfontein Section Wetland Delineation. Report EYC 190. 2004.
- Exxaro Coal (Eerstelingsfontein) Integrated Water Use License Application Technical Report S0226/01, (Synergists Environmental Services).December 2008.
- Ground Water Consulting Services cc (2004) Environmental Management Programme Report (EMPR) for the proposed Eerstelingsfontein Opencast, a Section of the Glisa Colliery, Belfast Magisterial District, Eastern Mpumalanga.
- Institute of Natural Resources and Associates (INR). 2010. *WRC Wetland Buffers – Draft Guideline*, March 2010
- Integrated Water Balance Report for the proposed Eerstelingsfontein Mine Exxaro Resources Limited, 2009.
- Rehab Green (2007) Soil Assessment and wetland delineation of two pans, situated on the Farm Eerstelingsfontein 406JT. Report RG2007/07/31/2, 2007.
- Schoeman JL, van der Walt M, Monnik KA, Thackrah A, Malherbe J & Le Roux RE (2002). Development and Application of a Land Capability Classification System for South Africa. GW/A/2000/57.ARC-Institute for Soil, Climate and Water, Pretoria
- Watercourse attributes assessment on the farm Eerstelingsfontein Mpumalanga Report Number 12406-9103 -1 (Golder Associates).September 2009.
- Wetland Assessment, Natural Scientific Services, 2011.
- .

Appendix A Terrestrial and Aquatic Ecological Assessment

Natural Scientific Services cc (2012) Baseline Biodiversity Assessment, Eerstelingsfontein Opencast Project

Appendix B Surface Water Assessment

WSP (2011) Surface Water Assessment: Eerstelingsfontein Mine

Appendix C Groundwater Assessment

Institute of Groundwater Studies (2011) Groundwater Specialist Study: Eerstelingsfontein Colliery

Appendix D Air Quality Impact Assessment

WSP (2011) Air Quality Impact Assessment: Exxaro Coal Eerstelingsfontein

Appendix E Noise Impact Assessment

WSP (2011) Environmental Noise Impact Assessment: Exxaro Eerstelingfontein

Appendix F Heritage Impact Assessment

Archaetnos Culture & Cultural Resource Consultants (2011) Report on the Heritage Impact Assessment for the proposed development at the Exxaro Eerstelingsfontein NDC Coal Mine, near Belfast in Mpumalanga

Appendix G Visual Impact Assessment

B Gebhardt (2011) Visual Impact Assessment for the Exxaro Eerstelingsfontein Coal Mine, Nkangala Magisterial District, Eastern Mpumalanga.

Appendix H Social Impact Assessment

WSP (2011) Social Impact Assessment: Eerstelingsfontein Coal Mine, Emakhazeni

Appendix I Blast and Vibration Assessment

Blast Management & Consulting (2011) Ground Vibration and Air Blast Study, Exxaro Eerstelingsfontein Mine.

Appendix J Traffic Impact Assessment

WSP Traffic Engineering Services (2011) Traffic Impact Assessment for the proposed new Eerstelingsfontein Opencast Coal Mine in Belfast, Mpumalanga.