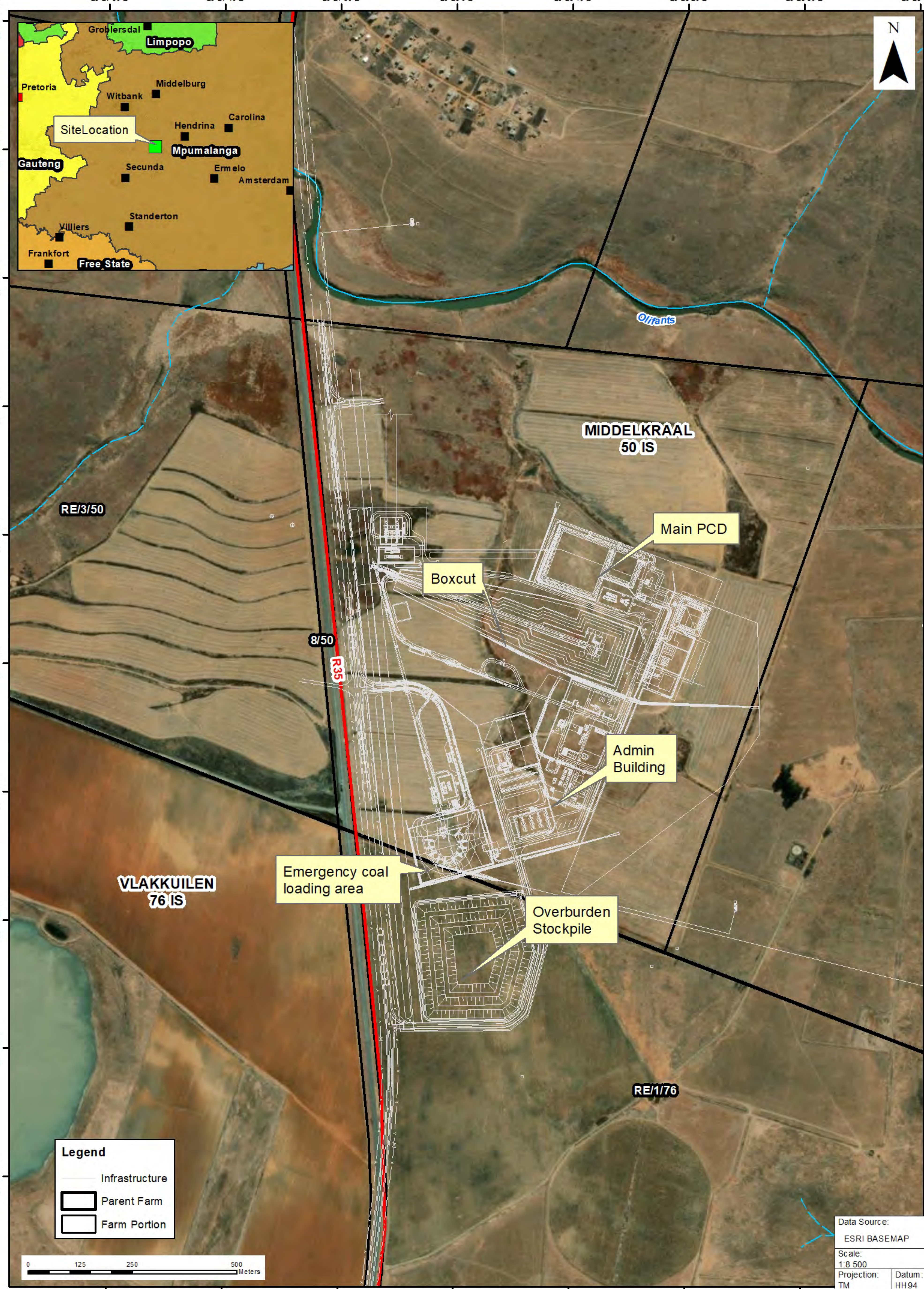
Appendices

Appendix A: Locality map



Data Source: ESRI BASEMAP	
Scale: 1:8 500	
Projection: TM	Datum: HH94
Central Meridian/Zone: LO 29	
Date: 06/04/2021	Compiled by: SCHB
Project No. 570283	Figure

srk consulting

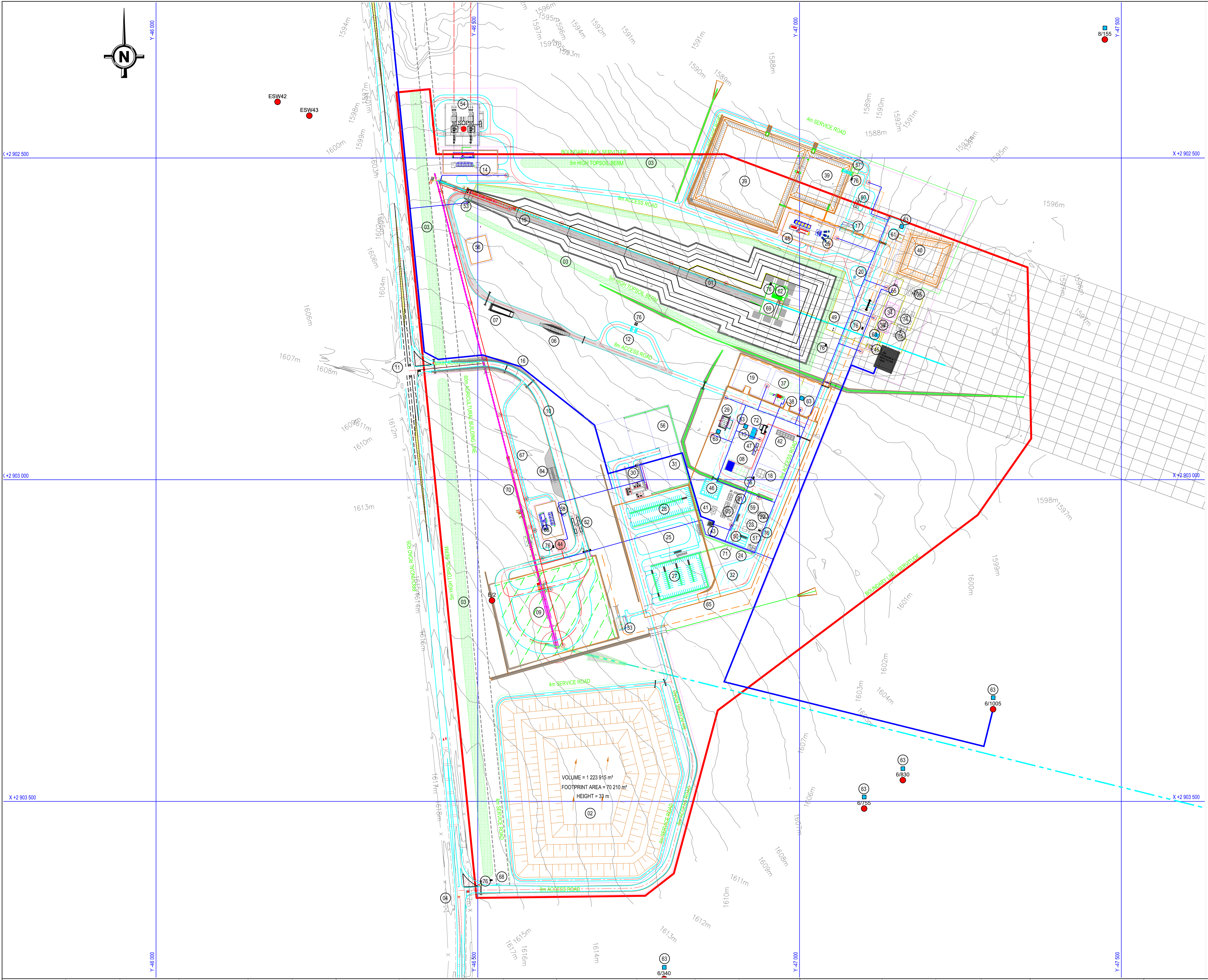
ELDERS COLLIERY
LOCALITY MAP

Path: J:\Proj\570283_Elders_EIA_WULA\8GIS\GISPROJ\MXD\570283_A3P_Elders_Block Plan_Locality Map_20210504.mxd

Revision: A Date: 03 2021

Appendix B: Proposed Elders Colliery Drawing

DRAWING No. 0295–0815–CED–0028

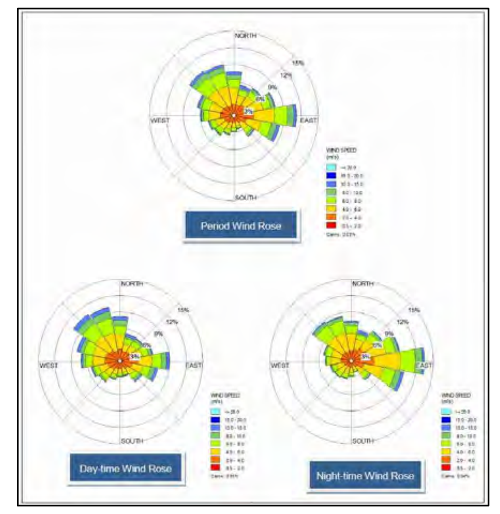


LEGEND

01 ADIT / BOXCUT
02 OVERBURDEN STOCKPILE
03 TOPSOIL STOCKPILE
04 MAIN ENTRANCE INTERSECTION
05 ADMIN BUILDING COMPLEX (BY MINING CONTRACTOR)
06 BRAKE TEST RAMP
07 ARRESTOR BED
08 WORKSHOP
09 1000 t BIN AND OVERFLOW STOCKPILE
10 TRUCK STACKING AREA
11 HAUL ROAD INTERSECTION
12 CM OFFLOADING
13 VEHICLE WASH BAY / OIL & SILT TRAP
14 11kV CONSUMER SUBSTATION
15 SHAFT CONVEYOR (CVY - 4013)
16 GUARD HOUSE
17 SILT TRAP AND DRYING BED
18 CABLE REPAIR STORE (BY MINING CONTRACTOR)
19 SALVAGE YARD (BY MINING CONTRACTOR)
20 STONE DUST SILO
21 MEDICAL FACILITY (BY MINING CONTRACTOR)
22 LAMP ROOM (BY MINING CONTRACTOR)
23 CHANGEHOUSE (BY MINING CONTRACTOR)
24 MAIN SECURITY HOUSE (BY MINING CONTRACTOR)
25 MINI BUS TAXI AND BUS DROP OFF ZONE
26 VENT SHAFT
27 OFFICE PARKING BAYS (123 BAYS)
28 VISITORS PARKING BAYS (94 BAYS)
29 FUEL DISPENSARY / STORAGE
30 OWNER`S TEAM SITE OFFICE
31 BOXCUT CONTRACTOR`S LAYDOWN AREA
32 TRUCK STOP
33 ROM SILT TRAP
34 GYPSUM PAD
35 FUTURE 7 500 m³/d EXCESS WATER RO PLANT
36 SMALL WATER TREATMENT PLANT
37 SLUDGE DRYING BEDS
38 SEWER TREATMENT PLANT
39 POLLUTION CONTROL DAMS
40 BRINE DAM
41 CONTROL ROOM
42 STORES BUILDING (BY MINING CONTRACTOR)
43 POTABLE WATER ELEVATED TANK
44 FIRE WATER PUMP STATION (BY OTHERS)
45 CM WATER STORAGE TANK, INLINE FILTERS & BOOSTER PS
46 MINE VEHICLE PARKING (17 BAYS)
47 SKIP WASTE BINS
48 VENT SHAFT SUB STATION
49 UNDERGROUND CABLE SERVICE DUCTS (2 No)
50 BUS PARKING (5 BAYS)
51 FUTURE CHANGEHOUSE (BY MINING CONTRACTOR)
52 WEIGHBRIDGES (2 No)
53 BOXCUT GUARD HOUSE
54 ESKOM 132kV POINT OF SUPPLY
55 POTABLE WATER 500 m³/d RO PLANT
56 MINING LAYDOWN AREA (BY MINING CONTRACTOR)
57 PCD PUMP STATION
58 TARPAULIN MOUNTING STATION OFFICE
59 MASS MEETING AREA
60 BOWSER FILLING POINT AND PUMP STATION
61 BRINE DAM PUMP STATION
62 BOXCUT SUMP & PUMP STATION
63 MCC (SUB-STATIONS)
64 TARPAULIN MOUNTING STATION
65 MAIN INFRASTRUCTURE TERRACE
66 CROSS / THROW OUT / BIN CONVEYOR SUBSTATION
67 CONVEYOR MAINTENANCE ROAD
68 SECURITY GATE
69 DECELERATION BARRIERS
70 CROSS CONVEYOR (CVY - 4014)
71 COVID 19 SCREENING AND TESTING STATION
72 SINGLE SILT TRAP WITH OIL TRAP AND DRYING BED
73 COMMUNICATION TOWER MAST
74 FUTURE GYPSUM PAD
75 FUTURE WATER TREATMENT PLANT
76 MINI SUBSTATION

THE CO-ORDINATE SYSTEM USED ON THIS DRAWING IS

GAUSS CONFORM Lo 29° EAST
ELLIPSOID - CLARKE 1880 MODIFIED
CAPE DATUM



NOTE:

THE CONTRACTOR MUST BRING TO THE ATTENTION OF THE ENGINEER ANY DISCREPANCIES FOUND ON THE DRAWING BEFORE CONSTRUCTION COMMENCES.

ACTUAL GROUND LEVELS NEED TO BE VERIFIED AGAINST LEVELS ON DRAWINGS AND CONFIRMED TO BE WITHIN ALLOWABLE LIMITS BEFORE CONSTRUCTION COMMENCES.

TITLE	DRG No

REFERENCES

DETAIL	MARK	DATE	INIT	APPV'D
CONVEYOR NAMES UPDATED	H	08/07/2020	GM	
ISSUED FOR MEASUREMENT	G	08/07/2020	GM	
ISSUED FOR FINAL APPROVAL	F	17/06/2020	MK	
UPDATED TITLE AND DRG NO.	E	14/05/2020	AMC	
SIGNATURES ADDED	D	11/05/2020	MK	
ISSUED FOR APPROVAL	C	28/04/2020	MK	
WM INFRASTRUCTURE CHANGED	J	08/08/2020	AC	
LEGEND NO. 58 CHANGED	I	03/08/2020	AC	

REVISIONS

No	DESCRIPTION OF HOLDS	ADDED	REMOVED

HOLDS

Semane Engineering Solutions (PTY) Ltd
22 Wellington Road
Parktown
Johannesburg
Gauteng
2193
Telephone: +27 (0) 11 891 1600
Fax: +27 (0) 11 833 1039
E-mail: corporate@semane.com
Website: www.semane.com
PostNet Suite #313
Private Bag X 30500
Houghton
2041

SEMANE DRG. No. 102-ELD-029-RS0022

	NAME	SIGNATURE	REGISTRATION	REG.NO.	DATE
APPROVED BY					
DESIGNED BY					
STRUC. CALCUL. FILE NO.			PROJECT		S

DESIGNED & APPROVED IN ACCORDANCE WITH SANS 1200 CIVIL ENGINEERING SPECIFICATION AND AA SPECIFICATIONS WHERE APPLICABLE

CIVIL ENGINEERING

CONT-APPROVAL	NAME	DATE	SIGNATURE
DRAWN	M. KISIELIUS	17/06/2020	M.KISIELIUS
CHECKED	D. PAIZES	17/06/2020	D. PAIZES
DESIGNED	A. CASSA	17/06/2020	A. CASSA
PROC ENG			
PROJ ENG	J. ARAUJO		
PR ENG	A. CASSA	17/06/2020	A. CASSA
PR ENG No.	20160530		

MINE – NOTED	NAME	DATE	SIGNATURE
PROJECT MANAGER	K. BERGH	01/07/2020	K. BERGH
PROJECT ENGINEER	N. MOSENA	01/07/2020	N. MOSENA
ENGINEERING MANAGER			

ANGLOAMERICAN-NOTED	NAME	DATE	SIGNATURE
PROJECTS DIRECTOR	S. CRANE	01/07/2020	S. CRANE
HEAD OF ENG			
MECH ENGINEER			
ELEC. ENGINEER			
C & I ENGINEER			
CIVIL ENGINEER	S. MADLIWA	01/07/2020	S. MADLIWA

AngloAmerican

COMPANY	ELDERS STUDY AREA
PROJECT	P0815 – ELDERS FEASIBILITY STUDY
AREA	UNDERGROUND
LOCATION	ELDERS
JOB	FEASIBILITY STUDY
TITLE	ELDERS UNDERGROUND ACCESS PROJECT BLOCK PLAN

SCALE: 1:3000

ORIGINAL DRG. SIZE A1

SHEET 1 OF 1

DRG No. 0295–0815–CED–0022 REV. J

MINE. PROJ. BUS. UNIT SEQ. No.

CO-ORD SYSTEM – CAPE DATUM Lo29

0 50 100 150

Appendix C: EAP CV and Qualifications

Natasha Anamuthoo

Senior Environmental Scientist

Profession	Environmental Scientist
Education	Certification in Project Management, 2016 BSoc Sc (Hons), Geography and Environmental Management, University of KwaZulu-Natal, Howard College, 2006 BSoc Sc, Geography and Environmental Management, University of KwaZulu-Natal, Howard College, 2005
Registrations/ Affiliations	EAP, EAPSA Member, IAIAsa Member, SSAG Golden Key Honorary Society of South Africa
Awards	National Research Fund (NRF) Bursary to undertake Honors Research

Specialisation

Environmental social, impact assessments, basic assessments, environmental, social management plans/programmes, environmental due diligence auditing, project management, environmental, social management frameworks, bankable programme reports, environmental performance assessments, specialist coordination and stakeholder engagement.

Expertise

Natasha Anamuthoo has been involved in the field of environmental management for the past 14 years. Her expertise includes:

- environmental impact assessments and basic assessments for service stations, industrial, linear, energy, cement and mining related projects both in South Africa and Southern African countries such as the DRC and Sierra Leone;
- environmental, social impact assessment (ESIA) and environmental social management plan (ESMP) for financial institutions such as the International Finance Cooperation, World Bank and African Development Bank;
- development and implementation of stakeholder engagement processes;
- specialist team co-ordination and drafting Terms of Reference (ToR);
- conducting environmental control officer work environmental projects;
- due diligence reporting;
- project management;
- environmental control officer (ECO);
- environmental performance assessments;
- environmental social management framework for Southern African Groundwater Management Institute.

Employment

2010 – present	SRK Consulting (Pty) Ltd, Environmental Scientist, Johannesburg
2009 – 2010	SRK Consulting (Pty) Ltd, Environmental Scientist, Durban
2007 – 2009	Kantey and Templer Consulting Engineers Pty (Ltd), Environmental Officer, Durban
2006 – 2006	WSP Pty (Ltd), Environmental Intern, Durban

Publications

Authored in 4 articles about environmental management.

Languages

English – read, write, speak (Excellent)
Afrikaans – read, write, speak (Fair)
Zulu – read, write, speak (Fair)

Natasha Anamuthoo
Senior Environmental Scientist

Publications

1. Removing barriers to entry (2015)
2. Forging links within DRC’s cement sector (2016)
3. Integrating environmental and social safeguards in regional power projects (2017)
4. Learning from progress in managing Africa’s groundwater (2021)

Natasha Anamuthoo
Senior Environmental Scientist

Key Experience: **Environmental impact assessments, environmental management plans and public participation**

Location:	South Africa
Project duration & year:	2020 – ongoing
Client:	Anglo American
Name of Project:	Elders Colliery
Project Description:	Environmental Impact Assessment and Management Plan
Job Title and Duties:	Project Manager
Value of Project:	n/a

Location:	Zambia
Project duration & year:	2020 - ongoing
Client:	Mopani
Name of Project:	Gap Analysis for Mopani Copper Mine
Project Description:	Project Manager
Job Title and Duties:	Gap analysis
Value of Project:	n/a

Location:	Zimbabwe
Project duration & year:	2019
Client:	PLZ Lithium Mine
Name of Project:	Upgrade to the ESIA for Arcadia Lithium Mining Project
Project Description:	Project co-ordinator
Job Title and Duties:	Reporting
Value of Project:	n/a

Location:	Southern Africa
Project duration & year:	2018 – 2019
Client:	Groundwater Management Institute
Name of Project:	Environmental and Social Safeguard Project
Project Description:	Environmental and Social Safeguard Specialist
Job Title and Duties:	Site work, reporting and advisor
Value of Project:	n/a

Location:	Guinea
Project duration & year:	2018 – 2019
Client:	AngloGold Ashanti
Name of Project:	Environmental, Health, Social Impact Assessment
Project Description:	Undertake Baseline Studies
Job Title and Duties:	Project Manager
Value of Project:	n/a

Location:	South Africa
Project duration & year:	2018
Client:	Sereti Coal
Name of Project:	Kriel Matla
Project Description:	Section 29
Job Title and Duties:	Project Manager
Value of Project:	n/a

Natasha Anamuthoo
Senior Environmental Scientist

Key Experience: Environmental impact assessments, environmental management plans and public participation

Location:	Southern African
Project duration & year:	2016-2017
Client:	South African Power Pool
Name of Project:	Environmental Social Management Framework
Project Description:	Environmental Social Management Framework
Job Title and Duties:	Project Coordinator
Value of Project:	n/a

Location:	South Africa
Project duration & year:	2016-2017
Client:	Anglo American
Name of Project:	Landau EIA and EMP for the Power line
Project Description:	Undertake EIA and EMP
Job Title and Duties:	Project manager, Reporting and Client Liaison
Value of Project:	n/a

Location:	South Africa
Project duration & year:	2012-2017
Client:	Anglo American
Name of Project:	Kriel Opencast EIA
Project Description:	Undertake EIA and EMP
Job Title and Duties:	Project manager, Reporting and Client Liaison
Value of Project:	n/a

Location:	South Africa
Project duration & year:	2015 – current
Client:	Optimum Coal
Name of Project:	EIA Amendment for Optimum Coal
Project Description:	EIA Amendment to include a new portion of mining area
Job Title and Duties:	Project manager, Reporting and Client Liaison
Value of Project:	n/a

Location:	Democratic Republic of Congo
Project duration & year:	2014 - current
Client:	TERRA
Name of Project:	Preliminary ESIA and ESMP for TERRA
Project Description:	Preliminary Environmental Social and Impact Assessment
Job Title and Duties:	Project Co coordinator, Reporting and Client Liaison
Value of Project:	n/a

Location:	Democratic Republic of Congo
Project duration & year:	2014 – 2016
Client:	ENRC
Name of Project:	ESIA for the Metalkol RTR Project
Project Description:	ESIA for the Metalkol RTR Project
Job Title and Duties:	Project Co-ordinator
Value of Project:	n/a

Natasha Anamuthoo

Senior Environmental Scientist

Key Experience:	**Environmental impact assessments, environmental management plans and public participation**
Location:	Democratic Republic of Congo
Project duration & year:	2013 - 2015
Client:	Nymba
Name of Project:	ESIA and ESMP for NYA
Project Description:	Environmental Social and Impact Assessment
Job Title and Duties:	Project manager and Co- coordinator and Reporting
Value of Project:	n/a
Location:	Democratic Republic of Congo
Project duration & year:	2013- 2015
Client:	PPC Cement
Name of Project:	ESIA and ESMP for PPC , Barnet
Project Description:	Environmental Social and Impact Assessment
Job Title and Duties:	Project Co coordinator, Reporting and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2011 - current
Client:	Anglo Platinum American
Name of Project:	MPM Tailings Retreatment Plant EIA
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	Zambia
Project duration & year:	2011 - 2013
Client:	Barrick Gold
Name of Project:	Lumwana Gold
Project Description:	Environmental, Social Impact Assessment (ESIA)
Job Title and Duties:	Project Co- coordinator
Value of Project:	n/a
Location:	South Africa
Project duration & year:	Completed and approved by the Limpopo Department of Economic Development and Environment and Tourism in 2012
Client:	Anglo Platinum American
Name of Project:	MPM Road Deviation
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	Completed and approved by the Department of Environmental Affairs in 2012
Client:	Samancor Chrome
Name of Project:	Tubaste Chrome
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a

Natasha Anamuthoo
Senior Environmental Scientist

Key Experience:	**Environmental impact assessments, environmental management plans and public participation**
Location:	Democratic Republic of Congo
Project duration & year:	2010 - current
Client:	Teal
Name of Project:	Kalumines
Project Description:	Environmental, Social Impact Assessment (ESIA)
Job Title and Duties:	Project manager and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2010 - current
Client:	De Beers
Name of Project:	Venetia
Project Description:	Environmental, Social Impact Assessment
Job Title and Duties:	Social engagement and EMPr Research
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2010-current
Client:	Anglo Thermal Coal
Name of Project:	Kriel Block F
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Reporting
Value of Project:	n/a
Location:	South Africa
Project duration & year:	Completed and approved by the Department of Environmental Affairs in 2010
Client:	Minmetals
Name of Project:	Naboom
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Reporting
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2010
Client:	ABI
Name of Project:	ABI Tank EMP and Audit
Project Description:	EMP and Environmental Control Officer (ECO)
Job Title and Duties:	Reporting and ECO work
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2010
Client:	Air Liquid
Name of Project:	Air Liquid 24G
Project Description:	24G application
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a

Natasha Anamuthoo
Senior Environmental Scientist

Key Experience:	**Environmental impact assessments, environmental management plans and public participation**
Location:	South Africa
Project duration & year:	2010
Client:	Shell
Name of Project:	Shell Phola EIA
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2010
Client:	Sara Lee
Name of Project:	Sisonke Farms Market
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009-2010
Client:	Ethekwini Municipality
Name of Project:	Westville Triangle
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009-2010
Client:	Transnet
Name of Project:	Transnet EIA
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	Shell
Name of Project:	Shell Ladysmith EIA
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	NPC
Name of Project:	NPC EIA
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a

Natasha Anamuthoo
Senior Environmental Scientist

Key Experience:	**Environmental impact assessments, environmental management plans and public participation**
Location:	South Africa
Project duration & year:	2009
Client:	Illovo Sugar
Name of Project:	Umfolozi Waste
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	Foskor
Name of Project:	Foskor Dry Wall EIA
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a

Key Experience:	**Environmental impact assessments, environmental management plans and public participation**
Location:	South Africa
Project duration & year:	2009
Client:	Sasol
Name of Project:	Sasol Tongaat
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	Shell
Name of Project:	Shell Newscastle
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	Shell
Name of Project:	Shell Wavecrest
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a

Natasha Anamuthoo

Senior Environmental Scientist

Key Experience:	**Environmental impact assessments, environmental management plans and public participation**
Location:	South Africa
Project duration & year:	2009
Client:	Shu Powders
Name of Project:	Shu Powders EIA
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	Total
Name of Project:	Prospecton Motors
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	Total
Name of Project:	Pomoroy Service Station
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2009
Client:	Total
Name of Project:	Pomoroy Service Station
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2008
Client:	Sasol
Name of Project:	Sasol Oogies
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2008
Client:	Total
Name of Project:	Amalgamated Bulk
Project Description:	Basic Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a

Natasha Anamuthoo

Senior Environmental Scientist

Key Experience: Environmental impact assessments, environmental management plans and public participation

Location: South Africa
Project duration & year: 2008
Client: Exxaro
Name of Project: Exxaro Sands
Project Description: Basic Assessment
Job Title and Duties: Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project: n/a

Location: South Africa
Project duration & year: 2008
Client: NMR Consultants
Name of Project: NMR Logistics
Project Description: Basic Assessment
Job Title and Duties: Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project: n/a

Location: South Africa
Project duration & year: 2008
Client: Total
Name of Project: Trimborm Agency
Project Description: Basic Assessment
Job Title and Duties: Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project: n/a

Location: South Africa
Project duration & year: 2008
Client: Engen
Name of Project: Stonehaven Garage
Project Description: Environmental Impact Assessment
Job Title and Duties: Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project: n/a

Location: South Africa
Project duration & year: 2008
Client: FNB
Name of Project: FNB Underground Storage Tank
Project Description: Basic Assessment
Job Title and Duties: Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project: n/a

Location: South Africa
Project duration & year: 2008
Client: Total
Name of Project: Waston Motors
Project Description: Environmental Impact Assessment
Job Title and Duties: Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project: n/a

Natasha Anamuthoo

Senior Environmental Scientist

Key Experience:	Environmental impact assessments, environmental management plans and public participation
Location:	South Africa
Project duration & year:	2008
Client:	Total
Name of Project:	Total Empangeni
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2008
Client:	Total
Name of Project:	Total Westville
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a
Location:	South Africa
Project duration & year:	2008
Client:	Total
Name of Project:	Total Merebank
Project Description:	Environmental Impact Assessment
Job Title and Duties:	Project Co- coordinator, Reporting, Public Participation and Client Liaison
Value of Project:	n/a

Michelle Miles
Environmental Scientist

Profession	Environmental Science and Management
Education	B.Sc (Hons) Environmental Water Management, Rhodes University, 2013 B.Sc, Geography and Environmental Science, Rhodes University, 2014
Registrations/ Affiliations	Member, EAPASA, 2020/1057
Awards	None

Specialisation

Environmental project management; environmental and social impact assessments, Environmental advisory, environmental construction management.

Expertise

Michelle has 5 years' experience within the environmental science and management field. She has been involved in a various aspects of projects ranging from concept studies all the way through to environmental construction management.

Michelle has experience in conducting environmental legal reviews as well as environmental permitting processes such as Environmental Impact Assessments and Basic Assessments.

Her experience include:

- Environmental authorisations such as Basic Assessments and Environmental Impact Assessments as well as other associated environmental permits
- Environmental Baseline Assessments
- Environmental design criteria as well as permitting strategies
- Construction environmental management plans
- Independent weekly audit report for construction
- Legislative reviews of various countries
- Geographical information systems (GIS) analyses
- Waste management plans
- Water monitoring sampling and analysis
- Environmental Compliance Auditing

Employment

2021 - present	SRK Consulting (Pty) Ltd, environmental Scientist, Johannesburg
2016 - 2021	Hatch Africa (Pty) Ltd, Intermediate Environmental Advisor, Johannesburg

Publications

None

Languages

English – read, write, speak (excellent)

Afrikaans – read, speak (fair)

Michelle Miles
Environmental Scientist

Key Experience: Environmental permitting

Location:	Welkom and Virginia, Free State Province, South Africa
Project duration & year:	3 years, 2017 - 2019
Client:	Matjhabeng Local Municipality,
Name of Project:	Nyakallong, Theronia and Virginia Waste Water Treatment Works Upgrade,
Project Description:	This project was to upgrade three existing Waste Water Treatment Works (WWTW), namely the Nyakallong, Theronia and Virginia WWTW, within the Free State. This involved conducting a Scoping and Environmental Impact Report (S&EIR) as well as the associated Environmental Management Plans. It was also identified that the three WWTWs did not have a Water Use Licence, thus resulting in the 3 WUL Application being required.
Job Title and Duties:	Junior Environmental Consultant in compiling the S&EIR for all three WWTWs.
Value of Project:	R 2.5 million in environmental fees

Location:	North West, South Africa
Project duration & year:	6 months, 2020 - 2021
Client:	Anglo American Platinum
Name of Project:	Mortimer SO2 Abatement Project
Project Description:	The consulting company was appointed to conduct a Feasibility and Revalidation Study for the Mortimer SO2 Abatement Project. Based on the Lessons learnt from a previous project (the Polokwane SO2 Abatement Project), a revalidation study was conducted to assessed how the project may have changed from the Feasibility study conducted in 2018. In addition this, the lessons learnt were incorporated into the design and as well as incorporate lessons learnt for procurement, environmental, safety and construction management. As part of the lessons learnt, the design changed and it was identified that the existing Environmental Authorisation would expire prior to the commencement of the construction. Due to his, a Section 29 Amendment was conducted to extend the EA Validity.
Job Title and Duties:	Environmental Assessment Practitioner and Environmental Project Manager
Value of Project:	R500 000

Location:	Richards Bay, KwaZulu Natal, South Africa
Project duration & year:	2 years, 2019 - 2020
Client:	Nyanza Light Metals,
Name of Project:	Nyanza TiO2 Pilot Plant,
Project Description:	Arkein Capital Partners (Arkein), operating as Nyanza Light Metals (Nyanza), investigated the possibility of developing an industrial titanium dioxide (rutile) pigment production facility in the Richard's Bay Industrial Development Zone (IDZ), South Africa. To identify whether the project was viable on a commercial level, a pilot plant was developed. This pilot plant was also developed to identify the most effective and efficient process to follow. The TiO2 Pilot plant required an Environmental Impact Assessment process to be followed.
Job Title and Duties:	Junior environmental advisor which included compiling the Scoping Report and Environmental Impact Report as well as conducted the Public Participation process.
Value of Project:	R1.5 Million

Michelle Miles
Environmental Scientist

Location:	Redford Road, Western Cape, South Africa
Project duration & year:	2.5 Years, 2019 -2021
Client:	Western Cape Government: Road and Public Transport
Name of Project:	DR 1797 Road Upgrade Project
Project Description:	The DR 1797 Road was an existing gravel road which required upgrading to a surfaced road. The upgrade required some realignment to ensure a 60km/hr speed limit could be maintained. Due to the realignment some land along the DR 1797 Road required expropriation (with compensation). Due to this, a Basic Assessment was required as some of these areas were within a watercourse. The following environmental activities were conducted: • A Pre-Application Process as well as the Public Participation Process. • Development of a Public Participation Plan • A Basic Assessment Report and Environmental Management Programme • A General Authorisation
Job Title and Duties:	Environmental Assessment Practitioner
Value of Project:	R500 000 in environmental fees

Location:	Western Cape, South Africa
Project duration & year:	Two years, 2017-2018
Client:	Western Cape Government Roads
Name of Project:	Basic Assessment for the flood damage repairs to structures on the MR309 in Seweweekspoort Pass, Western Cape
Project Description:	A Basic Assessment and Water Use Licence process was conducted for the upgrade and repair of 30 stormwater management structures along the MR309 road within the Seweweekspoort in the Western Cape.
Job Title and Duties:	Environmental assistant of the Basic Assessment Process
Value of Project:	R250 000 in environmental fees

Location:	Jericho Dam, Amsterdam, Mpumalanga Province, South Africa
Project duration & year:	One year, 2017-2018
Client:	Department of Water and Sanitation
Name of Project:	Jericho Dam Pump Station Refurbishment
Project Description:	Environmental permitting (Basic Assessment) for the construction of a new pump station to replace the existing pump station at the Jericho Dam which is a National Key Point.
Job Title and Duties:	Environmental Advisor and project manager responsible for conducting the Basic Assessment Process.
Value of Project:	R 216 000 in environmental fees

Key Experience — Environmental Management and Advisory

Location:	Polokwane, Limpopo Province, South Africa
Project duration & year:	2017 – 2018
Client:	Anglo American Platinum
Name of Project:	SO_2 Abatement Plant at Polokwane Smelter
Project Description:	Environmental Control Officer for the construction phase of the SO_2 Abatement Plant. This required conducting weekly site audits for the duration of the construction (2.5 years). The SO_2 Abatement project was required for the Polokwane Smelter in order to assist the smelter in meeting the 2020 minimum emissions standards in terms of the National Air Quality Management Act.
Job Title and Duties:	Environmental Control Officer for the construction phase, tender evaluation of contractor’s and Environmental Awareness training.
Value of Project:	R 2.2 million in environmental fees

Michelle Miles
Environmental Scientist

Location:	Richards Bay, KwaZulu Natal, South Africa
Project duration & year:	2018 - 2020
Client:	Rio Tinto
Name of Project:	Zulti South
Project Description:	The Zulti South Project was to develop a mining lease area. The two major components of the Project were (1) mining the lease area, and (2) constructing a services corridor including water supply, electrical supply and slurry pipeline between the Zulti South lease area and Richard Bay Mineral's plant about 40 kilometres south near the town of Richards Bay. The environmental component included: • Compilation of the Construction EMPs • Assisting with incorporating all legally approved permits into environmental management specifications in tender documentation • Assisting with the establishment of environmental management criteria for tender adjudication • Assisting with all environmental matters between the client and the engineering team
Job Title and Duties:	Environmental Advisor
Value of Project:	Confidential

Location	Mpumalanga, South Africa
Project duration & year:	2 Months, 2018
Client:	Keben and Associates
Name of Project:	African Renaissance LNG Pipeline Project,
Project Description:	Keben and Associates undertook various studies for the China Petroleum Pipeline Bureau for the development of a transboundary multipurpose pipeline. An environmental assessment up to a prefeasibility level for the Mozambique and South African portions of the development was conducted. The petroleum pipeline entered South Africa in Mpumalanga and extended to Springs in Gauteng. The client wanted to include a socio-economic review that considered inclusion of developed areas along the pipeline route to enable off-take locations.
Job Title and Duties:	Environmental advisor
Value of Project:	R700 000 in environmental fees

Location:	Secunda, Mpumalanga, South Africa
Project duration & year:	2019, 6 Months
Client:	Sasol Technology Group,
Name of Project:	Coarse Ash Waste Disposal Project
Project Description:	Sasol identified that the currently Coarse Ash Dump would reach it's capacity, thus a project was conducted to identify the best option to expand the Coarse Ash Dump. The following environmental components for this project: • An Environmental Design Criteria • Two permitting strategies for the short term solution and the long term solution • A site selection
Job Title and Duties:	Environmental Project Lead
Value of Project:	R 200 000

Michelle Miles
Environmental Scientist

Location:	Mpumalanga, South Africa
Project duration & year:	Two years, 2016-2017
Client:	Eskom
Name of Project:	Eskom Majuba Rail Project
Project Description:	Eskom constructed a Railway line to the Majuba Power Station. This project included but was not limited to ensuring that contractors complied with all relevant health and safety and environmental legislation, EMP requirements, Eskom procedures and protocols and the project schedule. This project also included environmental such as environmental application for borrow pit closures, developing and implementing the water sampling requirements for the project, ongoing awareness training and reporting incidents as well as water monitoring in line with the WUL.
Job Title and Duties:	Assistance with all environmental aspects as well as conducting water monitoring and reporting.
Value of Project:	R 2 million

Location	Northern KwaZulu Natal, South Africa
Project duration & year:	6 months, 2020
Client:	Umkhanyakude District Municipality
Name of Project:	Wastewater Risk Abatement Plan
Project Description:	The Umkhanyakude District Municipality required various WWTW within Northern KwaZulu Natal to identify whether the existing WWTW were compliant with National Legislation and whether these WWTWs required upgrades in order to operate efficiently.
Job Title and Duties:	Environmental Advisor – Environmental reporting and risk assessment
Value of Project:	R500 000

Location:	Mpumalang, South Africa
Project duration & year:	2017
Client:	Govan Mbeki Local Municipality (GMLM)
Name of Project:	Govan Mbeki Sanitation Studies project
Project Description:	The focus of this study was on the bulk sanitation infrastructure contained within the GMLM. By focusing on the bulk sanitation infrastructure and addressing the challenges, resulting in large improvements in service delivery based on the operating constraints within the GMLM. The environmental services provided were a sensitivity baseline assessment on six of the WWTW within the Govan Mbeki and well as permitting strategies for each WWTW
Job Title and Duties:	Environmental Assistant
Value of Project:	Confidential

Appendix D: Final Scoping Report Acceptance Letter

mineral resources
& energy

Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

Private Bag X7279, Emalahleni, 1035, Tel: 013 653 0500, Fax: 013 656 1474

1st Floor, Saveways Crescent Centre, Mandela Drive, Emalahleni 1035

Enquiries: Mrs. M.C Mutengwe **Email:** mashudu.mutengwe@dmre.gov.za
Ref number: (MP) 30/5/1/2/3/2/1 (10117) EM
Directorate: Mine Environmental Management: Mpumalanga Region

BY REGISTERED MAIL

The Directors
Anglo American Inyosi Coal
Private Bag X1
Marshalltown
JOHANNESBURG
2107

Attention: Leonore van Wyk email:Leonore.vanwyk@angloamerican

ACCEPTANCE OF THE SCOPING REPORT SUBMITTED IN TERMS OF REGULATION 21 OF THE ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS, 2014 FOR THE MINING RIGHT IN RESPECT OF PORTIONS 3 AND 10 OF THE FARM ELANDSFONTEIN 75 IS, PORTION 1 AND 2 OF THE FARM GELUK 226 IS, PORTION RE/2,RE/3, PORTION OF PORTION 4,12/3 AND 13/3 OF THE FARM HAFGEWONNEN 190 IS, PORTION 5/1,6/1,7/1 AND 17/5 OF THE FARM LEGDAAR 78 IS, PORTION RE, RE/3,5,6/3,8/3 OF THE FARM MIDDELKRAAL 50 IS, PORTION RE/7,12/5,13/5,14/6,22/10,RE/26,27/26 OF THE FARM SCHUVEKOP 227 IS AND PORTION RE OF THE FARM VLAKKUILEN 76 IS, SITUATED WITHIN THE MAGISTERIAL DISTRICT OF GERT SIBANDE DISTIC MUNICIPALITY: MPUMALANGA REGION

The Scoping Report (SR) and Plan of study for Environmental Impact Assessment received by the Department on 23 June 2021 refers.

a) The Department has evaluated the submitted SR and Plan of the study for Environmental Impact Assessment and is satisfied that the documents comply with the minimum requirements of Appendix 2(2) of the National environmental Management Act, 1998 (as amended) (NEMA) Environmental Impact assessment (EIA) Regulations, 2014. The SR is hereby accepted by the Department in terms of Regulation 22(a) of the NEMA EIA Regulations, 2014.

b) You may proceed with the Environmental Impact Assessment process in accordance with the tasks contemplated in the Plan of study for environmental Impact assessment as required in terms of the NEMA EIA Regulations, 2014.

c) Please ensure that comments from all relevant stakeholders are submitted to the Department with the Environmental Impact Assessment Report (EIAR). This includes but is not limited to the Provincial Heritage Resources Authority, Department of Agriculture, Forestry and Fisheries (DAFF), Department of Water and Sanitation (DWS), Mpumalanga Department of Public Works, Roads and Transport and the local municipality. Proof of correspondence with the various stakeholders must be included in the EIAR. Should you be unable to obtain comments, proof of the attempts that were made to obtain comments should be submitted to the Department.

d) It should be noted that the Department requires the following to be provided/included and form part of the final EIR and EMPr to be submitted.

- The financial provision calculations must be provided for the proposed activities.

- The plan to be submitted must depict the location and aerial extent of all proposed mining activities.

- A map at an appropriate scale which superimposes the proposed activity and its associated structructures and infrastructure on the environmental sensitivities of the preferred site indicating any areas that should be avoided, including buffers. All maps must be visible in A3 with clear legend.

- Public Participation Process must be transparent and all comments received during the process must be incorporated into the comments and response report of the final Environmental Impact Report. Note that the stakeholder database is outdated

- Proof of correspondence with the various stakeholders must be included in the EIAR. Should you be unable to obtain comments, proof of the attempts that were made to obtain comments should be submittesd to the Department.

- All comments from interested and affected parties must be adequately addressed in the final Environmental Impact Report.

- Furthermore, it must be reiterated that, should an application for Environmental Authorisation be subjected to any permits or authorisations in terms of the provisions of any Specific Environmental Management Acts (SEMAs), proof of such application will be required.

- Any other matters required in terms of Appendix 3 (3) and Appendix 4 (1) of the EIA Regulation 2014.

e) The applicant is hereby reminded to comply with the requirements of Regulation 3 of the EIA regulations, 2014 with regards to the time and period allowed for complying with the requirements of the Regulations.

f) Please ensure that the EIAR includes the A3 size locality map of the area and illustrates the exact location of the proposed development. The map must be of acceptable quality and as a minimum, have the following attributes , maps are related to one another, Co-ordinates, Legible legends, Indicate alternative, Scale and Vegetation types of the study area.

g) Your attention is brought to Section 24F of the NEMA which stipulates "that no activity may commence prio to an Environmental Authorisation being granted by the competent authority".

Note that the site notice must be visible

For any enquiry regarding this application please contact the above mentioned Official

Yours faithfully

REGIONAL MANAGER: MINERAL AND PETROLEUM REGULATION
MPUMALANGA REGION
DATE...17/08/2021

Appendix E: Public Participation

Appendix E1: Public Participation Plan

COAL

ANGLO COAL ENVIRONMENTAL SERVICES
Private Bag X9
Leraatsfontein
Witbank
1038

The Regional Manager
DEPARTMENT OF MINERAL RESOURCES AND ENERGY
Private Bag X7279
Emalahleni
1035

17 July 2020

Attention: Ms. Mashudu Maduka,

PUBLIC PARTICIPATION PROCESS PLAN AS CONTEMPLATED IN ANNEXURE 3 OF THE DIRECTIONS ISSUED BY THE HONORABLE MINSTER OF FORESTRY, FISHERIES AND ENVIRONMENT, BARBARA CREECY. (GN 650), ISSUED ON 5 JUNE 2020 ENVIRONMENTAL AUTHORIZATION APPLICATIONS; ENVIRONMENTAL MANAGEMENT PROGRAMME AMENDMENTS APPLICATIONS AND ENVIRONMENTAL AMENDMENT APPLICATIONS PROJECTS

Minister of Forestry, Fisheries and the Environment, Barbara Dallas Creecy (the "**Minister**") has, under regulation 10(8) of the Regulations issued in terms of section 27(2) of the Disaster Management Act, 2002 (Act No. 57 of 2002), issued directions to address, prevent and combat the spread of COVID-19 and to alleviate, contain and minimise the effects of the national state of disaster (the "Directions").

The Directions are effective from the 5th of June 2020, in accordance with Government Gazette (No. 650). Annexure 3 under the general provisions of the Directions requires a Public Participation Plan (PPP) plan be presented to, and agreed upon by, the case officer at the Department of Mineral Resources and Energy ("**DMRE**"), before the commencement of any Public Participation Process required under legislation.

This document contains the PPP that Anglo Operations (Pty) Ltd, including Anglo American Inyozi Coal (Pty) Ltd and Mafube Coal (Pty) Ltd', would like to implement for any of the following applications during the Covid19 Lockdown Period:

- Environmental Authorisation (EA) applications submitted under the National

Environmental Management Act, 1998 (**"NEMA**");

- amendment applications for Environmental Authorisations issued under NEMA; and
- amendment applications for Environmental Management Programmes (EMPRs) approved under the Mineral Petroleum Resources Development Act, 2002 ("**MPRDA**"), NEMA or National Environmental Management: Waste Act, 2008 ("**NEMWA**").

The PPP is and will only be effective while the Directions and the PPP requirements thereunder remain valid and enforceable.

The PPP will apply to the following operations / facilities which have been identified and confirmed as essential services:

- Isibonelo Colliery (130MR);
- Khwezela Colliery previous known as Kleinkopje Colliery (307MR) and Landau Colliery (306MR);
- Goedehoop Colliery (122MR & 403MR);
- Greenside Colliery (304MR);
- Mafube Coal (172MR & 10026MR);
- Zibulo Colliery (338MR & 305MR); and
- Emalahleni Water Reclamation Plant (EWRP)

The proposed PPP is detailed below.

1. Background

Independent environmental consultants are appointed at various Anglo Coal Operations to compile and submit Environmental Authorisation Applications; amendment applications for Environmental Authorisations and Environmental Management Programmes together with the supporting reports to the DMRE.

These application processes require the environmental consultant to conduct a public participation process to give Interested and Affected Parties an opportunity to submit comments on reports in accordance with the NEMA and NEMWA.

The countrywide lockdown was announced by honourable President Cyril Ramaphosa and directions was issued by the Minister under Government Notice N0.439 on the 27th March 2020. The directions issued under the Government Notice No. 439 directed that all time frames of any authorisation, permit or license applied for through NEMA be suspended from the 27th of March 2020 until further notice. Subsequent to the above, the Minister issued the Directions under Government Notice No.650 on the 5th of June 2020, which repealed the Government Notice No. 439 directions and issued new directions for amongst other actions, public participation processes as required by NEMA and NEMWA.

The Directions require that a PPP must be compiled or held and agreed to with the case officer of the competent authority where a public participation process must be conducted. In view of the above, a proposed PPP (this document), detailing the process to be followed during the Covid-19 national lockdown, is submitted to the DMRE (competent authority) for its perusal and agreement.

2. Application Phase

The Interested and Affected Parties (I&Aps) will be identified from the existing I&AP databases from the relevant operations and additional I&APs will be identified by assessing directly affected land owners as well as adjacent land owner as well as assessing in which Local Municipal Ward the project area is located to ensure the relevant ward councillor are be identified. Other I&APs that will be identified will relate to:

- the competent authority;
- every State department that administers a law relating to a matter affecting the environment relevant to an application for an environmental authorisation; and
- all organs of state which have jurisdiction in respect of the activity to which the application relates.

3. Registration/ Scoping Phase/EMPR/EA Amendment Phase

Below is the description of the proposed process that will be followed for the consultation with Interested and Affected Parties during the Scoping Phase of the any Environmental Authorisation Applications; any amendment applications for Environmental Authorisations and any amendment applications for Environmental Management Programmes in terms of the MPRDA, NEMA and NEMWA.

3.1 Notification of potential Interested and Affected Parties

During the Scoping Phase consultation process, the public will be offered an opportunity to register as Interested & Affected Parties as well as to comment on the draft Scoping Report. Should more parties register, their names will be added to the stakeholder list during the Environmental Impact Assessment ("**EIA**") phase.

The following methods of notification will be used to notify the potential Interested and Affected Parties of the consultation process and the opportunity to register and comment on the draft Scoping Report for the proposed project:

3.1.1 Written Notices

Written notices will be sent to all the landowners, lawful occupiers, municipal councillors, commenting authorities and the competent authority inviting comments on the draft Scoping Report from the Interested and Affected Parties. The written notices will be sent either sent via emails or SMS. Where the process has already commenced prior to the COVID 19 national lockdown, the period remaining for commenting on the draft Scoping report will be clearly indicated. Due to the risks associated with COVID-19, no hand delivery of notices will be conducted.

3.1.2 Newspaper Advertisement

A Public Notice in English will be published in the local newspaper in accordance with Regulation 41 of Government Notice No. 982 and section 24 of NEMA informing the public of the availability of the draft scoping report at designated public places for a 30 day period.

3.1.3 Site Notices

Two site notices will be compiled in English and other local language to effectively communicate with the community surrounding the Operations and placed at the proposed site, Operations' security gate and at nearby community public places, which can be safely accessed during Lockdown, if available.

Where the process has already commenced prior the COVID 19 national lockdown, two site notices for the resumption of the Public Participation Process (in English and local language versions) will be placed at the proposed site and the other places at the surrounding residential area. The site notices will clearly indicate the resumption of the consultation process and will continue with additional days left before the Lockdown for the public to comment on the draft Scoping report.

3.1.4. Placement of the Scoping report for Public Comment

Since none of the public libraries have reopened due to COVID-19 and lockdown, an alternative method of making the draft Scoping Report available to the public was identified. Based on the above, and after assessment of available platforms, it was decided that the website of the appointed independent Environmental Consultants will be used for making the report available to the public. This method has also been selected since it will limit physical contact of the public with the hard copy documents. The full draft scoping report will be uploaded and made available on the website of the appointed independent Environmental Consultants. This will afford Interested and Affected Parties an opportunity to peruse the Scoping Report. Should an Interested and Affected Party request a copy of the draft Scoping Report, a soft copy will be sent to them via email or any other electronic method.

3.1.5. Other methods of consultation with registered Interested and Affected Parties

A virtual public meeting will be arranged and conducted during the Scoping phase/EMPR/EA Amendment phase. The meeting will be advertised in a local newspaper for at least 7 working days in advance of the meeting where registered and potential Interested, and Affected Parties will be invited to attend. The meeting will be used to present the proposed projects and scoping phase activities and to collect any comments and issues that may be raised by the Interested and Affected Parties. Members of the public keen to attend the virtual meeting must, with notification express the interest in attending the virtual meeting via a written email to the contact person stipulated on the said newspaper advertisement. The consultant conducting the public participation process will then share the details of the virtual meeting with the keen attendees in order for them to have access to the virtual public meeting.

Provision for a physical meeting with Interested and Affected Parties will be made for persons who request such a meeting due to limitations in literacy or accessibility to other feasible electronic measures. This meeting will be advertised in a local newspaper for at least 7 working days in advance of the meeting. However, strict measures shall be undertaken to adhere to the COVID-19 regulations. The venue scheduled for such a meeting shall be sanitised prior to the meeting. Any person who would like to attend such a meeting will have to disclose if she/he has any comorbidities through a telephonic or email-based questionnaire. No persons with common comorbidities known to be high risk to contracting the COVID-19 will be allowed in the meeting. Limited number of people will be permitted to the physical meeting to allow adequate social distancing. The maximum of 50 participants in line with other public engagement provisions under other relevant Lockdown Regulations and Directions will be adhered to. Any person interested in attending such a meeting will be subjected toscreening prior to attending the meeting. A checklist with the list of COVID-19 common symptoms will be used as part of the screening method together with a body temperature check. No person deemed to have any underlying COVID-19 symptoms and or a temperature of over 37.5 Degrees Celsius post the screening process will be allowed in the meeting. No persons will be allowed in the venue of the such a meeting without a facemask. Every person attending such a meeting will be hand-sanitised before entering the venue where the meeting is held.

3.1.6. Comments, Issues and Responses on Draft Environmental Impact Report (EIR) and Environmental Management Programme Report (EMPr)

Once the commenting period lapses, all comments and issues received will be recorded and responses to the comments will be made.

The comments and issues raised by the Interested and Affected Parties, their responses and reaction to the response will be presented in a table as prescribed by the Scoping Report and or EMPr/ EA Amendment report template from the relevant competent authority.

4. EIA Phase

The draft EIR and EMPr will be made available for comment to all registered and potential Interested and Affected Parties during the EIA phase of the any Environmental Authorisation Applications; amendment applications for Environmental Authorisations and amendment applications for Environmental Management Programmes under NEMA or NEMWA.

4.1. Notification of registered Interested and Affected Parties

The following methods of notification will be used to notify the registered and potential Interested and Affected Parties of the opportunity to comment on the draft EIR and EMPr during the public participation process for the proposed project:

- Written notices inviting comments on the draft EIR and EMPr will be sent to all registered Interested and Affected Parties via email and/or SMS. The written notices will be compiled to comply with the requirements of Regulation 41(3) of the EIA Regulations, 2014. Where the process has already commenced prior to the COVID 19 national lockdown, the period remaining for commenting on the draft EIR report will continue with additional days left before the Lockdown. Due to the risks associated with the COVID-19, no hand delivery of notices will be conducted.
- Advertisements inviting potential and registered Interested and Affected Parties to comment on the draft EIR and EMPr will be published in a local newspaper The newspaper notices will be published in both English and other local language. The advertisements will be compiled to comply with the requirements of Regulation 41(3) of the EIA Regulations, 2014.
- The draft EIR and EMPr will be submitted to the competent authority and all commenting authorities for their comments via email or any other feasible electronic systems to limit the risk of contravention of the COVID -19 Regulations.

- A soft copy of the draft EIR and EMPr will be available on the website of the appointed Independent Environmental Consultant. Upon request, a soft copy of the draft EIR and EMPr will be made available to Interested and Affected Parties. The requested draft EIR and EMPr and will be sent via email or any feasible electronic system. A virtual public meeting will be arranged and conducted during the EIA phase. The meeting will be advertised in a local newspaper where registered and potential Interested, and Affected Parties will be invited to attend. The meeting will be used to present the findings of the environmental investigation and environmental impact assessment for the proposed project and to collect any comments and issues that may be raised by the Interested and Affected Parties. Members of the public keen to attend the virtual meeting must, with notification express the interest in attending the virtual meeting via a written email to the contact person stipulated on the said newspaper advertisement. The consultant conducting the public participation process will then share the details of the virtual meeting with the keen attendees in order for them to have access to the virtual public meeting.

  Provision for a physical meeting with Interested and Affected Parties will be made for persons who request such a meeting due to limitations in literacy or accessibility to other feasible electronic measures. The meeting will be advertised in a local newspaper at least 7 working days in advance of the meeting where registered and potential Interested and Affected will request such a meeting due to limitations in literacy or accessibility to other feasible electronic measures. However, strict measures shall be undertaken to adhere to the COVID-19 regulations. The venue scheduled for such a meeting shall be sanitised prior to the meeting. Any person who would like to attend such a meeting will have to disclose if she/he has any comorbidities through a telephonic or email-based questionnaire. No persons with common comorbidities known to be high risk to contracting the COVID-19 will be allowed in the meeting. Limited number of people will be permitted to the physical meeting to allow adequate social distancing. The maximum number of people will be determined by the capacity of the venue and its eligibility to host such a meeting. Any person interested in attending such a meeting is subject to screening prior to attending the meeting. A checklist with the list of COVID-19 common symptoms will be used as part of the screening method together with a body temperature check. No person shall be allowed in the meeting deemed to have any underlying COVID-19 symptoms and or a temperature of over 37.5 Degrees Celsius post the screening process. No persons will be allowed in the venue of the such a meeting without a facemask. Every person attending such a meeting shall be hand-sanitised before entering the venue where the meeting is scheduled

4.2. Comments, Issues and Responses on Draft EIR and EMPr

Once the commenting period lapses, all comments and issues received will be recorded and responses to the comments will be made.

The comments and issues raised by the Interested and Affected Parties, their responses and reaction to the response will be presented in a table as prescribed by the EIR and EMPr template.

5. Integrated Environmental Authorisation or EMPR/EA Amendment Decided on

- Inform registered Interested and Affected Parties of the decision by the competent authority directly in writing, via email as well as SMS and indirectly through public notice in a local newspaper. A soft copy of the written decision from the competent authority will be made available via email or any other feasible electronic system upon request.

6. Confirmation of PPP Approval

Please confirm that you agree to Anglo Operations (Pty) Ltd, including Anglo American Inyozi Coal (Pty) Ltd and Mafube Coal (Pty) Ltd', applying the proposed PPP for the duration of the applicability of the Directions to the following applications:

- Environmental Authorisation applications submitted under NEMA
- amendment applications for Environmental Authorisations issued under NEMA; and
- amendment applications for Environmental Management Programmes approved the MPRDA, NEMA and NEMWA.

Should you have any queries, please feel free to contact the undersigned.

Your sincerely,

Daphney Tshehla
Environmental Manager
Anglo Coal South Africa
Tel: 013 691 5086
Cell: 082 455 8772
Email: daphney.tshehla@angloamerican.com

Appendix E2: Announcement Documentation

BACKGROUND INFORMATION DOCUMENT AND INVITATION TO COMMENT

Integrated Environmental Authorisation for Anglo American Inyosi Coal Elders Colliery, Near Bethal in the Mpumalanga Province

DMRE Reference No: MP 30/5/1/2/3/2/1 (10117) EM

October 2021

(Available in English, Zulu and Afrikaans)

INTRODUCTION

The Elders Colliery is a proposed underground coal mine located approximately 25 km north of the town of Bethal, on the R35 provincial road in the Mpumalanga Province. Anglo Operations (Pty) Ltd (AOPL) submitted an environmental authorisation application to the Mpumalanga Department of Mineral Resources (DMR) (now known as the Department of Mineral Resources and Energy (DMRE) for the project on 16 July 2015 and subsequently a Scoping Report and Environmental Management Programme (EMPr) was submitted in terms of the National Environmental Management Act (Act No. 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014. The EMPr was submitted for authority review on 25 January 2016.

AOPL submitted a section 11 application in terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) (MPRDA) to the DMR to transfer the Elders mining right from AOPL to Anglo American Inyosi Coal (Pty) Ltd (AAIC). The mining right execution, Deed of Cession and EA (DMRE Reference Number: (MP) 30/5/1/2/3/2/1/ (10117) EM) was issued on 29 July 2020.

A Water Use Licence Application (WULA) was submitted to the Department of Water and Sanitation (DWS) (now known as the Department of Human Settlements, Water and Sanitation (DHSWS)) on 2 December 2015 and approved on 13 April 2017. The WUL amendment was approved on 13 November 2017. One of the conditions of the WUL states: if the water use described in this licence is not exercised within 3 years of the date of the licence, the authorisation will be withdrawn. The extension was granted for an additional three years and it was noted that no further extension would be given should the mine not execute the water use license within the three-year period (i.e. 13 April 2023).

PURPOSE OF THIS LETTER

This document serves to provide you with information on the Elders Colliery Project and includes:

- Project background and description;
- Details on the integrated environmental authorisation process;
- Contact details of the Environmental Authorisation Practitioner (EAP);
- Invitation to register as an Interested and Affected Party (I&AP) for this project; and
- Availability of the Integrated Draft Environmental Impact Assessment Report for comment.

We enclose a Registration and Comment Form which provides I&APs with an opportunity to comment on the proposed project as well as register as an I&AP for this project. In doing so, you will be kept informed of the authorisation process, project meetings and other documentation that will become available during the authorisation process.

PROJECT DESCRIPTION

The Elders Colliery proposed to develop a new box cut to access the coal resources. The No. 2 and No. 4 coal seams will be mined by means of bord and pillar underground mining methods, making use of continuous miners and shuttle cars. The average depth at Elders Colliery is 51 m for No. 4 seam and 60 m for No. 2 seam. The planned Life of Mine (LoM) is approximately 14 years. The coal from the No. 2 and No.4 seams will be transported by trucks along the existing R35 and R542 tar roads to various coal processing facilities, for processing.

AAIC is proposing changes to the 2016 project description which includes a change in mine plan, block plan and an additional transport method for mined coal.

The proposed changes to the project scope are as follows:

- Underground mining sequencing
- Mining No. 2 and 4 Seam by means of bord and pillar mining methods using continuous miners at a slower rate
- Changes to the mine plan and block plan including:
    - Smaller boxcut (5.0365ha);
    - Ventilation shaft outside boxcut (but adjacent);
    - Interim coal loading area (temporary loading periods);
    - Road layout change to accommodate trucks; and
    - 132 kV power line layout change (main bulk supply from ESKOM)
- Loading from stockpile and trucking of ore to an existing processing facility; and
- Widening of the R35 at intersections

The Run-of-Mime Coal (RoM) from the underground workings will be loaded into bins as well as onto a RoM stockpile. An area is designated for the coal loading area. Coal mined from underground will be stored in a dual steel bin from where it will be loaded onto trucks and hauled to an existing processing facility. Overflow from the bin will be loaded directly onto trucks and will thus be cleared from the emergency coal loading area.Refer to Figure 1 for the site layout map.

PROJECT LOCATION

The Elders Colliery Project will be located on the following farms:

Farm Name	Farm Portions
Elandsfontein 75 IS	Portion 3 & 10
Geluk 226 IS	Portion 1 & 2
Halfgewonnen 190 IS	Portion RE/2, RE/3, portion of portion 4, 12/3 and 13/3
Legdaar 78 IS	Portion 5/1, 6/1, 7/1, 16/5 and 17/5
Middelkraal 50 IS	Portion RE, RE/3, 5 and 6/3, 8/3
Schurvekop 227 IS	Portion RE/7, 12/5, 13/5, 14/6, 22/10, RE/26, 27/26 and 28/26
Vlakkuilen 76 IS	Portion RE

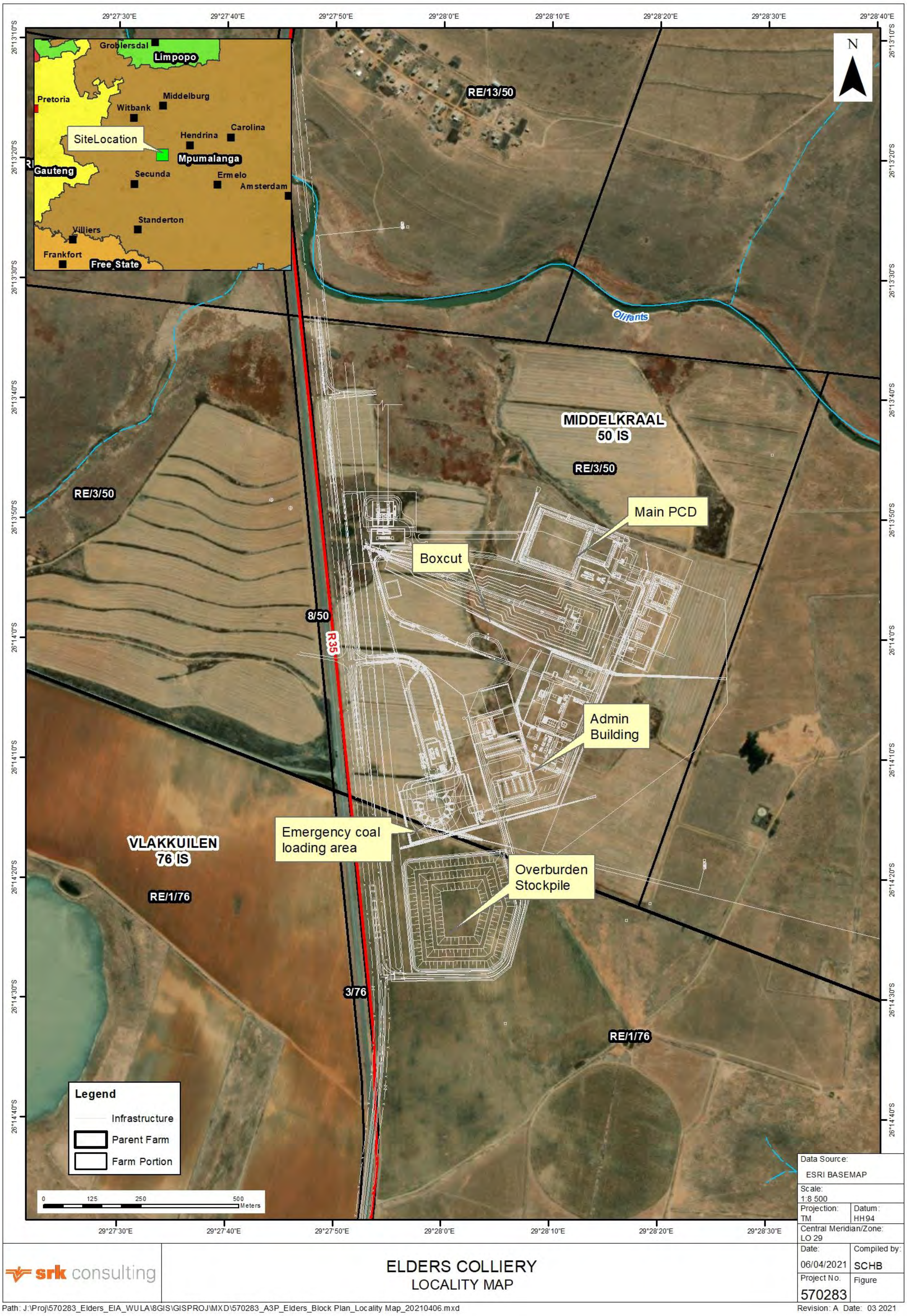


Figure 1: **Site Layout Map**

LEGAL REQUIREMENTS

Prior to AAIC commencing with the additional mining related activities, the following environmental authorisations and licences need to be undertaken in accordance with the relevant national legislation:

Scoping and Environmental Impact Assessment Reporting

The proposed changes to the Elders Colliery project description, required a Scoping and Environmental Impact Assessment Reporting (S&EIR) as well as a Regulation 31 Amendment in terms of the NEMA EIA Regulation. The proposed changes triggered the following NEMA EIA Regulation Listed Activities:

Table 1: Applicable legislation associated with the proposed changes

Name of activity	Listed activity triggered	Applicable legislation	Waste management authorisation
Change in mine plan		NEMA Section 31 application process - EMPr Amendment (Integrated into S&EIR process)	
Change in block plan layout Ventilation shaft (outside box cut) Hauling of coal with trucks via road		NEMA Section 31 application process – EMPr Amendment (Integrated into S&EIR process)	
Widening of the R35 for 2 intersections	X	NEMA Listing Notice 1(GNR 983): Activity 56 triggered	
Coal Loading Area	X	NEMA Listing Notice 1 (GNR 983): Activity 27; NEMA Listing Notice 2 (GNR 984): Activity 6 and 17; NEMA Listing Notice 3 (GNR 985): Activity 12 and 15	X (Category B Activity 10 and 11)

An Environmental Application Form was submitted for each of these process, however, based on discussions with the DMRE, it was requested that the Regulation 31 Amendment be integrated into the S&EIR process. Thus, an integrated S&EIR process is being conducted for the proposed changes.

Water Use Licence Application

A Water Use Licence Application (WULA) was submitted to the Department of Water and Sanitation (DWS) on 2 December 2015 under the National Water Act (Act No. 36 of 1998) (NWA), and approved on 13 April 2017 (WUL No. 03/B22A/ACFGIJ/5047, File No. 27/2/2/B111/11/1). The WUL amendment was approved on 13 November 2017 under the same WUL No.)

Due to the changes in the mine plan, a new WULA is being applied for under the NWA, in respect of the following water uses that will be triggered by the proposed project:

- **Section 21 (c) and (i)** water uses associated with the construction of a coal loading area within a wetland
- **Section 21 (e)** water uses associated with engaging in a controlled activity for the irrigation of land with waste or water containing waste;
- **Section 21 (f)** water use associated with an increase in volume for the authorised discharge of treated mine-water; and
- **Section 21 (g)** water uses associated with a new coal loading area and storage tank (CM tank) and increase in volume for the authorised pollution control dam and dust suppression.

The required authorisations processes will run concurrently and require the involvement of stakeholders. A public participation process will be undertaken in compliance with all relevant legislative requirements. The integrated authorisation process, timeframes and associated public participation are illustrated in Figure 2.

Independent environmental assessment practitioner

AAIC appointed SRK Consulting (South Africa) (SRK) as the independent Environmental Assessment Practitioner (EAP) to manage and facilitate the integrated environmental authorisation, water use licence application and associated public participation process in accordance with NEMA and NWA.

PRE-APPLICATION PHASE (07 December 2020)

Pre-application meeting with DMRE

Compilation of environmental application form

Submission of environmental application form to DMRE

SCOPING PHASE

Project announcement and availability of the Scoping Report for comment (30 calendar day review period from 19 May 2021 to18 June 2021)

Virtual meetings and telephonic consultations

Update comments and responses table

Update Scoping Report with stakeholder comments

Submission of the scoping report to DMRE

IMPACT ASSESSMENT PHASE

Undertake Specialist Studies

Availability of the EIA Report for comment (30 calendar day review period from 6 October 2021 to 11 November 2021)

Virtual feedback meetings

Update EIA Report with stakeholder comments

Submission of the EIA Report to DMRE

DECISION NOTIFICATION PHASE 22 November 2021 to 11 March 2022)

Notify Stakeholders of authorities' decision

Figure 2: Integrated Environmental Authorisation Process

HOW CAN YOU BE INVOLVED

You are receiving this letter as we currently have you registered in our stakeholder database as an interested and affected party (I&AP) for the Elders Colliery. If you wish to remain a registered I&AP and receive information with regards to the authorisation processes, you are invited to comment or raise any issue of concern relating to this project by completing the attached comment sheet form. Should you require more information on the proposed changes to the Elders Colliery project or the associated authorisation processes, please feel free to contact SRK at the details provided below.

I&APs are invited to register and comment on the Draft Environmental Impact Assessment Report that is available for public comment for a period of 30 calendar days from 6 October 2012 to 11 November 2021 2021.

The Integrated Draft Environmental Impact Assessment Report is available for public comment on the SRK website: https://docs.srk.co.za/en/za-elder-colliery-iea and at the following public places:

- Elders Colliery Proposed Access Road
- Bethal Public Library
- Kriel Public Library
- Komati Paypoint and Library
- Vlakkuilen Community
- Middelkraal Community
- Emalahleni Local Municipality - Kriel Offices

Your comments and suggestions on any aspect of the proposed project, including the technical and stakeholder engagement processes, will help to focus the technical studies, and will ultimately assist the authorities in their decision-making process.

If your contact information has changed, or if you know of anyone who would like to be added as an I&AP, kindly send back the attached form, either via email, post, fax or telephonically to SRK, so that we can update your information.

In terms of the WULA process, I&APS were notified of the 60-day public participation period whereby should an I&AP wish to submit written comments or objections in respect of the proposed project and associated water uses they could do so. The WULA public participation process has been completed and has subsequently closed.

Please contact the SRK Stakeholder Engagement Offices (details below) to register as an I&AP:

Ms Karabo Maruapula
Stakeholder Engagement Office
SRK Consulting, P. O. Box 55291, Northlands, 2116
Tel: (011) 441 1015
Fax: 086 230 1462
E-mail: KMaruapula@srk.co.za
srk consulting

We look forward to your participation during the integrated environmental authorisation process.

Yours faithfully,

SRK Consulting (South Africa) (Pty) Ltd

SRK Consulting - Certified Electronic Signature
srk consulting
570283/44472/Other
1564-4851-2227-MILM-05/10/2021
This signature has been printed digitally. The Author has given permission for its use for this document. The details are stored in the SRK Signature Database

Michelle Miles

Environmental Scientist, Register EAP

Integrated Environmental Authorisation for Anglo American Inyosi Coal Elders Colliery, near Bethal, Mpumalanga Province	Ms Karabo Maruapula srk consulting Tel: (011) 441 1015 Fax: 086 230 1462 E-mail: KMaruapula@srk.co.za
REGISTRATION AND COMMENT FORM	

To register as an I&AP please complete and return to Ms Maruapula (as above) by 11 November 2021.

DMRE Reference No: MP 30/5/1/2/3/2/1 (10117) EM

TITLE		**FIRST NAME**	
INITIALS		**SURNAME**	
ORGANISATION			
POSTAL ADDRESS			
		POSTAL CODE	
LAND LINE TEL NO		**CELL NO**	
FAX NO		**EMAIL**	

COMMENTS (please use separate sheets if you wish)

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THANK YOU FOR YOUR CONTRIBUTION

NAME:	**SIGNATURE:**	**DATE:**

IDOKHUMENTI YOLWAZI LWESENDLALELO NESIMEMO SOKUPHAWULA

Ukugunyazwa Okuhlanganisiwe Kwezemvelo kwe-Anglo American Inyosi Coal Elders Colliery, Eduzane naseBethal esifundazweni saseMpumalanga

Inombolo Yerefurense ye-DMRE: MP 30/5/1/2/3/2/1 (10117) EM

Okthoba 2021

ISINGENISO

I-Elders Colliery iyimayini yomgodi wamalahle ehlongozwayo esendaweni cishe ekuma-25 km enyakatho yedolobha lase-Bethal, emgwaqweni wesifundazwe u-R35 esiFundazweni saseMpumalanga. I-Anglo Operations (Pty) Ltd (AOPL) ifake isicelo sokugunyazwa ngokwezemvelo kuMnyango Wezimbiwa waseMpumalanga (Mpumalanga Department of Mineral Resources) (DMR) (manje eseyaziwa njengoMnyango Wezimbiwakanye Namandla (Department of Mineral Resources and Energy) (DMRE) ngokuphathelene nephrojekthi ngomhlaka-16 Julayi 2015 kwase kulandela Umbiko Wokuhlola Indawo kanye Nohlelo Lokwengamela Evemvelo (EMPr) okwafakwa ngokuphathelene noMthetho kaZwelonke Wokwenganyelwa Kwezemvelo (Umthetho No. 107 ka-1998) (NEMA) Ukuhlolwa Komthelela Kwezemvelo (EIA) Imithetho Eshayiwe ka-2014. I-EMPr yathunyelwa ukuba ibuyekezwe ngeziphathimandla ngomhlaka 25 Januwari 2016.

I-AOPL yathumela isicelo seSigaba 11 ngokoMthetho Wezokumbiwa Phansi kanye noPhethiloli (uMthetho No. 28 ka-2002) (MPRDA) ku-DMR ukuze kudluliswe ilungelo lezimayini le-Elders lisuke ku-AOPL liye e-Anglo American Inyosi Coal (Pty) Ltd (AAIC) . Ukwenziwa kwelungelo lezimayini, Umbhalo Wokuyeka (Deed of Cession) kanye Nokugunyazwa Kwezemvelo (Inombolo Yerefurense ye-DMRE: (MP) 30/5/1/2/3/2/1 / (10117) EM) yakhishwa ngomhlaka 29 Julayi 2020.

> **INJONGO YALE NCWADI**
>
> Le dokhumenti yenzelwe ukukunikeza imininingwane nge-Elders Colliery Project futhi ibandakanya:
>
> - Isendlalelo sephrojekthi kanye nencazelo;
> - Imininingwane ngenqubo edidiyelwe yokugunyazwa kwemvelo;
> - Imininingwane yokuxhumana yoMsebenzi Wokugunyazwa Kwezemvelo (EAP);
> - Isimemo sokubhalisa njengeQembu Elinentshisekelo Kanye Nelithintekayo (I&AP) sale phrojekthi; kanye
> - Ukutholakala Kohlaka Oludidiyelwe Lokuhlolwa Komthelela Wemvelo Umbiko okuzophawulwa ngawo.
>
> Sifaka Ifomu Lokubhalisa Nelokuphawula elinikeza ama-I & AP ithuba lokubeka imibono ngeprojekthi ehlongozwayo kanye nokubhaliswa njenge-I & AP yale phrojekthi. Ngokwenza njalo, uzokwaziswa ngenqubo yokugunyazwa, imihlangano yephrojekthi namanye amadokhumenti azotholakala ngesikhathi senqubo yokugunyazwa.

Isicelo Selayisense Yokusebenzisa Amanzi (WULA) sathunyelwa eMnyangweni Wezamanzi Nokuthuthwa Kwendle (i-DWS) (manje esaziwa njengoMnyango Wezokuhlaliswa Kwabantu, Amanzi Nenhlanzeko (i-DHSWS)) ngomhlaka 2 Disemba 2015 futhi samukelwa ngomhlaka 13 Ephreli 2017. Ukuchitshiyelwa kwe-WUL kwamukelwa ngomhlaka 13 Novemba 2017. Omunye wemibandela ye-WUL uthi: uma ukusetshenziswa kwamanzi okuchazwe kule layisense kungasetshenziswanga kungakapheli iminyaka emithathu kusukela ngosuku lwelayisense, ukugunyazwa kuzohoxiswa. Ukunwetshwa kwanikezwa iminyaka emithathu eyengeziwe futhi kwaphawulwa ukuthi ngeke kuselulwa esinye isikhathi uma imayini ingasebenzisi ilayisense yokusebenzisa amanzi esikhathini esiyiminyaka emithathu (isb. 13 Ephreli 2023).

INCAZELO YEPROJEKTHI

I-Elders Colliery ihlongoze ukusika i-box cut entsha ukuze ithole izinsiza zamalahle. Imigqa yamalahle engu-2 no-4 izombiwa ngokusebenzisa ama-bord nezinsika izindlela zokumba ngaphansi komhlaba, kusetshenziswa abavukuzi abaqhubekayo nezimoto ezihamba ngomgwaqo. Isilinganiso sokujula e-Elders Colliery singama-51 m ku-No 4 seam kanye no-60 m ku-No.2 seam. Iminyaka Yokusebenza Kwemayini (Life of Mine) (LoM) ehleliwe icishe ibe yiminyaka eyi-14. Amalahle aqhamuka ngaphansi kwemigqa engu-2 no-No.4 azothuthwa ngamaloli emigwaqeni ekhona engu-R35 no-R542 yetiyela ezindaweni ezahlukahlukene zokulungiswa kwamalahle, ukuze ayocutshungulwa.

I-AAIC iphakamisa izinguquko encazelweni yephrojekthi yango-2016 okubandakanya ushintsho kuhlelo lwezimayini, uhlelo lwebhulokhi kanye nangezinye izindlela zokuthutha amalahle embiwe.

Izinguquko ezihlongozwayo ebubanzini bephrojekthi zimi kanje:

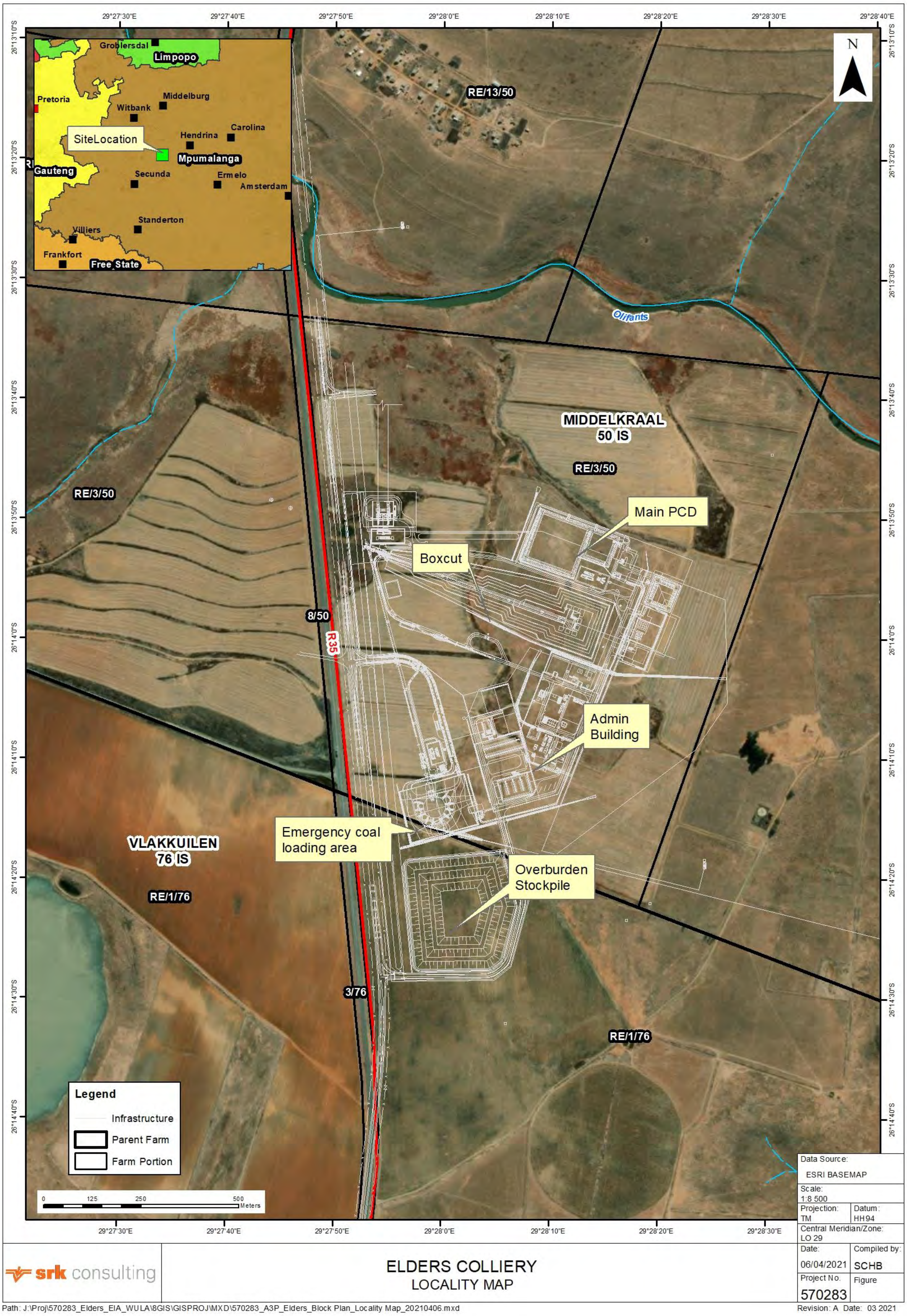
- Ukulandelana kwezimayini ezingaphansi komhlaba
- Izimayini ezingunombolo 2 no-4 Seam ngokusebenzisa izindlela zezimayini ze-bord nezinsika kusetshenziswa abavukuzi abaqhubekayo ngesilinganiso esincane
- Izinguquko ohlelweni lwezimayini nohlelo lokuvimba kufaka:
  - I-boxcut encane (5.0365ha),
  - Umshini wokungenisa umoya ngaphandle kwe-boxcut (kodwa eliseduze),
  - Indawo yesikhashana yokulayisha amalahle (izikhathi zokulayisha okwesikhashana),
  - Kushintsho lokuhlelwa komgwaqo ukuhlalisa amaloli, kanye
  - Noshintsho lwesakhiwo sezintambo zikagesi ezingu-132 kV (okuphakelayo ngakuningi okuyinhloko okuvela kwa-ESKOM)
- Ukulayishwa kusuka ekugcinweni kwesitoko kanye nokuthuthwa kwensimbi kuye esakhiweni esivele sisebenza; futhi
- Ukunwetshwa kuka-R35 ezimpambanweni zomgwaqo

I-Run-of-Mime Coal (RoM) evela ekusebenzeni komhlaba izolayishwa emigqonyeni kanye nasetokweni se-RoM. Indawo iqokelwe indawo yokulayisha amalahle. Amalahle ambiwa ngaphansi komhlaba azogcinwa emgqonyeni wensimbi ombaxambili lapho ezolayishwa khona emalolini bese eyiswa endaweni esetshenziswayo ekhona. Okuchichimayo okuvela emgqonyeni kuzolayishwa ngqo emalolini futhi ngaleyo ndlela kuzosuswa endaweni yokulayisha amalahle aphuthumayo. Bhesa Umdwebo 1 ngemephu yesakhiwo sesiza.

INDAWO YEPHROJEKTHI

I-Elders Colliery Project izoba semapulazini alandelayo:

Igama Lepulazi	Izingxenye Zamapulazi
Elandsfontein 75 IS	Ingxenye 3 no-10
Geluk 226 IS	Ingxenye 1 no-2
Halfgewonnen 190 IS	Ingxenye RE/2, RE/3, ingxenye yengxenye 4, 12/3 no-13/3
Legdaar 78 IS	Ingxenye 5/1, 6/1, 7/1, 16/5 no-17/5
Middelkraal 50 IS	Ingxenye RE, RE / 3, 5 no-6/3, 8/3
Schurvekop 227 IS	Ingxenye RE / 7, 12/5, 13/5, 14/6, 22/10, RE/26, 27/26 no-28/26
Vlakkuilen 76 IS	Ingxenye RE



Umdwebo 1: Ibalazwe Lesakhiwo Sendawo

IZIDINGO ZEZOMTHETHO

Ngaphambi kokuthi i-AAIC iqale ngemisebenzi eyengeziwe ephathelene nezimayini, ukugunyazwa kwezemvelo okulandelayo kanye namalayisense kumele kwenziwe ngokulandela umthetho kazwelonke ofanele:

Inqubo Yokubika Umphumela Wokuhlola kanye Nokubika Umthelela Wezemvelo

Izinguquko ezihlongozwayo encazelweni yephrojekthi ye-Elders Colliery, zazidinga iScoping kanye neRegital Impact Assessment Reporting (S & EIR) kanye nokuchibiyelwa koMthethonqubo 31 ngokoMthethonqubo we-NEMA EIA. Izinguquko ezihlongozwayo zidale le Misebenzi Esohlwini Lokulawulwa Komthetho we-NEMA EIA:

Ithebula 1: Umthethonqubo osebenzayo ohlotshaniswa nezinguquko ezihlongozwayo

Igama lomsebenzi	Imisebenzi efakwe kuhlu ibangele	Umthethonqubo osebenzayo	Ukugunyazwa kokwenganyelwa kwemfucuza
Ushintsho kuhlelo lwemayini		Inqubo yokufaka isicelo se-NEMA Isigaba 31-Ukuchitshiyelwa kwe-EMPr (Kuhlanganiswe nenqubo ye-S & EIR)	
Ushintsho ekuhlelweni kwepulani I-shaft yokungenisa umoya (ukusika ibhokisi langaphandle) Ukuhanjiswa kwamalahle ngamaloli ngomgwaqo		Inqubo yokufaka isicelo se-NEMA Isigaba 31-Ukuchitshiyelwa kwe-EMPr (Kuhlanganiswe nenqubo ye-S & EIR)	
Ukunwetshwa kuka-R35 ezimpambanweni zomgwaqo ezi-2	X	Isaziso Sokufakwa Kuhlu se-NEMA 1(GNR 983): Umsebenzi 56 uqalile	
Indawo Yokulayisha Amalahle	X	Isaziso Sokufakwa Kuhlu se-NEMA 1(GNR 983): Umsebenzi 27; Isaziso Sokufakwa Kuhlu se-NEMA 2(GNR 984): Umsebenzi 6 no-17; Isaziso Sokufakwa Kuhlu se-NEMA 3(GNR 985): Umsebenzi we-12 no-15	X (Isigaba B Umsebenzi 10 no-11)

Ifomu Lokufaka Isicelo Sezemvelo lalethwa kuleyo naleyo nqubo, kepha, ngokususelwa ezingxoxweni ne-DMRE, kwacelwa ukuthi Ukuchitshiyelwa koMthethonqubo 31 kuhlanganiswe nenqubo ye-S&EIR. Ngakho-ke, kwenziwa inqubo edidiyelwe ye-S&EIR yezinguquko ezihlongozwayo.

Isicelo Selayisense Yokusebenzisa Amanzi

Isicelo Selayisense Yokusebenzisa Amanzi (WULA) safakwa eMnyangweni Wezamanzi Nokuthuthwa Kwendle (DWS) ngomhlaka 2 Disemba 2015 ngaphansi koMthetho Kazwelonke Wamanzi (Umthetho No. 36 ka-1998) (NWA), futhi savunywa ngomhlaka 13 Ephreli 2017 (WUL 03 / B22A / ACFGIJ / 5047, Ifayela No. 27/2/2 / B111 / 11/1). Ukuchitshiyelwa kwe-WUL kwamukelwa ngomhlaka 13 Novemba 2017 ngaphansi kwe-WUL No. efanayo.)

Ngenxa yezinguquko ohlelweni lwezimayini, kufakwa isicelo se-WULA entsha ngaphansi kwe-NWA, maqondana nokusetshenziswa kwamanzi okulandelayo okuzobangelwa yiphrojekthi ehlongozwayo:

- **Isigaba 21 (c) no- (i)** ukusetshenziswa kwamanzi okuhambisana nokwakhiwa kwendawo yokulayisha amalahle ngaphakathi kwexhaphozi
- **Isigaba 21 (e)** ukusetshenziswa kwamanzi okuhambisana nokubandakanya umsebenzi olawulwayo wokunisela umhlaba ngodoti noma ngamanzi aqukethe udoti;
- **Isigaba 21 (f)** ukusetshenziswa kwamanzi okuhambisana nokukhuphuka kwevolumu yokukhishwa okugunyaziwe kwamanzi emayini ahlanjululiwe; kanye
- **Isigaba 21 (g)** ukusetshenziswa kwamanzi okuhambisana nendawo entsha yokulayisha amalahle kanye nethangi lesitoreji (i-CM tank), nokukhuphula ivolumu yedamu eligunyaziwe lokulawula ukungcola nokucindezelwa kothuli.

Izinqubo ezidingekayo zokugunyazwa zizosebenza ngasikhathi sinye futhi zidinga ukubandakanyeka kwababambiqhaza. Inqubo yokubamba iqhaza komphakathi izokwenziwa ngokuhambisana nazo zonke izidingo zomthetho ezifanele. Inqubo edidiyelwe yokugunyazwa, izikhathi ezibekiwe kanye nokuzibandakanya komphakathi okuhambisana nakho kukhonjisiwe kuMdwebo 2.

Isisebenzi sokuhlola imvelo esizimele

I-AAIC iqoke i-SRK Consulting (South Africa) (i-SRK) njengoMsebenzi oZimele wokuHlola ezeMvelo (EAP) ukuphatha nokusiza ukugunyazwa kwezemvelo okuhlangene, i-WULA kanye nenqubo ehambisanayo yokubamba iqhaza komphakathi ngokuya nge-NEMA ne-NWA.

ISIGABA SANGAPHAMBI KOKUFAKWA KWESICELO (07 Disemba 2020)

Umhlangano wangaphambi kokufakwa kwesicelo ne-DMRE

Ukuhlanganiswa kwefomu lezemvelo

Ukufakwa kwefomu lesicelo sezemvelo ku-DMR

ISIGABA SOKUHLOLWA KWENDAWO

Ukumenyezelwa kwephrojekthi kanye nokutholakala koMbiko Wokuhlolwa Kwendawo ukuze kuphawulwe ngawo (izinsuku zekhalenda ezingama-30 zokubuyekeza kusukela mhlaka-19 Meyi 2021 ukuya mhlaka 18 Juni 2021)

Imihlangano yaku-inthanethi kanye nokudingida ngocingo

Ukufakwa kwemininingwane yokuphawula kanye nezimpendulo ethebuleni

Ukufakwa Kwemininingwane Yakamuva Yokuhlolwa Kwendawo enokuphawula kwababambiqhaza

Ukufakwa kombiko wokuhlolwa kwendawo ku-DMR

ISIGABA SOKUHLOLWA KOMTHELELA

Ukwenziwa Kwezingcwaningo Zongoti

Ukutholakala Kombiko Womthelela Kwezemvelo (EIA Report) ukuze kuphawulwe ngawo (izinsuku zekhalenda ezingama-30 zokubuyekeza kusukela ngomhlaka 6 Okthoba 2021 ukuya ngomhlaka 11 November 2021)

Imihlangano yembiyisambiko ku-inthanethi

Ukufakwa Kwemininingwane Yakamuva Yombiko Womthelala Kwezemvelo enokuphawula kwababambiqhaza

Ukufakwa Kombiko Womthelela Kwezemvelo ku-DMRE

ISIGABA SOKWAZISWA NGESINQUMO

(Ngomhlaka-22 November 2021 ukuya kumhlaka-11 March 2022)

Ukwaziswa Kwababambiqhaza mayelana nesinqumo seziphathimandla

Umdwebo 2: Imininingwane Yenqubo Edidiyelwe Yokugunyazwa Kwemvelo

UNGABANDAKANYEKA KANJANI

Uthola le ncwadi njengoba njengamanje sikubhalisile kusizindalwazi sethu sababambiqhaza njengeqembu elinentshisekelo nelithintekayo (I&AP) le-Elders Colliery. Uma ufisa ukuhlala uyi-I&AP ebhalisiwe futhi uthola ulwazi maqondana nezinqubo zokugunyazwa, uyamenywa ukuba uphawule noma uphakamise noma yikuphi ukukhathazeka okuphathelene nale phrojekthi ngokugcwalisa ifomu lephepha lamazwana elinamathiselwe. Uma kwenzeka udinga ulwazi olwengeziwe ngezinguquko ezihlongozwayo kuphrojekthi ye-Elders Colliery noma ngezinqubo ezihambisana nokugunyazwa, sicela ukhululeke ukuxhumana ne-SRK ngemininingwane enikezwe ngezansi.

Amaqembu Anentshisekelo Nathintekayo (Ama-I & APs) ayamenywa ukuthi abhalise futhi aphawule ngombiko Owuhlaka Wokuhlolwa Kokuthinteka Kwezemvelo okutholakala ukuze umphakathi uphawule ngawo isikhathi esiyizinsuku ezingama-30 zekhalenda kusukela ngomhlaka 6 Okthoba 2021 ukuya ngomhlaka 11 November 2021.

Umbiko Owuhlaka Wokuhlolwa Kokuthinteka Kwemvelo uyatholakala kuwebhusayithi ye-SRK: https://docs.srk.co.za/en/za-elder-colliery-iea nasezindaweni ezilandelayo zomphakathi:

- Umgwaqo Ohlongozwayo Wokungena e-Elders Colliery
- Umtapo Wezincwadi Womphakathi waseBethal
- Umtapo Wezincwadi Womphakathi waseKriel
- I-Komati Paypoint kanye noMtapo Wezincwadii
- Umphakathi waseVlakkuilen
- Umphakathi waseMiddelkraal
- UMasipala Wendawo Emalahleni - Amahhovisi aseKriel

Ukuphawula kwakho neziphakamiso zakho kunoma yisiphi isici sephrojekthi ehlongozwayo, kufaka phakathi izinqubo zobuchwepheshe kanye nababambiqhaza, kuzosiza ukugxila ezifundweni zobuchwepheshe, futhi ekugcineni kuzosiza iziphathimandla enqubweni yazo yokwenza izinqumo.

Uma imininingwane yakho yokuxhumana ishintshile, noma uma wazi noma ngubani ongathanda ukwengezwa njenge-I&AP, ngomusa uthumele ifomu elinamathiselwe, kungaba nge-imeyili, ngeposi, ngefeksi noma ngocingo ku-SRK, ukuze sivuselele imininingwane yakho.

Ngokwenqubo ye-WULA, ama-I&APS aziswa ngesikhathi sokubamba iqhaza komphakathi kwezinsuku ezingama-60 lapho i-I&AP ifisa ukuletha imibono ebhaliwe noma ukuphikisa maqondana nephrojekthi ehlongozwayo kanye nokusetshenziswa kwamanzi okuhambisanayo abangakwenza lokho. Inqubo yokubamba iqhaza komphakathi ye-WULA isiqediwe futhi ngemuva kwalokho ivaliwe.

Uyacelwa ukuthi uthinte Amahhovisi Okubandakanywa Kwababambiqhaza e-SRK (imininingwane engezansi) ukuze ubhalise njengeQembu Elinentshisekelo kanye Nelithintekile (I & AP) futhi uhlinzeke ukuphawula Embikweni Owuhlaka Wokuhlelwa Kwezemvelo:

UNksz. Karabo Maruapula
Ihhovisi Lokubandakanya Ababambiqhaza
SRK Consulting, P. O. Box 55291, Northlands, 2116
Ucingo:(011) 441 1015,
Ifeksi: 086 230 1462
I-imeyili: KMaruapula@srk.co.za
srk consulting

Silangazelele ukubamba iqhaza kwakho ngesikhathi kuhlanganiswa inqubo yokugunyazwa kwemvelo.

Ozithobayo,

SRK Consulting (South Africa) (Pty) Ltd

SRK Consulting - Certified Electronic Signature
srk consulting
570283/44472/Other
9128-3962-716-MILM-05/10/2021
This signature has been printed digitally. The Authoriser has given permission for its use for this document. The details are stored in the SRK Signature Database

Michelle Miles

Omkhulu Wezemvelo, Obhalisa i-EAP

Ukugunyazwa Okuhlanganisiwe Kwezemvelo kwe-Anglo American Inyosi Coal Elders Colliery, eduzane naseBethal esifundazweni saseMpumalanga	UNksz. Karabo Maruapula srk consulting Ucingo: (011) 441 1015 Ifeksi: 086 230 1462 I-imeyli: KMaruapula@srk.co.za
IFOMU LOKUBHALISA NELOKUPHAWULA	

Ukuze ubhalise njenge-I&AP sicela ugcwalise bese ubuyisela kuNksz. Maruapula (njengasenhla) ngomhlaka 11 November 2021 .

Inombolo Yerefurense ye-DMRE: MP 30/5/1/2/3/2/1 (10117) EM

ISIHLOKO		IGAMA	
AMA-INISHIYALI		ISIBONGO	
INHLANGANO			
IKHELI LEPOSI			
		IKHOWUDI YEPOSI	
INOMBOLO YOCINGO LWASENDLINI		INOMBOLO YESELULA	
INOMBOLO YEFEKSI		I-IMEYLI	

UKUPHAWULA (sicela usebenzise amaphepha ahlukile uma ufisa kanjalo)

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SIYABONGA NGEGALELO LAKHO

IGAMA:	ISIGINESHA:	USUKU:

AngloAmerican

srk consulting

AGTERGRONDINLIGTINGSDOKUMENT EN UITNODIGING OM KOMMENTAAR TE LEWER

Geïntegreerde omgewingsmagtiging vir Anglo American Inyosi Coal Elders-steenkoolmyn naby Bethal in die Mpumalanga-provinsie

DMRE-Verwysingsnommer: MP 30/5/1/2/3/2/1 (10117) EM

Oktober 2021

(Beskikbaar in Engels, Zulu en Afrikaans)

INLEIDING

Die Elders-steenkoolmyn is 'n beplande ondergrondse steenkoolmyn geleë ongeveer 25 kilometer noord van die dorp Bethal op die R35-provinsiale pad in die Mpumalanga-provinsie. AOPL het 'n artikel 11-aansoek ingevolge die Wet op Ontwikkeling van Minerale en Petroleumhulpbronne (Wet 28 van 2002) (MPRDA) by die DMR ingedien om die Elders-mynreg van AOPL na Anglo American Inyosi Coal (Pty) Ltd (AAIC) oor te dra. Die uitvoering van die mynreg, sederingsakte en omgewingsmagtiging (DMRE-verwysingsnommer (MP) 30/5/1/2/3/2/1/ (10117) EM) is op 29 Julie 2020 vir magtigingshersiening ingedien.

AOPL het 'n artikel 11-aansoek ingevolge die Wet op Ontwikkeling van Minerale en Petroleumhulpbronne (Wet 28 van 2002) (MPRDA) by die DMR ingedien om die Elders-mynreg van AOPL na Anglo American Inyosi Coal (Pty) Ltd (AAIC) oor te dra. Die uitvoering van die mynreg, die sederingsakte en die omgewingsmagtiging (DMRE-verwysingsnommer (MP) 30/5/1/2/3/2/1/ (10117) EM) is op 29 Julie 2020 vir magtigingshersiening ingedien.

'n Aansoek om 'n watergebruikslisensie (WULA) is op 2 Desember 2015 by die Departement van Water en Sanitasie (DWS) (tans bekend as die Departement van Menslike Nedersettings, Water en Sanitasie (DHSWS)) ingedien en goedgekeur op 13 April 2017. Die WUL- wysiging is goedgekeur op 13 November 2017. Een van die voorwaardes van die WUL lui: Indien die watergebruik wat in hierdie lisensie beskryf word, nie binne drie jaar na die datum van die lisensie benut word nie, word die magtiging ingetrek. Die verlenging is vir nog drie jaar toegestaan en daar is aangeteken dat geen verdere verlenging gegee sou word as die myn nie die watergebruikslisensie binne die driejaarperiode (dit is, teen 13 April 2023) sou gebruik nie.

DOEL VAN HIERDIE BRIEF

Hierdie dokument dien as inligting oor die Elders-steenkoolmynprojek en sluit in:

- Projekagtergrond en -beskrywing;
- Besonderhede van die geïntegreerde proses vir omgewingsmagtiging;
- Kontakbesonderhede van die omgewingsmagtigingspraktisyn (EAP);
- Uitnodiging om as 'n belanghebbende en geaffekteerde party (I&AP) vir hierdie projek te registreer; en
- beskikbaarheid van die konsepverslag oor omgewingsimpak vir openbare kommentaar.

Ons sluit 'n registrasie- en kommentaarvorm in. Dit bied I&APs die geleentheid om kommentaar te lewer op die voorgestelde projek en om as I&AP te registreer. Sodoende sal u op hoogte gehou word van die magtigingsproses, projekvergaderings en ander dokumentasie wat tydens die magtigingsproses beskikbaar sal wees.

PROJEKBESKRYWING

Die Elders-steenkoolmyn is van voornemens om 'n nuwe opening te sny vir toegang tot die steenkoolhulpbronne. Die nommer 2-steenkoollaag en nommer 4-steenkoollaag sal ontgin word met ondergrondse kamer-en-pilaar-mynboumetodes deur aaneendelwers en wisselvoerders te gebruik. Die gemiddelde diepte by die Elders-steenkoolmyn is 51 meter vir die nommer 4-steenkoollaag en 60 meter vir die nommer 2-steenkoollaag. Die beplande leeftyd van die myn (LoM) is ongeveer 14 jaar. Die steenkool uit die nommer 2-steenkoollaag en die nommer 4-steenkoollaag sal met vragmotors langs die bestaande R35- en R542-teerpaaie na verskillende steenkoolverwerkingsgeriewe vervoer word vir verwerking.

AAIC is van voornemens om veranderinge aan te bring aan die 2016-projekbeskrywing wat 'n verandering aan die mynplan, blokplan en 'n addisionele vervoermetode vir ontginde steenkool insluit.

Die voorgestelde veranderinge aan die projekomvang is soos volg:

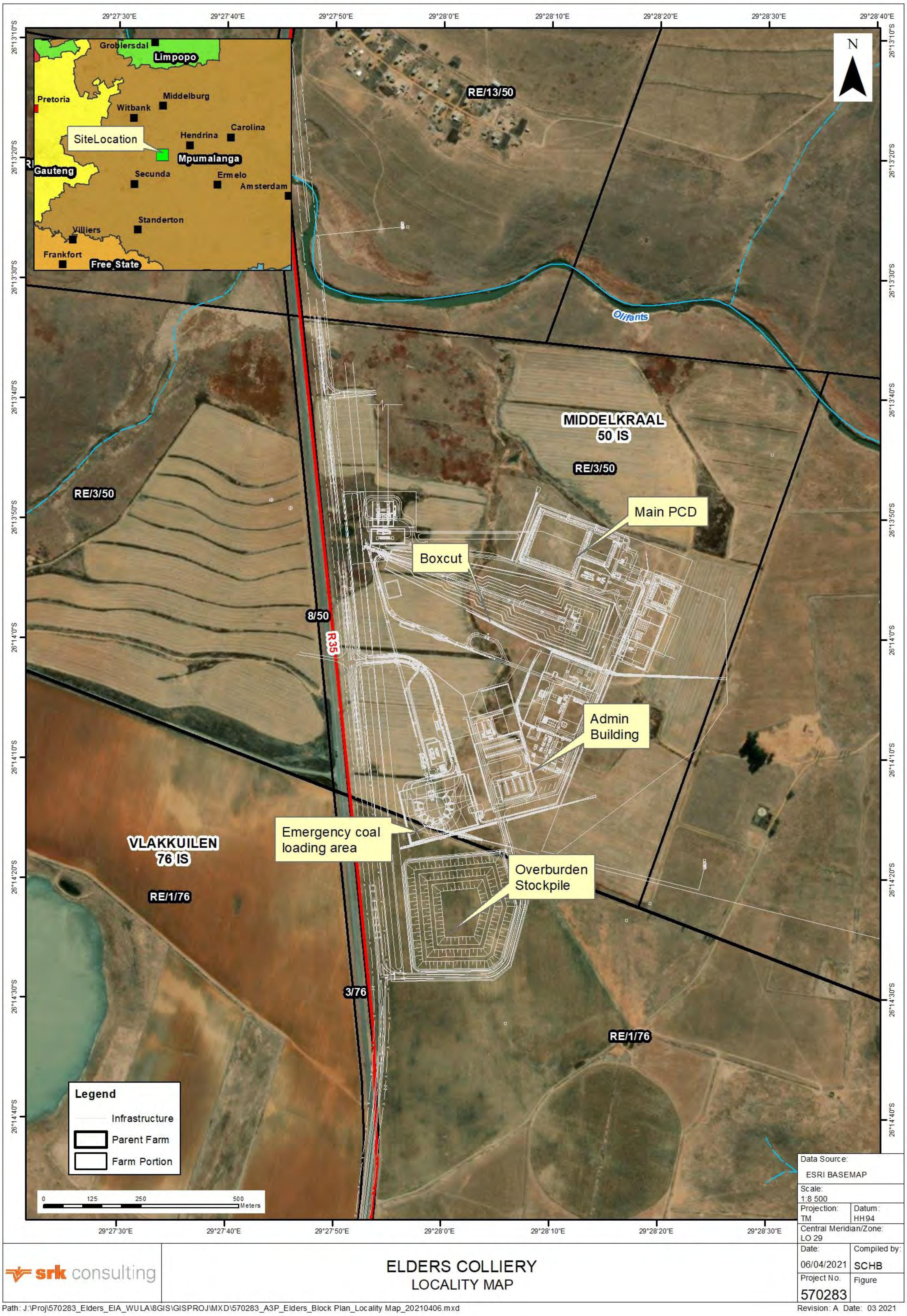
- Ondergrondse mynbouvolgorde
- Ontginning van nommer 2- en nommer 4-steenkoollaag deur kamer-en pilaar-mynboumetodes met aaneendelwers teen 'n stadiger tempo;
- Veranderinge aan die mynplan en blokplan, ingesluit:
  - Kleiner toegangsopening (5.0365 ha);
  - Ventilasieskag buite die toegangsopening (maar aangrensend);
  - Interim steenkoollaaigebied (tydelike laaitye);
  - Paduitlegverandering om vragmotors te akkommodeer; en
  - 132 kV-kraglynuitleguitleg (hoofvoorraad van ESKOM).
- Laai van voorraad en vervoer van erts na 'n bestaande verwerkingsfasiliteit; en
- Verbreding van R35 by kruisings.

Die ongegradeerde/ru steenkool (RoM) uit die ondergrondse bewerking sal in bakke en op 'n RoM-voorraadopstapeling gelaai word. 'n Gebied is aangewys vir die steenkool-laaigebied. Steenkool wat ondergronds ontgin word, sal in 'n dubbelstaalbak gestoor word waarvandaan dit op vragmotors gelaai en na 'n bestaande verwerkingsfasiliteit vervoer sal word. Oorvloei uit die staalbak word direk op vragmotors gelaai en sal dus uit die noodsteenkool-laaigebied verwyder word. Sien Figuur 1 vir die terreinuitlegkaart.

PROJEKLIGGING

Die Elders-steenkoolmyn-projek sal geleë wees op die volgende plase:

Naam van plaas	Gedeelte van plaas
Elandsfontein 75 IS	Gedeelte 3 & 10
Geluk 226 IS	Gedeelte 1 & 2
Halfgewonnen 190 IS	Gedeelte RE/2, RE/3, gedeelte van gedeelte 4, 12/3 en 13/3
Legdaar 78 IS	Gedeelte 5/1, 6/1, 7/1, 16/5 en 17/5
Middelkraal 50 IS	Gedeelte RE, RE/3, 5 en 6/3, 8/3
Schurvekop 227 IS	Gedeelte RE/7, 12/5, 13/5, 14/6, 22/10, RE/26, 27/26 en 28/26
Vlakkuilen 76 IS	Gedeelte RE



Figuur 1: **Terreinuitlegkaart**

WETLIKE VEREISTES

Voordat AAIC met die addisionele mynbouverwante aktiwiteite begin, moet die volgende omgewingsmagtigings en lisensies onderneem word in ooreenstemming met die relevante nasionale wetgewing:

Omvangsbepalings en omgewingsimpak-assesseringverslagdoening

Die beplande veranderings aan die beskrywing van die Elders-steenkoolmynprojek het ’n verslagdoening vereis van die omvang en omgewingsimpak (S&EIR) en 'n regulasie 31-wysiging ingevolge die NEMA EIA-regulasie. Die beplande veranderings het aanleiding gegee tot die volgende NEMA EIA-regulasie gelyste aktiwiteite:

Tabel 1: Toepaslike wetgewing geassosieer met die beplande veranderinge

Naam van of aktiwiteit	Gelyste aktiwiteit veroorsaak	Tersaaklike wetgewing	Afvalbestuur-magtiging
Verandering in mynplan		NEMA-artikel 31-aansoekproses – EMPr-Wysiging (geïntegreer in S&EIR-proses)	
Verandering in blokplanuitleg Ventilasieskag (buite-opening) Vervoer van steenkool met vragmotors per pad		NEMA-artikel 31-aansoekproses – EMPr-Wysiging (geïntegreer in S&EIR-proses)	
Verwyding van die R35 vir 2 kruisings	X	NEMA-Lystingskennisgewing 1 (GNR 983): Aktiwiteit 56 veroorsaak	
Steenkoollaaigebied	X	NEMA-Lystingskennisgewing 1 (GNR 983): Aktiwiteit 27; NEMA-Lystingskennisgewing 2 (GNR 984): Aktiwiteit 6 en 17; NEMA-Lystingskennisgewing 3 (GNR 985): Aktiwiteit 12 en 15	X (Kategorie B Aktiwiteit 10 en 11)

'n Omgewingsaansoekvorm is vir elk van hierdie prosesse ingedien. Op grond van gesprekke met die DMRE is daar egter versoek dat die wysiging van regulasie 31-verandering in die S&EIR-proses geïntegreer word. Dus word 'n geïntegreerde S&EIR-proses uitgevoer vir die beplande veranderinge.

Watergebruiklisensie-aansoek

'n Watergebruiklisensie-aansoek (WULA) is op 2 Desember 2015 ingevolge die Nasionale Waterwet (Wet 36 van 1998) (DWS) by die Departement van Water en Sanitasie (DWS) ingedien en goedgekeur op 13 April 2017 (WUL-nommer 03/B22A/ACFGIJ/5047, lêernommer 27/2/2/B111/11/1). Die WUL-wysiging is op 13 November 2017 goedgekeur onder dieselfde WUL-nommer).

As gevolg van die veranderinge in die mynplan, word 'n nuwe WULA ingevolge die NWA aangevra ten opsigte van die volgende watergebruike wat deur die voorgestelde projek veroorsaak sal word:

- **Artikel 21 (c) en (i)** -watergebruik geassosieer met die konstruksie van ’n steenkoollaaigebied in ’n vleiland;
- **Artikel 21 (e)** -watergebruik geassosieer met betrokkenheid in 'n beheerde aktiwiteit vir die besproeiing van grond met afval of water wat afval bevat;
- **Artikel 21 (f)** -watergebruik geassosieer met ’n toename in volume vir die gemagtigde afvoer van behandelde mynwater; en
- **Artikel 21 (g)** -watergebruik geassosieer met 'n nuwe steenkool-laaigebied en opgaartenk (CM-tenk), en toename in volume vir die gemagtigde besoedelingskontroledam en stofonderdrukking.

Die vereiste magtigingsprosesse sal gelyktydig verloop en vereis die betrokkenheid van belanghebbendes. 'n Openbare deelnameproses sal uitgevoer word in ooreenstemming met alle relevante wetlike vereistes. Die geïntegreerde magtigingsproses, tydraamwerke en gepaardgaande openbare deelname word in Figuur 2 geïllustreer.

Onafhanklike omgewingsassesseringspraktisyn

AAIC het SRK Consulting (South Africa) (SRK) aangestel as die onafhanklike omgewingsassesseringspraktisyn (EAP) om die geïntegreerde omgewingsmagtiging, aansoek om lisensie vir watergebruik en gepaardgaande openbare deelnameproses te bestuur en te fasiliteer in ooreenstemming met NEMA en NWA.

PRE-APPLIKASIEFASE (07 Desember 2020)

Pre-applikasie-ontmoeting met DMRE

Samestelling van omgewingsaansoekvorm

Voorlegging van omgewingsaansoekvorm aan DMR

BESTEKFASE

Projekbekendstelling en beskikbaarheid van die bestekverslag vir kommentaar (30 kalenderdae van 19 Mei 2021 tot 18 Junie 2021)

Virtuele ontmoetings en telefoniese konsultasies

Opdatering van tabel vir kommentaar en response

Opdatering van die bestekverslag met belanghebbendes se kommentaar

Indiening van die bestekverslag aan DMRE

IMPAKASSESSERINGSFASE

Onderneem spesialisstudies

Beskikbaarheid van die EIA-verslag vir kommentaar (30 kalenderdaehersieningstydperk van 6 Oktober 2021 tot 11 November 2021)

Virtuele terugvoervergaderings

Opdatering van EIA-verslag met belanghebbers se kommentaar

Indiening van die EIA-verslag aan DMRE

BESLUITKENNISGEWINGSFASE

(22 November 2021 tot 11 March 2022)

Stel belanghebbers in kennis van owerhede se besluit

Figuur 2: Geïntegreerde proses vir omgewingsmagtiging

HOE U BETROKKE KAN WEES

U ontvang hierdie brief aangesien ons u tans op ons databasis van belanghebbendes geregistreer het as 'n belanghebbende en geaffekteerde party (I&AP) vir die Elders-steenkoolmyn. As u 'n geregistreerde I&AP wil bly en inligting oor die magtigingsprosesse wil ontvang, word u uitgenooi om kommentaar te lewer of enige kwessie omtrent hierdie projek aan die orde te stel deur die aangehegte kommentaarvorm in te vul. As u meer inligting benodig oor die voorgestelde veranderings aan die Elders-steenkoolmynprojek of die gepaardgaande magtigingsprosesse, kontak gerus SRK by die onderstaande besonderhede.

I&AP's word uitgenooi om te registreer en kommentaar te lewer op die konsep-omgewingsimpakassesseringsverslag vir wat vir openbare kommentaar beskikbaar is vir 'n tydperk van 30 kalenderdae vanaf 6 Oktober 2012 tot 11 November 2021.

Die geïntegreerde konsep-omgewingsimpakassesseringsverslag is beskikbaar vir openbare kommentaar op die SRK-webblad https://docs.srk.co.za/en/za-elder-colliery-ieaen en by die volgende openbare plekke:

- Elders-steenkoolmyn voorgestelde toegangspad
- Bethal Openbare Biblioteek
- Kriel Openbare Biblioteek
- Komati-betaalpunt en -biblioteek
- Vlakkuilen-gemeenskap
- Middelkraal-gemeenskap
- Emalahleni Plaaslike Munisipaliteit – Kriel-kantoor

U kommentaar en voorstelle oor enige aspek van die voorgestelde projek, ingesluit die tegniese en belanghebbende prosesse, sal help om die tegniese studies te fokus, en sal uiteindelik die owerhede help met hulle besluitnemingsproses.

As u kontakinligting verander het, of as u weet van iemand wat as 'n I&AP bygevoeg wil word, stuur die aangehegte vorm per e-pos, pos, faks of telefonies na SRK sodat ons u inligting kan opdateer.

Ingevolge die WULA-proses is I&AP's in kennis gestel van die tydperk van 60 dae vir openbare deelname waardeur 'n I&AP skriftelike kommentaar of besware kan indien ten opsigte van die voorgestelde projek en gepaardgaande watergebruik. Die WULA-proses vir openbare deelname is voltooi en is vervolgens gesluit.

Kontak asseblief die SRK Kantoor vir Belanghebbersbetrokkenheid (besonderhede hier onder) om as 'n I&AP te registreer:

Ms Karabo Maruapula
Kantoor vir Belanghebbersbetrokkenheid
SRK Consulting, Posbus 55291, Northlands, 2116
Tel: (011) 441 1015
Faks: 086 230 1462
E-pos: KMaruapula@srk.co.za
srk consulting

Ons sien uit na u deelname tydens die geïntegreerde proses vir omgewingsmagtiging.

Die uwe,

SRK Consulting (South Africa) (Pty) Ltd

Natasha Anamuthoo

Senior Omgewingswetenskaplike Register EAP

Geïntegreerde omgewingsmagtiging vir Anglo American Inyosi Coal Elders-steenkoolmyn naby Bethal in die Mpumalanga-provinsie	Me Karabo Maruapula srk consulting Tel: (011) 441 1015 Faks: 086 230 1462 E-pos: KMaruapula@srk.co.za
REGISTRASIE- EN KOMMENTAARVORM	

Om as 'n I&AP te registreer, voltooi asseblief en stuur en stuur terug aan Me Maruapula (soos hier bo) teen 11 November 2021

DMRE-verwysingsnommer: MP 30/5/1/2/3/2/1 (10117) EM

TITEL		NOEMNAAM	
VOORLETTERS		VAN	
ORGANISASIE			
POSADRES			
		POSKODE	
LANDLYNNOMMER		SELNOMMER	
FAKSNOMMER		E-POS	

OPMERKINGS (gebruik asseblief aparte blaaie soos verlang)

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DANKIE VIR U BYDRAE

NAAM:	HANDTEKENING:	DATUM:

srk consulting

AngloAmerican

Site Notice

Proof of placement will be provided in the Final Scoping Report

INTEGRATED ENVIRONMENTAL AUTHORISATION PROCESS FOR ANGLO AMERICAN INYOSI COAL

ELDERS COLLIERY, NEAR BETHAL, MPUMALANGA PROVINCE

AVAILABILITY OF THE DRAFT ENVIRONMENTAL IMPACT REPORT FOR PUBLIC COMMENT

The Elders Colliery is a proposed underground coal mine located approximately 25 km north of the town of Bethal, on the R35 provincial road in the Mpumalanga Province.

Background

Anglo Operations (Pty) Ltd (AOPL) submitted an environmental authorisation application to the Mpumalanga Department of Mineral Resources (DMR) (now known as the Department of Mineral Resources and Energy (DMRE) for the project on 16 July 2015 and subsequently a Scoping Report and Environmental Management Programme (EMPr) was submitted in terms of the National Environmental Management Act (Act No. 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014.

AOPL submitted a Section 11 application in terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) (MPRDA) to the DMR to transfer the Elders mining right from AOPL to Anglo American Inyosi Coal (Pty) Ltd (AAIC). The mining right execution, Deed of Cession and Environmental Authorisation (DMRE Reference Number: (MP) 30/5/1/2/3/2/1/ (10117) EM) was issued on 29 July 2020.

Proposed Project

AAIC is proposing changes to the 2016 project description which includes a change in mine plan, block plan and an additional transport method for mined coal.

The proposed changes to the project description are as follows:

- Underground mining sequencing
- Mining No. 2 and 4 Seam by means of bord and pillar mining methods using Continuous Miners at a slower rate resulting in changes to the mine plan and block plan including:
    - a smaller boxcut (5.0365ha),
    - a ventilation shaft outside boxcut (but adjacent),
    - an interim coal loading area (temporary loading periods),
    - road layout change to accommodate trucks and
    - a 132 kV power line layout change (main supply from ESKOM)
- Loading from stockpile and trucking of ore to an existing processing facility; and
- Widening of the R35 at intersections

Environmental Authorisation

Prior to the commencement of mining activities for the proposed project an Environmental Authorisation process is required due to Listed Activities being triggered in terms of the NEMA EIA Regulations and the National Environmental Management: Waste Act (Act No. 59 of 2008) (NEM:WA).

An Environmental Application was submitted to the DMRE for the Scoping and Environmental Impact Assessment Reporting (Scoping & Environmental Impact Report (S&EIR)) process as well as a Regulation 31 Amendment process to commence with the Environmental Authorisation Process. Subsequently, based on discussions with the DMRE, it has been suggested that these environmental applications be integrated into a single process thus, an Integrated S&EIR process will be conducted for this project.

Water Use Licence Application

A Water Use Licence Application (WULA) was submitted to the Department of Water and Sanitation (DWS) on 2 December 2015 under the National Water Act (Act No. 36 of 1998) (NWA), and approved on 13 April 2017 (WUL No. 03/B22A/ACFGIJ/5047, File No. 27/2/2/B111/11/1). The WUL amendment was approved on 13 November 2017 under the same WUL No.)

Due to the changes in the mine plan, a new WULA is being applied for under the NWA, in respect of the following water uses that will be triggered by the proposed project:

- **Section 21 (c) and (i)** water uses associated with infrastructure development and irrigation within 500 m of a wetland;
- **Section 21 (e)** water uses associated with engaging in a controlled activity for the irrigation of land with waste or water containing waste;
- **Section 21 (f)** water use associated with an increase in volume for the authorised discharge of treated mine water; and
- **Section 21 (g)** water uses associated with an interim coal loading area, and increase in volume for the authorised pollution control dam and dust suppression.

Interested and Affected Parties (I&APs) have 60 days to submit written comments or objections in respect of the proposed project and associated water uses. Should you have any comments or objections please contact the SRK Stakeholder Engagement Offices (details below) by 13 December 2021.

Environmental Assessment Practitioner

AAIC appointed SRK Consulting (South Africa) (SRK) as the independent Environmental Assessment Practitioner (EAP) to manage and facilitate the integrated environmental authorisation, WULA and associated public participation process in accordance with NEMA and NWA.

Providing Comment

I&APs are invited to register and comment on the Draft Environmental Impact Assessment Report that is available for public comment for a period of 30 days from 6 October 2021 to 11 November 2021. The Draft Environmental Impact Assessment Report is available on the SRK website: https://docs.srk.co.za/en/za-elder-colliery-iea and at the following public places:

Public Place	Locality
Elders Colliery Proposed Access Road	Along R35
Bethal Public Library	Market Street, Bethal
Kriel Public Library	Cnr Quitin and Hendriks Street, Kriel
Komati Paypoint and Library	C/o Falcon Drive and Thrush Street, Komati, Middelburg
Vlakkuilen Community	Hirshaw Estate (Elders Property)
Middelkraal Community	Middelkraal Community
Emalahleni Local Municipality - Kriel Offices	2 Quintin St, Kriel

Due date for registration as an I&AP and comments on the Draft Environmental Impact Assessment Report is 4 November 2021.

Please contact the SRK Stakeholder Engagement Offices (details below) to register as an I&AP and provide comment on the Draft Environmental Impact Report:

Ms Karabo Maruapula
Stakeholder Engagement Office
SRK Consulting, P. O. Box 55291, Northlands, 2116
Tel: (011) 441 1111, **Fax:** 086 230 1462
E-mail: KMaruapula@srk.co.za

srk consulting

INQUBO EHLANGANISIWE YOKUGUNYAZWA KWEZEMVELO KWE-ANGLO AMERICAN INYOSI COAL ELDERS COLLIERY, EDUZE NASE-BETHAL, ESIFUNDAZWENI SASEMPUMALANGA

UKUTHOLAKALA KOMBIKO WOKUHLOLWA KOMTHELELA KWEZEMVELO ONGAKAPHOTHULWA OKOKUPHAWULA KOMPHAKATHI

I-Elders Colliery iyimayini yomgodi wamalahle ehlongozwayo esendaweni cishe ekuma-25 km enyakatho yedolobha lase-Bethal, emgwaqweni wesifundazwe u-R35 esiFundazweni saseMpumalanga.

Isendlalelo

I-Anglo Operations (Pty) Ltd (AOPL) ifake isicelo sokugunyazwa ngokwezemvelo kuMnyango Wezimbiwa waseMpumalanga (Mpumalanga Department of Mineral Resources) (DMR) (manje eseyaziwa njengoMnyango Wezimbiwakanye Namandla (Department of Mineral Resources and Energy) (DMRE) ngokuphathelene nephrojekthi ngomhlaka-16 Julayi 2015 kwase kulandela Umbiko Wokuhlola Indawo kanye Nohlelo Lokwengamela Evemvelo (EMPr) okwafakwa ngokuphathelene noMthetho kaZwelonke Wokwenganyelwa Kwezemvelo (Umthetho No. 107 ka-1998) (NEMA) Ukuhlolwa Komthelela Kwezemvelo (EIA) Imithetho Eshayiwe ka-2014.

I-AOPL yathumela isicelo seSigaba 11 ngokoMthetho Wezokumbiwa Phansi kanye noPhethiloli (uMthetho No. 28 ka-2002) (MPRDA) ku-DMR ukuze kudluliswe ilungelo lezimayini le-Elders lisuke ku-AOPL liye e-Anglo American Inyosi Coal (Pty) Ltd (AAIC) . Ukwenziwa kwelungelo lezimayini, Umbhalo Wokuyeka (Deed of Cession) kanye Nokugunyazwa Kwezemvelo (Inombolo Yerefurense ye-DMRE: (MP) 30/5/1/2/3/2/1 / (10117) EM) yakhishwa ngomhlaka 29 Julayi 2020.

Iphrojekthi Ehlongozwayo

I-AAIC iphakamisa izinguquko encazelweni yephrojekthi yango-2016 okubandakanya ushintsho kuhlelo lwezimayini, uhlelo lwebhulokhi kanye nangezinye izindlela zokuthutha amalahle embiwe.

Izinguquko ezihlongozwayo encazelweni yephrojekthi zimi kanje:

- Ukulandelana kwezimayini ezingaphansi komhlaba
- Izimayini ezingunombolo 2 no-4 Seam ngokusebenzisa izindlela zezimayini ze-bord nezinsika kusetshenziswa Abavukuzi Abaqhubekayo ngesilinganiso esincane okuholela ekuguqulweni kohlelo lwezimayini kanye nohlelo lokuvimba olufaka:
    - i-boxcut encane (5.0365ha),
    - umshini wokungenisa umoya ngaphandle kwe-boxcut (kodwa eliseduze),
    - indawo yesikhashana yokulayisha amalahle (izikhathi zokulayisha okwesikhashana),
    - ushintsho lokuhlelwa komgwaqo ukuhlalisa amaloli futhi
    - ushintsho lwesakhiwo sezintambo zikagesi ezingu-132 kV (okuphakelayo okuyinhloko okuvela kwa-ESKOM)
- Ukulayishwa kusuka ekugcinweni kwesitoko kanye nokuthuthwa kwensimbi kuye esakhiweni esivele sisebenza; futhi
- Ukunwetshwa kuka-R35 ezimpambanweni zomgwaqo

Ukugunyazwa Kwezemvelo

Ngaphambi kokuqala kwemisebenzi yezimayini yephrojekthi ehlongozwayo inqubo yokugunyazwa kwemvelo iyadingeka ngenxa yemisebenzi efakwe kuhlu ebangelwe Yimithethonqubo ye-NEMA EIA kanye noKwenganyelwa Kwezemvelo Kuzwelonke: Umthetho Ophathelene Nemfucuzaa (UMthetho No. 59 ka-2008) (NEM: WA).

Isicelo Sezemvelo safakwa ku-DMRE ngenqubo ye-Scoping and Environmental Impact Assessment Reporting (Scoping & Environmental Impact Report (S & EIR)) kanye nenqubo Yokuchitshiyelwa Komthethonqubo 31 ukuze kuqale Inqubo Yokugunyazwa Kwezemvelo. Ngokulandelayo, ngokususelwa ezingxoxweni ne-DMRE, kuphakanyisiwe ukuthi lezi zicelo zemvelo zihlanganiswe nenqubo eyodwa ngaleyo ndlela, inqubo ehlanganisiwe ye-S & EIR izokwenzelwa le phrojekthi.

Isicelo Selayisense Yokusebenzisa Amanzi

Isicelo Selayisense Yokusebenzisa Amanzi (WULA) safakwa eMnyangweni Wezamanzi Nokuthuthwa Kwendle (DWS) ngomhlaka 2 Disemba 2015 ngaphansi koMthetho Kazwelonke Wamanzi (Umthetho No. 36 ka-1998) (NWA), futhi savunywa ngomhlaka 13 Ephreli 2017 (WUL 03 / B22A / ACFGIJ / 5047, Ifayela No. 27/2/2 / B111 / 11/1). Ukuchitshiyelwa kwe-WUL kwamukelwa ngomhlaka 13 Novemba 2017 ngaphansi kwe-WUL No. efanayo.)

Ngenxa yezinguquko ohlelweni lwezimayini, kufakwa isicelo se-WULA entsha ngaphansi kwe-NWA, maqondana nokusetshenziswa kwamanzi okulandelayo okuzobangelwa yiphrojekthi ehlongozwayo:

- **Isigaba 21 (c) no- (i)** ukusetshenziswa kwamanzi okuhambisana nokwakhiwa kwendawo yokulayisha amalahle ngaphakathi kwexhaphozi
- **Isigaba 21 (e)** ukusetshenziswa kwamanzi okuhambisana nokubandakanya umsebenzi olawulwayo wokunisela umhlaba ngodoti noma ngamanzi aqukethe udoti;
- **Isigaba 21 (f)** ukusetshenziswa kwamanzi okuhambisana nokukhuphuka kwevolumu yokukhishwa okugunyaziwe kwamanzi emayini ahlanjiwe; futhi
- **Isigaba 21 (g)** ukusetshenziswa kwamanzi okuhambisana nendawo entsha yokulayisha amalahle kanye nethangi lesitoreji (i-CM tank), nokukhuphula ivolumu yedamu eligunyaziwe lokulawula ukungcola nokucindezelwa kothuli.

Isisebenzi Sokuhlola Imvelo

I-AAIC iqoke i-SRK Consulting (South Africa) (i-SRK) njengoMsebenzi oZimele wokuHlola ezeMvelo (EAP) ukuphatha nokusiza ukugunyazwa kwezemvelo okuhlangene, i-WULA kanye nenqubo ehambisanayo yokubamba iqhaza komphakathi ngokuya nge-NEMA ne-NWA.

Ukunikeza Amazwana

Amaqembu Anentshisekelo Nathintekayo (Ama-I & APs) ayamenywa ukuthi abhalise futhi aphawule ngombiko Owuhlaka Wokuhlolwa Kokuthinteka Kwezemvelo okutholakala ukuze umphakathi uphawule ngawo isikhathi esiyizinsuku ezingama-30 kusukela ngomhlaka 6 October 2021 kuya kumhlaka 11 November 2021. Umbiko Owuhlaka Wokuhlolwa Kokuthinteka Kwemvelo uyatholakala kuwebhusayithi ye-SRK: https://docs.srk.co.za/en/za-elder-colliery-iea nasezindaweni zomphakathi ezilandelayo:

Indawo Yomphakathi	Indawo
Umgwaqo Ohlongozwayo Wokungena e-Elders Colliery	Endleleni u-R35
Umtapo Wezincwadi Womphakathi waseBethal	Market Street, eBethal
Umtapo Wezincwadi Womphakathi waseKriel	U-Cnr Quitin noHendriks Street, eKriel
I-Komati Paypoint kanye noMtapo Wezincwadii	Ekhoneni lila-Falcon Drive noThrush Street, eKomati, eMiddelburg
Umphakathi waseVlakkuilen	I-Hirshaw Estate (Impahla ye-Elders)
Umphakathi waseMiddelkraal	Umphakathi waseMiddelkraal
UMasipala Wendawo Emalahleni - Amahhovisi aseKriel	2 Quintin St, eKriel

Usuku okumele lubhaliswe ngalo njengeQembu Elinentshisekelo kanye Nelithintekile kanye nokuphawula ngoMbiko Owuhlaka Wokuhlolwa Komthelela Wemvelo ngumhlaka 13 December 2021. Ngokwenqubo ye-WULA, amaQembu Anentshisekelo kanye Nanentshisekelo anikezwa izinsuku ezingama-60 zokuletha imibono noma iziphikiso ezibhaliwe maqondana nephrojekthi ehlongozwayo kanye nokusetshenziswa kwamanzi okuhambisanayo.

Uyacelwa ukuthi uthinte Amahhovisi Okubandakanywa Kwababambiqhaza e-SRK (imininingwane engezansi) ukuze ubhalise njengeQembu Elinentshisekelo kanye Nelithintekile (I & AP) futhi uhlinzeke ukuphawula Embikweni Owuhlaka Wokuhlelwa Kwezemvelo:

UNksz. Karabo Maruapula
Ihhovisi Lokubandakanya Ababambiqhaza
SRK Consulting, P. O. Box 55291, Northlands, 2116
Ucingo:(011) 441 1111,
Ifeksi:086 230 1462; **I-imeyli**KMaruapula@srk.co.za

srk consulting

Geïntegreerde omgewingsmagtiging vir Anglo American Inyosi Steenkool Elders-steenkoolmyn naby Bethal in die Mpumalanga-provinsie

BESKIKBAARHEID VAN DIE KONSEPVERSLAG OOR OMGEWINGSIMPAK VIR OPENBARE KOMMENTAAR

Agtergrond

Die Elders-steenkoolmyn is 'n voorgestelde ondergrondse steenkoolmyn geleë ongeveer 25 kilometer noord van die dorp Bethal op die R35-provinsiale pad in die Mpumalanga- provinsie

Anglo Operations (Pty) Ltd (AOPL) het op 16 Julie 2015 'n aansoek om omgewingsmagtiging by die Mpumalanga Departement van Minerale Hulpbronne (DMR), (nou bekend as die Departement van Minerale Hulpbronne en Energie (DMRE)), vir die projek ingedien en daarna 'n omvangbepalingsverslag en omgewingsbestuursprogram (EMPr) ingevolge die Nasionale Omgewingsbestuurswet (Wet No. 107 van 1998) (NEMA) Regulasies vir Omgewingsimpakstudie (EIA) van 2014. Die EMPr is op 25 Januarie 2016 vir owerheidsondersoek voorgelê.

AOPL het 'n artikel 11-aansoek ingevolge die Wet op Ontwikkeling van Minerale en Petroleumhulpbronne (Wet 28 van 2002) (MPRDA) by die DMR ingedien om die Elders-mynreg van AOPL na Anglo American Inyosi Coal (Pty) Ltd (AAIC) oor te dra. Die uitvoering van die mynreg, die sederingsakte en die omgewingsmagtiging (DMRE-verwysingsnommer (MP) 30/5/1/2/3/2/1/ (10117) EM) is op 29 Julie 2020 vir magtigingshersiening ingedien.

Voorgestelde verslag

AAIC beplan veranderinge aan die 2016-projekbeskrywing wat 'n verandering aan die mynplan, blokplan en 'n addisionele vervoermetode vir ontginde steenkool insluit.

Die voorgestelde veranderinge aan die projekbestek is soos volg:

- Ondergrondse mynbouvolgorde;
- Ontginning van nommer 2- en nommer 4-steenkoollaag deur kamer-en-pilaarmynboumetodes met aaneendelwers teen 'n stadiger tempo met gevolglike veranderinge in die mynbou- en blokplan;
- Veranderinge aan die mynplan en blokplan, ingesluit:
  - Kleiner opening (5.0365 ha);
  - Ventilasieskag buite die opening (maar aangrensend);
  - Interim steenkoollaaigebied (tydelike laaitye);
  - Paduitlegverandering om vragmotors te akkommodeer; en
  - 132 kV-kraglynuitleguitleg (hoofvoorraad van ESKOM).
- Laai van voorraad en vervoer van erts na 'n bestaande verwerkingsfasiliteit; en
- Verbreding van R35 by kruisings.

Die ongegradeerde/ru-steenkool (RoM) uit die ondergrondse bewerking sal in bakke en op 'n RoM-voorraadopstapeling gelaai word. 'n Gebied is aangewys vir die steenkool-laaigebied. Steenkool wat ondergronds ontgin word, sal in 'n dubbelstaalbak gestoor word waarvandaan dit op vragmotors gelaai en na 'n bestaande verwerkingsfasiliteit vervoer sal word. Oorvloei uit die staalbak word direk op vragmotors gelaai en sal dus uit die noodsteenkool-laaigebied verwyder word. Sien Figuur 1 vir die terreinuitlegkaart.

Omgewingsmagtiging

Alvorens 'n aanvang geneem word met die ontginningsaktiwiteite vir die beplande projek word 'n omgewingsmagtigingsproses vereis as gevolg van die gelyste aktiwiteite wat veroorsaak is ingevolge die NEMA EIA-regulasies en Nasionale Omgewingsbestuur: Wet op Afval (Wet 59 van 2008) (NEM:WA).

'n Omgewingsaansoek is by die DMRE ingedien vir die omvangbepalings- en omgewingsimpakassesseringsverslagdoening (omvangbepalingsverslag en omgewingsimpakverslag (S&EIR)), en 'n regulasie 31-wysigingsproses om met die omgewingsmagtigingsproses te begin. Vervolgens, op grond van besprekings met die DMRE is daarna voorgestel dat hierdie omgewingsaanpassings in 'n enkele proses geïntegreer word, en dus 'n geïntegreerde S&EIR-proses sal vir hierdie projek uitgevoer word.

Aansoek om watergebruikslisensie

'n Aansoek om watergebruikslisensie (WULA) is op 2 Desember 2015 ingevolge die Nasionale Waterwet (Wet 36 van 1998) (DWS) by die Departement van Water en Sanitasie (DWS) ingedien en goedgekeur op 13 April 2017 (WU-nommer 03/B22A/ACFGIJ/5047, lêer-nommer 27/2/2/B111/11/1). Die WUL-wysiging is op 13 November 2017 goedgekeur onder dieselfde WUL-nommer).

As gevolg van die veranderinge in die mynplan, word 'n nuwe WULA ingevolge die NWA aangevra ten opsigte van die volgende watergebruike wat deur die voorgestelde projek veroorsaak sal word:

- **Artikel 21 (c) en (i) -**watergebruik geassosieer met die konstruksie van 'n steenkoollaaigebied in 'n vleiland;
- **Artikel 21 (e) -**watergebruik geassosieer met betrokkenheid in 'n beheerde aktiwiteit vir die besproeiing van grond met afval of water wat afval bevat;
- **Artikel 21 (f) -**watergebruik geassosieer met 'n toename in volume vir die gemagtigde afvoer van behandelde mynwater; en
- **Artikel 21 (g) -**watergebruik geassosieer met 'n nuwe steenkool-laaigebied en opgaartenk (CM-tenk), en toename in volume vir die gemagtigde besoedelingskontroledam en stofonderdrukking.

Omgewingsassesseringspraktisyn

AAIC het SRK Consulting (South Africa) (SRK) aangestel as die onafhanklike omgewingsassesseringspraktisyn (EAP) om die geïntegreerde omgewingsmagtiging, WULA, en gepaardgaande openbare deelnameproses in ooreenstemming met NEMA en NWA te bestuur en te fasiliteer.

Kommentaarlewering

Belangstellende en geaffekteerde partye (I&AP's) word uitgenooi om te registreer en kommentaar te lewer op die konsepverslag vir omgewingsimpak wat vir 'n tydperk van 30 dae van 6 October 2021 tot 11 November 2021 vir openbare kommentaar beskikbaar is op die SRK-webwerf https://docs.srk.co.za/en/za-elder-colliery-iea en by die volgende openbare plekke:

Openbare plek	Ligging
Elders-steenkoolmyn voorgestelde toegangspad	Langs R35
Bethal Openbare biblioteek	Markstraat Bethal
Kriel Openbare bibliotеek	Op die hoek van Quitin en Hendriksstraat, Kriel
Komati-betaalpunt en biblioteek	Op die hoek van Falcon-rylaan en Thrush-straat, Komati, Middelburg
Vlakkuilen-gemeenskap	Hirshaw-landgoed (Elders-eiendom)
Middelkraal-gemeenskap	Middelkraal Community
Emalahleni munisipale gemeenskap – Kriel-kantoor	Quintinstraat 2, Kriel

Die sperdatum vir registrasie as 'n IA&P en kommentaar op die konsepverslag vir omgewingsimpakevaluering is 13 December 2021 . Ingevolge die WULA-proses is aan I&AP 60 dae gegee om skriftelike kommentaar of besware in te dien ten opsigte van die voorgestelde projek en gepaardgaande watergebruik.

Kontak asseblief die SRK-betrokkenheidskantore (besonderhede hier onder) om as 'n IA&P te registreer en kommentaar te lewer op die konsep-omgewingsimpakverslag.

Ms Karabo Maruapula
Kantoor vir Belanghebbersbetrokkenheid
SRK Consulting, Posbus 55291, Northlands, 2116
Tel: (011) 441 1111, **Faks:** 086 230 1462; **E-pos:** KMaruapula@srk.co.za

srk consulting

Newspaper Article

Proof of placement will be provided in the Final Scoping Report

Geïntegreerde omgewingsmagtiging vir Anglo American Inyosi Steenkool Elders-steenkoolmyn naby Bethal in die Mpumalanga-provinsie

BESKIKBAARHEID VAN DIE KONSEPVERSLAG OOR OMGEWINGSIMPAK VIR OPENBARE KOMMENTAAR

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Voorgestelde verslag

AAIC beplan veranderinge aan die 2016-projekbeskrywing wat 'n verandering aan die mynplan, blokplan en 'n addisionele vervoermetode vir ontginde steenkool insluit.

Die voorgestelde veranderinge aan die projekbestek is soos volg:

- Ondergrondse mynbouvolgorde;
- Ontginning van nommer 2- en nommer 4-steenkoollaag deur kamer-en-pilaarmynboumetodes met aaneendelwers teen 'n stadiger tempo met gevolglike veranderinge in die mynbou- en blokplan;
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Omgewingsmagtiging

Alvorens 'n aanvang geneem word met die ontginningsaktiwiteite vir die beplande projek word 'n omgewingsmagtigingsproses vereis as gevolg van die gelyste aktiwiteite wat veroorsaak is ingevolge die NEMA EIA-regulasies en Nasionale Omgewingsbestuur: Wet op Afval (Wet 59 van 2008) (NEM:WA).

'n Omgewingsaansoek is by die DMRE ingedien vir die omvangbepalings- en omgewingsimpakassesseringsverslagdoening (omvangbepalingsverslag en omgewingsimpakverslag (S&EIR)), en 'n regulasie 31-wysigingsproses om met die omgewingsmagtigingsproses te begin. Vervolgens, op grond van besprekings met die DMRE is daarna voorgestel dat hierdie omgewingsaanpassings in 'n enkele proses geïntegreer word, en dus 'n geïntegreerde S&EIR-proses sal vir hierdie projek uitgevoer word.

Aansoek om watergebruikslisensie

'n Aansoek om watergebruikslisensie (WULA) is op 2 Desember 2015 ingevolge die Nasionale Waterwet (Wet 36 van 1998) (DWS) by die Departement van Water en Sanitasie (DWS) ingedien en goedgekeur op 13 April 2017 (WU-nommer 03/B22A/ACFGIJ/5047, lêer-nommer 27/2/2/B111/11/1). Die WUL-wysiging is op 13 November 2017 goedgekeur onder dieselfde WUL-nommer).

As gevolg van die veranderinge in die mynplan, word 'n nuwe WULA ingevolge die NWA aangevra ten opsigte van die volgende watergebruike wat deur die voorgestelde projek veroorsaak sal word:

- **Artikel 21 (c) en (i) -**watergebruik geassosieer met die konstruksie van 'n steenkoollaaigebied in 'n vleiland;
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Omgewingsassesseringspraktisyn

AAIC het SRK Consulting (South Africa) (SRK) aangestel as die onafhanklike omgewingsassesseringspraktisyn (EAP) om die geïntegreerde omgewingsmagtiging, WULA, en gepaardgaande openbare deelnameproses in ooreenstemming met NEMA en NWA te bestuur en te fasiliteer.

Kommentaarlewering

Belangstellende en geaffekteerde partye (I&AP's) word uitgenooi om te registreer en kommentaar te lewer op die konsepverslag vir omgewingsimpak wat vir 'n tydperk van 30 dae van 6 October 2021 tot 11 November 2021 vir openbare kommentaar beskikbaar is op die SRK-webwerf https://docs.srk.co.za/en/za-elder-colliery-iea en by die volgende openbare plekke:

Openbare plek	Ligging
Elders-steenkoolmyn voorgestelde toegangspad	Langs R35
Bethal Openbare biblioteek	Markstraat Bethal
Kriel Openbare biblioteek	Op die hoek van Quitin en Hendriksstraat, Kriel
Komati-betaalpunt en biblioteek	Op die hoek van Falcon-rylaan en Thrush-straat, Komati, Middelburg
Vlakkuilen-gemeenskap	Hirshaw-landgoed (Elders-eiendom)
Middelkraal-gemeenskap	Middelkraal Community
Emalahleni munisipale gemeenskap – Kriel-kantoor	Quintinstraat 2, Kriel

Die sperdatum vir registrasie as 'n IA&P en kommentaar op die konsepverslag vir omgewingsimpakevaluering is 13 December 2021 . Ingevolge die WULA-proses is aan I&AP 60 dae gegee om skriftelike kommentaar of besware in te dien ten opsigte van die voorgestelde projek en gepaardgaande watergebruik.

Kontak asseblief die SRK-betrokkenheidskantore (besonderhede hier onder) om as 'n IA&P te registreer en kommentaar te lewer op die konsep-omgewingsimpakverslag.

Ms Karabo Maruapula
Kantoor vir Belanghebbersbetrokkenheid
SRK Consulting, Posbus 55291, Northlands, 2116
Tel: (011) 441 1111, **Faks:** 086 230 1462; **E-pos:** KMaruapula@srk.co.za

srk consulting

INTEGRATED ENVIRONMENTAL AUTHORISATION PROCESS FOR ANGLO AMERICAN INYOSI COAL ELDERS COLLIERY, NEAR BETHAL, MPUMALANGA PROVINCE

AVAILABILITY OF THE DRAFT ENVIRONMENTAL IMPACT REPORT FOR PUBLIC COMMENT

The Elders Colliery is a proposed underground coal mine located approximately 25 km north of the town of Bethal, on the R35 provincial road in the Mpumalanga Province.

Background

Anglo Operations (Pty) Ltd (AOPL) submitted an environmental authorisation application to the Mpumalanga Department of Mineral Resources (DMR) (now known as the Department of Mineral Resources and Energy (DMRE) for the project on 16 July 2015 and subsequently a Scoping Report and Environmental Management Programme (EMPr) was submitted in terms of the National Environmental Management Act (Act No. 107 of 1998) (NEMA) Environmental Impact Assessment (EIA) Regulations of 2014.

AOPL submitted a Section 11 application in terms of the Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) (MPRDA) to the DMR to transfer the Elders mining right from AOPL to Anglo American Inyosi Coal (Pty) Ltd (AAIC). The mining right execution, Deed of Cession and Environmental Authorisation (DMRE Reference Number: (MP) 30/5/1/2/3/2/1/ (10117) EM) was issued on 29 July 2020.

Proposed Project

AAIC is proposing changes to the 2016 project description which includes a change in mine plan, block plan and an additional transport method for mined coal.

The proposed changes to the project description are as follows:

- Underground mining sequencing
- Mining No. 2 and 4 Seam by means of bord and pillar mining methods using Continuous Miners at a slower rate resulting in changes to the mine plan and block plan including:
  - a smaller boxcut (5.0365ha),
  - a ventilation shaft outside boxcut (but adjacent),
  - an interim coal loading area (temporary loading periods),
  - road layout change to accommodate trucks and
  - a 132 kV power line layout change (main supply from ESKOM)
- Loading from stockpile and trucking of ore to an existing processing facility; and
- Widening of the R35 at intersections

Environmental Authorisation

Prior to the commencement of mining activities for the proposed project an Environmental Authorisation process is required due to Listed Activities being triggered in terms of the NEMA EIA Regulations and the National Environmental Management: Waste Act (Act No. 59 of 2008) (NEM:WA).

An Environmental Application was submitted to the DMRE for the Scoping and Environmental Impact Assessment Reporting (Scoping & Environmental Impact Report (S&EIR)) process as well as a Regulation 31 Amendment process to commence with the Environmental Authorisation Process. Subsequently, based on discussions with the DMRE, it has been suggested that these environmental applications be integrated into a single process thus, an Integrated S&EIR process will be conducted for this project.

Water Use Licence Application

A Water Use Licence Application (WULA) was submitted to the Department of Water and Sanitation (DWS) on 2 December 2015 under the National Water Act (Act No. 36 of 1998) (NWA), and approved on 13 April 2017 (WUL No. 03/B22A/ACFGIJ/5047, File No. 27/2/2/B111/11/1). The WUL amendment was approved on 13 November 2017 under the same WUL No.)

Due to the changes in the mine plan, a new WULA is being applied for under the NWA, in respect of the following water uses that will be triggered by the proposed project:

- **Section 21 (c) and (i)** water uses associated with infrastructure development and irrigation within 500 m of a wetland;
- **Section 21 (e)** water uses associated with engaging in a controlled activity for the irrigation of land with waste or water containing waste;
- **Section 21 (f)** water use associated with an increase in volume for the authorised discharge of treated mine water; and
- **Section 21 (g)** water uses associated with an interim coal loading area, and increase in volume for the authorised pollution control dam and dust suppression.

Interested and Affected Parties (I&APs) have 60 days to submit written comments or objections in respect of the proposed project and associated water uses. Should you have any comments or objections please contact the SRK Stakeholder Engagement Offices (details below) by 13 December 2021.

Environmental Assessment Practitioner

AAIC appointed SRK Consulting (South Africa) (SRK) as the independent Environmental Assessment Practitioner (EAP) to manage and facilitate the integrated environmental authorisation, WULA and associated public participation process in accordance with NEMA and NWA.

Providing Comment

I&APs are invited to register and comment on the Draft Environmental Impact Assessment Report that is available for public comment for a period of 30 days from 6 October 2021 to 11 November 2021. The Draft Environmental Impact Assessment Report is available on the SRK website: https://docs.srk.co.za/en/za-elder-colliery-iea and at the following public places:

Public Place	Locality
Elders Colliery Proposed Access Road	Along R35
Bethal Public Library	Market Street, Bethal
Kriel Public Library	Cnr Quitin and Hendriks Street, Kriel
Komati Paypoint and Library	C/o Falcon Drive and Thrush Street, Komati, Middelburg
Vlakkuilen Community	Hirshaw Estate (Elders Property)
Middelkraal Community	Middelkraal Community
Emalahleni Local Municipality - Kriel Offices	2 Quintin St, Kriel

Due date for registration as an I&AP and comments on the Draft Environmental Impact Assessment Report is 4 November 2021.

Please contact the SRK Stakeholder Engagement Offices (details below) to register as an I&AP and provide comment on the Draft Environmental Impact Report:

Ms Karabo Maruapula
Stakeholder Engagement Office
SRK Consulting, P. O. Box 55291, Northlands, 2116
Tel: (011) 441 1111, **Fax:** 086 230 1462
E-mail: KMaruapula@srk.co.za

srk consulting

Appendix F: Consultation with DWS

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Anglo American Inyosi Coal (Pty) Ltd (AAIC)

Minutes for the Meeting: DWS Pre-application meeting for Elders Colliery

Held: Via Microsoft Teams, 24 November 2020 at 10h00

Attendees:

Daphney Tshehla (Anglo)	Kobus Bergh (Anglo)
Liezel Louw (Anglo)	Nompumelelo Mandlazi (DWS)
Jacky Burke (SRK)	Megan Kim Govender (SRK)
Natasha Anamuthoo (SRK)	

Action

1 Welcome and Introductions

Natasha Anamuthoo (NA) welcomed everyone to the meeting. All attendees introduced themselves.

The presentation for the meeting is attached in Appendix A.

Kobus Bergh (KB) highlighted a safety moment with regards to a resurgence of Covid-19. Social distancing and mask wearing must continue to be implemented.

2 Confirmation of agenda

The agenda was confirmed with no additional topics added.

3 Introduction

NA introduced the project. The applicant for the project is Anglo American Inyosi Coal. The Elders Colliery mine development is authorised but requires WUL amendments and additional activities to be authorised due to changes in mine plan.

The project is located in Mpumalanga in catchment areas B11A and B11B.

4 Project Description

The project description was presented by KB.

<u>Background to the project</u>
In 2017 the WUL was received but due to delays in granting and execution of the mining right, the EA approval was only received recently in July 2020. The delays were due to DMR Witbank being closed for a year and closed during the initial Covid-19 lockdown.

The WUL stated that if the water use was not exercised within 3 years of the issuing of the WUL, the authorisation will be withdrawn. In June 2020 Anglo received an extension of the condition for 3 years to June 2023.

Action

The original plan was to convey the material to Goedehoop. Elders was meant to be a life extension for Goedehoop. Currently the processing plant at Goedehoop is under Care and Maintenance. The major change to the project description is thus from conveying the coal to Goedehoop to now trucking the coal.

Since the execution of the mining right, Anglo is under pressure in terms of timelines to execute the project. Anglo has a commercial agreement with the neighbouring Sudor Coal. There is an urgency to this application due to the tight timelines for construction to commence in 2021.

<u>Changes to project description</u>
The method remains the same however the Box cut is now smaller. The recent water balance shows an increase in groundwater therefore there is an increase in the volume of water that is to be processed.

KB showed a simulation of the coal loading area and bin. A dual bin has been designed to cater for the full consignment of the material but an emergency coal loading area is proposed for any overflow and during the initial boxcut development phase. No material will be stored in this area and overflows will be loaded directly onto trucks. Based on the simulation no material will have to be stored on the coal loading area during normal operations.

Nompumelelo Mandlazi (NM): Will this area be applied for?
KB: The idea is that this area is not going to be used for storage, only for loading. The material will not be in the coal loading area for more than 24 hours. The approach is to go for an amendment because it is not a stockpile.
NM: The concern is that it can rain during that period the material is on the coal loading area. The rain will impact the groundwater. This will have to be discussed with the DWS Civils Department.
KB: The material is type 3 but the proposed design of the coal loading area will be a Class D liner with sub-soil drainage. Dirty surface water runoff will be captured. Due to the urgency of the project, the approach is to not go for a full application.
NM: The Civils Department will need to be consulted before a comment can be made.
Daphney Tshehla (DT): Will a meeting similar to this be required with the Civils Department?
NM: A meeting date will be requested from Civils. A similar meeting can then be held to explain the project.

NM to request a meeting date from the Civils Department

<u>Changes to Block Plan</u>
KB explained the changes to the block plan. The PCD and Brine Dam have shifted in location. This is due to the implementation of using gravity feed to transfer the dirty water to the PCD. The location is slightly outside the current approved footprint area.

An area is designated for the coal loading area. Coal mined from underground is stored in a dual steel bin from where it will be loaded onto trucks and hauled to an existing processing facility. Overflow from the bin will be loaded directly onto trucks and will thus be cleared from the emergency coal loading area within 24 hours. The emergency coal loading area will only be required for initial development during mining of interburden and boxcut (approximately 3 months). Clean and dirty stormwater controls will be in place at the coal loading area. Clean water will be diverted by compacted earth berms and cut-off drains. Dirty water runoff in the coal loading area will flow in a channel feeding the coal loading area silt-trap. The dirty water will be transferred to the PCD using gravity flow via a concrete-lined drain to the PCD silt-trap. An open drain is provided to drain dirty water from the cross-over conveyor drive bunded area into the channel described above.

NM: The PCD and Brine Dam is authorised under 21 (c) and (i), will the volumes change? KB: There will be an increase in volumes as well as a physical change in location.

Action

DT: What is DWS' take on increase in capacity? Will they allow for an amendment? NM: A new application will need to be applied for.

5 Authorised Water Uses

Jacky Burke (JB) went through the authorised WUL and what has already been discussed in terms of new water uses and WUL amendments.

The existing WUL issued in 2017 authorises Section 21 (a) and (j) water uses for the boreholes and dewatering of the boxcut. Section 21 (c) and (i) water uses for all activities within 500 m of a wetland including discharges. Section 21 (f) water uses for discharging. Section 21 (g) water uses for dirty water dams, sewage sludge, gypsum dams and dust suppression.

Revised water balance
The revised water balance indicates an increase in volume for the PCD, but a reduction in capacity. The increase in volume triggers a new water use. The volume for discharge will also have to be increased which will trigger a new water use. Dust suppression will also require an increase in volume which will trigger a new WULA. There will be three increase in volume to be applied for.

NM: When Kobus was presenting it was mentioned that the dewatering volume will also be increasing? JB: No, dewatering volume in the water balance has not increased but transfer to the PCD has increased as the water will go to the PCD first before treatment. Dewatering is still within the licenced volumes, only the water handling has changed.

The average treatment rate over the LOM is 3200 m^3/d. The graph shows that the treatment volume required during mine development is low. The licensed volume is therefore adequate while the WULA is in progress for an increase in volume.

6 WUL Amendment and WULA Requirements

JB: Now looking at all the amendments and potential new water uses for confirmation.

WUL Amendments
Section 21 (c) and (i) water uses are now falling outside the previously authorised area. Can the coordinates be amended? They will still be within 500 m of a wetland. NM: Yes they can be amended.

JB: The other amendment relate to the conditions for calibration. Can we amend the conditions to the reflect verification of flowmeters is required. NM: Yes, those conditions can be amended.

JB: The Section 21 (g) uses will be relocated, can the coordinates be amended? NM: Yes.

New WULA
JB: The Section 21 (f) and (g) water uses have been discussed but there will also be a Section 21 (c) and (i) for the coal loading area because this is an additional activity within 500 m of a wetland.
NM: Will you also be applying for Section 21 (g)?
JB: The activity will need to be presented to Civils Department to see if it triggers Section 21 (g) or if it can it be managed in terms of storm water due to its temporary use.
DT: Do you foresee the Department agreeing with not authorising the temporary coal loading area as a stockpile?
NM: It is uncertain. It will rain during the 24 hours and this will have an impact.
DT: There will be stormwater controls to manage this.
NM: It will need to be discussed with Civils Department and Section 21 (c) and (i) should also be invited.

Action

WULA Requirements

JB: For the additional requirements should the amendment and WULA be a combined application or two separate applications?
NM: The applications should be separate because the amendment will have to be authorised first.
JB: In terms of the specialist studies, will all the studies need to be re-done or can the original studies be used where adequate?
NM: It depends when they were done. The specialist studies cannot be more than 5 years old. JB: The original WULA was done in 2015.
NM: New studies will be required.
DT: Will new studies or updated studies be required?
NM: Updated studies. JB: Where a previous study is still valid can the specialist provide a letter confirming its validity.
NM: Yes.

JB: For the Section 21 (c) and (i) water uses, is a hydropedology study needed?
NM: Yes. DT: It was done previously and will therefore need to be updated.

JB: In terms of supporting information, there is the regulated R267 checklist, but is there anything additional that you will require?
NM: No.

JB: For the public participation process, will a full process be required? NM: Yes a 60-day process is required.

7 Proposed Timelines

JB: Looking at the timelines proposed, it is aligned with the mine plan. Phase 1 is planned to be submitted by end of this month and the Phase 2 site visit to take place in December if possible.
NM: This cannot be commented on as there is no one else that can go to site so it will depend.

JB: In terms of the meeting with Civils, when can that be arranged?
NM: A meeting request will be sent today but the Civils Department is very busy therefore it is uncertain when they will be able to provide a meeting date.
JB: Will this be the Mpumalanga Civils Department not National Office?
NM: Yes.

JB: Phase 3 submission is planned for April next year and a decision on the application is anticipated for September 2021. This will allow construction to commence as planned for October 2021.

8 Environmental Authorisation

NA: The environmental authorisation process is planned to run parallel with the WULA. A Section 102 Application will be submitted to include Portion 4 of Halfgewonnen 190 IS into the Mining Right. Submission of the application is planned for 30 November 2020 to meet construction deadlines (2021).

A NEMA Application for either amendment to EA or Full Scoping and EIA will be submitted based on discussion with DMRE. The process will also depend on the feedback received from the Civils Department.

If we can have a meeting in the next few days it would be much appreciated as the decision has an impact on the EA process.
NM: I will try to but it is dependent on the Civils Department availability.

Action

9 Discussion

NA: Any further questions or comments?
NM: No, for now the two Departments will have to advise if the coal loading area requires a section 21 (g) use.
NA: The decision is critical, therefore it would be appreciated if the request could be expedited.

DT: The presentation must be updated to reflect the essential civil and geohydrology information.
NA: Yes, we can also invite Semane and Delta H to be part of the meeting.
KB: Presenting plans is difficult on a Microsoft Teams platform.
NA: Can this meeting be a physical meeting as it will be easier to explain the plans in person. NM: Yes it can be arranged.

Summary of actions:

- For SRK:
  - Apply for WUL amendment separately; and
  - Apply for new WULA for Section 21 (c) and (i), (f) and (g) water uses.

- For DWS
  - NM to request a meeting date from the Civils Department and query if the meeting can be undertaken in person

Minutes taken by: Megan Kim Govender
Draft minutes distributed on: XXX
Final minutes distributed on: XXXX

Appendices

Appendix A: Presentation

Anglo American - Inyosi Coal (Pty) Ltd (AAIC) WULA for Elders Colliery

DWS Pre-Application Meeting

0

Agenda

01	Welcome
02	Introduction and Background
03	WUL Amendment and WULA Requirements
04	Environmental Authorisation
05	Questions

1

Introduction and Background

2

Introduction

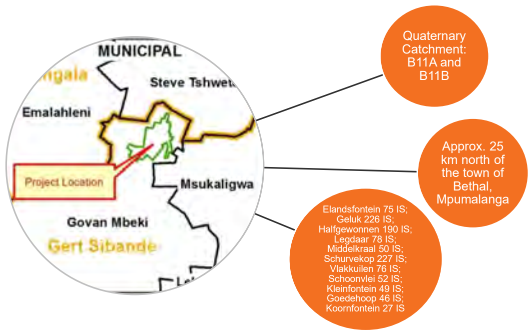
Applicant:
Anglo American - Inyosi Coal (Pty) Ltd (AAIC)

Proposed Project:
Mine development is authorised but requires WUL amendments and additional activities to be authorised due to changes in mine plan

Operations:
Elders Colliery

3

Project Location



Elders Colliery - DWS Pre-Application Meeting November 2020 srk consulting 4

4

Project Background

- WUL Authorisation received in April 2017, and amended WUL in November 2017 (WUL No. 03/B22A/ACFGIJ/5047, File No. 27/2/2/B111/11/1)
- Appendix I, Condition 12 of WUL stated that if the water use was not exercised within 3 year of the issuing of the WUL, the authorised will be withdrawn. In June 2020 Anglo received an extension of the condition for 3 years
- Mining Right issued in April 2018; Mining Right Executed 2020, and EA issued July 2020
- Since issuing of the WUL, synergy has been lost with Goedehoop as life extension. There have been resultant changes to project description and further changes since the DWS meeting in February 2019
- Neighboring Mine Sudor Coal (Pty) Ltd submitting Section 102 Application before end of the month
- Execution schedule – construction to start 2021

Elders Colliery - DWS Pre-Application Meeting November 2020 srk consulting 5

5

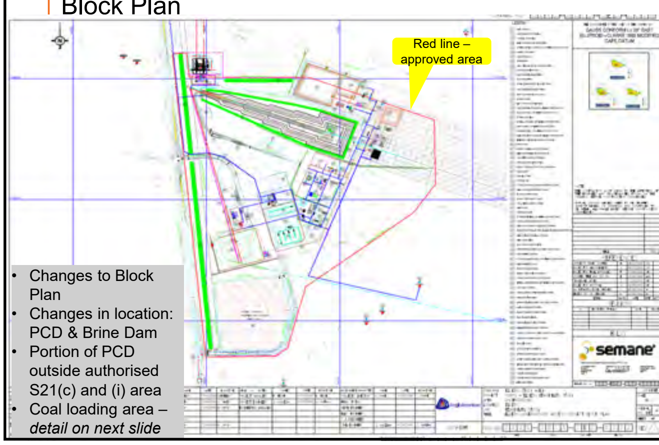
Changes to Project Description

2016 Project Description (WUL)	2020 Project Description

• Underground mining
• Mining No. 2 and 4 Seam by means of bord and pillar mining methods using Continuous Miners
• Box cut (7 ha) and associated surface infrastructure
• New overland conveyor belt (10 km) to Block 20
• Upgrading existing conveyor belt (8 km) from Block 20 to Goedehoop Colliery
	• Underground mining
	• Mining No. 2 and 4 Seam by means of bord and pillar mining methods using continuous miners at a slower rate
	• Change in block plan layout including:
	  ◦ Smaller boxcut (5.0365ha)
	  ◦ Ventilation shaft outside boxcut (but adjacent)
	  ◦ Coal loading area including storage bin and interim loading area during initial mine development (3 months); will also cater for emergency overflows during operation
	  ◦ Road layout change
	  ◦ 22 kV power line layout change
	• Trucking ore to existing processing facility
	• Widening of the R35 at intersections

6

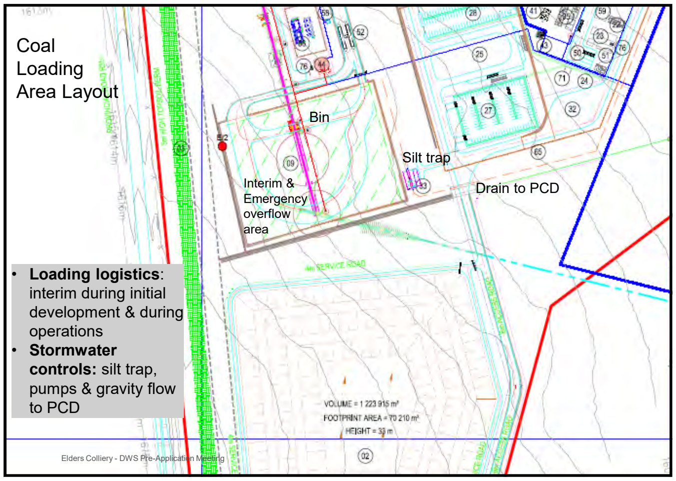
Block Plan



- Changes to Block Plan
- Changes in location: PCD & Brine Dam
- Portion of PCD outside authorised S21(c) and (i) area
- Coal loading area – *detail on next slide*

7

Coal Loading Area Layout



- **Loading logistics**: interim during initial development & during operations
- **Stormwater controls:** silt trap, pumps & gravity flow to PCD

8

Coal Loading Area

- Coal mined from underground is stored in a steel bin from where it will be loaded onto trucks and hauled to an existing processing facility
- Area earmarked for interim use and emergency overflow from the bin will be cleared within 24 hours
- Interim use only required for initial development during mining of interburden and boxcut (approximately 3 months)
- Base preparation of the loading area: Class D liner (compacted G8 material) with sub-soil drainage and collection into dirty water system
- Clean and dirty stormwater controls will be in place at the coal loading area
- Clean water will be diverted by compacted earth berms and cut-off drains
- Dirty water runoff collected on downside of the coal loading area in a channel feeding the coal loading area silt-trap. Concrete-lined drain feeds the PCD via the PCD silt-trap
- An open drain is provided to drain dirty water from the cross-over conveyor drive bunded area into the channel described above

9

Authorised Water Uses

WUL No. 03/B22A/ACFGIJ/5047, File No. 27/2/2/B111/11/1 (issued in 2017) authorised for:

- 21 (a)/(j) taking of water from a water resource: *Boxcut dewatering (a&j) and boreholes (a)*
- 21 (c) & (i) impeding or diverting the flow of water in a watercourse; altering the beds, banks and characteristics of a watercourse: *crossings, activities within 500m of a wetland including discharges*
- 21 (f) discharging waste or water contain waste into a water resource: *water and sewage treatment plants*
- 21 (g) disposing of waste or water containing waste in a manner which may detrimentally impacts on a water resource: *dirty water dams, sewage sludge, gypsum, dust suppression*

10

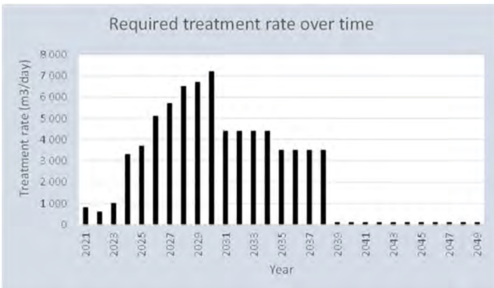
Revised water balance

Water Use	WUL Volume	Water Balance Volume
Section 21 (g): Main PCD	127 776 m^3 WULA capacity: 45 ML	1 218 370 m^3 Capacity ≥ 29 ML
Section 21 (f):Combined discharge of treated water from Water Treatment Plant	669 045 m^3 1833 m^3/d	1 168 000 m^3 3200 m^3/d
Section 21 (g): Dust Suppression using waste water from PCD	45 990 m^3	60 955 m^3

11

Treatment rate over LoM

2024-2038: average treatment rate is >3200m³/d
2021-2023 and 2039 - 2049 average treatment rate is well below 3200m³/d



12

WUL Amendment and WULA Requirements

13

Authorisation Requirements

WUL Amendment

- Amendment to coordinates: 21(c) and (i) and 21(g)
- Amendment to conditions for calibration:
  - Appendix II, condition 11: Change to flowmeter verification
  - Appendix IV, condition 3.1.3: Change to verification certificates
  - Appendix VI, condition 7: Change to verified
  - Appendix VI, condition 8: Change to Verification certificates

New WULA

- 21(c) and (i): Construction of coal loading area within 500m of a wetland
- 21(f) New use triggered by increase in volume
- 21(g): New use triggered by increase in volumes for PCD and dust suppression and change in PCD capacity

14

WULA Requirements

Combined or separate WULA and WUL Amendment Application?

Specialist Studies

Supporting Information

Public Participation

15

Proposed Timeline

End November 2020
Phase 1
Submission

Phase 2 (Site Visit)
December 2020

April 2021
Phase 3
Submission

Decision
September 2021

October 2021
Commencement
of Construction

16

Environmental Authorisation

17

National Environmental Management Act (Act No 107 of 1998)

- Section 102 Application to include Portion 4 of Halfgewonnen 190 IS into Mining Right. Submission planned for 30 November 2020 to meet construction deadlines (2021)
- Submit NEMA Application for either amendment to EA or Full Scoping and Environmental Impact Assessment (EIA) based on discussion with competent authority (DMRE)
- Outcome of the DWS pre-application meeting will determine whether amendment to EA or Full Scoping and EIA is required

18

Questions

Thank You

19

Appendix G: Specalist Studies

Appendix G1: Air Quality Specialist Study

Air Quality Specialist Report for the Proposed Elders Colliery, Mpumalanga

Project done on behalf of SRK Consulting (South Africa) (Pty) Ltd

Project Compiled by:
Oladapo Akinshipe

Project Manager
H Liebenberg-Enslin

Report No: 14SRK15_Rev.0.2 | Date: September 2015

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www.airshed.co.za

Report Details

Reference	14SRK15
Status	Revision 0.2
Report Title	Air Quality Specialist Report for the Proposed Elders Colliery, Mpumalanga
Date Submitted	November 2015
Client	SRK Consulting (South Africa) (Pty) Ltd
Prepared by *Reviewed by*	Oladapo Akinshipe M.Sc. (Env. Tech, Uni. of Pretoria) Hanlie Liebenberg-Enslin, PhD (University of Johannesburg)
Notice	Airshed Planning Professionals (Pty) Ltd is a consulting company located in Midrand, South Africa, specialising in all aspects of air quality, ranging from nearby neighbourhood concerns to regional air pollution impacts as well as noise impact assessments. The company originated in 1990 as Environmental Management Services, which amalgamated with its sister company, Matrix Environmental Consultants, in 2003.
Declaration	I, Oladapo Akinshipe, as authorised representative of Airshed Planning Professionals (Pty) Ltd hereby confirm my independence as a specialist and declare that neither I nor Airshed Planning Professionals (Pty) Ltd have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Airshed Planning Professionals (Pty) Ltd was appointed as air quality specialists in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the assessment summarised in this report. I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in this report.
Copyright Warning	Unless otherwise noted, the copyright in all text and other matter (including the manner of presentation) is the exclusive property of Airshed Planning Professionals (Pty) Ltd. It is a criminal offence to reproduce and/or use, without written consent, any matter, technical procedure and/or technique contained in this document.
Acknowledgements	The authors would like to thank Eskom for providing the meteorological and ambient monitoring data utilized in this report.

Revision Record

Revision Number	Date	Reason for Revision
0	September 2015	Draft for client review
0.1	20th October 2015	Incorporation of client review
0.2	5th November 2015	Inclusion of a small scale piggery as an AQSR

Abbreviations

AERMIC	AMS/EPA Regulatory Model Improvement Committee
Airshed	Airshed Planning Professionals (Pty) Ltd
APPA	Air Pollution and Prevention Act
AQSR	Air Quality Sensitive Receptor
ASG	Atmospheric Studies Group
ASTM	American Society for Testing and Materials
DEA	Department of Environmental Affairs (South Africa)
EETM	Emissions Estimation Technique Manual
ESL	Effects Screening Levels
FEL(s)	Front-end loaders
FOE	Frequency of Exceedance
GLC(s)	Ground Level concentration(s)
GLCC	Global Land Cover Characterisation
GV	Guideline Value
HPA	Highveld Priority Area
IFC	International Finance Corporation
L_{MO}	Monin-Obukhov Length
MH	Mixing Height
NAAQS	National Ambient Air Quality Standards (South Africa)
NAEIS	National Atmospheric Emissions Inventory System
NAERR	National Atmospheric Emission Reporting Regulations
NDCR	National Dust Control Regulations
NEMAQA	National Environmental Management Air Quality Act (South Africa)
NPI	National Pollutant Inventory (Australia)
ROM	Run-of-Mine
SA	South Africa(n)
SABS	South African Bureau of Standards
SRK	SRK Consulting (South Africa) (Pty) Ltd
TCEQ	Texas Commission for Environmental Quality
TSP	Total Suspended Particulates
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VKT	Vehicle kilometres travelled
VOC(s)	Volatile organic compound(s)
WHO	World Health Organization

Glossary

Air pollution	This means any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances
Ambient Air	This is defined as any area not regulated by Occupational Health and Safety regulations
Atmospheric emission or emission	Any emission or entrainment process emanating from a point, non-point or mobile source that results in air pollution
Averaging period	This implies a period of time over which an average value is determined
Dispersion	The spreading of atmospheric constituents, such as air pollutants
Dust	Solid materials suspended in the atmosphere in the form of small irregular particles, many of which are microscopic in size
Frequency of Exceedance	A frequency (number/time) related to a limit value representing the tolerated exceedance of that limit value, i.e. if exceedances of limit value are within the tolerances, then there is still compliance with the standard
Mechanical mixing	Any mixing process that utilizes the kinetic energy of relative fluid motion
Oxides of nitrogen (NO_x)	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide (NO_2)
Particulate Matter (PM)	These comprise a mixture of organic and inorganic substances, ranging in size and shape. These can be divided into coarse and fine particulate matter. The former is called Total Suspended Particulates (TSP), whilst PM_{10} and $PM_{2.5}$ fall in the finer fraction.
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 µm. it is also referred to as thoracic particulates and is associated with health impacts due to its tendency to be deposited in, and damaging to, the lower airways and gas-exchanging portions of the lung
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 µm. it is also referred to as respirable particulates. It is associated with health impacts due to its high tendency to be deposited in, and damaging to, the lower airways and gas-exchanging portions of the lung
Vehicle Entrainment	This is the lifting and dropping of particles by the rolling wheels leaving the road surface exposed to strong air current in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed

Symbols and Units

°C	Degree Celsius
µg	Microgram(s)
$µg/m^3$	Micrograms per cubic meter
CO	Carbon monoxide
CO_2	Carbon dioxide
m/s	Metres per second
m^2	Metres squared
mg	Milligram(s)
mg/m^3	Milligrams per cubic meter
mm	Millimeters
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
O_3	Ozone
Pb	Lead
PM	Particulate Matter
PM_{10}	Thoracic particulate matter
$PM_{2.5}$	Respirable particulate matter
SO_2	Sulphur dioxide

Executive Summary

Introduction

The proposed Elders Colliery project is located in the Mpumalanga Province, approximately 20km north from the town of Bethal. The proposed project falls within the Gert Sibande District Municipality and Govan Mbeki Local Municipality as well as in the Nkangala District Municipality and the Steve Tshwete Local Municipality.

Airshed Planning Professional (Pty) Ltd (Airshed) was appointed by SRK Consulting (Pty) Ltd (SRK) to undertake an air quality impact study for the proposed mine. The main purpose of the study is to evaluate and determine the impacts of the mine's operations on the ambient air quality and to recommend mitigation measures, if necessary, to reduce the simulated impacts. This is to be achieved through the use of the relevant legislation and regulation, emissions inventory, dispersion modelling and results assessment.

Scope and Approach

The aim of this investigation was to determine baseline air quality conditions, delineate sensitive receptors and identify potential impacts to air quality that may arise from the project. This formed the basis for the air quality impact assessment conducted for the proposed project.

The following tasks, typical of an air quality impact assessment, were included in the scope of work:

- A review of proposed project activities in order to identify sources of emission and associated pollutants.
- A study of regulatory requirements and health concentration thresholds for identified key pollutants against which compliance need to be assessed and health risks screened.
- A study of the receiving environment in the vicinity of the project; including:
    - The identification of potential air quality sensitive receptors (AQSRs);
    - A study of the atmospheric dispersion potential of the area taking into consideration local meteorology, land-use and topography; and
    - The analysis of all available ambient air quality information/data to determine pre-development ambient pollutant levels and dustfall rates.
- The compilation of a comprehensive emissions inventory which included:
    - Fugitive dust emissions from operational phase activities;
    - Combustion emissions (PM and gaseous pollutants) during the operational phase;
- Atmospheric dispersion modelling to simulate ambient air pollutant concentrations and dustfall rates as a result of the project.
- A screening assessment to determine:
    - Compliance of criteria pollutants with ambient air quality standards;
    - Potential health risks as a result of exposure to non-criteria pollutants; and
    - Nuisance dustfall
- The ranking of impact significance based on the methodology adopted by SRK.
- The compilation of a comprehensive air quality specialist report detailing the study approach, limitations, assumption, results and recommendations of mitigation and management of air quality impacts.

The air quality impact assessment included a study of the receiving environment and the quantification and assessment of the impact of the proposed project on human health and the environment. The receiving environment was described in terms of local atmospheric dispersion potential, the location of potential air quality sensitive receptors (AQSRs) in relation to proposed activities as well as ambient pollutant levels and dustfall rates.

A comprehensive atmospheric emissions inventory was compiled for the operational phase of the project. Pollutants quantified included those most commonly associated with coal mines i.e. particulate matter (PM) (TSP, PM_{10}, and $PM_{2.5}$). PM_{10} is defined as particulate matter with an aerodynamic diameter of less than 10 µm and is also referred to as thoracic particulates. Inhalable particulate matter, $PM_{2.5}$, is defined as particulate matter with an aerodynamic diameter of less than 2.5 µm. Whereas PM_{10} and $PM_{2.5}$ fractions are taken into account to determine the potential for human health risks, total suspended particulate matter (TSP) is included to assess nuisance effects.

Two scenarios were considered during the air quality assessment:

- Scenario 1: this scenario is planned to occur during the construction and mining of the initial box-cut which will serve as an adit to the underground mining operation.
- Scenario 2: this scenario takes into account only the operational phase of the underground mine.

In the quantification of impacts, the mine mitigation as provided by SRK was utilized.

Main Findings

A quantitative air quality impact assessment was conducted for operational phase activities of the project. The assessment included a study of the receiving environment as well as the estimation of atmospheric emissions, the simulation of pollutant levels and determining the significance of impacts.

The main findings of the assessment are:

- The receiving environment:
  - The area is dominated by strong winds from the east and north-west, with moderate winds from most of the north- eastern and south-western sectors. An average wind speed of 3.8 m/s was recorded over the 2011 to 2013 period.
  - Ambient air pollutant levels in the proposed project area are currently affected by the following sources of emission; mining; vehicles tail-pipe emissions; power generation; domestic fuel combustion and open areas exposed to wind erosion.
  - Sensitive receptors around the Elders Colliery boundary include Vlakkuilen, Vaalkop, Legdaar, Schurvekop, Elandsfontein, Middlekraal, Halfgewonnen and a small scale piggery.

- Impact of the proposed Project:
  - Scenario 1 (construction and mining of the initial box-cut):
    - Sources of emission quantified included drilling, blasting, crushing and screening, material handling, vehicles travelling on unpaved roads, windblown dust from the stockpiles and windblown dust from conveyor. PM emissions ($PM_{2.5}$, PM_{10} and TSP) were quantified and utilized in simulations.
    - The simulated PM_{10} and $PM_{2.5}$ frequency of exceedance (FOE) result in exceedance of their respective 4-day per-year South African (SA) National Ambient Air Quality Standards (NAAQS) outside the Elders boundary. The impact extends outside the Elders boundary along the conveyor belt. However, the simulated annual average PM_{10} and $PM_{2.5}$ GLCs does not result in exceedance of their respective SA NAAQS value outside the Elders boundary.

Exceedance of the 4-day per-year SA NAAQS FOE and annual average SA NAAQS for PM_{10} and $PM_{2.5}$ was not simulated at any AQSRs.

A significance rating of *'low'* was assigned to potential inhalation health impacts associated with PM_{10} and $PM_{2.5}$ impacts during the construction and mining of the initial box-cut.

- The simulated maximum daily dustfall deposition rate result in exceedance of the National Dust Control Regulations (NDCR) residential limit (600 mg/m^2-day) and non-residential limit (1200 mg/m^2-day) outside the Elders boundary, along the conveyor belt. The exceedance does not impact on nearby AQSRs. A significance rating of *'low'* was assigned to nuisance effects associated with dustfall during the construction and mining of the initial box-cut.

- Scenario 2 (operation of the underground mine):
  - Sources of emission quantified included crushing and screening, material handling, windblown dust from the stockpiles and windblown dust from conveyor. PM emissions ($PM_{2.5}$, PM_{10} and TSP) were quantified and utilized in simulations.
  - The simulated PM_{10} and $PM_{2.5}$ FOE result in exceedance of their respective 4-day per-year SA NAAQS outside the Elders boundary. The impact extends outside the Elders boundary along the conveyor belt. However, the simulated annual average PM_{10} and $PM_{2.5}$ GLCs does not result in exceedance of their respective SA NAAQS value outside the Elders boundary. Exceedance of the 4-day per-year SA NAAQS FOE and annual average SA NAAQS for PM_{10} and $PM_{2.5}$ was not simulated at any AQSRs.
    A significance rating of *'low'* was assigned to potential inhalation health impacts associated with PM_{10} and $PM_{2.5}$ impacts during the operation of the underground mine.
  - The simulated maximum daily dustfall deposition rate result in exceedance of the NDCR residential limit (600 mg/m^2-day) and non-residential limit (1200 mg/m^2-day) outside the Elders boundary, along the conveyor belt. The exceedance does not impact on nearby AQSRs. A significance rating of *'low'* was assigned to nuisance effects associated with dustfall during the operation of the underground mine.

Recommendations

To ensure the lowest possible impact on nearby AQSRs and the environment, it is recommended that the air quality management plan as set out in this report be adopted.

A summary of the recommended management plan is given below:

- The implementation of emission controls for the management of significant emission sources, most significantly, emissions from conveyor belts and crushing processes;
- It is recommended that the Elders ambient air quality monitoring campaign be continued as part of the project's air quality management plan. This should be undertaken throughout the life of the project to provide air quality trends and adequate data for cumulative impacts on AQSRs; and
- The Elders Colliery falls within the HPA footprint and it will contribute to the pollution within the Highveld airshed. It is recommended that the management plan for the Highveld Priority Area as published by the DEA be included in all management plans employed for the project.

It is also recommended that the project comply with the provisions of the National Atmospheric Emission Reporting Regulations (NAERR) 2015 as summarized in this report. The NAERR aims to standardize the reporting of data and information from an identified data provider to an internet-based National Atmospheric Emissions Inventory System, towards the compilation of atmospheric emission inventories.

Table of Contents

Table of Figures

List of Tables

Air Quality Specialist Report for the Proposed Elders Colliery, Mpumalanga

1 INTRODUCTION

The proposed Elders Colliery project is located in the Mpumalanga Province, approximately 20km north from the town of Bethal. The proposed project falls within the Gert Sibande District Municipality and Govan Mbeki Local Municipality as well as in the Nkangala District Municipality and the Steve Tshwete Local Municipality (Figure 2-1).

Airshed Planning Professional (Pty) Ltd (Airshed) was appointed by SRK Consulting (Pty) Ltd (SRK) to undertake an air quality impact study for the proposed mine. The main purpose of the study is to evaluate and determine the impacts of the mine's operations on the ambient air quality and to recommend mitigation measures, if necessary, to reduce the simulated impacts. This is to be achieved through the use of the relevant legislation and regulation, emissions inventory, dispersion modelling and results assessment.

1.1 Terms of Reference

Terms of reference for the current study comprise of two main components, viz a baseline assessment and air quality impact assessment.

The terms of reference of a *baseline assessment* include:

- The assessment of regional climate and site-specific atmospheric dispersion potential.
- Preparation of hourly average meteorological data for input to the dispersion model and simulation of wind field, mixing depth and atmospheric stability.
- The legislative and regulatory context, including emission limits and guidelines, ambient air quality guidelines and standards, and dustfall classifications with specific reference to the new and proposed South African legislation.

An impact assessment focuses generally on the estimation of the atmospheric emissions, modelling and the resultant impacts; this includes:

- The identification of possible emission sources and specific information about each potential source.
- The establishment of an emissions inventory.
- Dispersion simulations to determine potential air pollutant concentrations and dustfall values;
- An analysis of the dispersion modelling results.
- The evaluation of potential for human health and environmental impacts based on local ambient air quality guidelines and standards;
- Recommendations of mitigation and management measures.

The management plan is informed by the analyses of the baseline and impact assessments and comprises recommendations including mitigation and management measures and monitoring.

1.2 Description of Project Activities from an Air Quality Perspective

Air quality impacts will be associated with four distinct phases namely: the construction phase, the operational phase, the decommissioning phase and the post-closure phase. A description of each of these phases, from an air quality impact perspective is summarised below.

Construction will typically include land clearing of the construction footprint, general construction activities (i.e. bulk earthworks and infrastructure development for the plant, buildings, dams, onsite roads etc.), bulldozing, loading and grading activities. These operations will likely result in fugitive[1] PM emissions as well as particulate and gaseous vehicle exhaust emissions. Gaseous emissions, associated with the combustion of diesel, mainly include carbon monoxide (CO), oxides of nitrogen (NO_x), sulphur dioxide (SO_2) and volatile organic compounds (VOC). VOCs are also released from diesel storage tanks.

It is important to note that, in the discussion, regulation and estimation of PM emissions and impacts, a distinction is made between different particle size fractions, *viz*. TSP, PM_{10} and $PM_{2.5}$. PM_{10} is defined as particulate matter with an aerodynamic diameter of less than 10 µm and is also referred to as thoracic particulates. Inhalable particulate matter, $PM_{2.5}$, is defined as particulate matter with an aerodynamic diameter of less than 2.5 µm. Whereas PM_{10} and $PM_{2.5}$ fractions are taken into account to determine the potential for human health risks, total suspended particulate matter (TSP) is included to assess nuisance effects.

During the operational phase fugitive $PM_{2.5}$, PM_{10} and TSP emissions will result mainly as a result of the following; drilling, blasting, crushing and screening, ore and waste handling, truck traffic on unpaved haul routes and open dusty areas exposed to the wind. Diesel generators and exhaust from diesel mobile equipment will result in diesel particulate matter (DPM) (which is generally regarded to fall in the $PM_{2.5}$ and PM_{10} fractions), as well as CO, NO_x, SO_2 and VOC emissions. As with construction, the storage of diesel to be used during the operational phase may also result in VOC emission in the form of working and standing losses.

The closure phase will include fugitive PM generating activities such as bulk earthworks, demolition and re-vegetation, as well as gaseous emissions from combustion sources. With the successful implementation of a closure and rehabilitation plan, no atmospheric emissions will be expected during the post-closure phase.

1.3 Approach and Methodology

The approach to, and methodology followed in the completion of tasks completed as part of the scope of work are discussed.

1.3.1 Project Information and Activity Review

All project/process related information referred to in this study was provided by SRK.

[1] Fugitive emissions refer to emissions that are spatially distributed over a wide area and not confined to a specific discharge point as would be the case for process related emissions (IFC, 2007).

1.3.2 The Identification of Regulatory Requirements and Health Thresholds

In the evaluation of ambient air quality impacts and dustfall rates reference was made to:

- South African National Ambient Air Quality Standards (SA NAAQS) and National Dust Control Regulations (SA NDCR) as set out in the National Environmental Management Air Quality Act (Act No. 39 of 2004) (NEMAQA); and
- Screening levels for non-criteria pollutants published by various international institutions.

1.3.3 Study of the Receiving Environment

Physical environmental parameters that influence the dispersion of pollutants in the atmosphere include terrain, land cover and meteorology. Existing pre-development ambient air quality in the study area is also considered. Readily available terrain and land cover data was obtained from the Atmospheric Studies Group (ASG) via the United States Geological Survey (USGS) web site at (ASG, 2011). Use was made of Shuttle Radar Topography Mission (SRTM) (90 m, 3 arc-sec) data and Global Land Cover Characterisation (GLCC) data for Africa.

An understanding of the atmospheric dispersion potential of the area is essential to an air quality impact assessment. The nearest meteorological station to the proposed site is the Elandsfontein station managed by Eskom. Meteorological data was utilized for the period January 2011 to December 2013.

1.3.4 Determining the Impact of the Project on the Receiving Environment

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the project's emissions on the receiving environment. In the quantification of emissions, use was made of emission factors which associate the quantity of release of a pollutant to the activity. Emissions were calculated using emission factors and equations published by the United States Environmental Protection Agency (US EPA) and Environment Australia (EA) in their National Pollutant Inventory (NPI) Emission Estimation Technique Manuals (EETMs).

1.3.5 Compliance Assessment and Health Risk Screening

Compliance was assessed by comparing simulated ambient criteria pollutant concentrations ($PM_{2.5}$ and PM_{10}) and dustfall rates to selected ambient air quality and dustfall criteria.

1.3.6 Impact Significance

The significance of impacts was determined in accordance with the procedure adopted and prescribed by SRK.

1.3.7 The Development of an Air Quality Management Plan

The findings of the above components informed recommendations of air quality management measures, including mitigation and monitoring.

1.4 Assumptions and Limitations

The assumptions applicable to this assessment are as follows:

- The quantification of existing sources of emission was restricted to Elders Colliery operations.

- Particulates including TSP, PM_{10} and $PM_{2.5}$ were regarded the main pollutant of concern with no gaseous emissions quantified as part of the study.
- Information required to quantify emissions from fugitive dust sources for Elders Colliery was provided by SRK personnel and the information is assumed to be correct and accurate. Where information was lacking assumptions were based on similar studies done in the area.

The data limitations can be summarised as follows:

- No on-site meteorological data was available for the site and use was made of Eskom's Elandsfontein weather station data. The assessment utilized meteorological data for a period of three years (2011 to 2013).
- Emissions rates calculated reflect only normal operating conditions and non-routine operations are not accounted for.
- The dispersion model cannot compute real-time mining and production processes; and planned throughputs were therefore used. Operational locations and periods were selected to reflect the representative worst-case scenarios.

2 PROJECT DESCRIPTION

2.1 Project Description and Location

The proposed colliery will consist of underground coal mining; with initial mining the former method will utilise the pillar and borad mining method to extract the coal whereas the latter method will be a truck and shovel operation. The mined coal from the underground and initial box-cut will be transported using a conveyor to the nearby Goedehoop Mine washing plant.

The mine will be located on the farm Vlakkuilen 76 IS, situated approximately 25 km north of Bethal, 22 km east of Kriel and 49 km to the southeast of Emalahleni. The conveyor belt will run over the farms Middelkraal 50 IS, Schoon-Vlei 52 IS and Kleinfontein 49 IS to link up with the existing Goedehoop Mine washing plant. Open-cast mining will be established to the south-west and south of the ventilation shaft complex, still falling on the farm Vlakkuilen 76 IS (Figure 2-1).

2.2 Mining Process

The proposed Elders Colliery plans on developing a new box-cut access with 14 years Life of Mine (LOM), and to mine the No. 2 and No. 4 coal seams by means of board and pillar underground mining methods, making use of continuous miners and shuttle cars. The option analysis conducted during the project evaluation phase indicated that underground mining is deemed financially more feasible as an effective extraction method for the Elders project, although some open cast opportunity exit in the shallower portion of the resource and might be investigated later during the mine life. The coal deposit is located close to the northern margin of the Highveld Coalfield. It is proposed to mine both the No. 2 and No. 4 seams via a boxcut to be used for personnel, material and coal clearance. It is proposed to transport coal from the underground operations via a new conveyor route (11 km in length) to Block 20 (a mine out shaft currently on care and maintenance, owned by Goedehoop Colliery). Coal will be transported from Block 20 to the Goedehoop Colliery on an existing conveyor belt of 8 km for coal processing at the existing Goedehoop Colliery Processing Plant.

The proposed development includes the following activities:

- Box-cut and associated infrastructure
    - Access road;
    - Internal roads;
    - Service roads;
    - Powerlines;
    - Pipelines;
    - Bulk storage for fuel;
    - Surface silo;
    - Fencing;
    - Topsoil stockpiles;
    - Overburden stockpiles;
    - Pollution control dams;
    - Sewage treatment plant;

- Box-cut;
- Waste and scrap yard;
- Substation;
- Cable yard repair workshop;
- Washbay;
- Stone dust silo;
- Primary crusher;
- Offices; and
- Change houses.

➢ Conveyor route and servitude (new and update of existing)

- Service road;
- Powerline;
- Pipeline; and
- Fencing.

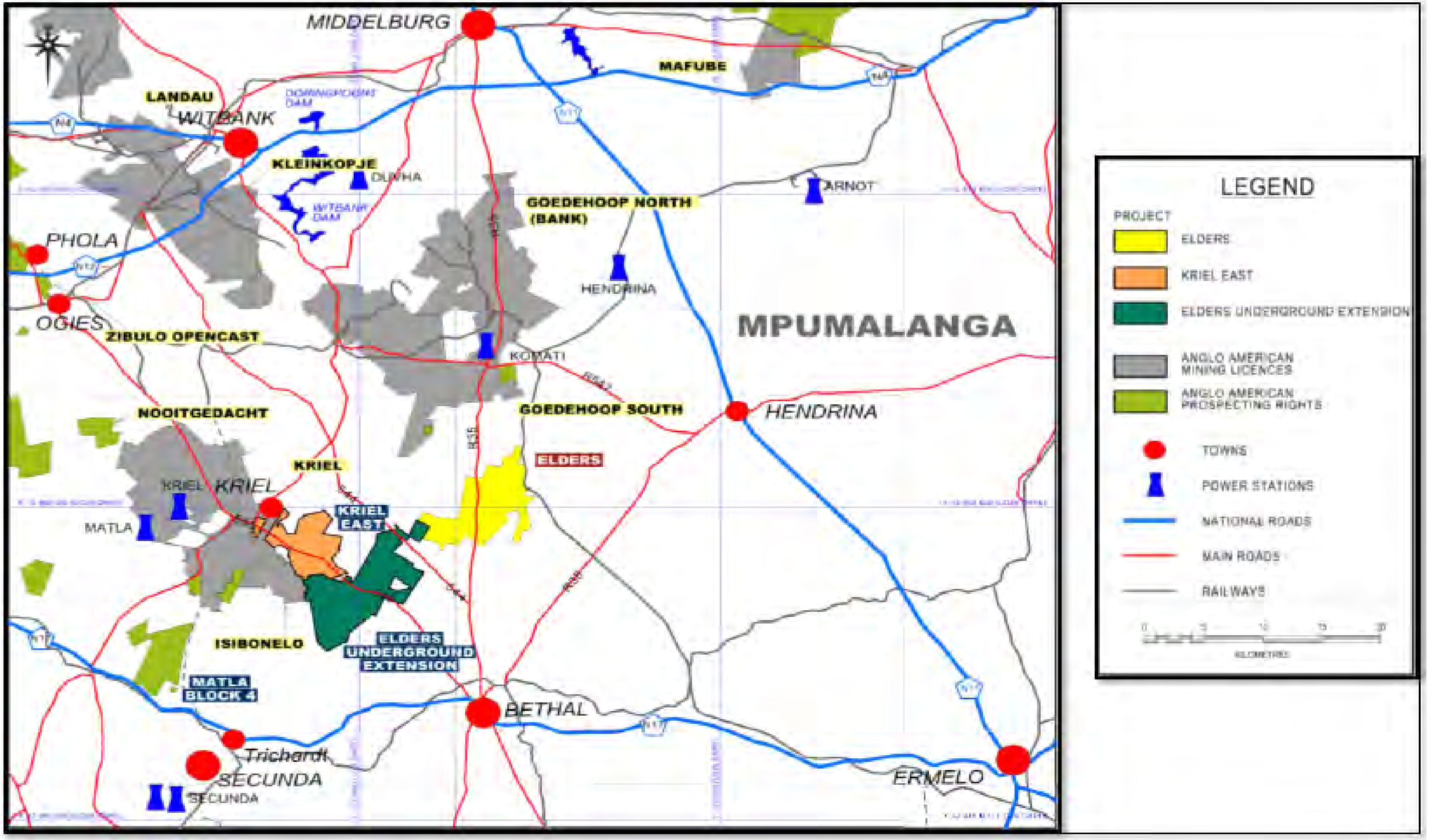


Figure 2-1: Regional location of the Elders Colliery

2.3 Land use and receptors

The current usage of land surrounding the mine includes agriculture (mainly farming) and coal mines. Goedehoop Colliery is situated approximately 10 km to the north-west with at least three other collieries within a 6 km radius from the proposed Elders Colliery.

The proposed mining area is surrounded by power stations with the nearest one, Kriel, approximately 22 km to the west of Elders Colliery. Both Komati and Hendrina Power Stations are about 25 km away, with Komati to the north and Hendrina to the north-east. Duvha Power Station is located further away (~50 km) to the north-northwest, near Emalahleni.

All farm houses and settlements in the area were identified as sensitive receptors from an air quality perspective. These are indicated on the map in Figure 2-2.

Nearby communities include Middlekraal, which is located about 1.5 km away to the north; Vlakkuilen is located about 4 km away to the south; while Elandsfontein, Vaalkop and Janpieta are located about 5 to 8 kms away to the east (Figure 2-2). A small scale piggery is located about 1 km to the southeast of the box-cut. The Eskom weather station – Elandsfontein – is also indicated on Figure 2-2.

Table 2-1: Co-ordinates of Elders Colliery identified sensitive receptors

Sensitive Receptor	Latitude	Longitude
Janpieta	26°13'33.51"S	29°25'12.51"E
Legdaar	26°17'57.51"S	29°26'23.34"E
Schurvekop	26°17'35.93"S	29°29'44.32"E
Elandsfontein	26°14'25.96"S	29°25'48.18"E
Middlekraal	26°13'12.20"S	29°27'50.88"E
Halfgewonnen	26°12'56.50"S	29°31'56.26"E
Vaalkop	26°14'1.01"S	29°25'8.07"E
Vlakkuilen	26°15'55.24"S	29°27'44.52"E
Small scale piggery	26°14'55.54"S	29°27'33.85"E

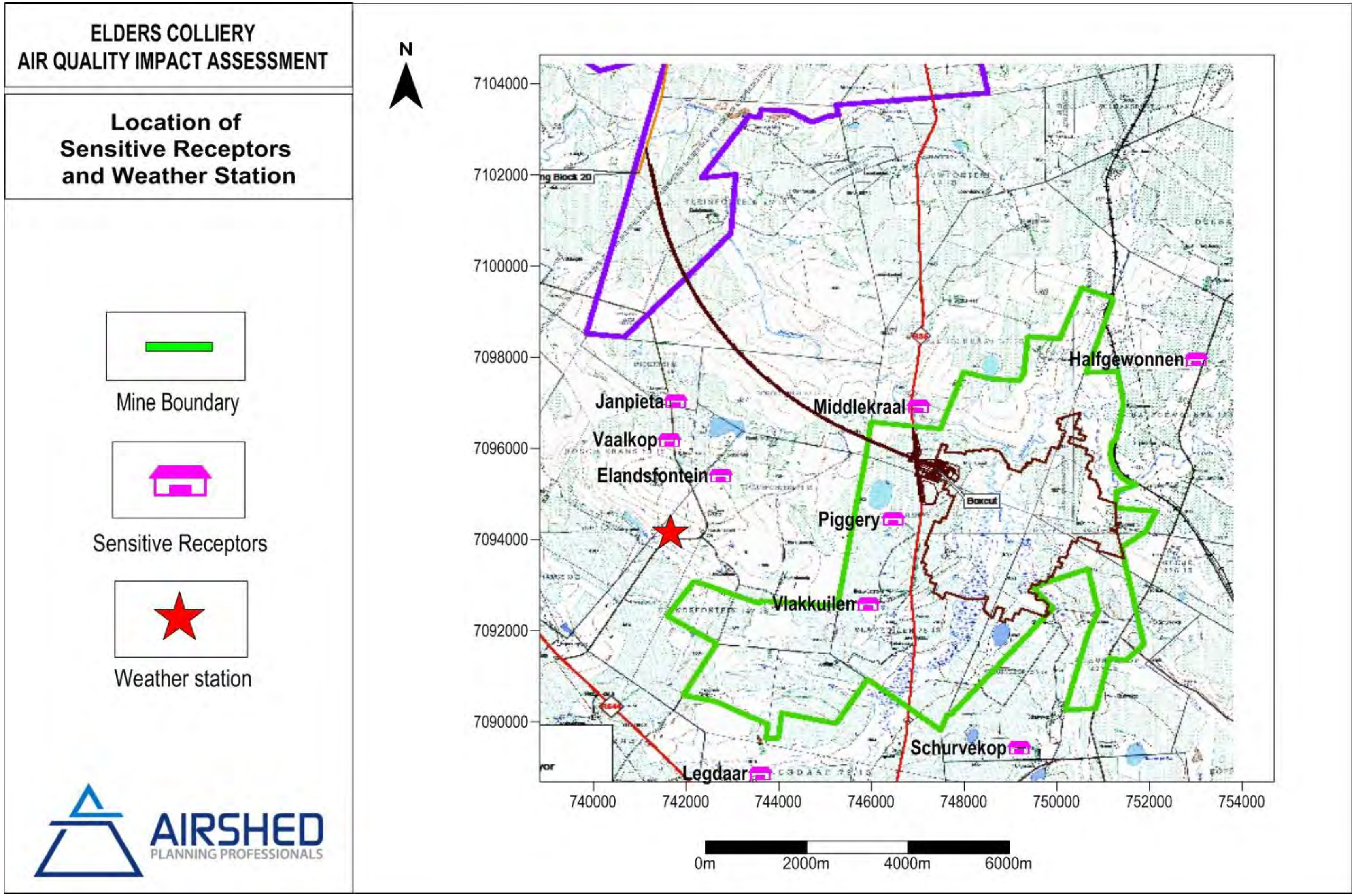


Figure 2-2: Elders Colliery in relation to identified sensitive receptors

3 REGULATORY REQUIREMENTS AND IMPACT ASSESSMENT CRITERIA

Prior to assessing the impact of proposed activities on human health and the environment, reference needs to be made to the environmental regulations governing the impact of such operations i.e. emission standards, ambient air quality standards and dust control regulations.
Emission standards are generally provided for point sources and specify the amount of the pollutant acceptable in an emission stream and are often based on proven efficiencies of air pollution control equipment.

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality standards and guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging or exposure periods.

This section summarises legislation for criteria pollutants relevant to the current study and dustfall. A discussion on inhalation health risk for VOC and elemental is also provided.

3.1 Emission Standards

The NEMAQA (Act No. 39 of 2004 as amended) mandates the Minister of Environment to publish a list of activities which result in atmospheric emissions and consequently cause significant detrimental effects on the environment, human health and social welfare. All scheduled processes as previously stipulated under the Air Pollution Prevention Act (APPA) are included as listed activities with additional activities being added to the list. The updated Listed Activities and Minimum National Emission Standards were published on the 22nd November 2013 in Government Gazette No. 37054 (DEA, 2013).

According to the Air Quality Act, air quality management control and enforcement is in the hands of local government with District and Metropolitan Municipalities as the licensing authorities. Provincial government is primarily responsible for ambient monitoring and ensuring municipalities fulfil their legal obligations, with national government primarily as policy maker and co-ordinator. Each sphere of government must appoint an Air Quality Officer responsible for co-ordinating matters pertaining to air quality management. Given that air quality management under the old Act was the sole responsibility of national government, local authorities have in the past only been responsible for smoke and vehicle tailpipe emission control.

Emission limits are generally provided for point sources and specify the amount of the pollutant acceptable in an emission stream and are often based on proven efficiencies of air pollution control equipment. The project does not include any Listed Activities; hence Minimum Emission Standards do not apply.

3.2 Ambient Air Quality Standards for Criteria Pollutants

Criteria pollutants are considered those pollutants most commonly found in the atmosphere, that have proven detrimental health effects when inhaled and are regulated by ambient air quality criteria. In the context of this project, these include CO, NO_2, $PM_{2.5}$, PM_{10} and SO_2 (Table 3-1).

The South African Bureau of Standards (SABS) assisted the Department of Environmental Affairs (DEA) in the development of ambient air quality standards. National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for PM_{10}, $PM_{2.5}$, dustfall, sulphur dioxide (SO_2), Nitrogen oxide (NO_2), ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene (C_6H_6).

The final revised SA NAAQS were published in the Government Gazette on 24 of December 2009 and included a margin of tolerance i.e. frequency of exceedance (FOE) and implementation timelines linked to it. SA NAAQSs for $PM_{2.5}$ were published on 29 July 2012 (Table 3-1).

Table 3-1: Air quality standards for specific criteria pollutants (SA NAAQS)

Pollutant	Averaging Period	Limit Value (µg/m³)	Limit Value (ppb)	Frequency of Exceedance	Compliance Date
CO	1 hour	30 000	26 000	88	Immediate
	8 hour	10 000	8 700	11	Immediate
NO_2	1 hour	200	106	88	Immediate
	1 year	40	21	0	Immediate
PM_{10}	24 hour	75	-	4	1 Jan 2015
	1 year	40	-	0	1 Jan 2015
$PM_{2.5}$	24 hour	40	-	4	1 Jan 2016 – 31 Dec 2029
	1 year	20	-	0	1 Jan 2016 – 31 Dec 2029
SO_2	10 minutes	500	191	526	Immediate
	1 hour	350	134	88	Immediate
	24 hour	125	48	4	Immediate
	1 year	50	19	0	Immediate
Pb	1 year	0.5	-	0	Immediate
O_3	8 hour	120	61	11	Immediate
C_6H_6	1 year	5	-	0	1 Jan 2015

3.3 National Dust Control Regulations

The National Dust Control Regulations (NDCR) was published on the 1st of November 2013. The purpose of the regulation is to prescribe general measures for the control of dust in all areas including residential and non-residential areas. Acceptable dustfall rates according to the regulation are summarised in Table 3-2.

Table 3-2: Acceptable dustfall rates

Restriction areas	Dustfall rate (D) in mg/m²-day over a 30 day average	Permitted frequency of exceedance
Residential areas	D < 600	Two within a year, not sequential months.
Non-residential areas	600 < D < 1 200	Two within a year, not sequential months.

The regulation also specifies that the method to be used for measuring dustfall and the guideline for locating sampling points shall be ASTM D1739 (1970), or equivalent method approved by any internationally recognized body. It is important to note that dustfall is assessed for nuisance impact and not inhalation health impact.

3.4 Screening Criteria for Animals and Vegetation

Limited information is available on the impact of dust on vegetation and grazing quality. While there is little direct evidence of what the impact of dustfall on vegetation is under a South African context, a review of European studies has shown the potential for reduced growth and photosynthetic activity in Sunflower and Cotton plants exposed to dustfall rates greater than 400 mg/m²/day.

3.5 Regulations Regarding Air Dispersion Modelling

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. Regulations regarding Air Dispersion Modelling were promulgated in Government Gazette No. 37804 vol. 589; 11 July 2014, (DEA, 2014) and recommend a suite of dispersion models to be applied for regulatory practices as well as guidance on modelling input requirements, protocols and procedures to be followed. The Regulations regarding Air Dispersion Modelling are applicable –

(a) in the development of an air quality management plan, as contemplated in Chapter 3 of the AQA;
(b) in the development of a priority area air quality management plan, as contemplated in section 19 of the AQA;
(c) in the development of an atmospheric impact report, as contemplated in section 30 of the AQA; and,
(d) in the development of a specialist air quality impact assessment study, as contemplated in Chapter 5 of the AQA.

The Regulations have been applied to the development of this report. The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Chapter 2 of the Regulations present the typical levels of assessments, technical summaries of the prescribed models (SCREEN3, AERSCREEN, AERMOD, SCIPUFF, and CALPUFF) and good practice steps to be taken for modelling applications. The proposed operation falls under a Level 2 assessment – described as follows;

- The distribution of pollutants concentrations and depositions are required in time and space.
- Pollutant dispersion can be reasonably treated by a straight-line, steady-state, Guassian plume model with first order chemical transformation. The model specifically to be used in the air quality impact assessment of the proposed operation is AERMOD.
- Emissions are from sources where the greatest impacts are in the order of a few kilometers (less than 50 km) downwind)

Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Chapter 3 of the Regulations prescribe the source data input to be used in the model. Dispersion models are particularly useful under circumstances where the maximum ambient concentration approaches the ambient air quality limit value and provide a means for establishing the preferred combination of mitigation measures that may be required.

Chapter 4 of the Regulations prescribe meteorological data input from onsite observations to simulated meteorological data. The chapter also gives information on how missing data and calm conditions are to be treated in modelling applications. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere.

Topography is also an important geophysical parameter. The presence of terrain can lead to significantly higher ambient concentrations than would occur in the absence of the terrain feature. In particular, where there is a significant relative difference in elevation between the source and off-site receptors large ground level concentrations can result.

The modelling domain would normally be decided on the expected zone of influence; the latter extent being defined by the predicted ground level concentrations from initial model runs. The modelling domain must include all areas where the ground level concentration is significant when compared to the air quality limit value (or other guideline). Air dispersion models require a receptor grid at which ground-level concentrations can be calculated. The receptor grid size should include the entire modelling domain to ensure that the maximum ground-level concentration is captured and the grid resolution (distance between grid points) sufficiently small to ensure that areas of maximum impact adequately covered. No receptors however should be located within the property line as health and safety legislation (rather than ambient air quality standards) is applicable within the site.

Chapter 5 provides general guidance on geophysical data, model domain and coordinates system required in dispersion modelling, whereas Chapter 6 elaborates more on these parameters as well as the inclusion of background air concentration data. The chapter also provides guidance on the treatment of NO_2 formation from NOx emissions, chemical transformation of sulphur dioxide into sulphates and deposition processes.

Chapter 7 of the Regulations outline how the plan of study and modelling assessment reports are to be presented to authorities.

3.6 National Atmospheric Emission Reporting Regulations (NAERR)

The National Atmospheric Emission Reporting Regulations (NAERR) was published on the 2nd of April 2015 by the Minister of Environmental Affairs. The regulation aims to standardize the reporting of data and information from an identified point, non-point and mobile sources of atmospheric emissions to an internet-based National Atmospheric Emissions Inventory System (NAEIS), towards the compilation of atmospheric emission inventories (DEA , 2015).

Annexure 1 of the NAERR classify mines (holders of a mining right or permit in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) as a data provider under Group C. Sections of the regulation that applies to data providers are summarized below.

With regards to registration, the regulation stipulates that:

(a) A person classified as a data provider must register on the NAEIS within 30 days from the date upon which these Regulations came into effect;
(b) A person classified as a data provider and who commences with an activity or activities classified as emission source in terms of the regulation 4(1) after the commencement of these Regulations, must register on the NAEIS within 30 days after commencing with such an activity or activities.

With regards to reporting and record keeping, the regulation stipulates that:

(a) A data provider must submit the required information for the preceding calendar year, as specified in Annexure 1 to these Regulations, to the NAEIS by 31 March of each calendar year.
(b) A data provider must keep a record of the information submitted to the NAEIS for five years and such record must, on request, be made available for inspection by the relevant authority.

With regards to verification of information, the regulation requires data providers to verify requested information within 60 days after receiving the written request from the relevant authority.

4 BASELINE CHARACTERISATION

The baseline air quality assessment characterises further details about:

- Atmospheric dispersion potential, and
- Physical environment of the surrounding area

4.1 Atmospheric Dispersion Potential

In order to understand and assess the possible impacts on the surrounding environment and human health, it is vital to have an understanding of the regional climate and local air dispersion potential of the area.

Meteorological characteristics of a site govern the dispersion, transformation and eventual removal of pollutants from the atmosphere (Pasquill and Smith, 1983; Godish, 1990). Dispersion potential refers to the ability of pollutants to spread in different directions and therefore to different locations. Dispersion potential can be observed both horizontally and vertically and is dependent on the degree of thermal and mechanical turbulence within the earth's boundary layer. Wind field largely facilitates horizontal dispersion leading to wind speed determining both the distance of downward transport and dilution of pollutants as a result of plume stretching. Vertical dispersion is facilitated by atmospheric stability and the depth of the surface mixing layers. The generation of mechanical turbulence is similarly a function of the wind speed coupled with surface roughness.

Pollution concentration levels fluctuate in response to changes in atmospheric stability, to concurrent variations in the mixing depth, and to shifts in the wind field. Spatial variations, and diurnal and seasonal changes, in the wind field and stability regime are functions of atmospheric processes operating at various temporal and spatial scales (Goldreich and Tyson, 1988). Atmospheric processes at macro- and meso-scales need therefore be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area.

Parameters that need to be taken into account in the characterisation of meso-scale ventilation potentials include wind speed, wind direction, extent of atmospheric turbulence, ambient air temperature and mixing depth. No on-site meteorological data exist and use was made of data recorded by Eskom's Elandsfontein weather station, (location shown in). Data for the period of January 2011 to December 2013 was utilized.

4.1.1 Surface wind field

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the yellow area, for example, represents winds in between 4 and 6 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

The period wind field and diurnal variability in the wind field are shown in Figure 4-1. Seasonal variations in the wind field are provided in Figure 4-2.

The wind field is predominantly characterised by winds from the eastern and north-western quadrants. The recorded wind speeds are generally moderate; below 8 m/s for 68% of the time with peak wind speeds greater than 10 m/s recorded for only 3.4% of the time. On average, the wind speed is 4.8 m/s with calm conditions (< 1 m/s) occurring for 0.8 % of the time.

During day-time, the wind field is characterised by north-westerly airflow with less frequent winds from the east (<9%). Calm conditions occurred for 0.7 % of the time. During the night, the prevailing wind field shifted to easterly winds and less frequent winds from the north-west. The wind speed decreased during the night with increasing occurrence of calm conditions (0.8 % of the time).

The seasonal wind field for the Elandsfontein station, as presented in Figure 4-2, shows considerable differences in the wind fields between the seasons. During summer and autumn the dominant winds are from the easterly sectors, while in winter westerly winds dominate, and in spring the winds are predominantly from the northerly sectors.

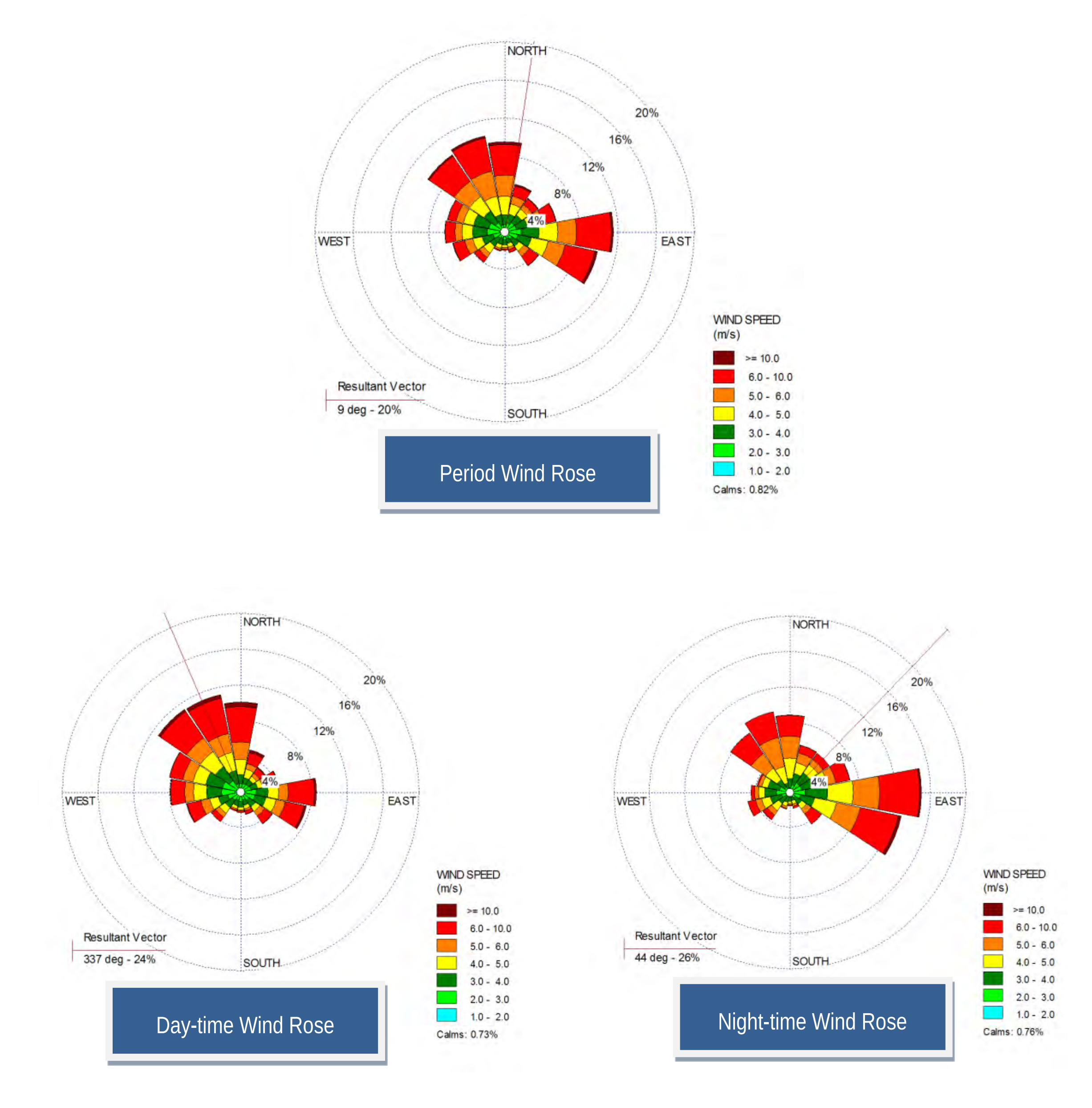


Figure 4-1: Period, day and night-time wind roses (Elandsfontein data, 2011 to 2013)

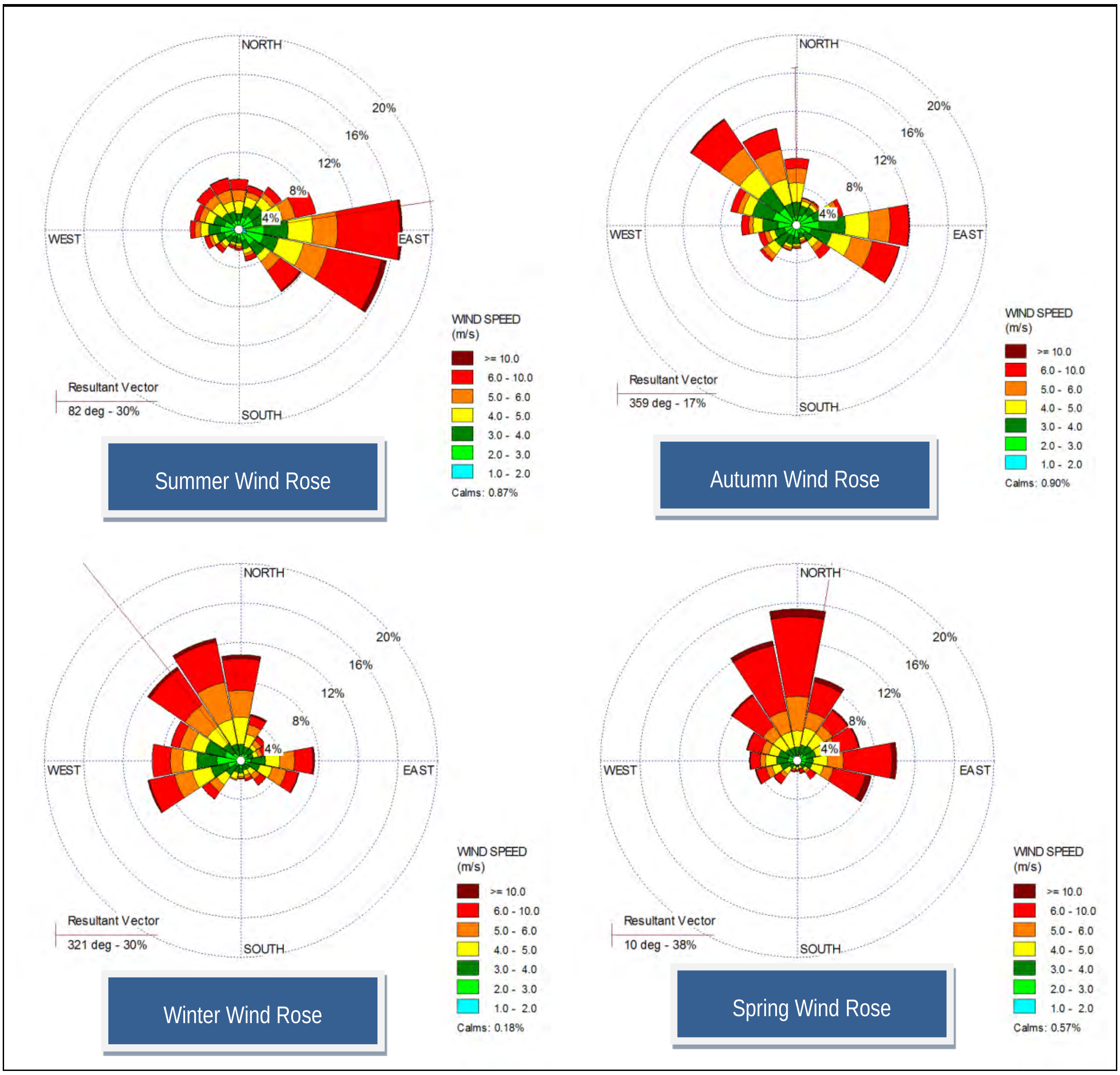


Figure 4-2: Seasonal wind roses (Elandsfontein data, 2011 to 2013)

4.1.2 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the emission plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

Diurnal and average monthly temperature trends are presented in Figure 4-3. Monthly mean and hourly maximum and minimum temperatures are given in Table 4-1.

Temperatures range between -5.0 and 33.7 °C. The highest temperatures were recorded in October and February, and the lowest in May. During the day, temperatures increase to reach maximum at around 15:00 in the afternoon. Ambient air temperatures decreases to reach a minimum at around 07:00 i.e. just before sunrise.

Table 4-1: Monthly minimum, maximum and average hourly temperatures

Monthly Minimum, Maximum and Average Temperatures (°C)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	10.4	9.3	9.5	1.0	0.4	-3.6	-1.7	-3.7	-0.8	6.2	4.3	11.3
Average	19.7	19.2	18.4	14.6	13.5	10.4	10.3	11.9	14.6	16.8	18.6	18.7
Maximum	39.1	35.1	33.1	28.1	28.5	23.8	22.0	28.3	29.3	34.1	34.8	34.9

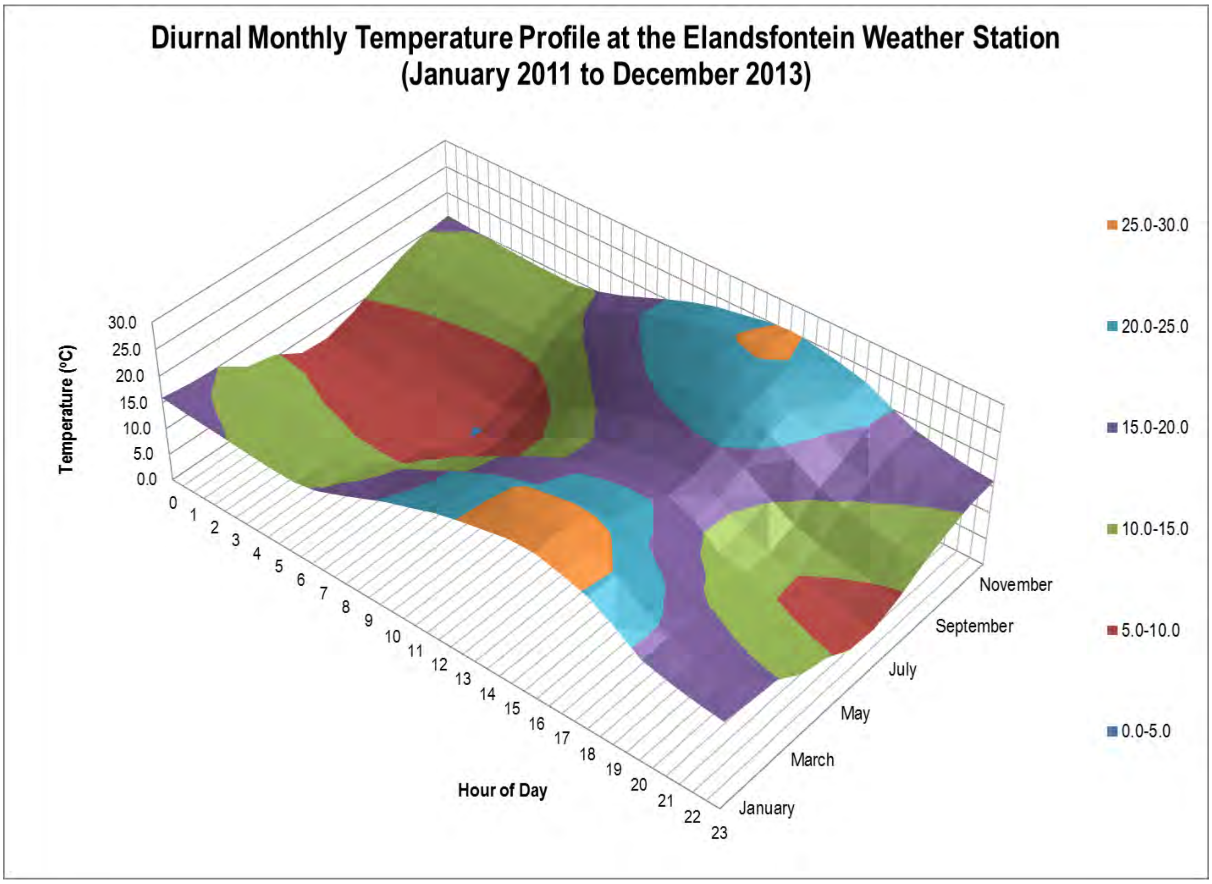


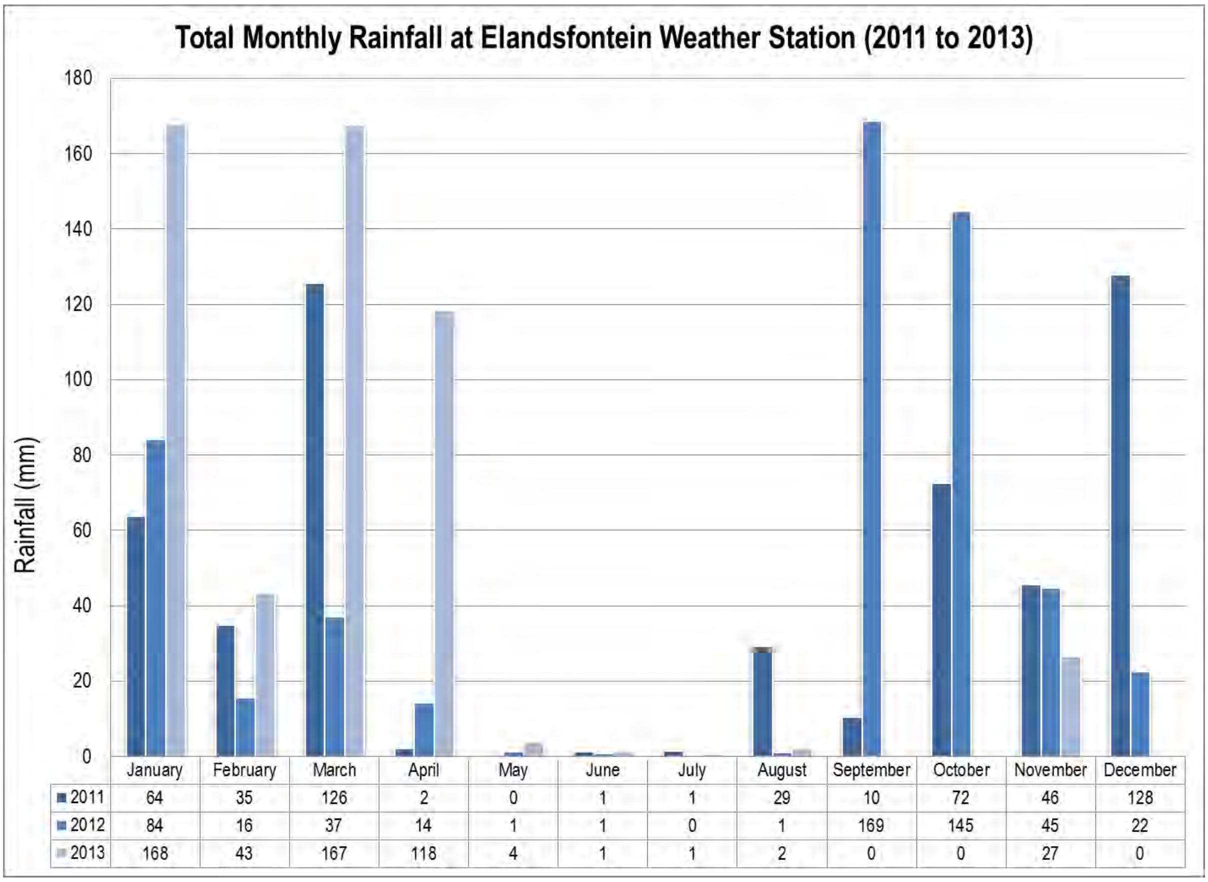
Figure 4-3: Diurnal temperature profile (Elandsfontein data, 2011 to 2013)

4.2 Precipitation

Precipitation represents an effective removal mechanism of atmospheric pollutants. Precipitation reduces wind erosion potential by increasing the moisture content of materials. Rain-days are defined as days experiencing 0.1 mm or more rainfall. Rainfall data for the Elandsfontein weather station is used for this study. Data availability for the period January 2011 to December 2013 is ~87.92 %.

Rainfall in the region is almost exclusively due to showers and thunderstorms and falls mainly in spring and summer months (October to March). The maximum rainfall occurs during the October to January period. Whereas spring and summer months receive about 85% of the rainfall, winter months are normally dry. An average number of 90 rain days are experienced per year in the region (Weather Bureau, 1986).

Annual rainfall recorded for 2011, 2012 and 2013 was ~514.2 mm, 534 mm and 531 mm respectively with annual data availability of 99.0 %, 94.6 % and 70.3 % respectively.



	January	February	March	April	May	June	July	August	September	October	November	December
2011	64	35	126	2	0	1	1	29	10	72	46	128
2012	84	16	37	14	1	1	0	1	169	145	45	22
2013	168	43	167	118	4	1	1	2	0	0	27	0

Figure 4-4: Total Monthly Rainfall at Elandsfontein Weather Station (2011 to 2013)

4.2.1 Atmospheric stability

The vertical component of dispersion is a function of the extent of thermal turbulence and the depth of the surface mixing layer. Unfortunately, the mixing layer is not easily measured, and must therefore often be estimated using prognostic models that derive the depth from some of the other parameters that are routinely measured, e.g. solar radiation and temperature. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated inversion. Radiative flux divergence during the night usually results in the establishment of ground based inversions and the erosion of the mixing layer. The mixing layer ranges in depth from ground level (i.e. only a stable or neutral layer exists) during night-times to the base of the lowest-level elevated inversion during unstable, day-time conditions.

Atmospheric stability is frequently categorised into one of six stability classes. These are briefly described in Table 4-2.

Table 4-2: Atmospheric stability classes

A	very unstable	calm wind, clear skies, hot daytime conditions
B	moderately unstable	clear skies, daytime conditions
C	unstable	moderate wind, slightly overcast daytime conditions
D	neutral	high winds or cloudy days and nights
E	stable	moderate wind, slightly overcast night-time conditions
F	very stable	low winds, clear skies, cold night-time conditions

The atmospheric boundary layer is normally unstable during the day as a result of the turbulence due to the sun's heating effect on the earth's surface. The thickness of this mixing layer depends predominantly on the extent of solar radiation, growing gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. This situation is more pronounced during the winter months due to strong night-time inversions and a slower developing mixing layer. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral.

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

4.3 Baseline Characterisation

The identification of existing sources of emission in the region, and the characterisation of ambient pollutant concentrations is fundamental to the assessment of the potential for cumulative impacts and synergistic effects given the mine's operation and its associated emissions. The source types present in the area and the pollutants associated with such source types are noted with the aim of identifying pollutants which may be of importance in terms of cumulative impact potential.

4.3.1 Sources of Air Pollution in the Region

The Mpumalanga Highveld has frequently been the focus of air pollution studies for two reasons. Firstly, elevated air pollution concentrations have been noted to occur in the region itself. Secondly, various elevated sources of emission located in this region have been associated with long-range transportation of pollutants and with the potential for impacting on the air quality of adjacent and more distant regions (Piketh, 1996).

4.3.1.1 Power Generation

Operational power stations in close proximity of the proposed Elders Colliery include Matla, Kriel, Kendal, and Komati power stations. The main emissions from such electricity generation operations are carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen dioxides and ash (particulates). Fly-ash particles emitted comprise various trace elements such as arsenic, chromium, cadmium, lead, manganese, nickel, vanadium and zinc. Small quantities of volatile organic compounds are also released from such operations.

The power stations are large sources of SO_2, which oxidizes in the atmosphere to particulate sulfate at a rate of between 1 and 4% per hour. Fine particulate sulfate has been used to trace the transportation of power station plumes across the southern African sub-continent.

4.3.1.2 Mining and industrial activities

Emissions from coal combustion by power generation, metallurgical and petrochemical industries represent the greatest contribution to total emissions from the industrial/ institutional / commercial fuel use sector within the Mpumalanga region (HPA, 2011).

The metallurgical group is estimated to be responsible for at least ~50% of the particulate emissions from this sector. This group includes iron and steel, ferro-chrome, ferro-alloy and stainless steel manufacturers (includes Highveld Steel & Vanadium, Ferrometals, Columbus Stainless, Transalloys, Middelburg Ferrochrome)(HPA, 2011).

Petrochemical and chemical industries are primarily situated in Secunda (viz. Sasol Chemical Industries). The use of coal for power generation and the coal gasification process represent significant sources of sulphur dioxide emissions. (Particulate emissions are controlled through the implementation of stack gas cleaning equipment.)

Other industrial sources include: brick manufacturers which use coal (e.g. Witbank Brickworks, Quality Bricks, Corobrik, Hoeveld Stene, Middelwit Stene) and woodburning and wood drying by various sawmills (Bruply, Busby, M&N Sawmills) and other heavy industries (use coal and to a lesser extent heavy fuel oil for steam generation). In the immediate vicinity of the mine, the industrial activities include but are not limited to Komati, Kriel and Hendrina power stations; Goedehoop, Koornfontein, Kriel and Sudor coal mines.

4.3.1.3 Biomass burning

The biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Within the project vicinity, wild fires (locally known as veld fires) may represent significant sources of combustion-related emissions.

The biomass burning is an incomplete combustion process (Cachier, 1992), with carbon monoxide, methane and nitrogen dioxide gases being emitted. Approximately 40% of the nitrogen in biomass is emitted as nitrogen, 10% is left is the ashes, and it may be assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds (Held et al, 1996). The visibility of the smoke plumes is attributed to the aerosol (particulate matter) content.

4.3.1.4 Vehicle entrainment on paved and unpaved roads

Vehicles travelling on unpaved roads are significant sources of fugitive dust emissions. The force of the wheels of vehicles travelling on unpaved roads causes the pulverisation of surface material. Particles are lifted and dropped from the rotating wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The quantity of dust emissions from unpaved roads varies linearly with the volume of traffic.

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

4.3.1.5 Vehicle tailpipe emissions

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants form in the atmosphere because of chemical reactions. Significant primary pollutants emitted by internal combustion engines include CO_2, CO, carbon, SO_2, NOx, (mainly Nitric oxide), particulates and Pb. Secondary pollutants include NO_2, photochemical oxidants such as O_3, sulphuric acid, sulphates, nitric acid, and nitrate aerosols (particulate matter). Vehicle (i.e. model-year, fuel delivery system), fuel (i.e. type, oxygen content), operating (i.e. vehicle speed, load), and environmental parameters (i.e. altitude, humidity) influence vehicle emission rates (Onursal, 1997). Roads that are in the vicinity of the mine are the R35, R38, R544 and R542.

4.3.1.6 Informal refuse burning

Additional sources of emissions come from the waste sector and typically include informal refuse and tyre burning. The informal burning of refuse within former township areas and burning of waste at local municipal landfill sites represents a source of concern in all provinces. For example, refuse tip combustion has been found to contribute significantly to the total airborne particulate concentrations within Soweto in the Gauteng Province.

4.3.1.7 Wind erosion of open areas

Emissions generated by wind erosion are dependent on the frequency of disturbance of erodible surface. Every time that a surface is disturbed, its erosion potential is restored (EPA, 2004). Further erodible surfaces may occur as a result of agriculture and \or grazing activities.

4.3.2 Measured Ambient Air Quality within the Region

The identification of existing sources of emission and the characterisation of ambient pollutant concentrations is fundamental to the assessment of the potential for cumulative impacts in the region. Ambient monitoring data was obtained from Eskom's Elandsfontein monitoring station and from Elders monitoring campaign.

Ambient data for the period January 2011 to December 2013 was obtained from the Elandsfontein station (Figure 2-2) for PM_{10}. Also, dustfall results from the April 2013 to September 2014 Elders monitoring campaign are also provided.

*4.3.2.1 **Eskom's Elandsfontein** Monitoring Station **–** Thoracic particulate matter (PM_{10})*

Ambient PM_{10} data were obtained from the Eskom Elandsfontein monitoring station for the period January 2011 to December 2013. Data availability was recorded as 25.14% for PM_{10}. The relatively low data availability for PM_{10} should be taken into account when interpreting the data.

The recorded daily PM_{10} concentrations are presented in Figure 4-5. Exceedances of the NAAQ limit of 75 µg/m³ occur eighteen times in 2011, none in 2012 and once in 2013. The yearly frequency of exceedance and annual average is provided in Table 4-3. Annual concentrations ranged between 14.77 µg/m³ in 2011 to 26.89 µg/m³ in 2013 (Table 4-3).

A diurnal profile in the PM_{10} concentrations is provided in Figure 4-6 showing peak PM_{10} concentrations in the afternoon and evening. This may be related to anthropogenic activities such as vehicular transport or industrial activities in the region.

Table 4-3: Measured exceedances of the daily NAAQ Limits and annual average concentrations

Year	Daily FOE of NAAQ Limit – 75 µg/m³	Annual average concentration (µg/m³)
2011	18[(1)]	25.17
2012	0	14.77
2013	1	26.89

NOTE: [(1)] values in bold indicate non-compliance with the NAAQS limit

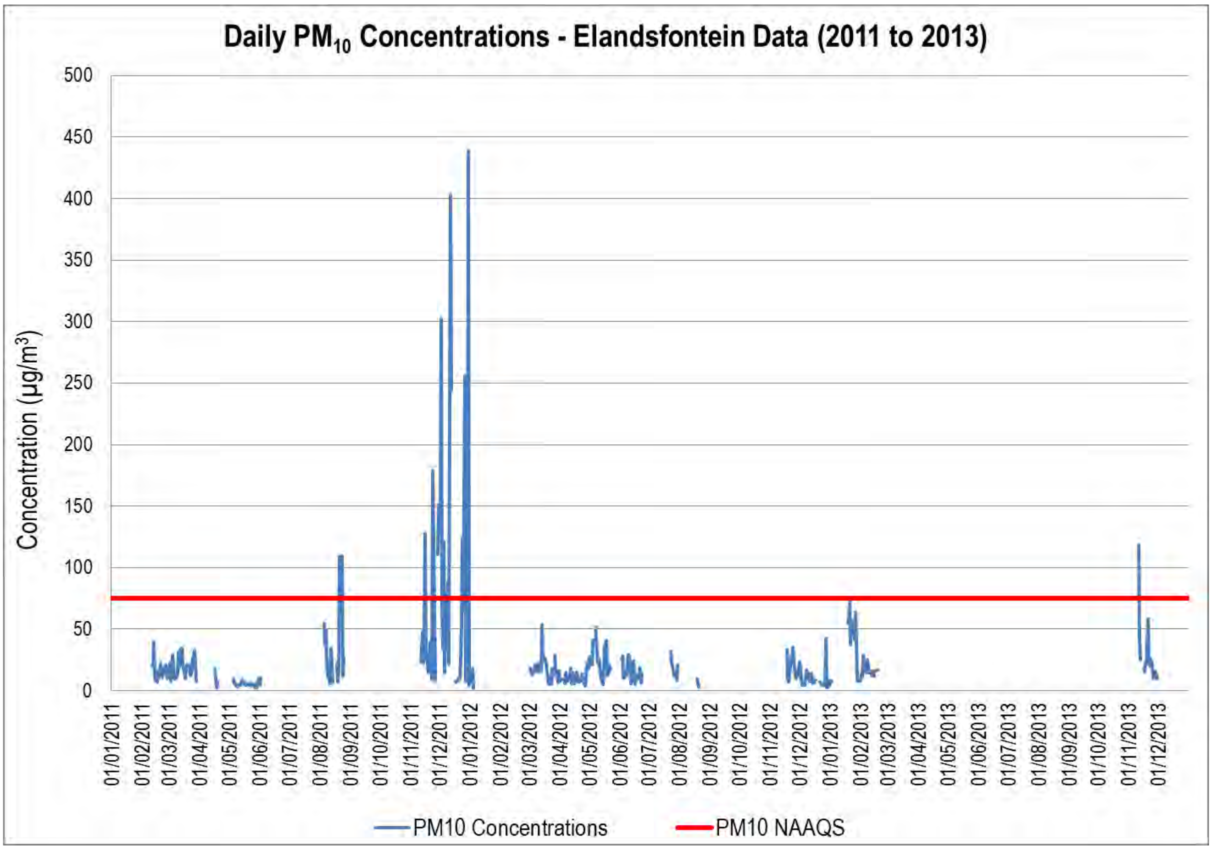


Figure 4-5: Daily PM_{10} concentrations recorded at Elandsfontein (January 2011 to December 2013)

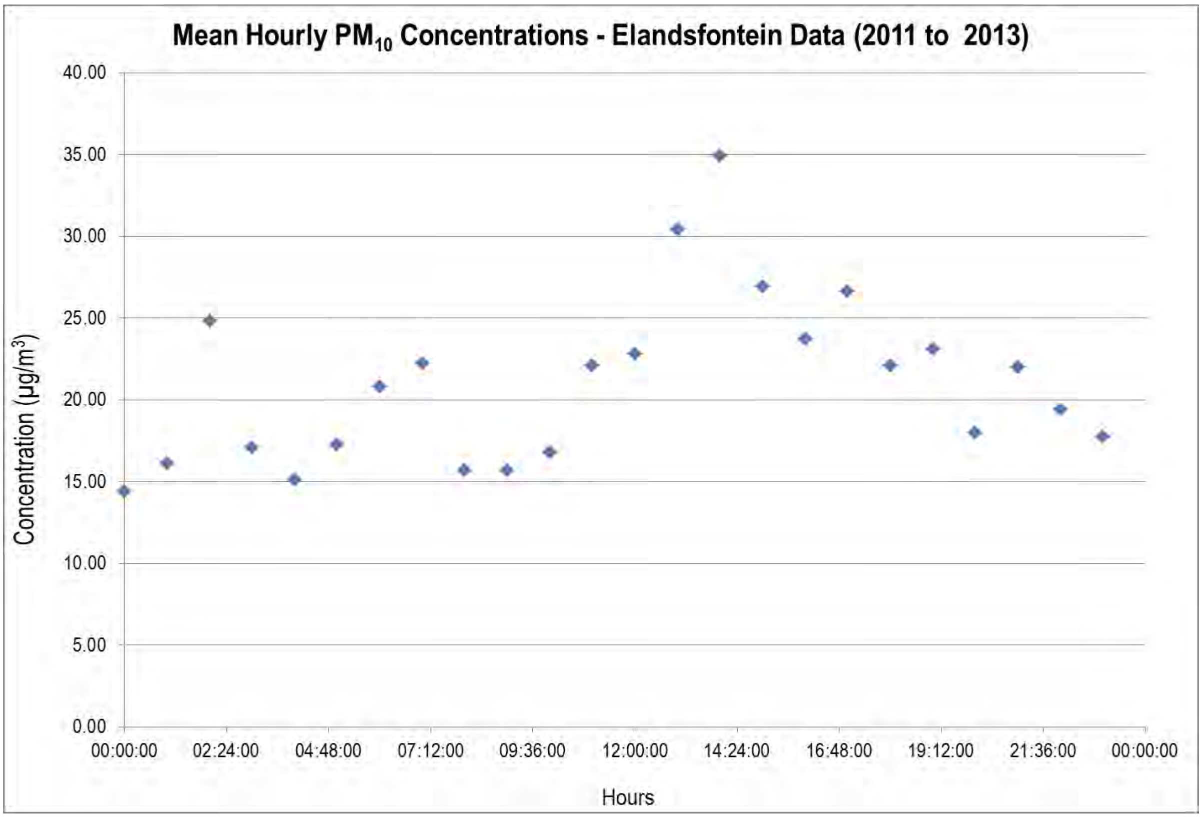


Figure 4-6: Mean hourly PM_{10} concentrations recorded at Elandsfontein (January 2011 to December 2013)

4.3.2.2 Elders Monitoring Campaign

The location of the dust buckets at the Elders monitoring dustfall buckets is illustrated in Table 4-4. Maximum daily dustfall rates for Elders Colliery for 2013 and 2014 are given in Table 4-5 and Table 4-6. Dustfall sampling was conducted over 30± day periods and the deposition rates compared to the NDCR as published Section 2.

Dustfall sampling results for the period April to November 2013 indicate that dustfall rates were low and generally in compliance with the NDCR; with the exception of sites EDB 02 and EDB 05 which exceeded the non-residential limit. The former produced dustfall rates above 816 mg/m^2-day throughout the sampling period (Figure 4-8). The exceedance is associated with an unpaved roads adjacent to the sampling site, which provides access to the nearby Sudor mine. Agricultural activities (harvesting) could also be a contributor to the elevated dustfall levels.

Sampled dustfall rates at sites EDB 06 to EDB 07 were found to be in compliance with the regulation, remaining below 300 mg/m^2-day throughout the sampling period. Results from site EDB 01, EDB 03 and EDB 05 were inconclusive; this is due to the lack of data in the latter months of the year.

Sampled dustfall rates for the period January to September 2014 were low and within the acceptable dustfall rates for non-residential areas (1 200 mg/m^2-day), ranging between a minimum of 7 mg/m^2-day and a maximum of 403 mg/m^2-day (Figure 4-9). It must be noted that results for site EDB 01 to EDB 05 are inconclusive due to poor data quality.

Table 4-4: Previous Dustfall buckets location at Elders Colliery

Dust bucket	Latitude	Longitude
EDB01	-26°13'57.555 S	29°27'32.022 E
EDB02	-26°13'41.821 S	29°27'36.374 E
EDB03	-26°13'45.946 S	29°27'26.951 E
EDB04	-26°13'51.053 S	29°27'24.645 E
EDB05	-26°11'56.59 S	29°25'03.23 E
EDB06	-26°09'57.245 S	29°24'07.805 E
EDB07	-26°09'33.319 S	29°24'02.779 E
EDB08	-26°13'57.555 S	29°27'32.022 E

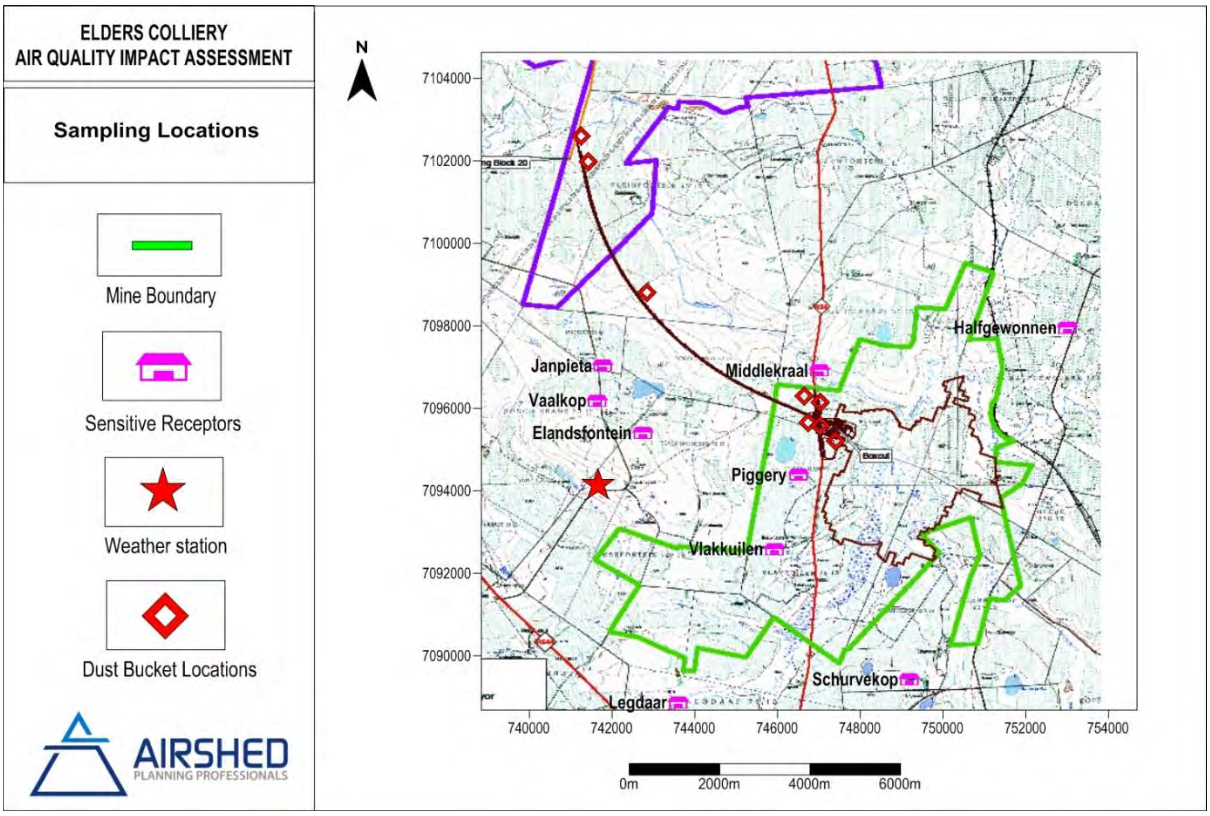


Figure 4-7: Elders Colliery sampling locations

Table 4-5: Elders Colliery sampled dustfall rates for 2013 (mg/m²-day)

Site ID	Description	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
EDB01	South-east of the operation	978[(a)]	441	(b)	(c)	(c)	(d)	(d)	(d)
EDB02	At the weather station	2 348	1 093	1 285	1 872	2 203	1 111	816	1 833
EDB03	North of the operations	107	132	(c)	(c)	(c)	(d)	(d)	(d)
EDB04	Conveyor transfer point #1	141	313	(c)	4[(e)]	249	235	369	(c)
EDB05	Conveyor transfer point #2	2 638	2 750	(c)	(c)	(c)	(d)	(d)	(d)
EDB06	Next to the conveyor	(d)	224 [(e)]	104	139	167	116	354	145
EDB07	South of the loading facility at Goedehoop	120	107	120	198	204	268	(c)	278[(e)]
EDB08	West of the loading facility at Goedehoop	146	57	142	160	137	170	(c)	351[(e)]

Notes:

(a) Values in green indicate an exceedance of the residential limit of 600 mg/m²-day and values in red signal an exceedance of the industrial limit of 1 200 mg/m²-day.

(b) Buckets removed or stolen

(c) Access denied due to harvesting, ploughing or rain.

(d) No data

(e) Value over two months

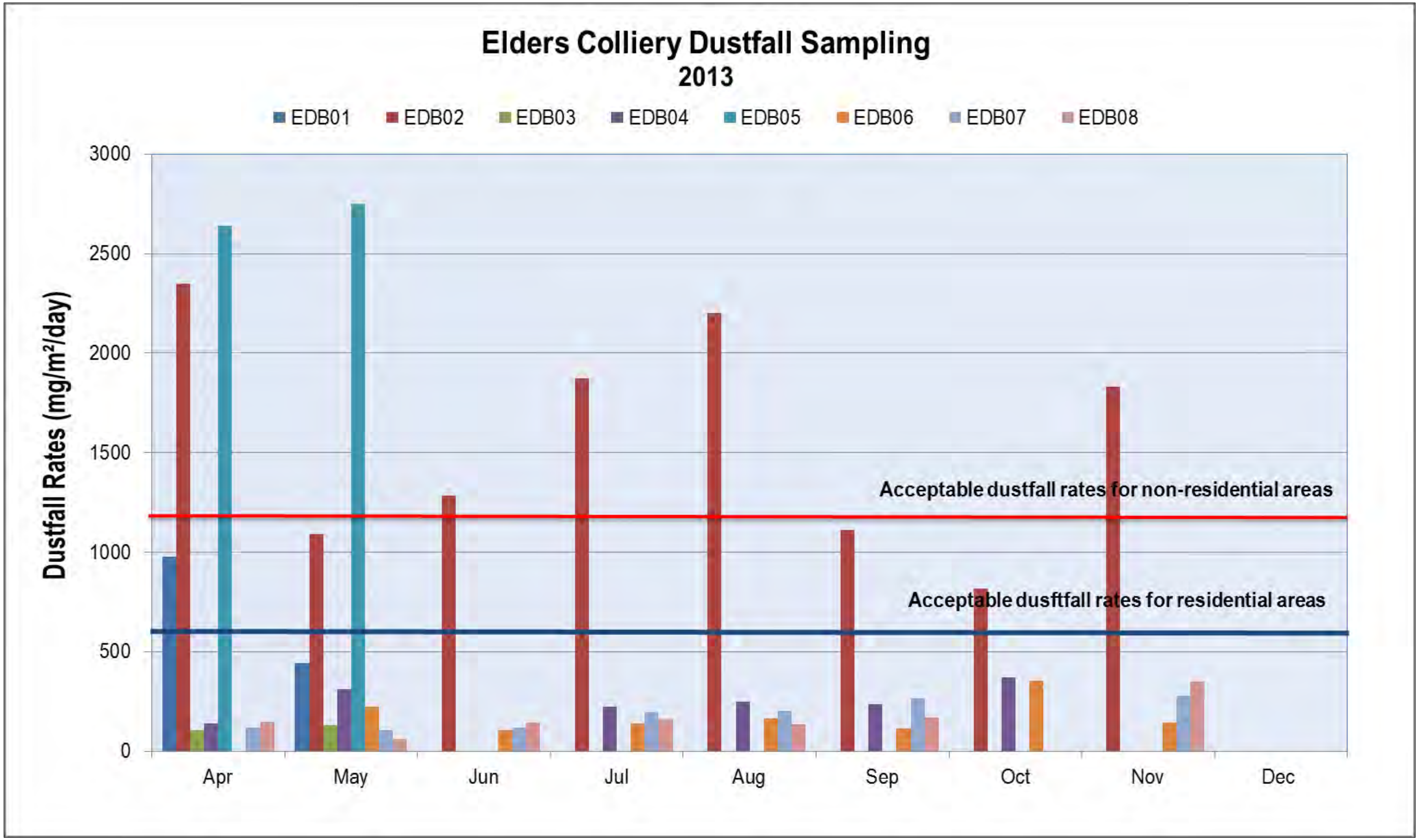


Figure 4-8: Sampled dustfall levels at Elders Colliery in 2013

Table 4-6: Elders Colliery sampled dustfall rates for 2014

Site ID	Description	Jan	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
EDB01	South-east of the operation	(b)	(b)	(b)	(d)	(d)	(d)	(d)	(d)	(d)
EDB02	At the weather station	110(e)	87(e)	214	(b)	(b)	(d)	(d)	(d)	(b)
EDB03	North of the operations	(d)	(b)	(b)	(d)	(d)	(d)	(d)	(d)	(d)
EDB04	Conveyor transfer point #1	(d)	(f)	100	(c)	(b)	(d)	(d)	(d)	(c)
EDB05	Conveyor transfer point #2	(d)	(b)	(b)	(d)	(d)	(d)	(d)	(d)	(d)
EDB06	Next to the conveyor	49(e)	(g)	403	251	187	170	(d)	184	251
EDB07	South of the loading facility at Goedehoop	7(e)	(c)	(f)	118	167	152	68	(d)	118
EDB08	West of the loading facility at Goedehoop	15(e)	(c)	(f)	115	208	17	181	157	115

Notes:

(a) Values in green indicate an exceedance of the residential limit of 600 mg/m²-day and values in red signal an exceedance of the industrial limit of 1 200 mg/m²-day.
(b) Buckets removed or stolen
(c) Access denied due to harvesting, ploughing or rain.
(d) No data
(e) Value over two months
(f) Not processed due to excessive decomposing invertebrates or insects.

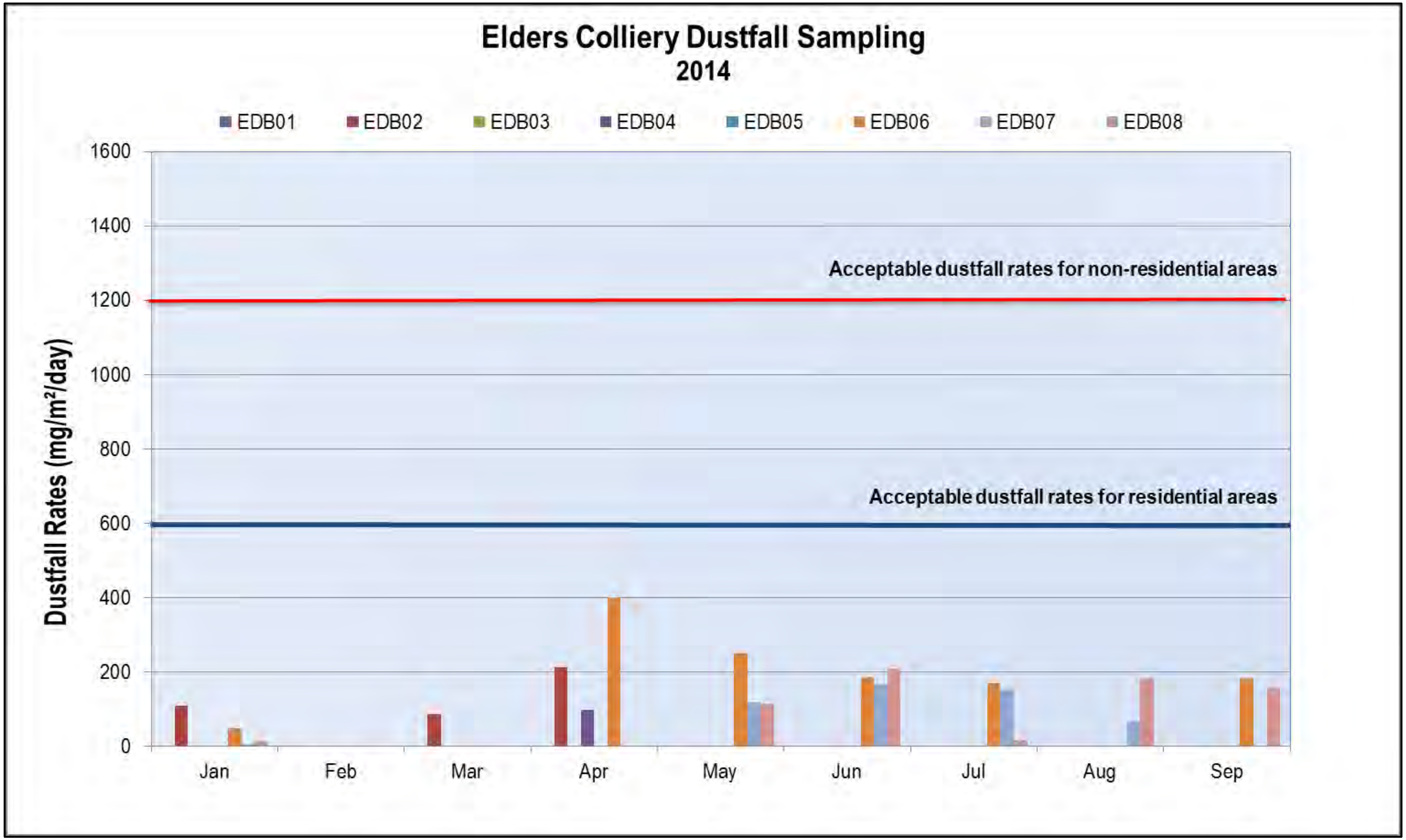


Figure 4-9: Sampled dustfall levels at Elders Colliery in 2014

4.3.3 Modelled Ambient Air Quality – Mpumalanga Highveld Priority Area

Elders Colliery is located in the Mpumalanga Highveld and is therefore situated within the boundaries of the Highveld Priority Area (HPA), which is an area that has been identified as characterized with poor air quality. As a result of the concerns over the poor ambient air quality over the Highveld area, the Minister of Environmental Affairs declared a portion of Mpumalanga and Gauteng provinces an air quality priority area in November 2007.

A comprehensive emissions inventory was completed for the region as part of the HPA baseline study. The results of the inventory were used to carry out a comprehensive dispersion modelling study over the area using the CALPUFF model (DEA, 2011b). Results of this dispersion study are illustrated in Figure 4-10 and Figure 4-11 for SO_2 and PM_{10} respectively. These figures give the areas in which ambient air quality standards are predicted to be exceeded for more than the allowed 1% of the time. The eMalahleni area is already elevated with respect to PM_{10} and SO_2 concentrations (Figure 4-10 and Figure 4-11). Based on these dispersion modelling results, the Air Quality Management Plan (AQMP) identified Baseline Hotspots for SO_2 and for PM_{10}. The project design should therefore also ensure minimal contribution to SO_2 and PM_{10} concentrations.

The CO concentrations are not included in the HPA ambient monitoring and modelling but in residential areas of high wood and coal combustion where there is high potential for increased CO concentrations.

Power Generation activity in the HPA is the major source of SO_2 emissions (82%) and NOx emissions (73%) while it is only responsible for a relatively small contribution to the total PM_{10} load (12%) (DEA, 2011b). Predicted source contributions to NOx, SO_2 and PM_{10} are shown in Figure 4-12. The largest contributors to all three pollutants are power generation, residential fuel burning and motor vehicles. The lowest contributors to NOx, SO_2 and PM_{10}, according to DEA (2011b), are coal mines and motor vehicles.

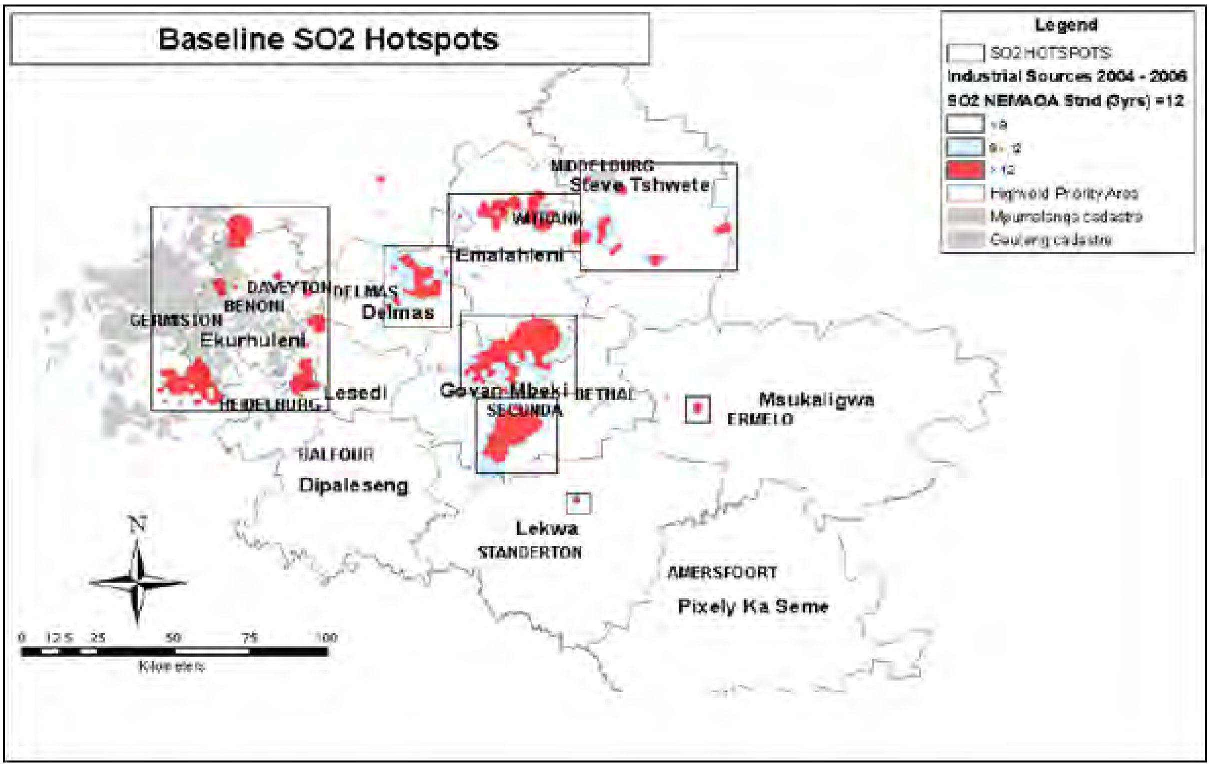


Figure 4-10: Simulated frequencies of exceedance of ambient SO_2 NAAQS (DEA, 2010)

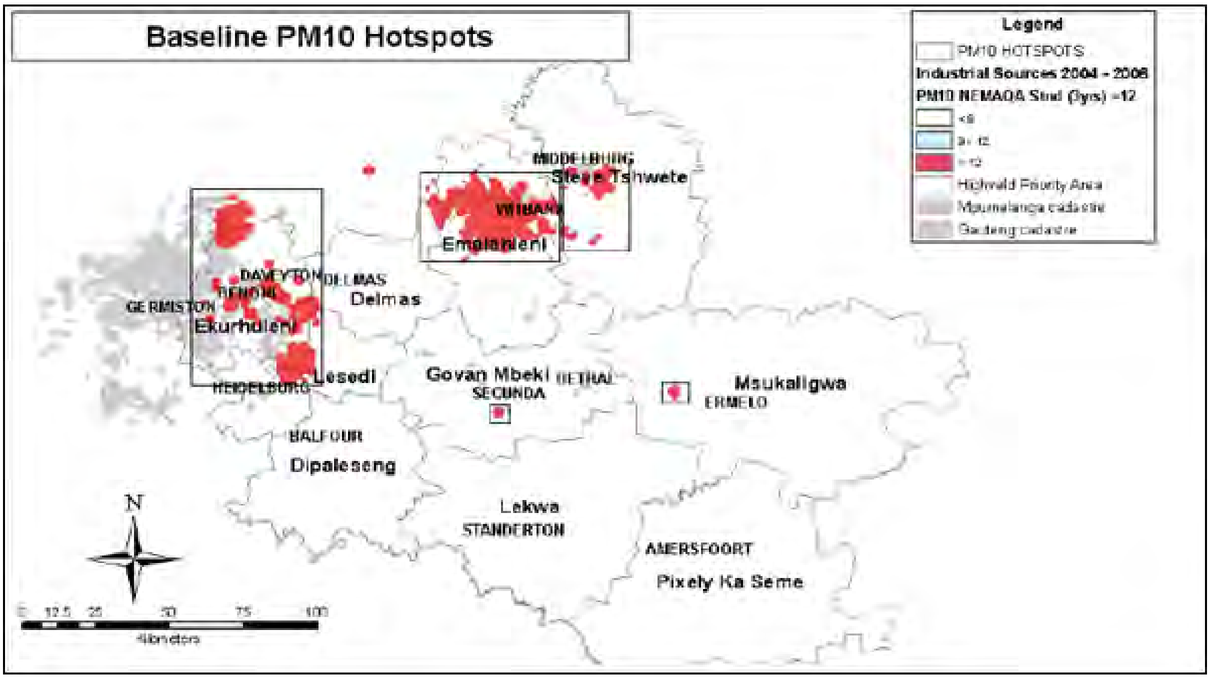


Figure 4-11: Simulated frequencies of exceedance of ambient PM_{10} NAAQS (DEA, 2010)

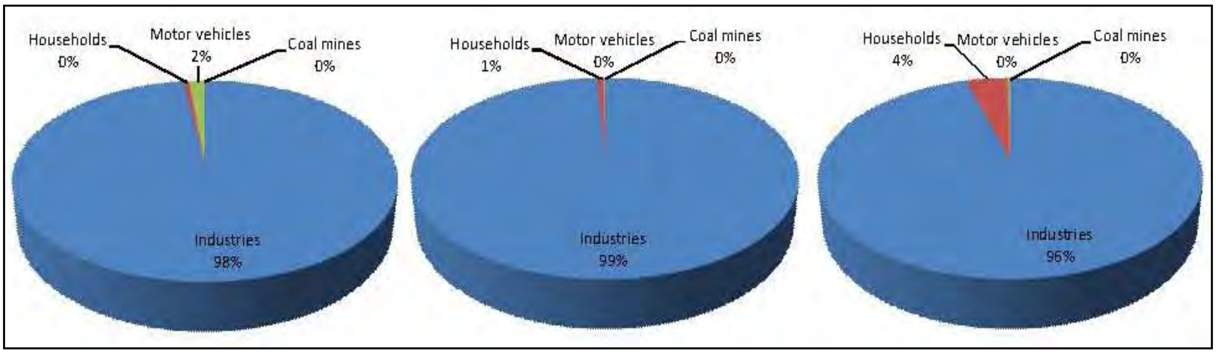


Figure 4-12: Contribution of different sources to ambient concentrations of NOx (left), SO_2 (middle) and PM_{10} (right) in the Kriel Hot Spot (DEA, 2011b)

According to the HPA, sources of concern within the Govan Mbeki and Steve Tshwete local municipalities include, but are not limited to mines, Sasol plant, motor vehicle (especially coal trucks), small industries, tyre burning and veld fires. Table 4-7 and Table 4-8 lists sources of atmospheric emission in the both the Gert Sibande and Nkagala DM respectively as identified in the HPA (2011).

Table 4-7: Air quality issues as identified in Gert Sibande DM

Sources	Gert Sibande DM	Govan Mbeki LM	Dipaleseng LM	Lekwa LM	Msukalingwa LM	Pixley ka Seme LM
Industries	x	x	x	x	x	x
Motor Vehicles	x	x	x	x	x	x
Residential fuel burning	x	x		x	x	x
Mining/quarries	x	x	x	x		
Agricultural burning	x		x			x
Tyre burning	x	x				x
Odour		x		x		
Dumping/landfill sites	x			x		
Other		x				

Table 4-8: Air quality issues as identified in Nkangala DM

Sources	Nkangala DM	Delmas LM	Emalahleni LM	Steve Tshwete LM
Industries	x	x	x	x
Motor Vehicles	x	x	x	x
Residential fuel burning	x	x	x	x
Mining/quarries	x	x	x	x
Agricultural burning	x		x	x
Tyre burning	x	x	x	x
Odour				
Dumping/landfill sites				
Other		x	x	

5 AIR QUALITY IMPACT ASSESSMENT

This section of the study focuses on the identification of emission sources associated with the proposed project, compilation of an emissions inventory and atmospheric dispersion modelling. These tasks serve to assess the spatial extent of the pollutants and compare the predicted impacts with the relevant standards for compliance and ultimately, propose mitigation measure which will result in the reduction of the total environmental impacts.

5.1 Emission Inventory

The establishment of an emissions inventory comprises the identification of sources of emissions, and the quantification of each source's contribution to ambient air pollution concentrations.

Pollutants included in the inventory are particulates only (TSP, PM_{10}, and $PM_{2.5}$) and were estimated based on the planned operations at the mine. The sources of emissions were identified and emission rates calculated based on process descriptions and detailed information provided by SRK personnel. Gaseous emissions associated mainly with vehicle operations are not included. The fugitive dust emission equations and emission factors utilised are taken from the NPI and US-EPA emission factor documents and are provided in section 11.

For the current project two scenarios were identified, inventoried and consequently modelled. The scenarios were chosen so as to take into account the overlap that exists between the underground mine and initial box-cut operations; they are further explained below.

- Scenario 1: this scenario is planned to occur during the construction and mining of the initial box-cut which will serve as an adit to the underground mining operation.
- Scenario 2: this scenario takes into account only the operational phase of the underground mine.

In assessing both scenarios, the design mitigation option was applied. The design mitigation is the mitigation included in the project design, which include the use of water sprayers on roads, water sprayers at the crushing plant and all materials handling/conveyor transfer points, as well as a doghouse single side covering for the conveyor.

Sources of emissions identified in the scenarios are tabulated in Table 5-1 and source parameters in Table 5-2. Estimated annual average emissions, per source group, are presented in Table 5-3. The contributions of each source group's emissions to the total are graphically presented in Figure 5-1 and Figure 5-2 for scenarios 1 and 2 respectively.

Table 5-1: Elders Colliery emission sources

Source of emissions	Scenario 1	Scenario 2
Site clearing	x	
Drilling	x	
Blasting	x	
Crushing	x	x
Material handling	x	x
Vehicle entrainment on unpaved roads	x	
Wind-blown dust from stockpiles	x	x
Wind-blown dust from the conveyor	x	x
Ventilation shafts [(a)]		

NOTE: [(a)] ventilation shaft emissions have not been included in this assessment. According to SRK personnel, "ventilation shafts are not planned on the surface. All foundations, ducting, motors and fans will be located within the box-cut".

Table 5-2: Source parameters and assumptions for Elders Colliery operations

Aspect	Source Description	Information used	Comments/Assumptions/Mitigation
Scenario 1: Initial box-cut construction 1.5 years	Site clearing	Emissions applied over the whole area of the initial box-cut and infrastructure area.	Mitigation: Water sprays with a control efficiency of 50%
	Drilling	The number of holes drilled per day = 35 (Coal) and 35 (Overburden)	Mitigation: Water sprays with a control efficiency of 70% (Drilling)
	Blasting	Blasting = 1 (Ore) and 1 (overburden); once every 2 weeks Blast duration: 1 hour	No mitigation applied
	Crushing and screening	Coal – 266 667 tons per year	Low moisture coal <4% Mitigation: Water sprays with a control efficiency of 50%.
	Materials handling	65 000 m^3 of topsoil to be removed 250 000 m^3 coal to be removed 142 000 m^3 of overburden	3 -5% soil moisture Average wind speed applied is 4.8 m/s Mitigation: Water sprays with a control efficiency of 50%.
	Vehicle entrainment on unpaved roads	Transport of topsoil and overburden by trucks 15 – 30 m^3capcaity construction trucks Road width 7 – 10 m	34 ton haul trucks Silt content of 8.4% was used for all unpaved roads. (US-EPA default) Mitigation: water sprays with an initial control efficiency of 50% for all roads
	Wind-blown dust	3 topsoil stockpiles: 12 000, 8 000 & 20 000 m^2; all 3 m high Overburden Stockpile: 142 000 m^2; 20 m high	Mitigation: vegetation cover on topsoil and overburden stockpiles, and water sprays on the RoM stockpiles
	Conveyor belt	266,667 tons conveyed in a year Conveyor length – 11,000 m Conveyor width – 1.35 m	Roof and side covering with a control efficiency of 65%

Aspect	Source Description	Information used	Comments/Assumptions/Mitigation
Scenario 2: Underground Operations 14 years	Crushing and screening	6 million tons of coal per year Coal to silo Coal to conveyor	Low moisture coal <4% Mitigation: Water sprays with a control efficiency of 50%.
	Conveyor belt	6 million tons of coal per year Conveyor length is 11 000m Conveyor width is 1.35 m	Roof and side covering with a control efficiency of 65%
	Wind-blown dust from stockpiles	3 topsoil stockpiles: 12 000, 8 000 & 20 000 m^2; All 3 m high Overburden Stockpile: 142 000 m^2; 20 m high	Mitigation: vegetation cover on topsoil and overburden stockpiles, and water sprays on the RoM stockpiles
	Materials handling	4.58 million tons of coal per year Coal to silo Coal to conveyor	Water sprays at material transfer points with a control efficiency of 50%.

Table 5-3: Elders Colliery emission rates

Scenario	Scenario 1 (tonnes/annum)			Scenario 2 (tonnes/annum)		
Source group	$PM_{2.5}$	PM_{10}	TSP	$PM_{2.5}$	PM_{10}	TSP
Topsoil scraping	1.8	12.7	17.0	–	–	–
Blasting	0.1	1.0	1.0	–	–	–
Drilling	3.4	6.4	6.4	–	–	–
Materials Handling	0.2	1.5	2.8	0.22	1.47	2.75
Wind Erosion	1.6	3.2	6.4	1.60	3.20	6.40
Unpaved Roads	1.0	10.5	29.5	–	–	–
Crushing and Screening	0.9	3.1	31.2	18.00	60.00	600.00
Conveyor	44.3	88.7	197.1	44.34	88.68	197.07
Total	54.0	127.8	291.3	64.16	153.35	806.22

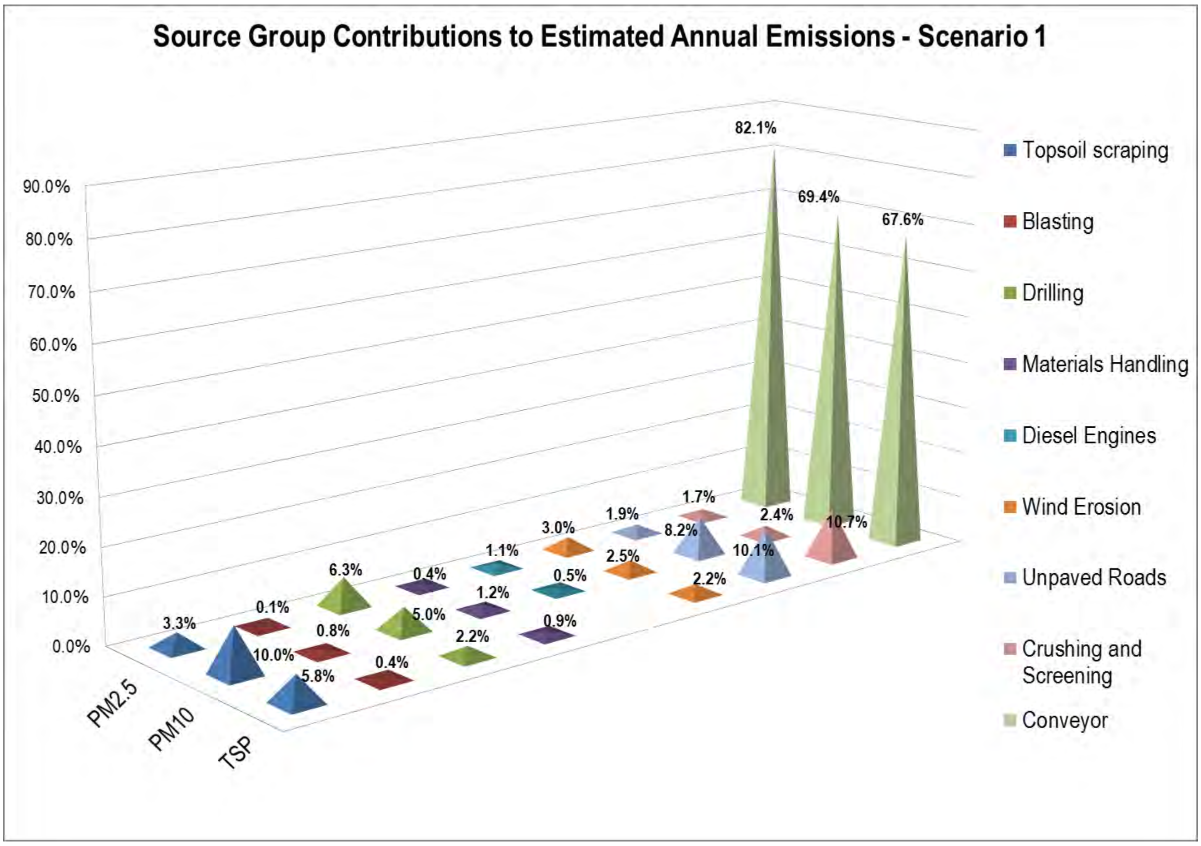


Figure 5-1: Source group contributions to estimated annual emissions (Scenario 1)

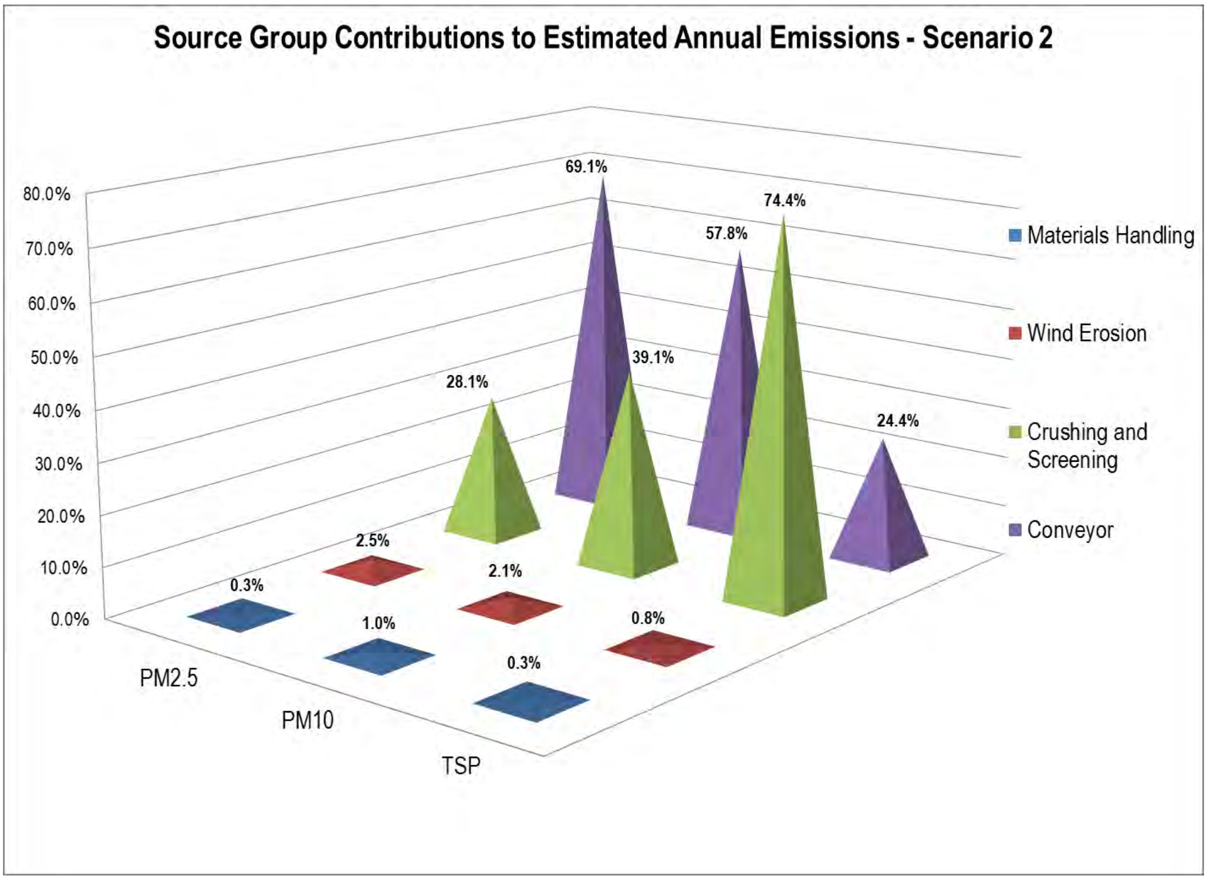


Figure 5-2: Source group contributions to estimated annual emissions (Scenario 2)

5.2 Atmospheric Dispersion Modelling

Dispersion models compute ambient concentrations as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. Increasing reliance has been placed on concentration estimates from models as the primary basis for environmental and health impact assessments, risk assessments and emission control requirements. It is therefore important to carefully select a dispersion model for this purpose.

5.2.1 Atmospheric dispersion modelling selection

Gaussian plume models are best used for near-field applications where the steady-state meteorology assumption is most likely to apply. The topography of the study area is fairly flat comprising of undulating hills, making it suitable for using a Gaussian plume model. The most widely used Gaussian plume model, the US.EPA Regulatory AERMOD model, was used in this study.

AERMOD is a model developed under the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state of the art science in regulatory models (Hanna et al., 1999). AERMOD is a dispersion modeling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

As with most Gaussian Plume models, the disadvantage is that spatial varying wind fields, due to topography or other factors cannot be included. Also, the range of uncertainty of the model predictions could to be -50% to 200%. The accuracy improves with fairly strong wind speeds and during neutral atmospheric conditions.

There will always be some error in any geophysical model, but it is desirable to structure the model in such a way to minimise the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere.

The stochastic uncertainty includes all errors or uncertainties in data such as source variability, observed concentrations, and meteorological data. Even if the field instrument accuracy is excellent, there can still be large uncertainties due to unrepresentative placement of the instrument (or taking of a sample for analysis). Model evaluation studies suggest that data input error term is often a major contributor to total uncertainty. Even in the best tracer studies, the source emissions are known only with an accuracy of ±5%, which translates directly into a minimum error of that magnitude in the model predictions. It is also well known that wind direction errors are the major cause of poor agreement, especially for relatively short-term predictions (minutes to hourly) and long downwind distances. All of the above factors contribute to the inaccuracies that are not associated with the mathematical models themselves. Nevertheless, dispersion modelling is generally accepted as a valuable tool in Air Quality Management, especially for predictive purposes.

5.2.2 Meteorological data requirements

AERMOD requires two specific input files generated by the AERMET pre-processor; upper air and surface data. AERMET is designed to be run as a three-stage processor and operates on three types of data (upper air data, on-site measurements, and the national meteorological database). Since the model was designed for the USA environment, various difficulties are found compiling the required dataset for the South African environment.

Three years (2011-2013) worth of meteorological data was obtained from Eskom's Elandsfontein weather station, the data was run through AERMOD's AERMET pre-processor to yield suitable input files for the dispersion model.

5.2.3 Source data requirements

The AERMOD model is able to model point, area, line, and volume sources. Sources in the current study were modelled as follows:

- Materials handling and crushing– modelled as volume sources; and
- Unpaved roads, site clearing, drilling, blasting, and windblown dust – modelled as area sources.

5.3 Atmospheric Dispersion Modelling Results and Compliance Assessment

Dispersion modelling was undertaken to determine highest hourly, highest daily and annual average incremental ground level concentrations for each pollutant. These averaging periods were selected to facilitate the comparison of predicted pollutant concentrations with relevant air quality standards and dust-fall limits. It should be noted that the ground level concentration isopleths depicted present interpolated values from the concentrations predicted by AERMOD for each of the receptor grid points specified.

Plots reflecting daily averaging periods contain only the 99th percentile predicted ground level concentrations, for those averaging periods, over the entire period for which simulations were undertaken. It is therefore possible that even though a high daily average concentration is predicted to occur at certain locations, that this may only be true for one day of the year.

5.3.1 Atmospheric dispersion simulation results

Dispersion modelling was undertaken to determine highest hourly, highest daily and annual average ground level concentrations as well as dustfall rates for each of the pollutants considered in the study. Averaging periods were selected to facilitate the comparison of predicted pollutant concentrations to relevant ambient air quality and inhalation health criteria as well as dustfall regulations.

Results are primarily provided in form of isopleths to present areas of exceedance of assessment criteria. Ground level concentration or dustfall isopleths presented in this section depict interpolated values from the concentrations simulated by AERMOD for each of the receptor grid points specified. The reader should take note that isopleths showing 1-hour or 24-hour concentrations reflect the 2nd highest 1-hour or 24-hour concentration simulated at grid receptor locations and not the frequency at which the specific concentration occurred over the simulation period. Separate isopleth plots are given to indicate the frequencies of exceedance.

Isopleth plots reflect the incremental ground level concentrations (GLCs) for $PM_{2.5}$ and PM_{10}, as well as deposition rates for TSP. Due to the unavailability of ambient baseline concentrations, cumulative pollutant concentrations could not be determined. The reader is reminded that the assessment in this section is based on the design mitigation received from SRK.

It should also be noted that ambient air quality criteria applies to areas where the occupational health and safety regulations do not apply, thus outside the property or lease area. Ambient air quality criteria are therefore not occupational health indicators but applicable to areas where the general public has access i.e. off-site.

5.3.1.1 Scenario 1

The plot for PM_{10} and $PM_{2.5}$ GLC daily frequency of exceedance is provided in Figure 5-3 and Figure 5-5 respectively for the year 2013, while the annual average plot is provided in Figure 5-4 and Figure 5-6 respectively.

The simulated PM_{10} and $PM_{2.5}$ FOE result in exceedance of their respective 4-day per-year SA NAAQS outside the Elders boundary. The impact extends outside the Elders boundary along the conveyor belt. However, the simulated annual average PM_{10} and $PM_{2.5}$ GLCs does not result in exceedance of their respective SA NAAQS value outside the Elders boundary. Exceedance of the 4-day per-year SA NAAQS FOE and annual average SA NAAQS for PM_{10} and $PM_{2.5}$ was not simulated at any AQSRs.

Isopleth plot due to nuisance effect of dustfall is provided in Figure 5-7 for scenario 1. The simulated maximum daily dustfall deposition rate result in exceedance of the NDCR residential limit (600 mg/m^2-day) and non-residential limit (1200 mg/m^2-day) outside the Elders boundary, along the conveyor belt. The exceedance does not impact on nearby AQSRs.

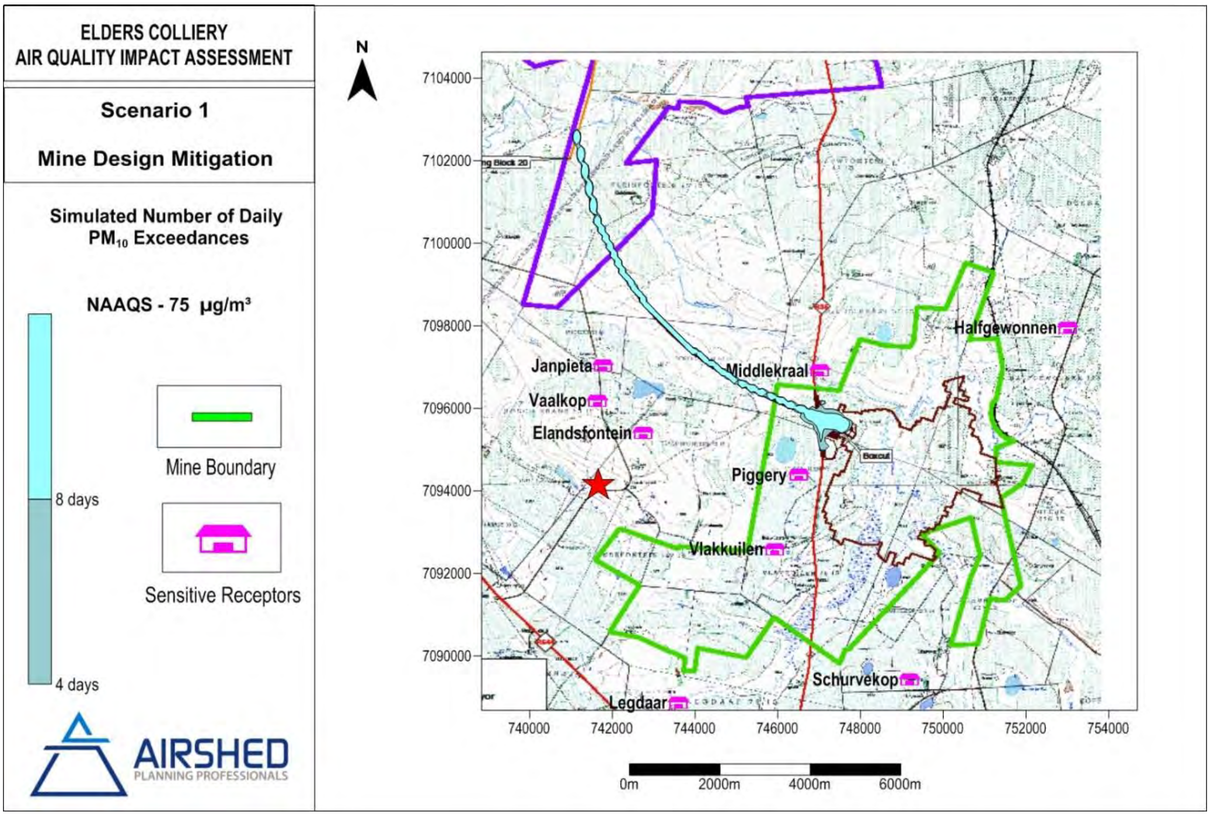


Figure 5-3: Area of exceedance of the 24-Hour SA NAAQS for PM_{10} due to scenario 1 (Post mitigation)

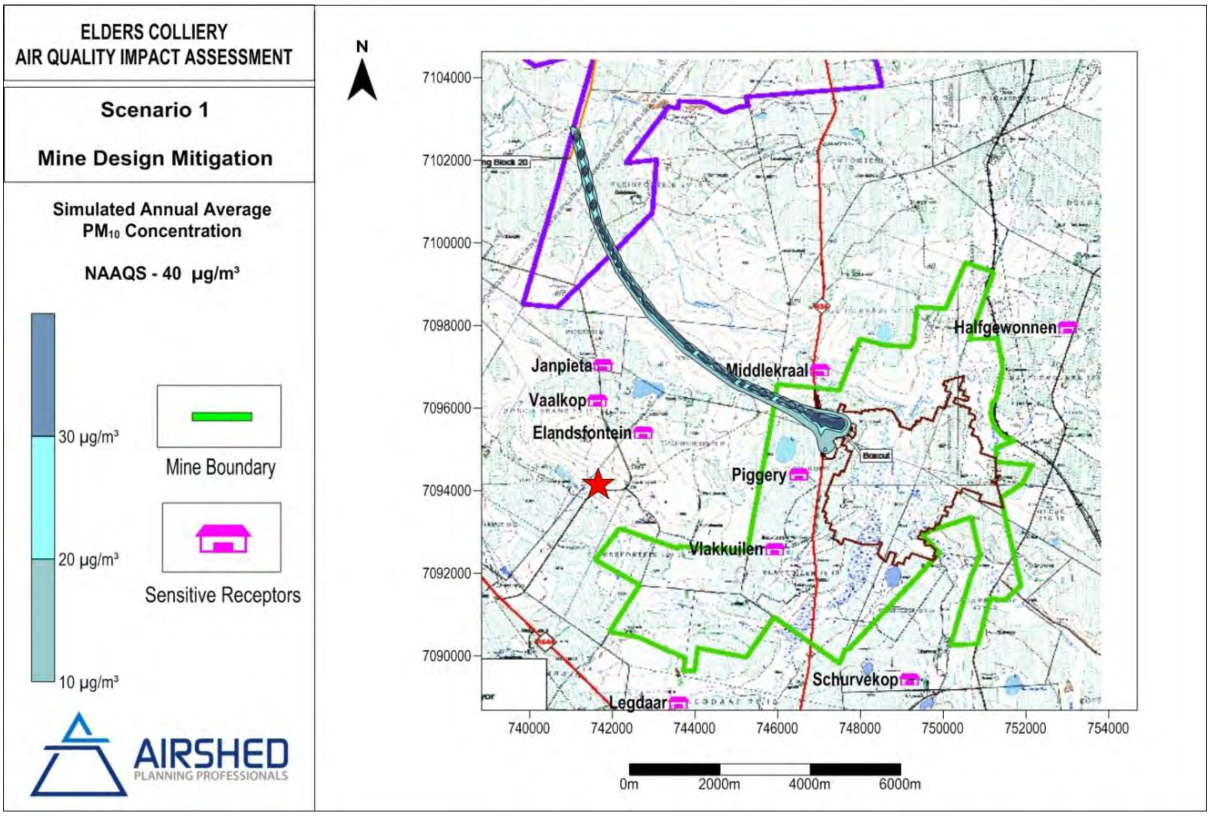


Figure 5-4: Simulated annual average PM_{10} GLCs due to scenario 1 (Post mitigation)

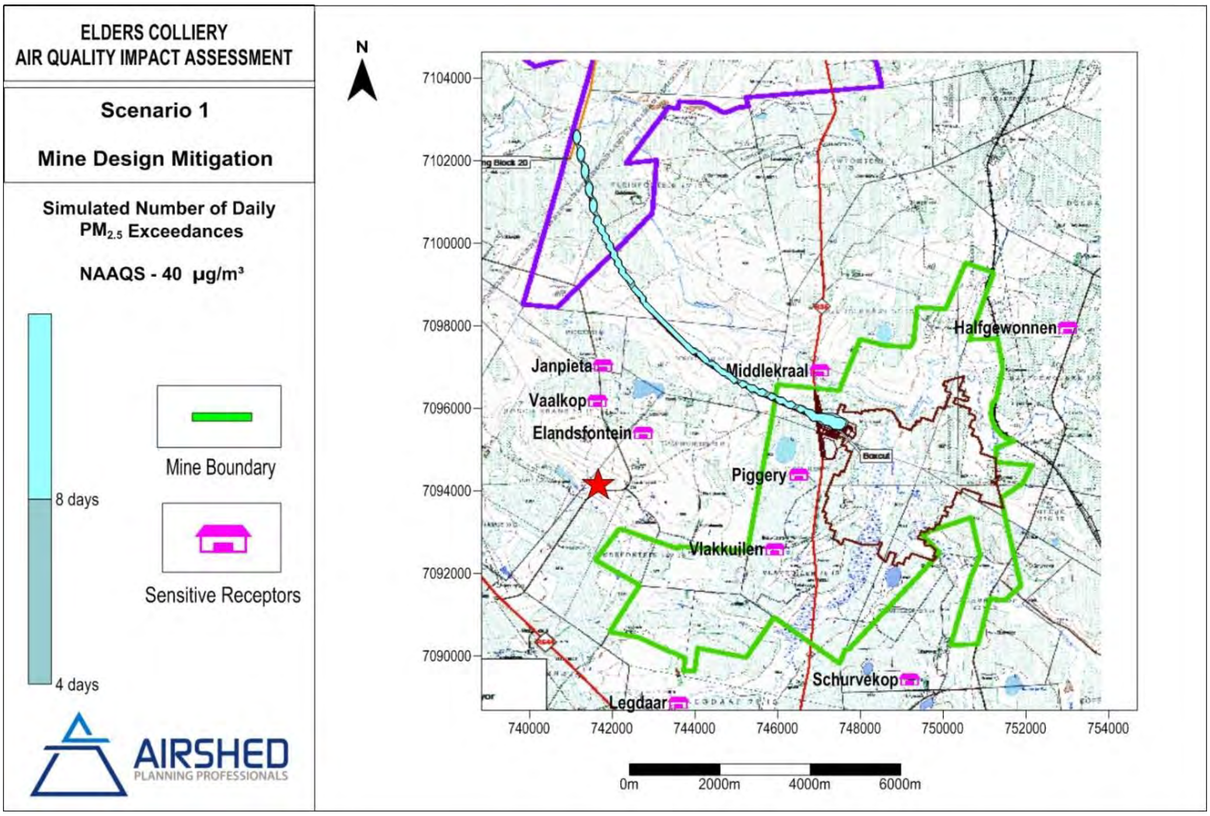


Figure 5-5: Area of exceedance of the 24-Hour SA NAAQS for $PM_{2.5}$ due to scenario 1 (Post mitigation)

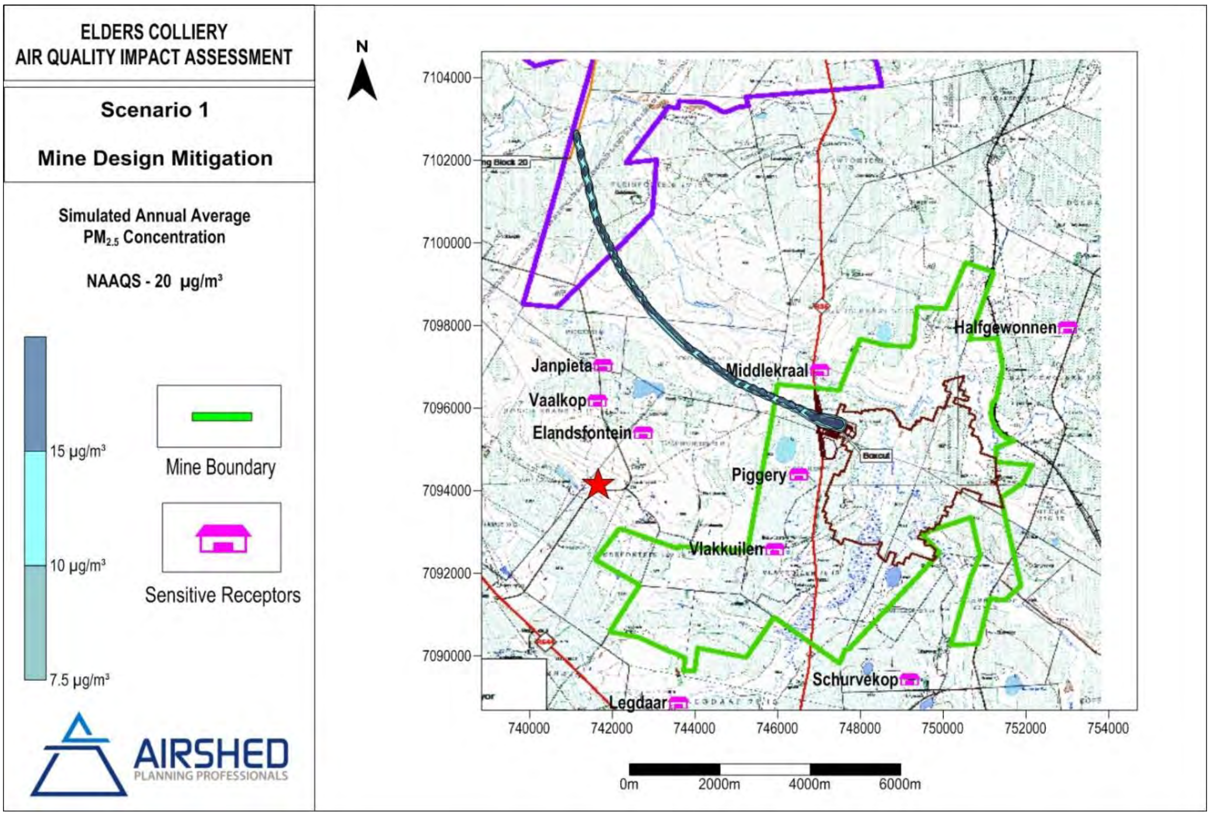


Figure 5-6: Simulated annual average $PM_{2.5}$ GLCs due to scenario 1 (Post mitigation)

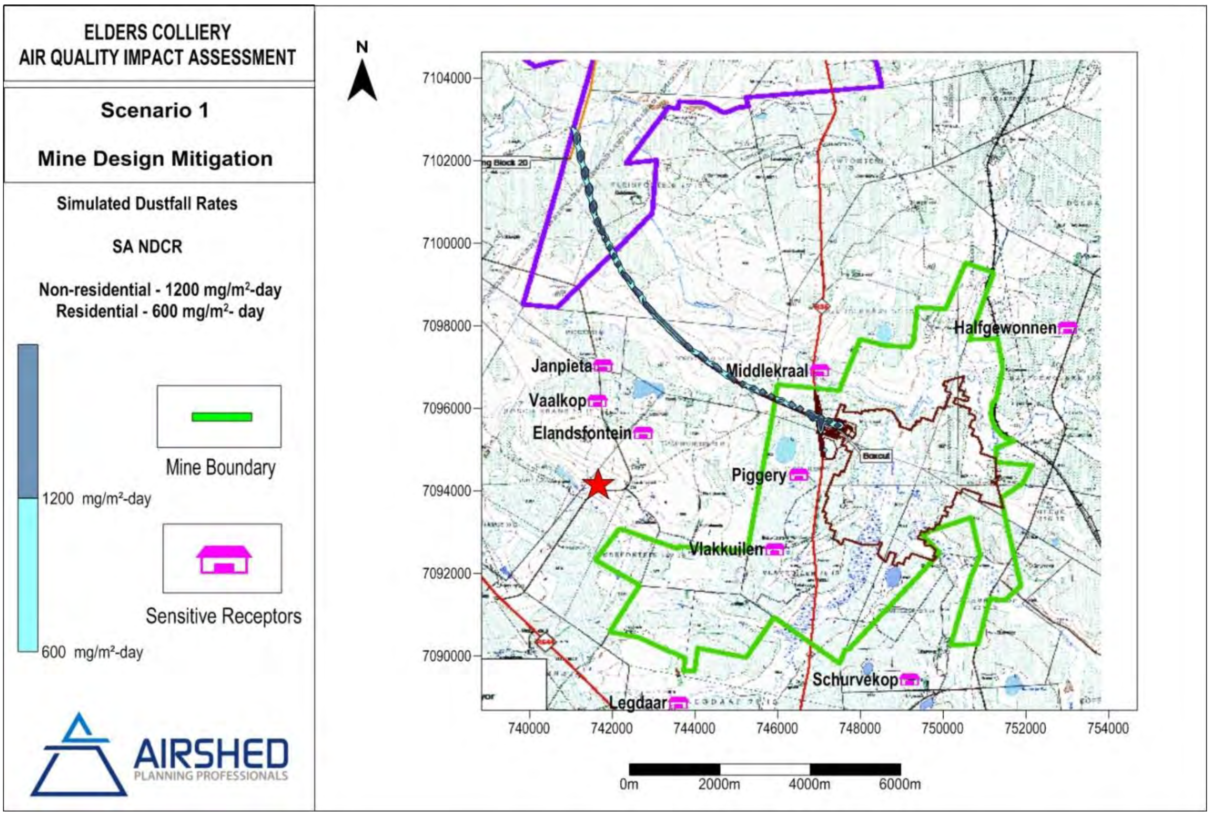


Figure 5-7: Area of exceedance of the dustfall limit due to Scenario 1 (Post mitigation)

Table 5-4: Scenario 1 maximum concentration at identified sensitive receptors

Sensitive receptors	PM_{10}			$PM_{2.5}$		
	Daily concentration (µg/m³)	Annual concentration (µg/m³)	Daily exceedances	Daily concentration (µg/m³)	Annual concentration (µg/m³)	Daily exceedances
Janpieta	4.2	1	0	1.7	0.5	0
Legdaar	1.6	0.2	0	0.6	0.1	0
Schurvekop	2.7	0.3	0	0.9	0.1	0
Elandsfontein	3.3	0.5	0	1.3	0.2	0
Middlekraal	8.3	0.8	0	1.8	0.4	0
Halfgewonnen	11.6	0.5	0	6.6	0.6	0
Vaalkop	1.9	0.2	0	0.7	0.1	0
Vlakkuilen	6.2	1	0	2	0.4	0
Piggery	15.5	2.5	0	4.9	1.1	0

5.3.1.2 Scenario 2

The plot for PM_{10} and $PM_{2.5}$ GLC daily frequency of exceedance is provided in Figure 5-8 and Figure 5-10 respectively for the year 2013, while the annual average plot is provided in Figure 5-9 and Figure 5-11 respectively.

The simulated PM_{10} and $PM_{2.5}$ FOE result in exceedance of their respective 4-day per-year SA NAAQS outside the Elders boundary. The impact extends outside the Elders boundary along the conveyor belt. However, the simulated annual average PM_{10} and $PM_{2.5}$ GLCs does not result in exceedance of their respective SA NAAQS value outside the Elders boundary. Exceedance of the 4-day per-year SA NAAQS FOE and annual average SA NAAQS for PM_{10} and $PM_{2.5}$ was not simulated at any AQSRs.

Isopleth plot due to nuisance effect of dustfall is provided in Figure 5-12 for scenario 1. The simulated maximum daily dustfall deposition rate result in exceedance of the NDCR residential limit (600 mg/m^2-day) and non-residential limit (1200 mg/m^2-day) outside the Elders boundary, along the conveyor belt. The exceedance does not impact on nearby AQSRs.

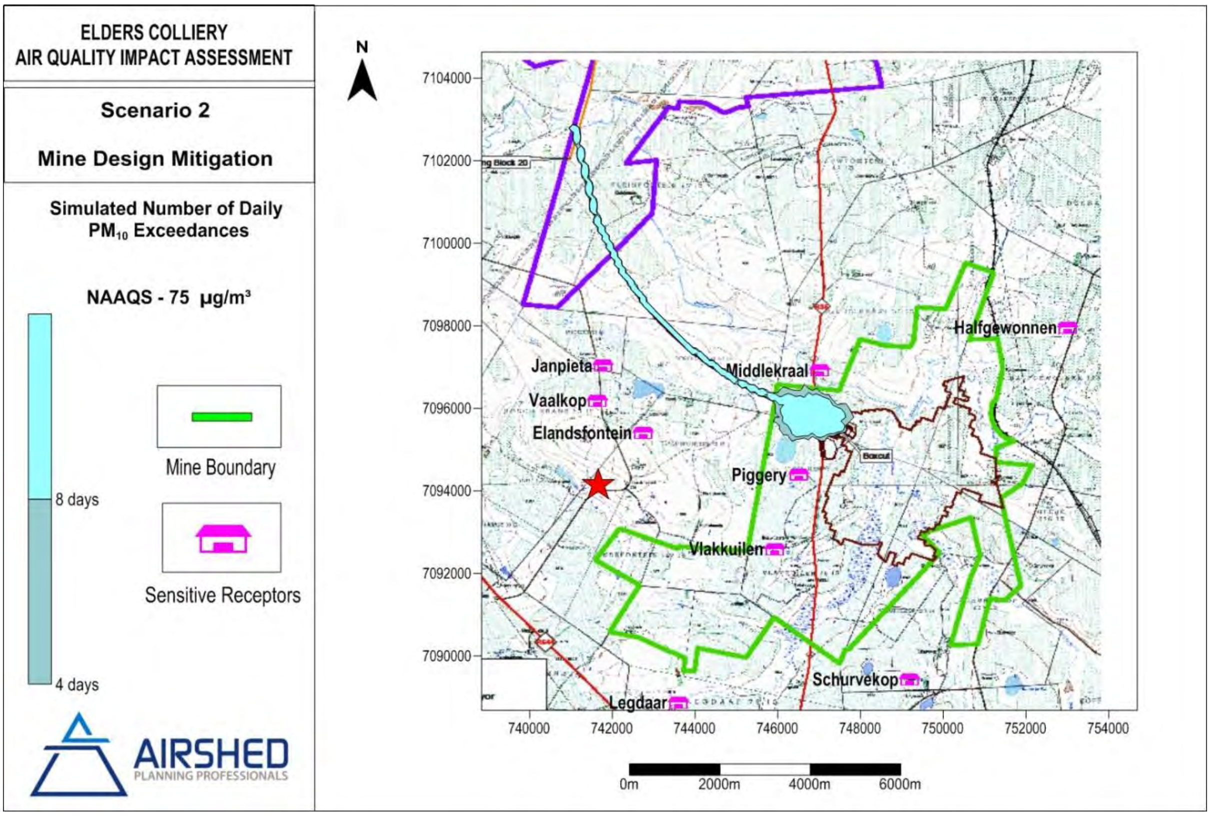


Figure 5-8: Area of exceedance of the 24-Hour SA NAAQS for PM_{10} due to scenario 2 (Post mitigation)

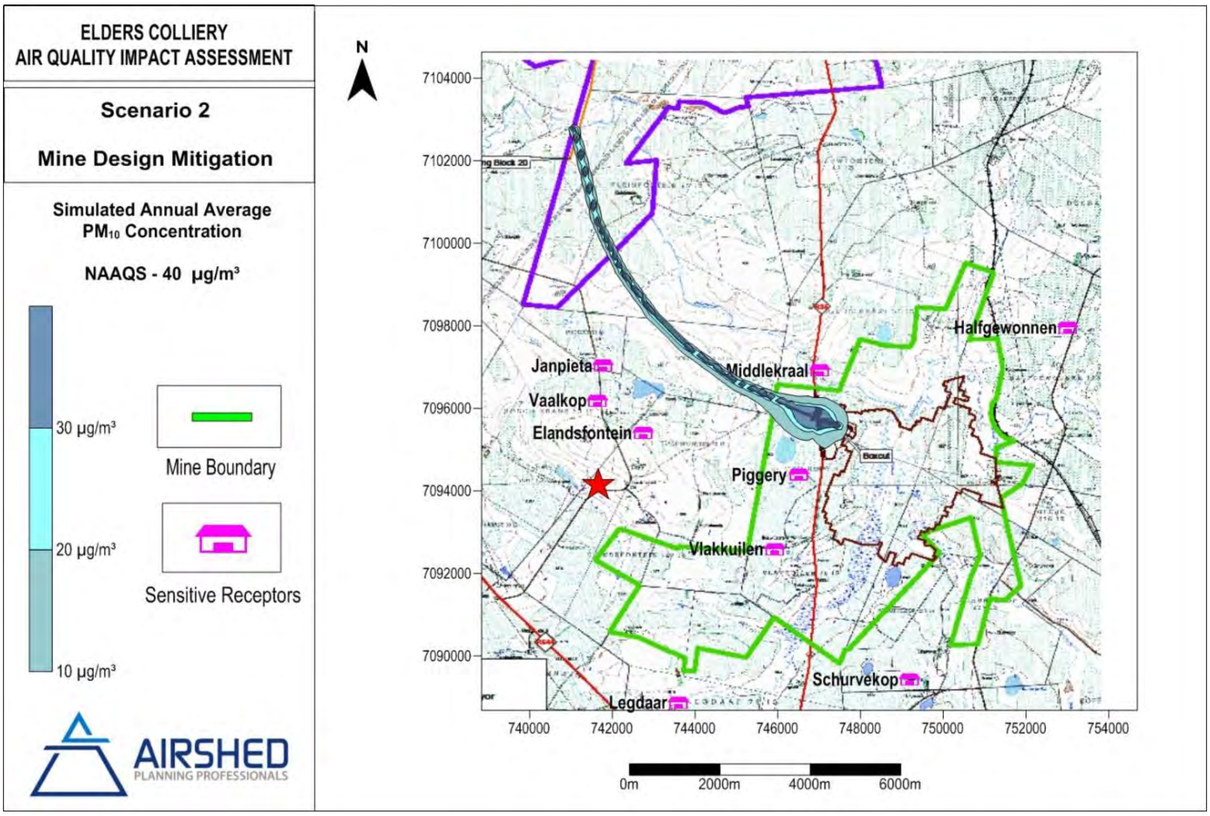


Figure 5-9: Simulated annual average PM_{10} GLCs due to scenario 2 (Post mitigation)

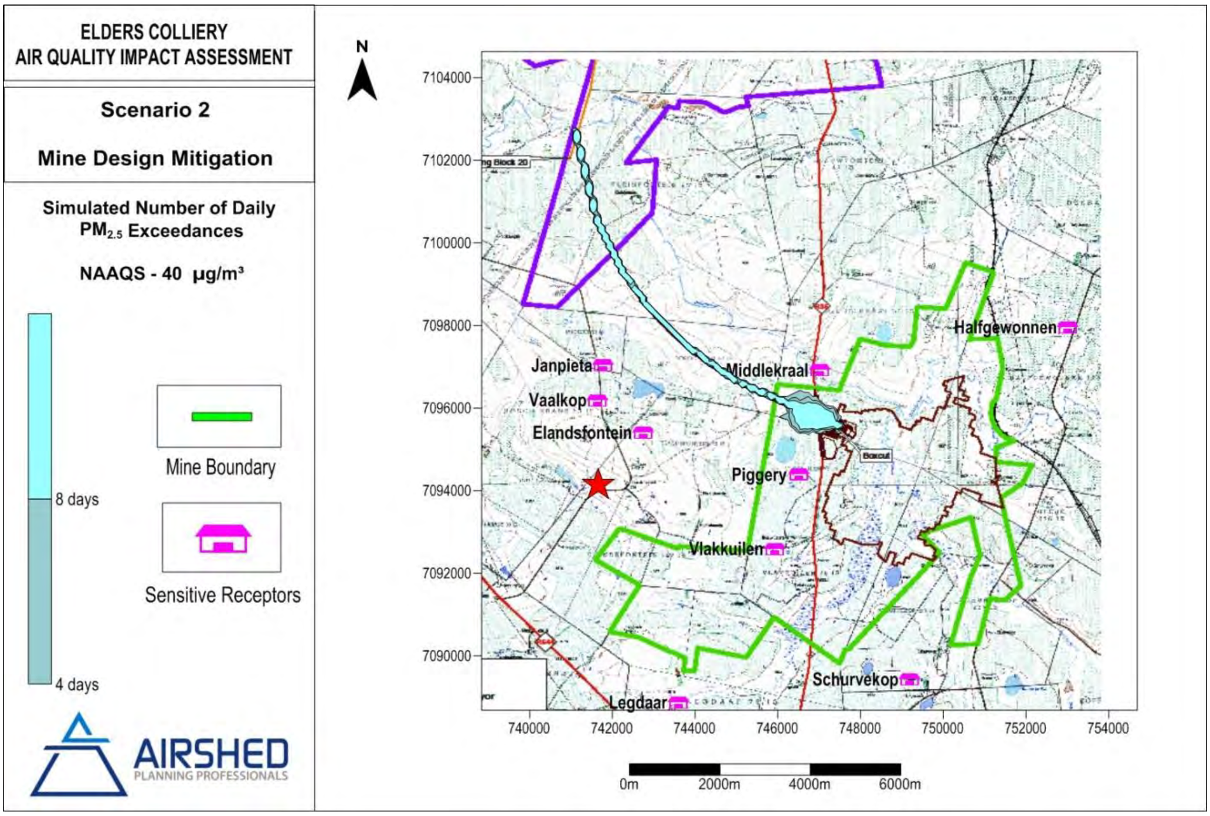


Figure 5-10: Area of exceedance of the 24-Hour SA NAAQS for $PM_{2.5}$ due to scenario 2 (Post mitigation)

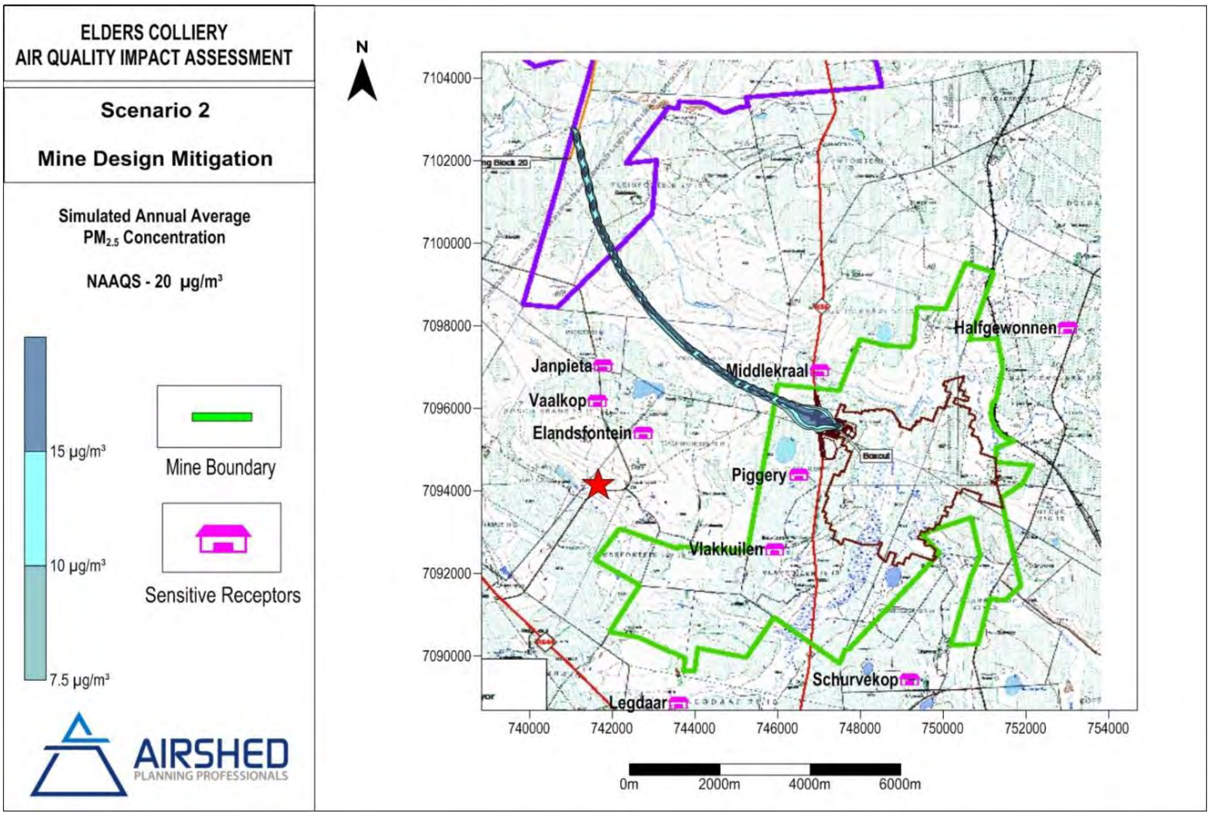


Figure 5-11: Simulated annual average $PM_{2.5}$ GLCs due to scenario 2 (Post mitigation)

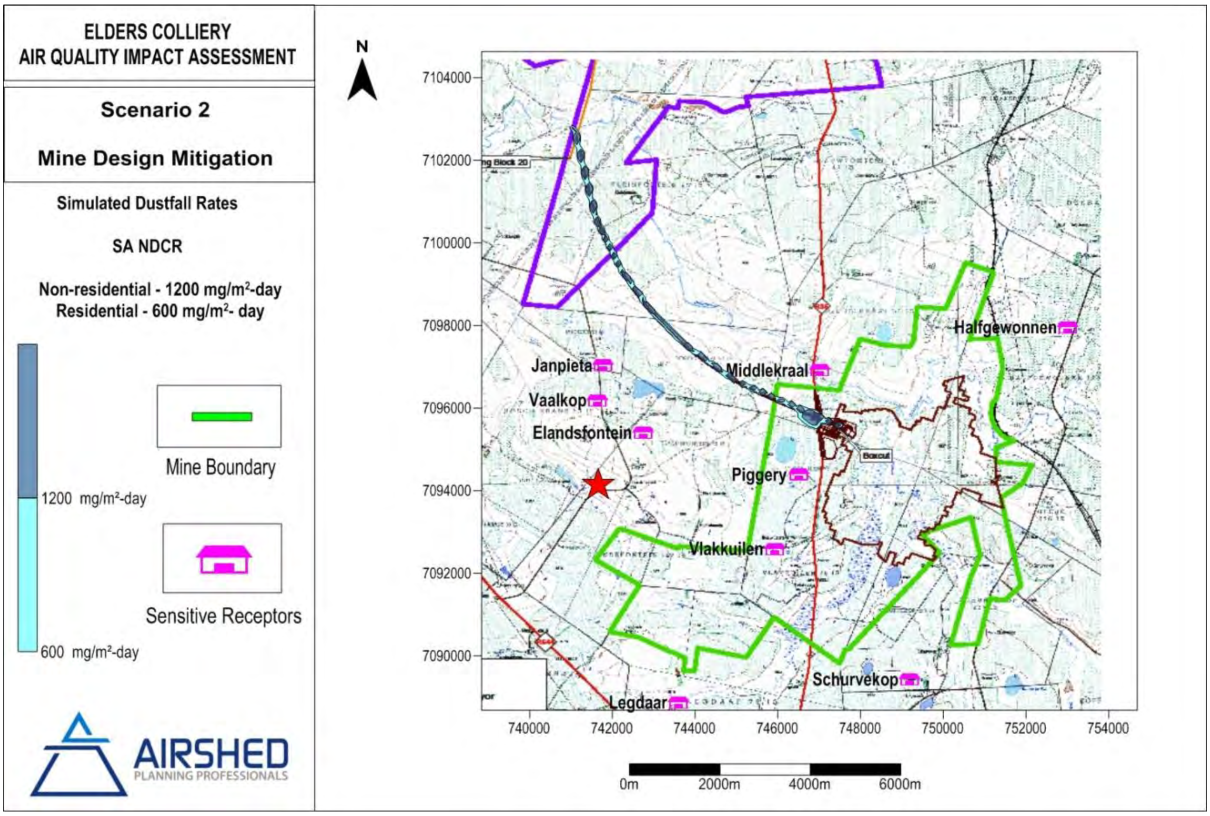


Figure 5-12: Area of exceedance of the dustfall limit due to Scenario 2 (Post mitigation)

Table 5-5: Scenario 2 maximum concentration at identified sensitive receptors

Sensitive receptors	PM_{10}			$PM_{2.5}$		
	Daily concentration (µg/m^3)	Annual concentration (µg/m^3)	Daily exceedances	Daily concentration (µg/m^3)	Annual concentration (µg/m^3)	Daily exceedances
Janpieta	7.5	1.2	0	1.8	0.5	0
Legdaar	3.3	0.3	0	0.7	0.1	0
Schurvekop	4.3	0.4	0	1.1	0.2	0
Elandsfontein	8.8	0.8	0	1.8	0.3	0
Middlekraal	11.6	1.1	0	2.2	0.4	0
Halfgewonnen	12.2	0.7	0	8.7	0.9	0
Vaalkop	6	0.3	0	1.3	0.1	0
Vlakkuilen	13.4	1.6	0	3.3	0.6	0
Piggery	33.5	4.2	0	8.25	1.5	0

6 RECOMMENDED AIR QUALITY MANAGEMENT MEASURES

In the light of the potential exceedances of the air quality limits, it is recommended that the project proponent commit itself to adequate air quality management planning throughout the life of the proposed project. The air quality management plan provides options on the control of dust particles and gases at the main sources, while the monitoring network is designed to track the effectiveness of the mitigation measures.

Based on the findings of the impact assessment, the following mitigation, management and monitoring recommendations are proposed.

6.1 Air Quality Management Objectives

The main objective of the proposed air quality management measures for the project is to ensure that operations result in ambient air concentrations (specifically PM_{10}) and dustfall rates that are within the relevant ambient air quality standards at nearby AQSRs. In order to define site specific management objectives, the main sources of pollution need to be identified. Once the main sources have been identified, target control efficiencies for each source can be defined to ensure acceptable cumulative ground level concentrations.

6.2 Proposed Mitigation Measures and Target Control Efficiencies

An air quality management has the aim of providing mitigation measures that can be utilised to reduce the impacts, improve ambient air quality and reduce impacts on humans and the ecology. The management plan is informed by the baseline and air quality impact assessment and draws management plans from atmospheric dispersion modelling results and conclusions.

Mitigation measures, as included in the design specifications of the mine, specified dust suppression on unpaved roads in and around the box-cut (SRK, 2013); this mitigation measure was taken into account during the emission inventory development and consequently atmospheric dispersion modelling. 50% control efficiency on unpaved roads was therefore applied on all roads.

Elders Colliery operations are in close proximity to the mine boundary; increasing the likelihood that impacts will affect sensitive receptors resulting in non-compliance of the relevant regulations (NAAQS and NDCR) It is for this reason that barriers around the mining activities (especially in the westerly direction) are suggested as a mitigation measure to deal with particulates emissions. Barriers may be erected during the construction phase and be dismantled when only the underground mine is operational; the barrier will serve to minimise impacts on sensitive receptors located south and west of the mine Mitigation measures per source group are shown in Table 6-1. Suggested mitigation measures should be applied to any new development throughout the life of the mine.

Measures aimed at binding the surface material or enhancing moisture retention, such as wet suppression and chemical stabilisation (EPA, 1987; Cowherd et al., 1988; APCD, 1995) are discussed in detail in section 10.

Table 6-1: Elders Colliery mitigation measures per source group

Source group	Aspect	Mitigation measure
Construction	Construction of underground mine shaft and associated infrastructure	Water sprays on unpaved roads, stockpiles and material handling points; this will results in 50% control efficiency Temporarily cover earthworks or have a barrier around the construction site, if possible.
Site clearing	Site preparation of the box-cut area	Water sprays; this will results in 50% control efficiency Machinery used in the process may be located further from the mine boundary.
Drilling	Drilling of overburden	Water sprays; this will results in 70% control efficiency.
Blasting	Blasting of overburden	No mitigation
Crushing	Crushing of RoM from underground mine and box-cut	Increase coal's moisture content thought the uses of water sprays. Enclose the crusher and fit with a dust extraction system.
Material handling	Topsoil removal ,overburden handling, truck loading	Water sprays; resulting in 50% control efficiency
Unpaved roads	Vehicle entrainment on unpaved roads	Reduce the extent of the roads through paving as a minimum or use chemical treatment on the road surface to ensure a 80% reduction in emissions. Traffic control done through restriction of traffic volumes on roads and vehicle speeds.
Wind-blown dust	Wind-blown dust from topsoil stockpile	Use water sprays on all stockpiles with special attention given to active stockpiles. Net screens with fine mist sprays around stockpiles areas. Netting, rock cladding or wind breaks r may be used on old stockpiles Long-term stockpiles should be vegetated or turfed.
	Wind-blown dust from conveyor	Adhere to specified design (with a roof and one side covered). The conveyor covering should be in the direction where most sensitive receptors are located (westerly direction of the mine)

6.2.1 Ambient Air Quality Monitoring

Ambient air quality monitoring can serve to meet various objectives, such as:

- Compliance monitoring;
- Validate dispersion model results;
- Use as input for health risk assessment;
- Assist in source apportionment;
- Temporal and spatial trend analysis;
- Source quantification; and,
- Tracking progress made by control measures.

It is recommended that the Elders dustfall monitoring campaign be continued as part of the project's air quality management plan. This should be undertaken throughout the life of the project to provide air quality trends and adequate data for cumulative impacts on AQSRs.

It is also recommended that a gravimetric $PM_{10}/PM_{2.5}$ monitor be installed at Middlekraal. This will provide adequate data on cumulative PM_{10} and $PM_{2.5}$ concentrations from the Elders Colliery and other mines/industries in the region.

Recommended monitoring locations are presented in Figure 6-1. The description of these locations is given in Table 6-2.

Table 6-2: Elders Colliery monitoring locations and parameters

Location No.	Description	Pollutant(s) to be Sampled
1	Near crusher	Dustfall
2	South of the Middelkraal community and north of the main operations	Dustfall/$PM_{10}/PM_{2.5}$
3	East of the main operations	Dustfall
4	South of the main operations	Dustfall
5	West of the main operations	Dustfall
6	West of the conveyor near Goedehoop boundary	Dustfall
7	Sewerage works (west if the conveyor)	Dustfall
8	Goedehoop (west of the conveyor)	Dustfall

6.3 Air Quality Management within the Highveld Priority Area

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

- Goal 1: By 2015, organisational capacity in government is optimised to efficiently and effectively maintain, monitor and enforce compliance with ambient air quality standards.
- Goal 2: By 2020, industrial emissions are equitably reduced to achieve compliance with ambient air quality standards and dustfall limit values.
- Goal 3: By 2020, air quality in all low-income settlements is in full compliance with ambient air quality standards.
- Goal 4: By 2020, all vehicles comply with the requirements of the National Vehicle Emission Strategy.

- Goal 5: By 2020, a measurable increase in awareness and knowledge of air quality exists.
- Goal 6: By 2020, biomass burning and agricultural emissions will be 30% less than current.
- Goal 7: By 2020, emissions from waste management are 40% less than current.

The Elders Colliery falls within the HPA footprint and it will contribute to the pollution within the Highveld airshed. It is recommended that the management plan for the Highveld Priority Area as published by the DEA be included in all management plans employed for the project.

6.4 Performance Indicators

Key performance indicators against which progress of implemented mitigation and management measures may be assessed form the basis for all effective environmental management practices. In the definition of key performance indicators careful attention is usually paid to ensure that progress towards their achievement is measurable, and that the targets set are achievable given available technology and experience.

Performance indicators are usually selected to reflect both the source of the emission directly (source monitoring) and the impact on the receiving environment (ambient air quality monitoring). Ensuring that no visible evidence of windblown dust exists represents an example of a source-based indicator, whereas maintaining off-site dustfall levels to below 600 mg/m^2-day represents an impact- or receptor-based performance indicator.

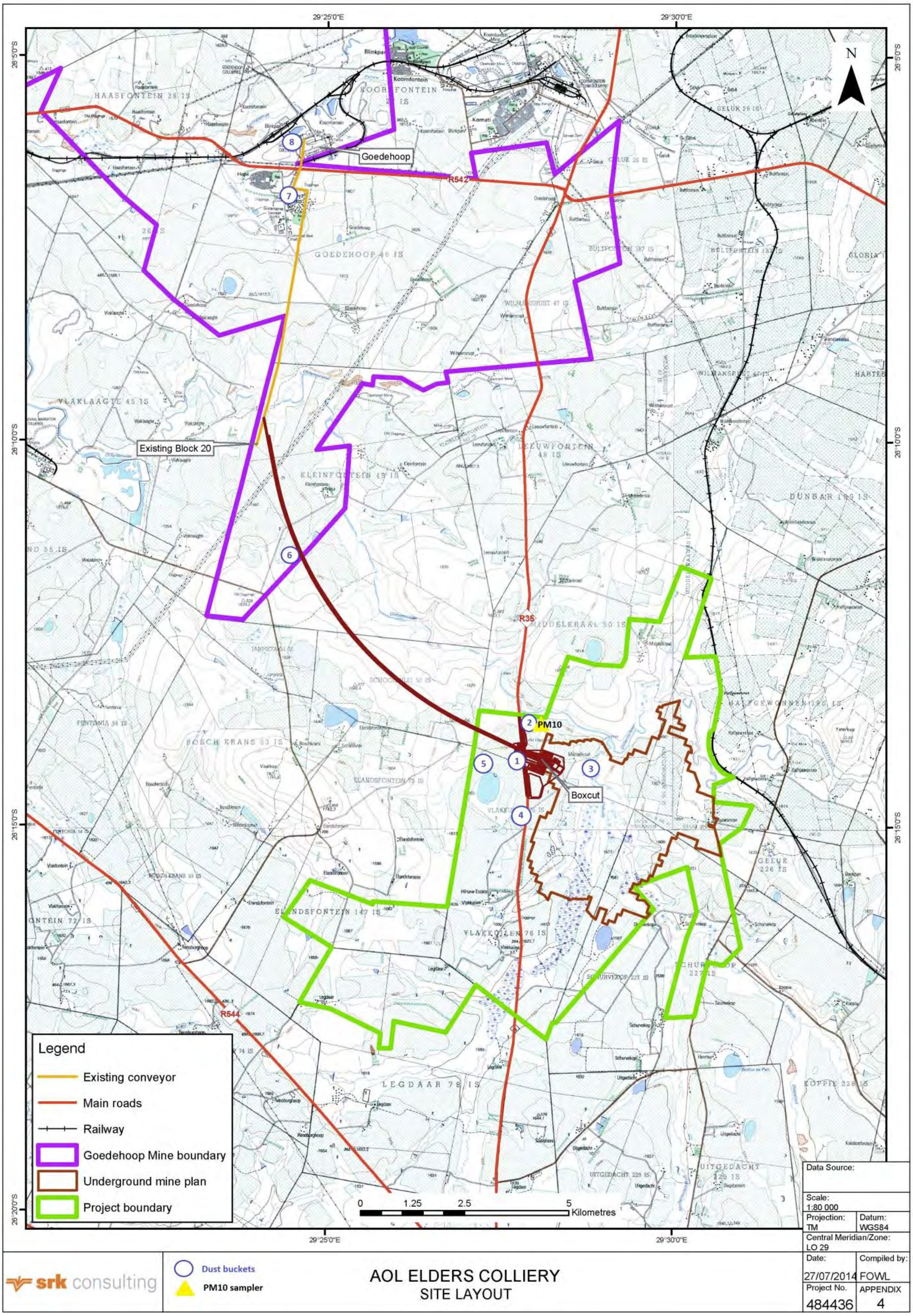


Figure 6-1: Recommended monitoring locations at Elders Colliery

6.5 Periodic Inspections, Audits and Community Liaison

6.5.1 Periodic Inspections and Audits

Periodic inspections and external audits are essential for progress measurement, evaluation and reporting purposes. It is recommended that site inspections and progress reporting be undertaken at regular intervals (at least quarterly), with annual environmental audits being conducted. Annual environmental audits should be continued at least until closure. Results from site inspections and monitoring efforts should be combined to determine progress against source- and receptor-based performance indicators. Progress should be reported to all interested and affected parties, including authorities and persons affected by pollution.

The criteria to be taken into account in the inspections and audits must be made transparent by way of minimum requirement checklists included in the management plan. Corrective action or the implementation of contingency measures must be proposed to the stakeholder forum in the event that progress towards targets is indicated by the quarterly/annual reviews to be unsatisfactory.

6.5.2 Liaison Strategy for Communication with I&APs

Stakeholder forums provide possibly the most effective mechanisms for information dissemination and consultation. Management plans should stipulate specific intervals at which forums will be held, and provide information on how people will be notified of such meetings. For operations for which un-rehabilitated or partly rehabilitated impoundments are located in close proximity (within 3 km) from community areas, it is recommended that such meetings be scheduled and held on a bi-annual basis.

6.6 Impact Significance Rating

The significance of air quality related impacts were assessed in accordance with the procedure set out by SRK, as described in section 9. Operational phase impacts were assessed quantitatively for scenarios 1 and 2.

6.6.1 $PM_{2.5}$, PM_{10} and dustfall impacts

Project Phase: Box-cut construction and underground mining operations (Scenario 1 and 2)

Activity: Activities include site clearing, tipping, conveying, crushing and screening, stockpiling, drilling, blasting and hauling.

Impact Description: During construction and operation phase of the project, the activities listed above will result in fugitive PM emissions ($PM_{2.5}$, PM_{10} and dustfall) as well as particulate and gaseous vehicle exhaust emissions (as described in Section 1.2). These PM emission have the potential to result in human health impacts and/or nuisance dust effects.

Table 6-3: $PM_{2.5}$ and PM_{10} impact significance table (Scenario 1)

Activity	Site clearing, tipping, conveying, drilling, blasting, stockpiling and hauling							
Project phase	Box-cut construction and mining phase (Scenario 1)							
Impact Summary	Health impacts due to $PM_{2.5}$ and PM_{10} emissions							
Potential Impact Rating	Magnitude	Duration	Scale	Conseq.	Probab.	Significance	+/-	Conf. level
	Moderate -	Short term	Local	Low	Possible	Low	-	High
Management Measures	Water sprays on unpaved roads, stockpiles, drilling and all material handling points							
	Long-term stockpiles should be vegetated and temporary cover/barrier be provided for earthworks							
	Conveyor covering design with a roof and one side covered in the direction where most sensitive receptors are located (westerly direction of the mine)							
After Management Impact Rating	Magnitude	Duration	Scale	Conseq.	Probab.	Significance	+/-	Conf. level
	Low -	Short term	Local	Low	Possible	Low	-	High

Table 6-4: $PM_{2.5}$ and PM_{10} impact significance table (Scenario 2)

Activity	Tipping, conveying, crushing, screening and stockpiling							
Project phase	Underground mining operation phase (Scenario 2)							
Impact Summary	Health impacts due to $PM_{2.5}$ and PM_{10} emissions							
Potential Impact Rating	Magnitude	Duration	Scale	Conseq.	Probab.	Significance	+/-	Conf. level
	Moderate -	Long term	Local	Medium	Possible	Medium	-	High
Management Measures	Water sprays on unpaved roads, stockpiles, drilling and all material handling points							
	Long-term stockpiles should be vegetated and temporary cover/barrier be provided for earthworks							
	Conveyor covering design with a roof and one side covered in the direction where most sensitive receptors are located (westerly direction of the mine)							
After Management Impact Rating	Magnitude	Duration	Scale	Conseq.	Probab.	Significance	+/-	Conf. level
	Low -	Long term	Local	Low	Possible	Low	-	High

Table 6-5: Dustfall impact significance table (Scenario 1 and 2)

Activity	Tipping, conveying, crushing, screening and stockpiling							
Project phase	Box-cut construction and underground mining operations (Scenario 1 and 2)							
Impact Summary	Nuisance effects due to dustfall emissions							
Potential Impact Rating	Magnitude	Duration	Scale	Conseq.	Probab.	Significance	+/-	Conf. level
	Low -	Long term	Local	Low	Possible	Low	-	High
Management Measures	Water sprays on unpaved roads, stockpiles, drilling and all material handling points							
	Long-term stockpiles should be vegetated and temporary cover/barrier be provided for earthworks							
	Conveyor covering design with a roof and one side covered in the direction where most sensitive receptors are located (westerly direction of the mine)							
After Management Impact Rating	Magnitude	Duration	Scale	Conseq.	Probab.	Significance	+/-	Conf. level
	Low -	Long term	Local	Low	Possible	Low	-	High

7 CONCLUSION AND RECOMMENDATION

7.1 Main Findings

A quantitative air quality impact assessment was conducted for operational phase activities of the project. The assessment included a study of the receiving environment as well as the estimation of atmospheric emissions, the simulation of pollutant levels and determining the significance of impacts.

The main findings of the assessment are:

- The receiving environment:
    - The area is dominated by strong winds from the east and north-west, with moderate winds from most of the north- eastern and south-western sectors. An average wind speed of 3.8 m/s was recorded over the 2011 to 2013 period.

    - Ambient air pollutant levels in the proposed project area are currently affected by the following sources of emission; mining; vehicles tail-pipe emissions; power generation; domestic fuel combustion and open areas exposed to wind erosion.

    - Sensitive receptors around the Elders Colliery boundary include Vlakkuilen, Vaalkop, Legdaar, Schurvekop, Elandsfontein, Middlekraal, Halfgewonnen and a small scale piggery.

- Impact of the proposed Project:
    - Scenario one (construction and mining of the initial box-cut):
        - Sources of emission quantified included drilling, blasting, crushing and screening, material handling, vehicles travelling on unpaved roads, windblown dust from the stockpiles and windblown dust from conveyor. PM emissions ($PM_{2.5}$, PM_{10} and TSP) were quantified and utilized in simulations.
        - The simulated PM_{10} and $PM_{2.5}$ FOE result in exceedance of their respective 4-day per-year SA NAAQS outside the Elders boundary. The impact extends outside the Elders boundary along the conveyor belt. However, the simulated annual average PM_{10} and $PM_{2.5}$ GLCs does not result in exceedance of their respective SA NAAQS value outside the Elders boundary. Exceedance of the 4-day per-year SA NAAQS FOE and annual average SA NAAQS for PM_{10} and $PM_{2.5}$ was not simulated at any AQSRs.
          A significance rating of *'low'* was assigned to potential inhalation health impacts associated with PM_{10} and $PM_{2.5}$ impacts during the construction and mining of the initial box-cut.
        - The simulated maximum daily dustfall deposition rate result in exceedance of the NDCR residential limit (600 mg/m^2-day) and non-residential limit (1200 mg/m^2-day) outside the Elders boundary, along the conveyor belt. The exceedance does not impact on nearby AQSRs. A significance rating of *'low'* was assigned to nuisance effects associated with dustfall during the construction and mining of the initial box-cut.

- Scenario two (operation of the underground mine):
    - Sources of emission quantified included crushing and screening, material handling, windblown dust from the stockpiles and windblown dust from conveyor. PM emissions ($PM_{2.5}$, PM_{10} and TSP) were quantified and utilized in simulations.
    - The simulated PM_{10} and $PM_{2.5}$ FOE result in exceedance of their respective 4-day per-year SA NAAQS outside the Elders boundary. The impact extends outside the Elders boundary along the conveyor belt. However, the simulated annual average PM_{10} and $PM_{2.5}$ GLCs does not result in exceedance of their respective SA NAAQS outside the Elders boundary. Exceedance of the 4-day per-year SA NAAQS FOE and annual average SA NAAQS for PM_{10} and $PM_{2.5}$ was not simulated at any AQSRs.

      A significance rating of *'low'* was assigned to potential inhalation health impacts associated with PM_{10} and $PM_{2.5}$ impacts during the operation of the underground mine.
    - The simulated maximum daily dustfall deposition rate result in exceedance of the NDCR residential limit (600 mg/m^2-day) and non-residential limit (1200 mg/m^2-day) outside the Elders boundary, along the conveyor belt. The exceedance does not impact on nearby AQSRs. A significance rating of *'low'* was assigned to nuisance effects associated with dustfall during the operation of the underground mine.

7.2 Recommendations

To ensure the lowest possible impact on nearby AQSRs and the environment, it is recommended that the air quality management plan as set out in section 6 of this report be adopted.

A summary of the recommended management plan is given below:

- The implementation of emission controls for the management of significant emission sources, most significantly, emissions from conveyor belts and crushing processes;
- It is recommended that the Elders ambient air quality monitoring campaign be continued as part of the project's air quality management plan. This should be undertaken throughout the life of the project to provide air quality trends and adequate data for cumulative impacts on AQSRs; and
- The Elders Colliery falls within the HPA footprint and it will contribute to the pollution within the Highveld airshed. It is recommended that the management plan for the Highveld Priority Area as published by the DEA be included in all management plans employed for the project.

It is also recommended that the project comply with the provisions of the NAERR 2015 as summarized in section 3.6 of this report. The NAERR aims to standardize the reporting of data and information from an identified data provider to an internet-based National Atmospheric Emissions Inventory System, towards the compilation of atmospheric emission inventories.

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9 Appendix A – Methodology for the Assessment of Impacts (SRK)

Generally, the impact assessment is divided into three parts:

- Issue identification - each specialist will be asked to evaluate the 'aspects' arising from the project description and ensure that all issues in their area of expertise have been identified;
- Impact definition - positive and negative impacts associated with these issues (and any others not included) then need to be defined – the definition statement should include the activity (source of impact), aspect and receptor as well as whether the impact is direct, indirect or cumulative. Fatal flaws should also be identified at this stage.
- Impact evaluation – this is not a purely objective and quantitative exercise. It has a subjective element, often using judgement and values as much as science-based criteria and standards. The need therefore exists to clearly explain how impacts have been interpreted so that others can see the weight attached to different factors and can understand the rationale of the assessment.

9.1 Impact significance rating

The impact significance rating system is presented in and involves four parts:

- Part A: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/population and duration;
- Part B: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A;
- Part C: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence; and
- Part D: Define the Confidence level.

The impact significance rating system is summarized in Table 9-1.

Table 9-1: Method for rating the significance of impacts

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE					
Impact characteristics	Definition		Criteria		
MAGNITUDE	Major -		Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation		
	Moderate -		Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally		
	Minor -		Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold		
	Minor +		Minor improvement; change not measurable; or threshold never exceeded		
	Moderate +		Moderate improvement; within or better than the threshold; or no observed		
	Major +		Substantial improvement; within or better than the threshold; or favourable		
DURATION	Short term		Up to 18 months.		
	Medium term		18 months to 5 years		
	Long term		Longer than 5 years		
SPATIAL SCALE OR POPULATION	Site or local		Site specific or confined to the immediate project area		
	Regional		May be defined in various ways, e.g. cadastral, catchment, topographic		
	National/ International		Nationally or beyond		
PART B: DETERMINING CONSEQUENCE RATING					
			SPATIAL SCALE/ POPULATION		
			Site or Local	Regional	National/ international
MAGNITUDE					
Minor	DURATION	Long term	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	DURATION	Long term	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium

Major	DURATION	Long term	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High
PART C: DETERMINING SIGNIFICANCE RATING					
			CONSEQUENCE		
			Low	Medium	High
PROBABILITY (of exposure to impacts)	Definite		Medium	Medium	High
	Possible		Low	Medium	High
	Unlikely		Low	Low	Medium
PART D: CONFIDENCE LEVEL					
High			Medium	Low	

9.2 Activities to be rated

Table 9-2 provides the activities per project phase for which impacts should be identified and assessed, and mitigation measures provided. Please note that this table is not limited to only the stated activities identified, but should be used as a guideline when identifying activities that could have potential impact on the biophysical and social environment.

Table 9-2: Elders Colliery Activities

Phase	Activities
Preconstruction and construction	Site clearing and grubbing of the footprint areas associated with the boxcut, ventilation shafts, conveyor route servitude, roads and mini pit area
	Establishment of the contractor laydown area.
	Construction of boxcut and associated infrastructure (including water treatment plant and sewage treatment plant), overburden stockpile and topsoil stockpile
	Construction of conveyor belt, pipeline, service road and a powerline
Operational	Underground mining.
	Run of mine (ROM) stockpile
	Conveying of coal to from Elders Colliery to Block 20
	Storage of water underground
	Operation of water treatment plant (including storage of brine and controlled release of treated water)
	Operation of sewage treatment plant (including storage of sludge)
Closure/Rehabilitation	Demolish all surface infrastructure
	Rehabilitation of shaft area and conveyor route servitude
Post-closure	Potential decant of groundwater

10 APPENDIX B: Mitigation measures

It is standard practice at most mines to utilise water trucks on unpaved roads. It is recommended that water be used in combination with chemical surfactants to reduce the amount of water required to achieve certain control efficiencies. An empirical model, developed by the US-EPA (EPA, 1996), was used to estimate the average control efficiency of certain quantifies of water applied to a road. The model takes into account rainfall, evaporation rates and traffic. Water and chemical sprays resulting in at least 90% control efficiency would be a requirement to result in a significant reduction in ground level concentrations and dust-fall levels. Should only water be applied, the amounts needed to ensure 90% control efficiency on the surface and in-pit haul roads (assuming 70 trucks/hour) are 1.478 l/m²/hour including rainfall and 1.882 l/m²/day excluding mitigation due to rainfall. Monthly watering rates for a variety of control efficiencies are presented in Figure 10-1 and Figure 10-2.

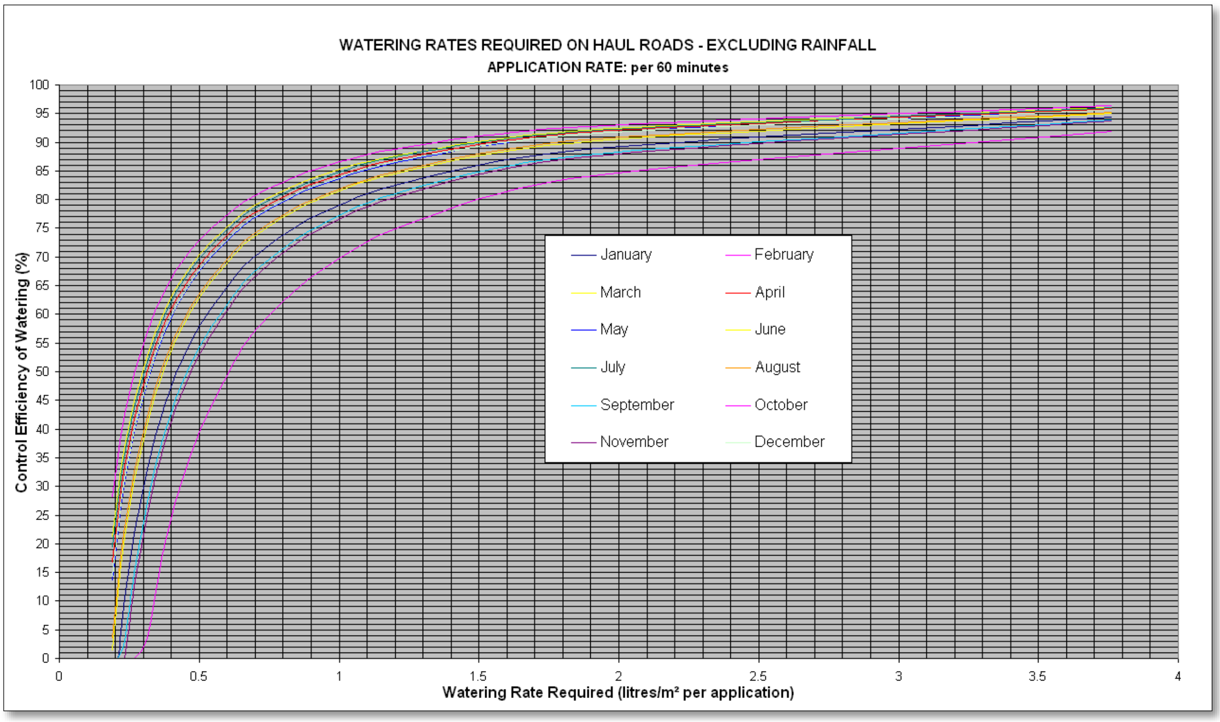

Figure 10-1: Monthly watering results excluding rainfall

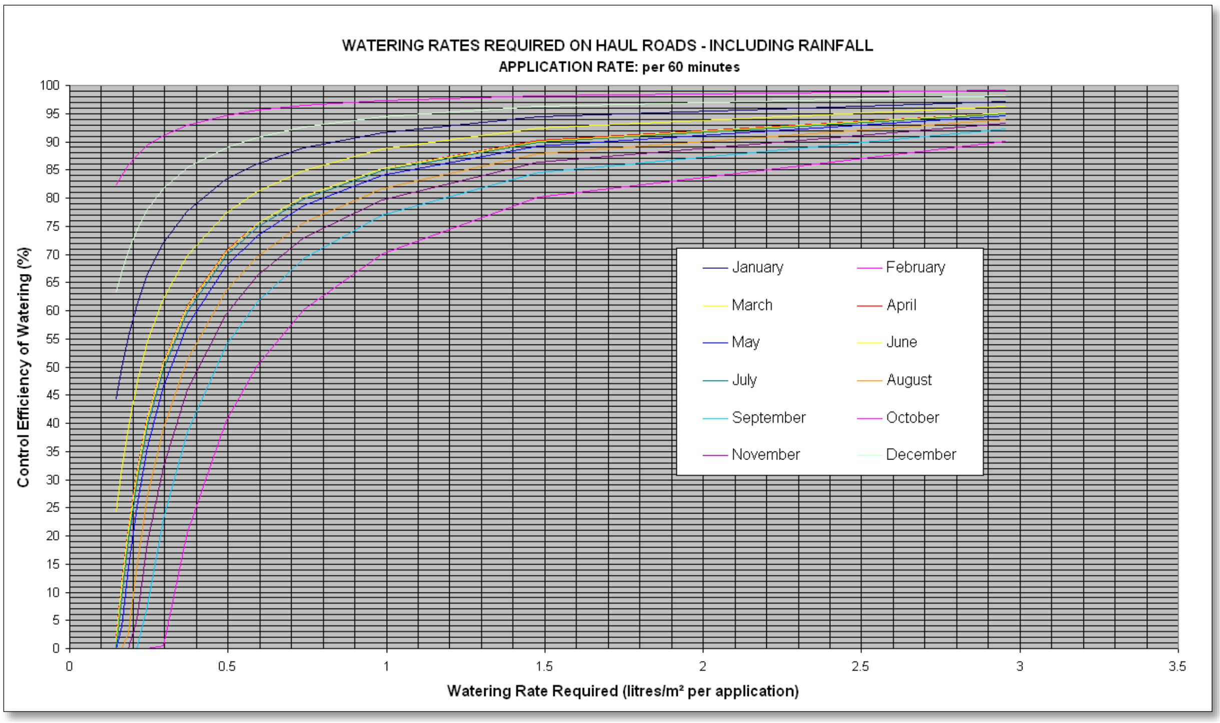

Figure 10-2: Monthly watering results excluding rainfall

<u>Materials handling operations</u>

Enclosure of crushing operations is very effective in reducing dust. The Australian NPi indicates that a telescopic chute with water sprays would ensure 75% control efficiency and enclosure of storage piles where tipping occur would reduce the emissions by 99%. In addition, chemical suppressants or water sprays on the primary crusher and dry dust extraction units with wet scrubbers on the secondary and tertiary crushers and screens will assist in the reduction of the cumulative dust impacts. According to the Australian NPi, water sprays can have up to 50% control efficiency and hoods with scrubbers up to 75%. If in addition, the scrubbers and screens were to be enclosed; up to 100% control efficiency can be achieved. Hooding with fabric filters can result in control efficiencies of 83%. It is important that these control equipment be maintained and inspected on a regular basis to ensure that the expected control efficiencies are met.

The control efficiency of pure water suppression can be estimated based on the US-EPA emission factor which relates material moisture content to control efficiency. This relationship is illustrated in Figure 10-3; from the relationship between moisture content and dust control efficiency it is apparent that by doubling the moisture content of the material an emission reduction of 62% could be achieved. Chemicals mixed into the water will not just save on water consumption but also improve the control efficiency of the application even further. It is recommended that a target control efficiency of 70% be achieved by increasing the material moisture 2.4 fold (136%).

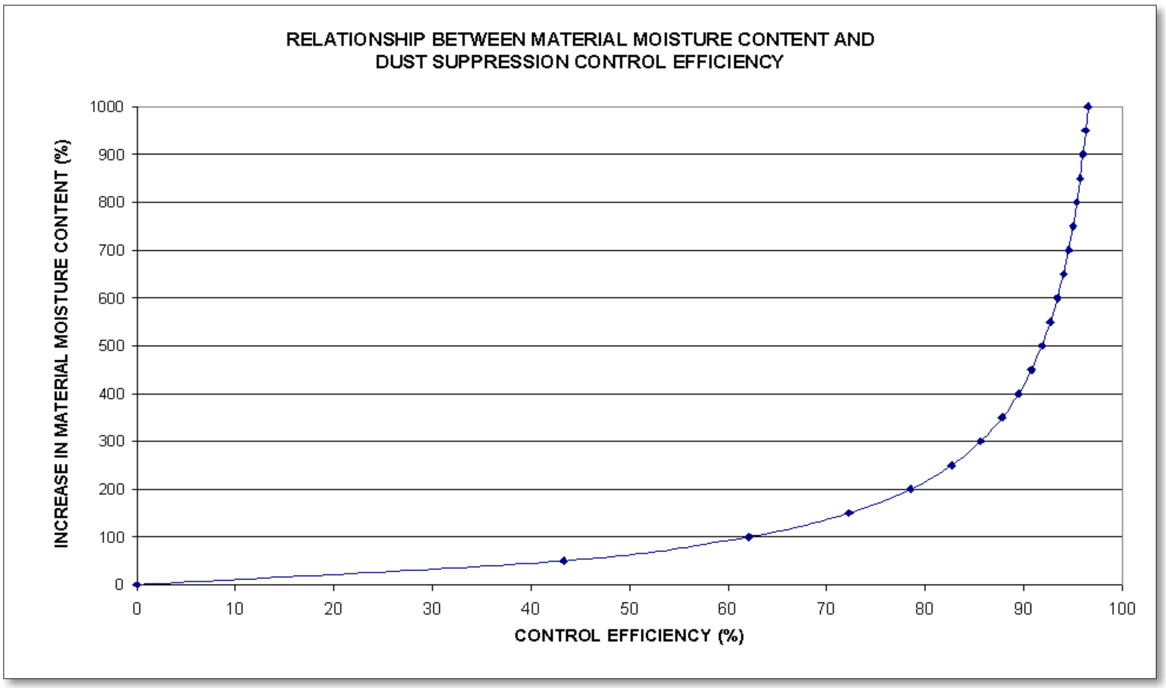

Figure 10-3: Relationship between moisture content and dust control efficiencies

Control efficiencies from the application of liquid spray systems at conveyor transfer points have *in practice* been reported to be in the range of 42% to 75%. General engineering guidelines which have been shown to be effective in improving the control efficiency of liquid spray systems are as follows:

- Of the various nozzle types, the use of hollow cone nozzles tend to afford the greatest control for bulk materials handling applications whilst minimising clogging;
- Optimal droplet size for surface impaction and fine particle agglomeration is about 500µm; finer droplets are affected by drift and surface tension and appear to be less effective; and,
- Application of water sprays to the underside of conveyor belts has been noted by various studies to improve the efficiency of water suppression systems and belt-to-belt transfer points.

11 APPENDIX C: Emission Factors and Equations

11.1 Construction

Construction normally comprise a series of different operations including land clearing, topsoil removal, road grading, material loading and hauling, stockpiling, compaction, (etc.). Each of these operations has their own duration and potential for dust generation. It is anticipated that the extent of dust emissions would vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing meteorological conditions. For the current project it is assumed that construction will occur only for two months.

It is not anticipated that the various construction activities will result in higher off-site impacts than the operational phase activities. The temporary nature of the construction activities, and the likelihood that these activities will be localised and for small areas at a time, will reduce the potential for significant off-site impacts.

Emissions from the construction activities were estimated on an area wide basis since no detailed construction schedule is available at this stage. This approach estimates construction emissions for the entire affected area without regard to the actual plans of the individual construction project. In the quantification of releases from the construction phase, use was made of emission factors published by the US.EPA (EPA, 1996). The approximate emission factors for construction activity operations are given as:

$$E_{TSP} = 2.69 \text{ Mg/hectare/month of activity}$$

This emission factor is most applicable to construction operations with (i) medium activity levels, (ii) moderate silt contents, and (iii) semi-arid climates and applies to TSP. Thus, it will result in conservatively high estimates when applied to PM_{10}. Also, because the derivation of the factor assumes that construction activity occurs 30 days per month, it is regarded as conservatively high for TSP as well (EPA, 1995). The emission factor does not provide an indication of which type of activity during construction would result in the highest impacts thus not providing information to develop an effective dust control plan. For example, secondary dust sources during construction might be far more significant than the actual on-site construction operations. Such secondary sources may include vehicle activity on off-site roads, quarry operations and stockpiles located away from the actual site (EPA, 1996).

According to the Australian Environmental Protection Agency on recommended separation distances from various activities, a buffer zone of 300 m from the nearest sensitive receptor is required when extractive-type materials handling activities occur (AEPA, 2007).

11.2 Scrapers

Scrapers are used to remove the remaining soil after site clearing and before drilling. Fugitive dust is released when the blades of the machine collide with the surface and the material is pushed to the sides. The emission factors utilised for this process follows:

EF_{PM10} =0.029 kg/t

EF_{TSP} =0.0073 kg/t

11.3 Drilling

Drilling is used to insert explosives into the earth surface in preparation for blasting. There are specific number of holes drilled and varying equipments used depending on the mine. The following emission factors were used to quantify the emissions associated with drilling:

EF_{TSP} =0.59 kg/hole

EF_{PM10} =0.31 kg/hole

$EF_{PM2.5}$=.31 kg/hole

11.4 Blasting

The aim of blasting is to gain access to the coal beneath the surface or to loosen the coal itself. This can be done through the use of explosives which turn the surface and coal and causes dust to rise up causing a plume. The equations utilised in the assessment are as follows:

$EF_{TSP}=0.00022 \times A^{1.5}$

$EF_{PM10}=0.000114 \times A^{1.5}$

$EF_{PM2.5}= EF_{TSP} \times 0.03$

Where,

A = area blasted in m^2

11.5 Crushing

Both primary and secondary crushing is done at Elders Colliery with the objective of making the coal into finer particle before being processed. The resulting fugitive dust emissions were calculated using the following emission factors:

Primary crushing

EF_{TSP}=0.01 kg/t

EF_{PM10}=0.004 kg/t

Secondary crushing

EF_{TSP}=0.03 kg/t

EF_{PM10}=0.012 kg/t

11.6 Wind erosion

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining) (Shao, 2008).

Windblown dust generates from natural and anthropogenic sources. For wind erosion to occur, the wind speed needs to exceed a certain threshold, called the threshold velocity. This relates to gravity and the inter-particle cohesion that resists removal. Surface properties such as soil texture, soil moisture and vegetation cover influence the removal potential. Conversely, the friction velocity or wind shear at the surface, is related to atmospheric flow conditions and surface aerodynamic properties. Thus, for particles to become airborne, the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity (Shao, 2008).

Saltation and suspension are the two modes of airborne particles in the atmosphere. The former relates to larger sand particles that hop and can be deposited as the wind speed reduces or changes. Suspension refers to the finer dust particles that remain suspended in the atmosphere for longer and can disperse and be transported over large distances. It should be noted that wind erosion involves complex physics that is not yet fully understood (Shao, 2008).

Airshed has developed an in-house wind erosion model called ADDAS (Burger et al., 1997; Burger, 2010). This model, developed for specific use by Eskom in the quantification of fugitive emissions from its ash dumps, is based on the dust emission models proposed by Marticorena and Bergametti (1995) and more recently the one by Shao (2008). The model attempts to account for the variability in source erodibility through the parameterisation of the erosion threshold (based on the particle size distribution of the source) and the roughness length of the surface. In the quantification of wind erosion emissions, the model incorporates the calculation of two important parameters, viz. the threshold friction velocity of each particle size, and the vertically integrated horizontal dust flux, in the quantification of the vertical dust flux (i.e. the emission rate).

In the quantification of wind erodable emissions, the model incorporates the calculation of two important parameters, viz. the threshold friction velocity of each particle size, and the vertically integrated horizontal dust flux, in the quantification of the vertical dust flux (i.e. the emission rate). The equations used are as follows:

$$E_i = G_i 10^{(0.134C-6)} \tag{3}$$

where,

$$G_i = 0.261 \frac{\rho_a}{g} U_*^3 (1+R_i)(1-R_i^{\,2}) \tag{4}$$

$$R_i = \frac{U_{t*i}}{U_*} \tag{5}$$

and,

E_i	= Emission rate (size category i)
C	= clay content (%)
ρ_a	= air density
g	= gravitational acceleration
U_*	= frictional velocity
U_{t*i}	= threshold frictional velocity (size category i)

Dust mobilisation occurs only for wind velocities higher than a threshold value, and is not linearly dependent on the wind friction and velocity. The threshold friction velocity, defined as the minimum friction velocity required to initiate particle motion, is dependent on the size of the erodible particles and the effect of the wind shear stress on the surface. The threshold friction velocity decreases with a decrease in the particle diameter, for particles with diameters >60 µm. Particles with a diameter <60 µm result in increasingly high threshold friction velocities, due to the increasingly strong cohesion forces linking such particles to each other (Marticorena and Bergametti, 1995). The relationship between particle sizes ranging between 1 µm and 500 µm and threshold friction velocities (0.24 m/s to 3.5 m/s), estimated based on the equations proposed by Marticorena and Bergametti (1995), is illustrated in Figure 11-1.

The logarithmic wind speed profile may be used to estimate friction velocities from wind speed data recorded at a reference anemometer height of 10 m (EPA, 1995):

$$U^{*} = 0.053U_{10}^{+} \qquad (6)$$

(This equation assumes a typical roughness height of 0.5 cm for open terrain, and is restricted to large relatively flat piles or exposed areas with little penetration into the surface layer.)

Equivalent friction velocity can also be calculated using a re-arrangement of the logarithmic distribution of the wind speed profile in the surface boundary (EPA, 1995):

$$U^{*} = \frac{KU_{10}}{\ln\left(\frac{Z}{Z_0}\right)} \qquad (7)$$

where,

U^{*}	= friction velocity (m/s)
K	= von Karma’s constant (0.41)
Z	= wind speed height (in this case 10 m)
Z_0	= wind speed height (in this case 10 m)

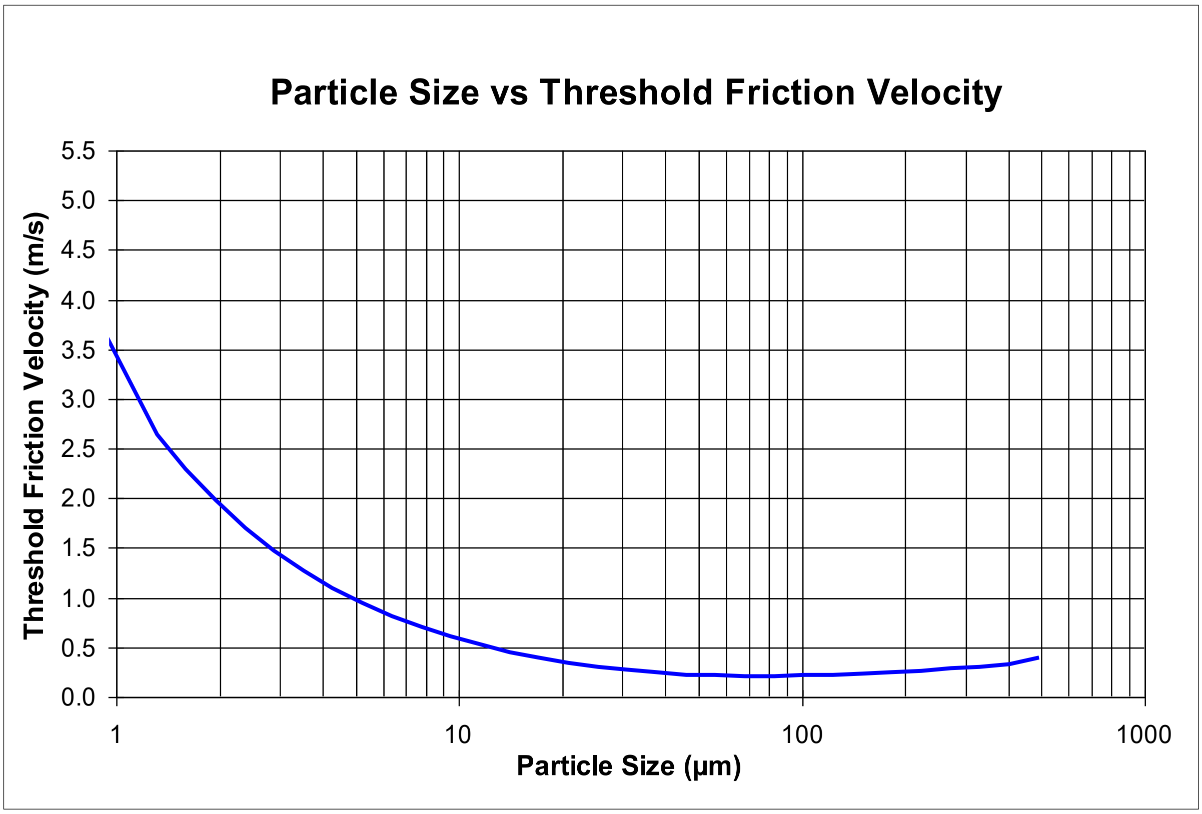

Figure 11-1: Relationship between particle sizes and threshold friction velocities using the calculation method proposed by Marticorena and Bergametti (1995).

The wind speed variation over the dump was based on the work of Cowherd et al. (1988). With the aid of physical modelling, the US EPA has shown that the frontal face of an elevated pile (i.e. windward side) is exposed to wind speeds of the same order as the approach wind speed at the top of the pile. The ratios of surface wind speed (u_s) to approach wind speed (u_r), derived from wind tunnel studies for two representative pile shapes, are indicated in Figure 11-2 (viz. a conical pile, and an oval pile with a flat top and 37° side slope. The contours of normalised surface wind speeds are indicated for the oval, flat top pile for various pile orientations to the prevailing direction of airflow. (The higher the ratio, the greater the wind exposure potential.)

Particle size distribution data were taken from similar operations. The particle size distribution was taken into account both in the estimation of emissions and in the simulation of resultant dustfall and ambient PM_{10} concentrations.

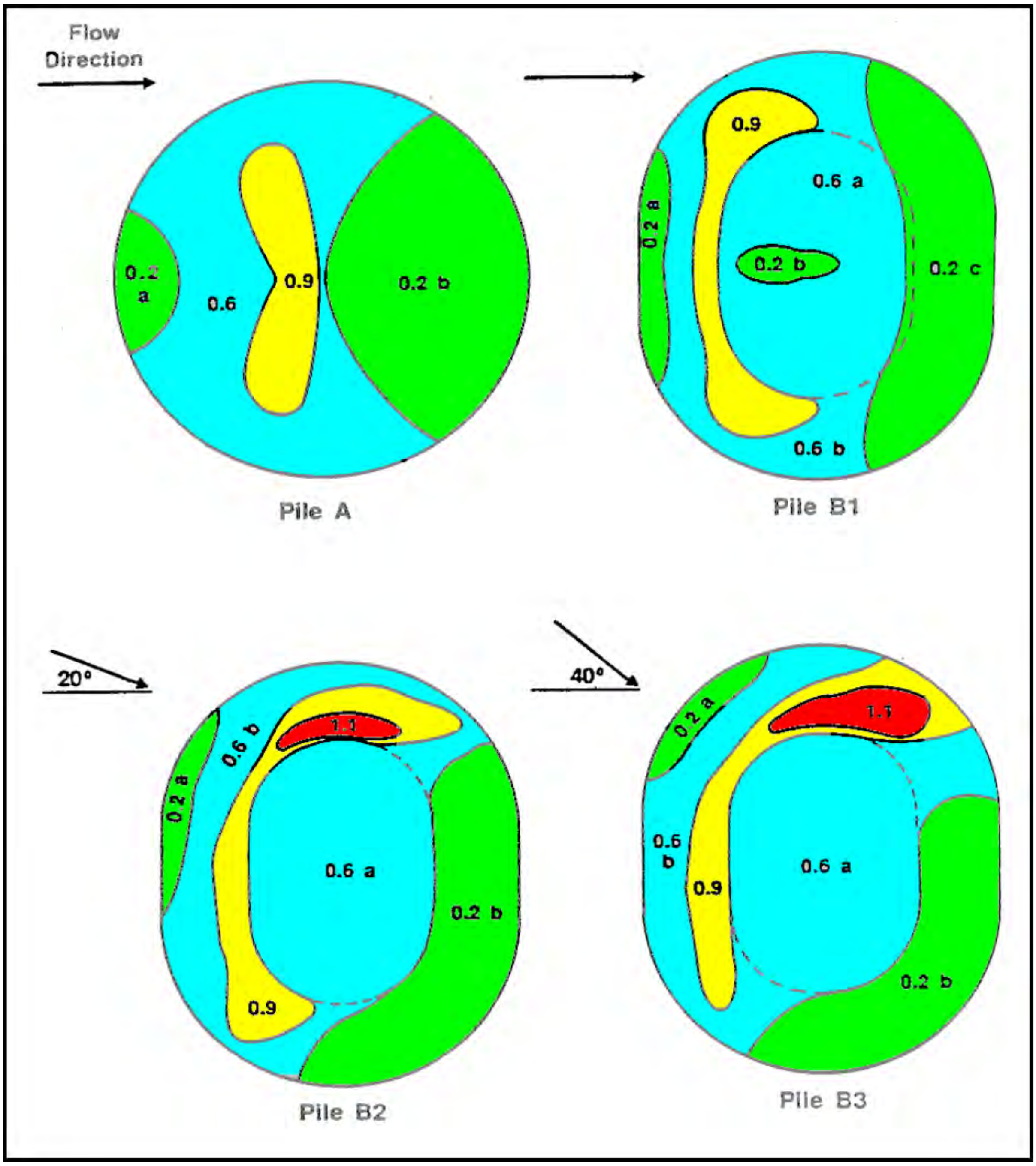

Figure 11-2: Contours of normalised surface wind speeds (i.e. surface wind speed/ approach wind speed) (EPA, 1996).

11.7 Material Handling

The quantity of dust that will be generated from materials handling operations will depend on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters such as the nature and volume of the material handled. Fine particulates are most readily disaggregated and released to the atmosphere during the material transfer process, as a result of exposure to strong winds. Increases in the moisture content of the material being transferred would decrease the potential for dust emission, since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles. The following equation was used to estimate emissions from material transfer operations:

EF_{TSP} =0.47*0.0016*(U/2.2)$^{1.3}$ /(M/2)$^{1.4}$

EF_{pm10} =0.35*0.0016*(U/2.2)$^{1.3}$ *(M/2)$^{1.4}$

Where,

U = mean wind speed in m/s

M = moisture content in % (by weight)

11.8 Vehicle entrainment on Unpaved Roads

Vehicles travelling on unpaved roads have to be a significant source of fugitive dust emissions. The force of the wheels of vehicles travelling on unpaved roads causes the pulverisation of surface material. Particles are lifted and dropped from the rotating wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The quantity of dust emissions from unpaved roads varies linearly with the volume of traffic.

The EPA Provides emission factors for unpaved roads (in g/vkt Vkt= vehicle kilometres travelled) the TSP is described as:

$$E_{TSP} = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b} \times 281.9$$

Where,

E_{TSP} = Emission Factor for TSP in g/VKT

K = Particle Size multiplier = 4.9

s = Silt content of the road material (%)

W = Average weight of vehicles (Mg)

a = 0.7

b = 0.45

281.9 is a conversion factor to bring calculation into metric units

PM_{10} is described as:

$$E_{PM10} = k\left(\frac{s}{12}\right)^{a}\left(\frac{W}{3}\right)^{b} \times 281.9$$

Where,

E_{PM10} = Emission Factor for TSP in g/VKT

K	= Particle Size multiplier = 1.5
s	= Silt content of the road material (%)
W	= Average weight of vehicles (Mg)
a	= 0.9
b	= 0.45
281.9	is a conversion factor to bring calculation into metric unit

11.9 Wind-blown dust from conveyor

The Elders Colliery conveyor is designed as such to ensure that limited dust should be generated from the conveying process. A picture of the conveyor is supplied in Figure 5 1 – the conveyor will have a roof and be covered on the western side. As a conservative approach, emissions from the conveyor were calculated assuming the conventional conveyor design with control efficiencies as provided for conveyors with an enclosed side and a roof.

The dust emissions from conventional conveyors are wind speed dependent with stronger wind speeds causing dust particles to be entrained by the wind. The degree of entrained dust also depends on the level of enclosure, i.e. roof cover and/or sides. The wind speed dependence has been based on the recommendations of Parrett (1992) where the dust emission rate (as grams per metre of conveyor) is equivalent to a constant multiplied by the difference between the friction velocity (u*) and the threshold friction velocity of the coal (u*t):

E=c(u^*-u_t^*)

An estimate for the constant (c) has been made on data reported by GHD/Oceanics (1975) for measured conveyor emissions at a wind speed of 10 m/s. The PM10 fraction has been estimated as 45% of the TSP.

As indicated, the approach is conservative since it assumes emissions from a conventional conveyor and based on emission factors provided for coal dust. A control efficiency of 65% for roofing and one side coverage of the conveyor was factored into the emissions calculation under the mitigated scenario. No mitigation measures were applied under the design-mitigated scenario.

Figure 11-3: Elders Colliery main overland conveyor

11.10 Ventilation shafts

Ventilation shafts can be treated as point sources when simulating operations at a mine; they release emissions from underground operations. Ventilation shaft emissions have not been included in this assessment. According to SRK personnel, "ventilation shafts are not planned on the surface. All foundations, ducting, motors and fans will be located within the box-cut".

Appendix G2: Soils and Land Capacity Specialist Study

Our Ref: SRK.EC2.S.15.01.00
Your Ref: Project No. 484436

Stonecap Trading 14 (Pty) Ltd

21st September 2015

SRK (South Africa) Pty Ltd

P.O. Box 55291

NORTHLANDS

Gauteng

2116

South Africa

Attention: Beth Candy/Suzanne Venter

Dear Beth/Suzanne,

Baseline Specialist Studies, Environmental Impact Assessment and Environmental Management Plan for the Anglo American Inyoni Coal Elders Colliery, Environmental Authorisation Project

Soils and Land Capability Aspects

Attached herewith is a draft of our specialist soils, land use and land capability report detailing the findings of the baseline investigation, the EIA and EMP being considered for the amendment to the Elders Colliery Mining Right Application by Anglo American Inyoni Coal (Order Q26020 - Underground Mining and Conveyer Line).

Please do not hesitate to contact us should you require any additional information in this regard.

Yours faithfully,

Earth Science Solutions (ESS) (Pty) Ltd

Ian Jones B.Sc. (Geol) Pr.Sci.Nat - EAPASA Certified

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Earth Science Solutions

DRAFT REPORT v1.1

ANGLO AMERICAN INYOSI COAL (PTY) LTD

ELDERS MINING RIGHT APPLICATION

UNDERGROUND MINING

&

CONVEYER ROUTE DEVELOPMENT

SPECIALIST

SOILS LAND USE AND LAND CAPABILITY STUDIES

BASELINE INVESTIGATION, EIA & EMP

Compiled For

srk consulting

Sustaining the Environment

September 2015

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Foreword

These Specialist Studies have been compiled in accordance with the requirements for the submission of an "Application for a Mining Right" under section 22 of the Minerals and Petroleum Resources Development Act (28) 2002 ("MPRDA") and the NEMA 2010 Regulations.

The Anglo American Inyosi Coal (Pty) Ltd, Elders Colliery Environmental Authorisation Project (Elders Project) is part of an on-going development and EIA being undertaken in consideration of the underground mining and beneficiation of the coal resource situated to the north of the town of Bethal in the Mpumalanga Province (South Africa).

The mining project requires that a number of specialist studies be undertaken as part of the application being made in terms of the NEMA and MPRDA legislation. The specialist soils, land capability and land use studies are undertaken in support of the larger EIA and EMP being undertaken by SRK Consulting (SA) (Lead Consultants).

The Minerals and Petroleum Resources Development Act (28) 2002 (MPRDA) specifies various requirements for the environmental scoping of any project. These include both the physical as well as the social and economic aspects. This document covers three of the physical aspects, namely:

- The Pedological (Soils) Study;
- The Land Capability Rating' and
- The Pre Development Land Use Assessment

Declaration

This specialist report has been compiled in terms of Regulation 33.3 of the National Environmental Management Act 107/1998 (R. 385 of 2006), and forms part of the overall impact assessment, both as a standalone document and as supporting information to the overall impact assessment for the proposed development.

The specialist Pedological, Land Use and Land Capability studies where managed and signed off by Ian Jones (Pr. Sci. Nat 400040/08 and EAPASA Certified scientist), an Earth Scientist with 34 years of experience in this field of expertise.

I declare that both, Ian Jones, and Earth Science Solutions (Pty) Ltd, are totally independent in this process, and have no vested interest in the project.

The objectives of the study were to:

- Provide a permanent record of the present soil resources in the area that are potentially going to be affected by the proposed development – Pre mining environment,
- Assess the nature of the site in relation to the overall environment and its present and proposed utilisation, and determine the capability of the land in terms of agricultural utilisation, and
- Provide a base plan from which long-term ecological and environmental decisions can be made, impacts of mining can be determined, and mitigation and rehabilitation management plans can be formulated.

The nationally recognised Taxonomic Soil Classification System and Chamber of Mines Land Capability Rating Systems were used as the basis for the soils and land capability investigations respectively.

<u>Signed</u>: 21st September 2015

Ian Jones B.Sc. (Geol) Pr.Sci.Nat 400040/08

Director

EXECUTIVE SUMMARY

The specialist soils, land capability and pre development land use studies in conjunction with the impact assessment and management planning have been prepared in terms of Section 22 of the Minerals and Petroleum Resource Development Act (Act 28 of 2002), and submitted as part of the motivation for the environmental authorisation required for the Elders Colliery Mining Project being considered by Anglo American Inyosi Coal Ltd (AAIC). In addition, a full and comprehensive EIA/EMP is to be compiled in terms of the NEMA regulations and requirements.

This report details the findings of the baseline investigations and the results of the assessment of the impacts expected for the proposed mining and beneficiation of the coal resource associated with the Elders coal deposit (Underground) and the associated support activities (primary crushing and screening and conveyencing of coal to Goedehoop), all considered part of the proposed development that is needed to meet the demands of the local energy market.

The mining and crushing of coal will potentially result in by-products and waste related contaminants (dirty water, dust etc.) that could impact the soils and affect the land use and its capability. This will need to be managed as part of the impact and management planning

In line with the minimum requirements and best practice guidelines, a comprehensive soil utilisation plan has been considered and submitted as part of the management plan.

The mining of the deeper coal seams by underground methods (bord and Pillar) will effect a relatively small footprint at surface, while the conveyencing of the raw materials and the primary crushing and screening of the coal will all occur at surface within the decline adit complex footprint. The underground mining will be accessed from surface via a decline shaft.

The potential impact footprint is relatively small in comparison with the size of the total area that is to be mined, and as long as the bord and pillar mining method is well engineered and the hanging wall remains stable (no collapse) the effects at surface will be limited and minor (Refer to Figure 1b – Mine Plan).

In terms of the legislation governing the development of new infrastructure and/or the change of a land use, the National Environmental Management Act (NEMA) has listed activities that require licensing. Mining and the impacting of land (change of land use from present state to mining) are considered listed activities.

To this end, a detailed environmental impact assessment (EIA) is considered necessary and all relevant information pertinent to the baseline conditions is essential to an understanding of the sensitivity of the natural resource that are going to be affected. In addition, the development of a management strategy to mitigate the potential impacts is required based on a comprehensive impact assessment.

The specialist soils and land capability information is tabled in terms of the S.A. Legislation and guidelines, with the principles for best practice being followed in terms of the IFC Performance Principles (a set of internationally accepted guidelines and principles for sustainable development).

Soil as a natural resource and one of the pillars of the eco system services is considered a sensitive medium as this is the stabilising material through which plants and animals sustain life, where water is stored and utilised, and where the rooting of vegetation is able to control erosion and the loss of the resource to the surface water bodies.

The development being proposed will impact a range of soil forms (deep sandy loams and sandy clay loams to shallow and in places wet based soils) and sites, some of which show sensitive to highly sensitive characteristics (wet based soils). The land capability ranges from land with a moderate to poor arable capability rating to moderate grazing land and a significant area of potentially wetland capability status.

Soil wetness and the presence of hydromorphic conditions are considered important aspects of a soil, the wetland characteristics of these environments considered as highly sensitive, and areas that need to be flagged as “No Go” or sites requiring special attention. A number of the activities being planned will impact directly on sensitive and in places highly sensitive sites, or are associated with the zone of influence that could affect these sites.

The land was historically used for winter grazing, with grasslands being the natural land/veld type. However, present farming activities have resulted in the cultivation of large tracts of land and converted the land use to commercial agriculture, inclusive of livestock grazing. These activities render the area a brownfields environment in terms of the baseline consideration and impact, the land use having been changed.

The mining activities and associated support infrastructure proposed (Decline Adit Complex and Conveyencing System) could, if not well managed have a negative impact on the surface area. This is especially true if the underground workings are not well engineered and managed (collapse and subsidence). However, all indications are from the geotechnical studies completed and with the current proposed safety factors in place that the bord and pillar methods will obviate any collapse of ground at surface.

The loss of the soil as a resource is of concern in any new development or area where it is going to be disturbed. The effects of mining activities will potential result in salinisation and/or contamination due to dirty water accumulations (lack of free draining and water management), sterilisation due to leaching of the soils, erosion by wind and/or water compaction due to uncontrolled access over unprotected soils, and the possibility of spillage and contamination by hydrocarbons, reagents and/or raw product/coal and carbonaceous shale. All of these effects will be detrimental to the capability of the land as well as changing the long term end land use.

However, with a well-structured and engineered mining plan and the implementation of the soil management plan, mitigation can be adequately instituted to acceptable levels of risk and a sustainable project realised.

GLOSSARY OF TERMS

Alluvium: Refers to detrital deposits resulting from the operation of modern streams and rivers.

Base status: A qualitative expression of base saturation. See base saturation **percentage.**

Buffer capacity: The ability of soil to resist an induced change in pH.

Calcareous: Containing calcium carbonate (calcrete).

Catena: A sequence of soils of similar age, derived from similar parent material, and occurring under similar macroclimatic conditions, but having different characteristics due to variation in relief and drainage.

Clast: An individual constituent, grain or fragment of a sediment or sedimentary rock produced by the physical disintegration of a larger rock mass.

Cohesion: The molecular force of attraction between similar substances. The capacity of sticking together. The cohesion of soil is that part of its shear strength which does not depend upon inter-particle friction. Attraction within a soil structural unit or through the whole soil in apedal soils.

Concretion: A nodule made up of concentric accretions.

Crumb: A soft, porous more or less rounded ped from one to five millimetres in diameter. See structure, soil.

Cutan: Cutans occur on the surfaces of peds or individual particles (sand grains, stones). They consist of material which is usually finer than, and that has an organisation different to the material that makes up the surface on which they occur. They originate through deposition, diffusion or stress. Synonymous with clayskin, clay film, argillan.

Desert Plain: The undulating topography outside of the major river valleys that is impacted by low rainfall (<25cm) and strong winds.

Denitrification: The biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen.

Erosion: The group of processes whereby soil or rock material is loosened or dissolved and removed from any part of the earth's surface.

Fertiliser: An organic or inorganic material, natural or synthetic, which can supply one or more of the nutrient elements essential for the growth and reproduction of plants.

Fine sand: (1) A soil separate consisting of particles 0,25-0,1mm in diameter.

(2) A soil texture class (see texture) with fine sand plus very fine sand (i.e. 0,25-0,05mm in diameter) more than 60% of the sand fraction.

Fine textured soils: Soils with a texture of sandy clay, silty clay or clay.

Hardpan: massive material enriched with and strongly cemented by sesquioxides, chiefly iron oxides (known as ferricrete, diagnostic hard plinthite, ironpan, ngubane, ouklip, laterite hardpan), silica (silcrete, dorbank) or lime (diagnostic hardpan carbonate-horizon, calcrete). Ortstein hardpans are cemented by iron oxides and organic matter.

Land capability: The ability of land to meet the needs of one or more uses under defined conditions of management.

Land type: (1) A class of land with specified characteristics. (2) In South Africa it has been used as a map unit denoting land, mapable at 1:250,000 scale, over which there is a marked uniformity of climate, terrain form and soil pattern.

Land use: The use to which land is put.

Mottling: A mottled or variegated pattern of colours is common in many soil horizons. It may be the result of various processes *inter alia* hydromorphy, illuviation, biological activity, and rock weathering in freely drained conditions (i.e. saprolite). It is described by noting (i) the colour of the matrix and colour or colours of the principal mottles, and (ii) the pattern of the mottling.

The latter is given in terms of abundance (few, common 2 to 20% of the exposed surface, or many), size (fine, medium 5 to 15mm in diameter along the greatest dimension, or coarse), contrast (faint, distinct or prominent), form (circular, elongated-vesicular, or streaky) and the nature of the boundaries of the mottles (sharp, clear or diffuse); of these, abundance, size and contrast are the most important.

Nodule: Bodies of various shapes, sizes and colour that have been hardened to a greater or lesser extent by chemical compounds such as lime, sesquioxides, animal excreta and silica. These may be described in terms of kind (durinodes, gypsum, insect casts, ortstein, iron, manganese, lime, lime-silica, plinthite, salts), abundance (few, less than 20% by volume percentage; common, 20 – 50%; many, more than 50%), hardness (soft, hard meaning barely crushable between thumb and forefinger, indurated) and size (threadlike, fine, medium 2 – 5mm in diameter, coarse).

Overburden: A material which overlies another material difference in a specified respect, but mainly referred to in this document as materials overlying weathered rock.

Ped: Individual natural soil aggregate (e.g. block, prism) as contrasted with a clod produced by artificial disturbance.

Pedocutanic,

Diagnostic

B-horizon: The concept embraces B-horizons that have become

enriched in clay, presumably by illuviation (an important pedogenic process which involves downward movement of fine materials by, and deposition from, water to give rise to cutanic character) and that have developed moderate or strong blocky structure. In the case of a red pedocutanic B-horizon, the transition to the overlying A-horizon is clear or abrupt.

Pedology: The branch of soil science that treats soils as natural phenomena, including their morphological, physical, chemical, mineralogical and biological properties, their genesis, their classification and their geographical distribution.

Slickensides: In soils, these are polished or grooved surfaces within the soil resulting from part of the soil mass sliding against adjacent material along a plane which defines the extent of the slickensides. They occur in clayey materials with a high smectite content.

Sodic soil: Soil with a low soluble salt content and a high exchangeable sodium percentage (usually EST > 15).

Swelling clay: Clay minerals such as the smectites that exhibit interlayer swelling when wetted, or clayey soils which, on account of the presence of swelling clay minerals, swell when wetted and shrink with cracking when dried. The latter are also known as heaving soils.

Texture, soil: The relative proportions of the various size separates in the soil as described by the classes of soil texture shown in the soil texture chart (see diagram on next page).

The pure sand, sand, loamy sand, sandy loam and sandy clay loam classes are further subdivided (see diagram) according to the relative percentages of the coarse, medium and fine sand subseparates.

Vertic, diagnostic

A-horizon: A-horizons that have both, high clay content and a predominance of smectitic clay minerals possess the capacity to shrink and swell markedly in response to moisture changes. Such expansive materials have a characteristic appearance: structure is strongly developed, ped faces are shiny, and consistence is highly plastic when moist and sticky when wet.

List of Abbreviations Used

%	Percent
A.W.C.	Available Water Capacity
Al	Aluminum
C.E.C.	Cation Exchange Capacity
Ca	Calcium
Cu	Copper
E.R.D	Estimated Rooting Depth
F.A.M.	Freely Available Moisture
Fe	Iron
g	Grams
ha	Hectare
K	Potassium
kg	Kilograms
km	kilometers
m	Meters
me	Milli-equivalents
mg	milligrams
Mg	Magnesium
mm	millimeters
mm/hr	millimeters per hour
mm/m	millimeters per meter
Mn	Manganese
N	Nitrogen
Na	Sodium
Org. Mat.	Organic Matter
P	Phosphorus
S	Sulphur
S. A.	South Africa
S.A.R.	Sodium Absorption Ratio
T.A.M.	Total Available Moisture (equivalent to T.A.W.C)
T.A.W.C	Total Available Water Capacity (Equivalent to TAM)
ToR	Terms of Reference
Zn	Zinc

1. INTRODUCTION AND PHYSIOGRAPHY

1.1 Introduction

The AAIC Elders Colliery (AAIC-EP) – Underground Mining Project being proposed is a greenfields mining project, albeit that a significant amount of exploration has been completed with the resultant impacts associated, while the effect of commercial farming renders much of the area of a "brownfield" nature in terms of the existing development and impacts that the cultivation and grazing of livestock has had on the soils and land capability. In addition, some existing mining and its associated activities noted in close proximity to the Elders area will potentially have impacts along their common boundaries.

The effects of these developments and activities are evident, with both erosion and compaction showing impacts on the soil resource and the capability of the land within the area of study. Approximately 80% of the study area has been altered by the present farming activities, and only small areas of unaffected (original grassland status) land still exist.

Anglo American Inyosi Coal currently hold a prospecting right to the project area, and are in the process of applying for a mining license for the proposed underground mining operation. The process proposed involves the mining of coal by mechanised underground bord and pillar mining, primary crushing and screening of the raw product and the transportation of the product using a new and dedicated conveyer line to Block 20 from where an existing conveyer conveys the coal to the Goedehoop Beneficiation Plant (existing infrastructure).

The support infrastructure for the underground mining will include the decline adit complex (inclusive of a boxcut, decline adit and ventilation ducts, crushing and screening equipment, administration and offices), an access road, a new and dedicated conveyencing system, workshops, temporary stockpiles for the RoM coal (cyclone's) as well as laydown areas for the storage/stockpiling of soil and soft overburden materials located close to the position of re-use.

There will be limited domestic and hazardous waste, sewage and water treatment plant waste, as well as overburden and topsoil stockpiles. This is addressed separately.

The proposed mining and related/associated activities will result in a number of changes and potential negative impacts due to the disturbance of the surface features. These include the soils, which in turn will have an effect on the land use, land capability and its functionality.

In an attempt at quantifying the potential impacts that might result, and in order to meaningfully develop a management plan that can mitigate the effects of the planned activities, it is imperative that an understanding of the pre development aspects and baseline conditions are understood and documented.

Failure to achieve a stable and free-draining environment will potentially result in the sterilisation of the soil resource and possible salinisation due to the concentration of salts. The impacts have been assessed and the management and mitigation (soil utilisation plan) tabled.

Of concern and importance to the earth sciences', is an understanding of the socio economics and possible effects on the eco-system services of the area that the mining activities will have, and the impacts on the land owners and land occupiers that make a living or sustain themselves from the soils. This includes the effects that might be felt off site due to the erosion of soil by wind and water.

One of the outcomes of the soil characterisation and classification exercise was the delineation and characterisation of dominant soils and the rating of the soil sensitivity in terms of the activities being proposed. These outcomes are considered meaningful tools and systems that can be used to identify areas that will require added inputs and or consideration in terms of legal requirements and/or licensing, and will assist in the engineering and long term planning of the operation.

The Department of Water Affairs and the Agricultural authorities require that soil wetness and the agricultural potential of the soils are assessed as part of any baseline assessment for a new development. During the pre-feasibility studies undertaken for the proposed Elders Project during 2005 and 2006, the concerns around mining of/through the wet lands associated with the Viskuile Rivier placed the project on hold (2007). The highly sensitive nature of wetlands and their inherent importance in the functionality of the overall ecological cycle (sensitivity) was thus noted as an important aspect of the baseline investigation, and is used in measuring the relative impact significance.

The sensitive nature of the wet based and classified wetland soils is of concern not only for the important contribution that these materials render to the storage and supply of clean water to the base flow in rivers, but also with regard to the geotechnical and ground engineering properties (structure, texture etc.) when considering the stripping, storage and re-instatement (rehabilitation) of the soils. These materials are inherently high in clay, often highly structured and difficult to work. Please note that the soils information must not be used for geotechnical aspects of founding materials or strength of materials etc. This requires a separate study and laboratory analysis.

The mining operations and areas within the proposed decline adit and underground mining complex footprint will impact on some of the hydromorphic environments identified (transition zone), with the conveyer route traversing at least three highly sensitive areas, and the Adit Complex infringing on both wetland and temporal/seasonal zone soils.

These issues have been dealt with in more detail as part of the impact assessment and management plan as contemplated in this document (Sections 5 and 6).

The sensitive sites (predominantly midslope seeps, wetlands associated with Pans and lower slope and stream/water ways and river crossings) have been dealt with in detailed discussions with the wetland scientist and hydrologist in a group workshop and as part of the final design planning. The inputs of the different specialist earth scientists added to the understanding and more in-depth comprehension of these issues, all of which will have an effect on the biodiversity and ecological status of the area.

This report has been compiled in line with the NEMA Guideline Document for Impact Assessment philosophy and Significance Rating System (Hacking Methodology), and the IFC Performance Principles as the basis for best practise.

The impact assessment aims to identify and quantify the environmental and social aspects of the proposed activities, to assess how the activities will affect the existing state, and link the aspects to variables that have been defined in terms of the baseline study.

1.2 Project Description

The proposed Elders Project is situated close to the town of Bethal on the Highveld region of the Mpumalanga Province in South Africa. The coal fields are part of the Highveld coalfields, a series of seams associated with the Karoo sediments (Refer to Figure 1-2 – Locality Plan).

AAIC proposes to develop a new incline shaft at the Elders Colliery, and to mine the No. 2 and No. 4 coal seams by means of bord and pillar underground mining methods

The project is considered a Greenfields Project in terms of mining, and is being planned primarily as an underground bord and pillar mine making use of continuous miners. The coal /raw product will be transported via a conveyor belt to Goedehoop's Block 20 Shaft from where the coal will be placed on an existing conveyor belt to the Goedehoop Colliery Plant, where the coal will be washed and screened. (Refer to Figure 1.3 – Mine Plan).

The coal deposit is located close to the northern margin of the Highveld Coalfield. The mining of the No. 2 and No. 4 seams will be via an incline shaft that will be used for personnel, material and coal clearance. An approximate 4.5 million tonnes per year of No. 2 and No. 4 seam coal are required to be transported annually from 2016 to 2036 from the Elders coal reserve to the existing Goedehoop Plant.

Surface infrastructure such as shaft offices, change house, lamp room, workshops and pollution control services are planned. Preliminary shaft infrastructure includes:

•	Incline shaft and conveyor	Surface silo
•	Surface stockpile	Transfer conveyor (incline to stockpile)
•	Flood protection berm	Brake test ramp
•	Silt traps	Mine offices
•	Stone dust silo	Lamp room
•	Re-fueling bay	Consumer substation
•	Bulk water supply tank	Fire water pump station
•	Fire water storage tank	Mine access road
•	Water treatment plant	Guard house
•	Workshops	Cable repair workshop
•	Change house	Sewage treatment plant
•	Elevated water tank	Bus shelter
•	Visitors parking	Staff parking
•	Vent shaft access road	Truck lay by area
•	Existing R35 alignment	Access roads
•	Main substation access road	22KV outdoor road
•	Silo substation	Polluted water mini sub
•	Offices mini sub	Change house mini sub
•	Workshop mini sub	Water system mini sub
•	Fan substation	Mini-pit tip and crusher
•	Overland conveyor (to existing Block 20 conveyor)	

As part of the proposed Elders Colliery project, the adit decline and boxcut complex will include the overland conveyor belt from Elders Colliery to Block 20, approximately 10km in length and the crushing and screening plant. The conveyer servitude will be 36m wide and will include the conveyor belt, a pipeline, 4m wide service road and two 22kV single pole power lines.

1.3 Background Information

The size of the venture is considered to be medium to large in terms of the volumes of coal that are being planned for mining , but small in terms of the footprint of impact that the activities will have on the surface extent. The Life of Mine is stated as 20 years.

Mining by underground bord and pillar methods will reduce the impacts at surface to a minimum, with the required infrastructure being confined to a small footprint of support activities and services within the decline adit complex, a number of vertical ventilation shafts and the transportation of the coal via a dedicated conveyer. The footprint of this infrastructure (conveyer belt and service road) is linear and limited to a 32m wide servitude. The conveyer line infrastructure will be supported on plinths above the ground.

There are other mining activities as well as commercial farming activities within the zone of influence of the proposed development that will have an effect on the cumulative impacts. The additional impacts from the proposed Elders Project are likely to be confined to the present land use and its capability, with the soils being disturbed to differing degrees depending on the specific activity being proposed.

The geology that hosts the coal resource being targeted is typical of the South African coal fields that occur on the eastern Highveld. The coal planned for mining is associated with the sediments of the Vryheid Formation of the Ecca Group and are of lower Permian age.

The Vryheid Formation consists of alternating sandstones and shale's ranging between coarse and gritty sandstones to shale's with all the intermediate variations between the two extremes.

These sediments were deposited on an undulated pre–Karoo floor which had a significant influence on the nature, distribution and thickness of many of the sedimentary formations, including the coal seams.

A pre-Karoo ridge – the Smithfield ridge - forms the southern limit of the Coalfield. Post-Karoo erosion has removed large parts of the stratigraphic column, including substantial volumes of coal over wide areas in the project area.

The coal seams are mainly flat lying to gently undulating with a general southerly dip of about 1 in 100. The five classically recognized coal seams are numbered from the base up as No's 1,2,3,4 and 5 respectively and are contained within a 120m succession.

Anglo American Inyosi Coal through their Elders Project is planning an underground mining operation in order to optimize on the coal resource that underlie the study area. The bord and pillar method of underground mining has been proven to be successful in mining coal seams that occur a depth. Adequate pillar volume needs to be calculated and left in place as support to the hanging wall if the roof is to remain in tacked and the surface topography is not to be affected. The collapse of underground workings generally results in ponding of water at surface, which in turn reduces the capability of the land through soil salinisation and saturation.

The actions of open cast mining (no O/C to be undertaken in this project) disturb the surface features and alter the land capability for the duration of the operation (Life of Mine – LoM), albeit that the areas that are rehabilitated behind the mining (roll over method) can be utilised for similar activities if managed and mitigated correctly. This is not true for areas that are impacted by the collapse of underground workings, and it is very much more difficult, and an expensive problem to rectify the effects of ponding and the potential for infiltration of poor quality water from surface to the underlying aquifers.

The sustainability of any project requires that not only a profit is made in terms of the resource mined, but that there is sufficient return of the investment to rehabilitate the disturbed environment at closure. The soil utilisation plan proposed has been tailored to best achieve these end results in terms of the soils and land capability aspects of the project. However, in order to achieve these ends it is important that an understanding of the pre development conditions is obtained, both in terms of having an accurate record of what exists now, as well as forming the basis for the impact assessment.

The development of feasible mitigation measures will hinge on the baseline information and an understanding of the impacts that the activities will impose.

Apart from these issues being required in terms of the law, it is important that the potential loss of an important resource (soil and land use) is understood in terms of the sustainability equation and the concept of “No Net Loss”.

The baseline mapping and characterisation of the soils is the basis from which the impact and effects on the land capability and soils has been measured. These outcomes and findings will be used in the design of site specific management planning and mitigation measures for the soils and the end land use.

These plans include defining how the mitigation will reduce the intensity and probability of the impact occurring, and what is necessary to ensure that the prescriptive mitigation proposed is clear, site specific and practical.

In addition, and as part of the soil utilisation and management plan, a comprehensive monitoring system has been proposed and tabled.

The proposed Elders project is part of the strategic development required in terms of energy production in South Africa, and although this is a new development, it is part of the optimisation and extension to the life of the Goedehoop operation.

The lead consultants (SRK South Africa) contracted Earth Science Solutions (Pty) Ltd (ESS) to assist with the specialist soils, land use and land capability sections of the baseline studies, the assessment of impacts and the development of a soil utilisation and management plan that will aid in the minimisation and mitigation for the life of the mining venture and through to post closure (construction, operation and closure).

The soils, land use and land capability are just three of the specialist disciplines that have been considered important aspects of the physical environment, and which will be affected by the activities being proposed.

In the planning of any new development it is important that the impacts are understood prior to the initiation of the design and/or implementation of the project.

These environmental aspects are not least of all part of the information that is needed in this decision making, with an understanding of how the soils, land use and the land capability will be affected being just part of the overall sustainability equation that needs to be answered and balanced.

Figure 1-2a shows the location of the proposed Elders Project, while 1.2b indicates the extent of the proposed surface development that is planned (Mine/Development Plan) within the extent of the mining right area.

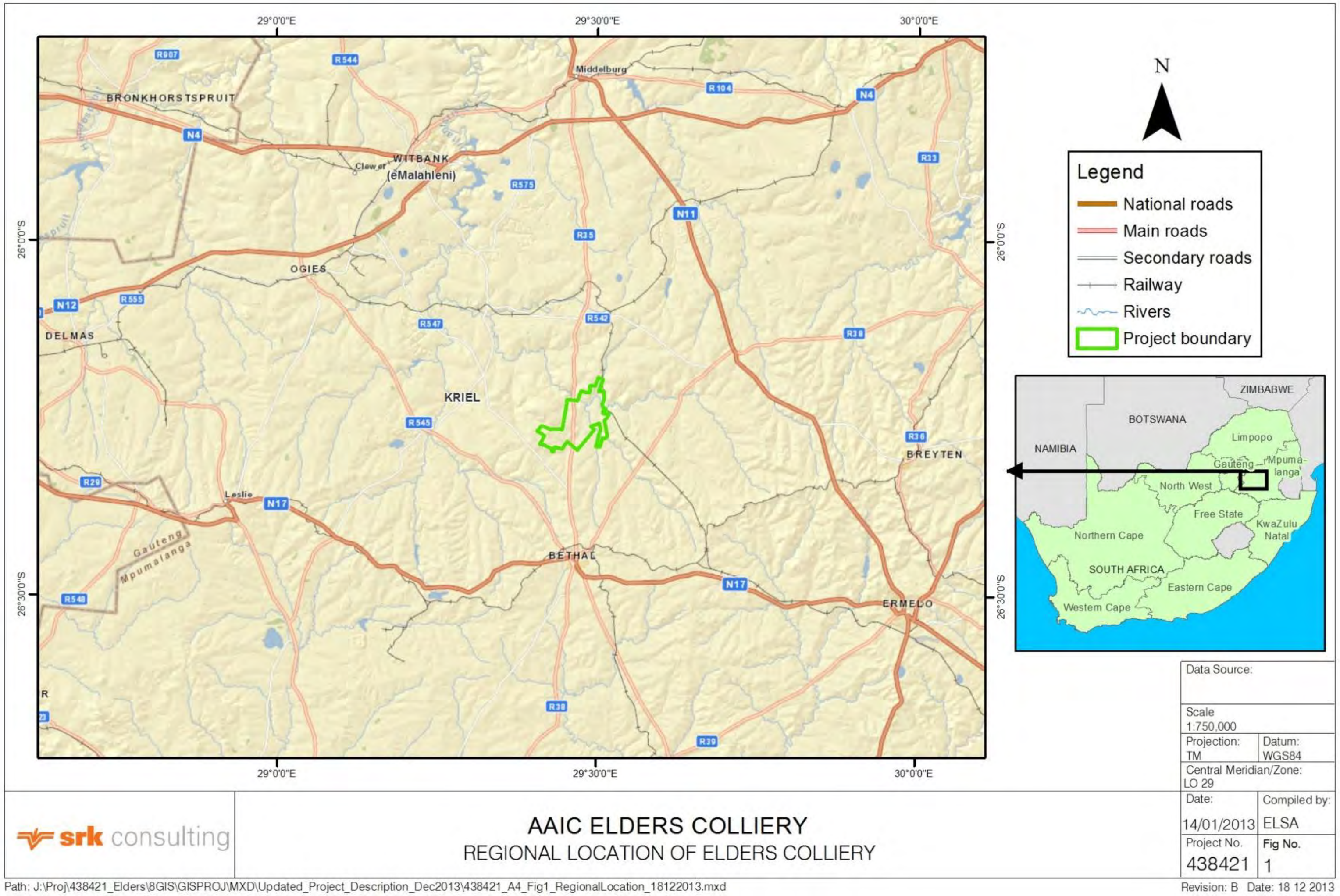

Figure 1-2a – Regional Locality Plan

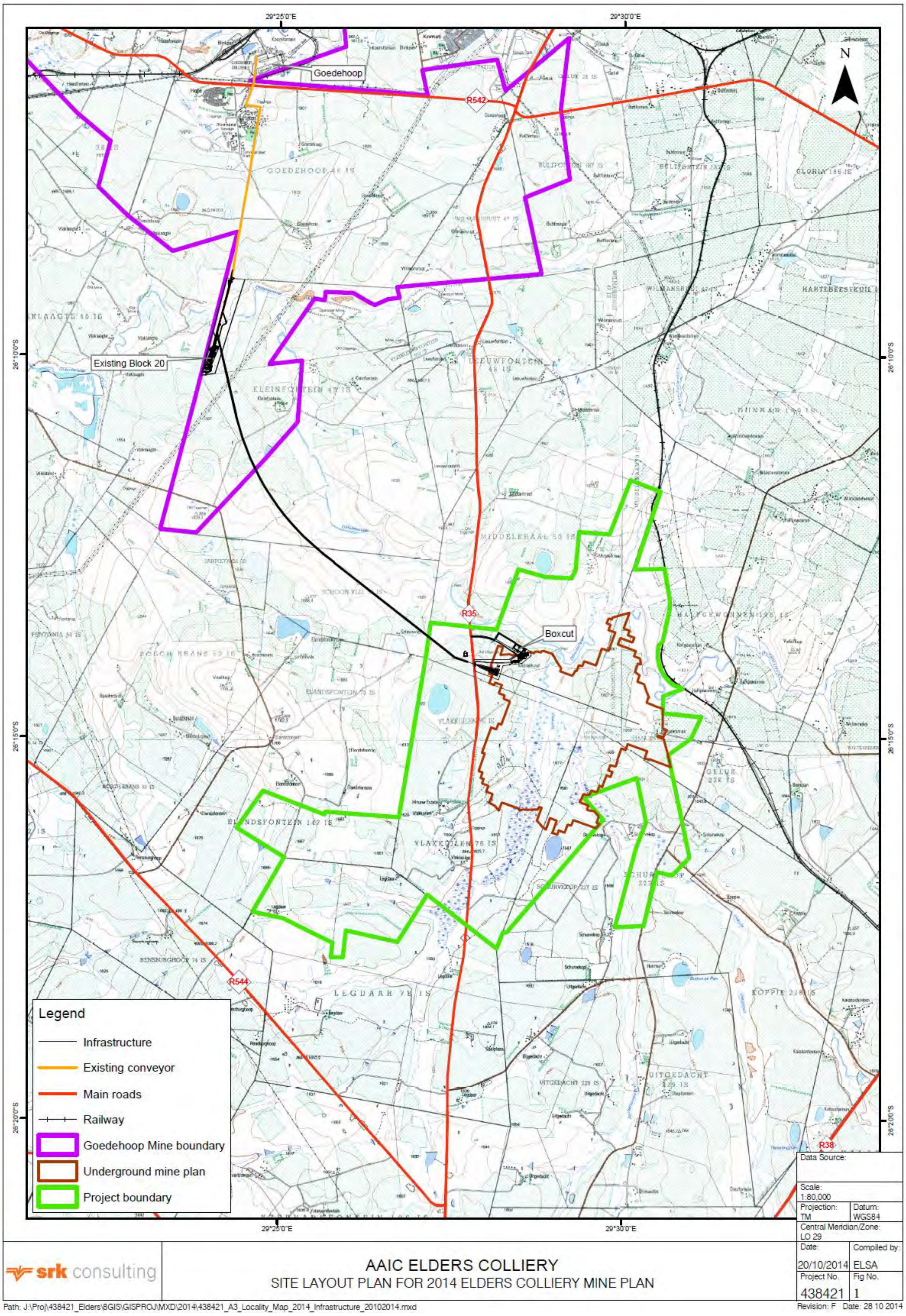

Figure 1-2b – Mining and Development Plan

The results of the soils and land capability study have been discussed in terms of “site sensitivity”, with the soils mapping having been simplified based on the dominant soil forms, their functionality and their associated land capability. In this way, the sustainability of the project can be measured in terms of the impacts and related mitigation, with sensitive areas being managed in a sound scientifically derived manner.

The baseline findings have been used to assess and rank the impacts that can be expected, and the management plan for mitigation is based on the activities tabled as part of the development plan and the findings of the impact assessment.

A comprehensive soil utilisation plan is tabled as part of the Environmental Management Planning and describes how the soils should be managed if the impacts are to be minimised.

The principle or concept of “No Net Loss” (NNL) has been tabled as the ultimate aim in developing a project that is sustainable. However, the mining of coal by open cast methods and some of the activities that are being proposed for this project will definitely challenge the concept of No Net Loss.

The activities will potentially have a variable but negative impact on the natural resources for a significant period of time, and the present land uses (soils) and land capabilities will definitely be impacted and altered for at least the life of the proposed operations and possibly even beyond.

1.3 Methodology and Approach

An evaluation at a desktop level of the geomorphology of the area (topography, geology, geohydrology and hydrogeology) indicated that all of the specialist earth sciences would be necessary if a sustainable solution was to be found for the many aspects of change that could affect the area due to a project of this nature. These are but three of the specialist studies that have been earmarked as important to the development of the sustainability plan.

The relative coverage proposed for the soils, land use and land capability baseline studies was tailored so as to obtain sufficient scientifically derived information that a statistically reliable data set was assimilated that could be utilised in the assessment of impacts and the design of a meaningful management plan for mitigation and minimisation.

These studies are not intended, and must not be used for engineering designs other than the soil stripping and rehabilitation planning. Detailed geotechnical evaluations for materials sourcing and use are essential for any engineering purposes and have been assessed and detailed as part of the Geotechnical Design undertaken by Saxum Mining (AAC 1306-519 – d/d December 2013).

The soil, land use and land capability specialist studies have been tailored to the site specifics, and developed as the basis for the characterisation and classification of the soils and the rating of the land capability. The mine plan has been used as the basis for the activities being planned.

These norms are based on a specific set of principles as set down in the “Taxonomic Soil Classification, a system designed for South Africa” (described in detail later), but of relevance to many of the Southern African regions as well. These norms are consistent with the NEMA Regulations, World Bank Standards and national nomenclature and are considered guideline principles by the Department of Agriculture, Forestry and Fisheries.

The resultant physical and chemical characteristics of the materials are used to assist characterising and classifying the soils and highlight the site specific sensitivities, all of which are then combined into dominant soils “groupings”.

These groups have similar physical and chemical characteristics and for which the possible impacts predicted will have similar effects, and for which the same mitigation and management measures can be apply for any given activity. This simplification of the soil forms can be used by the developer more easily and with better results as part of the planning and decision making tools (Not for design purposes). In addition, the interested or affected parties (Public and Authorities) can make informed and scientifically based decisions on the relative sustainability of the project for the soils and land capability using a more understandable explanation.

In better understanding and informing these studies on how sensitive or vulnerable a soil is, it was essential that the system being used is able to establish and measure in a repeatable manner, the aspects and determinants that contribute to a material being robust or sensitive.

The Soil Classification System and Land Capability Rating Systems supply the scientific basis and knowledge needed to determine the sensitivity or vulnerability of the different actions being proposed.

The soils physical and chemical properties and the way in which these react to the elements (wind, water erosion, heat, chemical reaction etc.), the sensitivity to having the vegetative cover removed, or their vulnerability to having the topsoil disturbed, and the reaction of the materials to chemical impacts (ease of being taken into solution), are all aspects that have been assessed in measuring sensitivity and ultimately vulnerability to development.

These measures are important when considering the impact assessment, and will dictate the mitigation and management measures (degree of input etc.) that will be required.

Using this philosophy the study area was investigated on a comprehensive reconnaissance grid base and an assessment and understanding of the baseline conditions for the soils and land capability obtained.

The level of study and intensity (spatial variance) of the observations made was guided by a number of practical variables. These included the geomorphology of the site (topography, ground roughness, attitude and climate) and knowledge of the proposed development (mine plan) and the actions that are intended.

Very little detailed soils information was available from any of the regional assessments, and although the Land Type Maps (Government) and Geological Maps were of help in understanding the proposed planning for the area and the high level understanding of the agricultural potential, land capability and associated earth sciences variables, the sensitivities and site specific variations and aspects that are important to the ecological balance of the area of study were lacking.

1.4 Legal Considerations

As part of understanding the consequences of the proposed development an knowledge of the national legislation that pertains to soils is important, and is a guide in understanding the permissible standards and limits that can be considered, albeit that there are no prescribed quantitative limits that can be quoted.

The most recent South African Environmental Legislation that needs to be considered for any new development with reference to management of soil includes:

- The Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal.
- The Bill of Rights (Chapter 2) states that environmental rights exist primarily to ensure good health and wellbeing, and secondarily to protect the environment through reasonable legislation, ensuring the prevention of the degradation of resources.
- The Environmental right is furthered in the National Environmental Management Act (No. 107 of 1998), which prescribes three principles, namely the precautionary principle, the "polluter pays" principle and the preventive principle.
- It is stated in the above-mentioned Act that the individual/group responsible for the degradation/pollution of natural resources is required to rehabilitate the polluted source.
- Soils and land capability are protected under the National Environmental Management Act 107 of 1998, the Minerals Act 28 of 2002 and the Conservation of Agricultural Resources Act 43 of 1983.
- The National Environmental Management Act 107 of 1998 requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimised and remedied.
- The Minerals Act 28 of 2002 requires an EMPR, in which the soils and land capability be described.
- The Conservation of Agriculture Resources Act 43 of 1983 requires the protection of land against soil erosion and the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and water courses are also addressed.

In addition to the South African legal compliance this proposed development has also been assessed in terms of the International Performance Standards as detailed by the International Finance Corporation (IFC).

The IFC has developed a series of Performance Standards to assist developers and potential clients in assessing the environmental and social risks associated with a project and assisting the client in identifying and defining roles and responsibilities regarding the management of risk.

Performance Standard 1 establishes the importance of:

- Integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects;
- Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and
- The client's management of social and environmental performance throughout the life of the project.

Performance Standards 2 through 8 establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate.

While all relevant social and environmental risks and potential impacts should be considered as part of the assessment, Performance Standards 2 through 8 describe potential social and environmental impacts that require particular attention in emerging markets. Where social or environmental impacts are anticipated, the client is required to manage them through its Social and Environmental Management System consistent with Performance Standard 1.

Of importance to this report are:

- The requirements to collect adequate baseline data;
- The requirements of an impact/risk assessment;
- The requirements of a management program;
- The requirements of a monitoring program; and most importantly;
- To apply relevant standards (either host country or other).

With regard to the application of relevant standards, there are no specific quantitative guidelines relating to soils and land use/capability, either locally or within the World Bank's or IFC's suite of Environmental Health and Safety Guidelines. However, the World Bank's Mining and Milling, guideline does state that project sponsors are required to prepare and implement an erosion and sediment control plan.

The plan should include measures appropriate to the situation to intercept, divert, or otherwise reduce the storm water runoff from exposed soil surfaces, any materials stockpiles, all tailings dams, and/or waste rock dumps.

Project sponsors are encouraged to integrate vegetative and non-vegetative soil stabilization measures in the erosion control plan.

Sediment control structures (e.g., detention/retention basins) should be installed to treat surface runoff prior to discharge to surface water bodies. All erosion control and sediment containment facilities must receive proper maintenance during their design life.

This will be included in the appropriate management plans where they are developed as part of the detailed design and as part of the project's life cycle.

1.5 Assumptions, Limitations and Uncertainties

It has been assumed that the total area of possible disturbance was included in the area of study, that the mining plan as tabled has documented and catered for all actions and activities that could potentially have an impact on the soils land use and land capability, and that the recommendations made, and impact ratings tabled will be re-assessed if the development plan changes.

Limitations to the accuracy of the pedological mapping (as recognised within the pedological industry) are accepted at between 50% (reconnaissance mapping) and 80% (detailed mapping), while the degree of certainty for the soils physical and chemical (analytical data) results has been based on **"composite"** samples taken from the dominant soil types mapped in the study area.

The area in question has been mapped on a comprehensive reconnaissance base, the degree and intensity of mapping and geochemical sampling being considered and measured based on the complexity of the soils noted in field during the field mapping, and the interplay of geomorphological aspects (ground roughness, slope, aspect and geology etc.).

2. DESCRIPTION OF THE PRE-CONSTRUCTION ENVIRONMENT

2.1 Data Collection and Gap Analysis

2.1.1 Review of Available Information

The specialist pedological, land use and land capability studies have been undertaken in phases, with the baseline assessment being undertaken during July 2015. The mapping was based on the most recent mining plan that was made available through the lead consultants (Underground Mining Plan 2015 – Decline Adit Complex).

The site specific nature of the proposed mining, and the spatial distribution of the resource renders the impact as site specific, and no alternatives were considered other than the no-mining option.

Site sensitivities and possible “No Go” considerations have been highlighted wherever pertinent, with specific regard being given to areas of wetness, shallow soil depths, soil erosion and compaction. When considering the effects that mining will have on the surface attributes and the soils and land capability in particular, these are the most likely aspects that will affect the loss of resource.

The site specific sensitivities have been highlighted and used in the delineation of environmentally sensitive “No Go” or “High Sensitivity” areas. These considerations are recognised as essential in the process of sustainable development and the obtaining of scientific information that is acceptable in answering the IAP’s and authorities concerns.

In line with the concept of continuous change, and the possibilities of additional activities or infrastructure to the mining plan being considered, it was important that the baseline study was comprehensive enough, and could be utilised by the developer for site selection and the development of a feasible plan for the mining venture.

The determination of a best alternative site plan for any/all facilities and associated linear structure, both existing or proposed is part of any sustainability plan and should be available to the design and planning team so that the best decisions can be considered.

Again it is emphasised that the soils study must not be used for engineering design purpose and strength of materials considerations. The soil physical properties are considered in terms of basic structure, texture and chemistry, and no engineering properties are implied or considered as part of these studies. The depths for soil stripping/removal and the workability of the soils can be inferred and utilised from the information documented.

The government survey maps (geological and topocadastral) and the regional descriptions were used in obtaining an understanding of the general lithological setting for the area, while discussions with the farming community helped in understanding the possible pedogenic processes that could be unique to the specific environment. However, the scale of this information is insufficient for the level of data needed for a project of this magnitude.

2.1.2 Field Assessments

A reconnaissance pedological study of the total area was undertaken using a comprehensive grid base/scale of mapping, while areas that are to be affected at surface (adit complex and conveyer route) have been assessed in greater detail, the underground mining footprint considered to impose a lesser risk of impact to surface conditions. This assumption has been tested by the geotechnical studies (Saxum Mining) and appropriate designs tabled for the bord and pillar requirements relative to the strength of the geological structures and materials. Collapse of ground at surface due to any subsidence of the underground workings will result in ponding, the degradation and potential for sterilisation of the soils, and the loss of land capability, something that is extremely difficult to mitigate.

The surface infrastructure and related activities will be subjected to the removal of all or a portion of the utilisable soil (Refer to the soil utilisation plan – section 6). These materials will need to be stockpiled and stored for use in the final void, and/or in the rehabilitation of the structures (roads, foundations, dumps, dams etc.) at closure.

As with the management of the underground mining methodology, the actions associated with adit complex and ventilation shafts will result in the alteration/modification of the surface topography and resultant changes in the landscape. These activities will if not well managed and engineered as part of the mine planning result in changes to the hydrological flow patterns on surface and potentially cause “ponding” at surface.

Ponding of surface water and the un-managed increased in infiltration of surface water into the vadose zone will have significant negative implications for the utilisation potential and land capability of the area. These are high negative impacts that are difficult to mend.

2.1.3 Field Methodology

In addition to the grid point observations, a representative selection of the soil forms mapped were sampled and analysed to determine their chemistry and physical attributes. The soil mapping of the decline adit complex was undertaken on a 1:10,000 scale (Refer to Figure 2.1.2b – Dominant Soils) orthophotographic base.

The majority of observations used to classify the soils were made using a hand operated bucket auger and Dutch (clay) auger.

Standard mapping procedures and field equipment were used throughout the survey.

The fieldwork comprised a number of site visits during which profiles of the soil were examined and observations made of the differing soil extremes. Relevant information relating to the climate, geology, wetlands and terrain morphology were also considered at this stage, and used in the classification of the soils of the area, while the variation in the natural vegetation was also used to help in the more accurate placing of the changes in soil form.

The pedological study was aimed at investigating/logging and classifying the soils within the area of potential disturbance.

Terrain information, topography and any other infield data of significance was also recorded, with the objective of identifying and classifying the area in terms of:

- The soil types to be disturbed/rehabilitated;
- The soil physical and chemical properties;
- The soil depth;
- The erodibility of the soils;
- Pre-construction soil utilisation potential, and
- The soil nutrient status.

2.1.4 Soil Profile Identification and Description Procedure

The identification and classification of soil profiles were carried out using the *Taxonomic Soil Classification, a System for South Africa (Mac Vicar et al, 2nd edition 1991*)

The Taxonomic Soil Classification System is in essence a very simple system that employs two main categories or levels of classes, an upper level or general level containing Soil Forms, and a lower, more specific level containing Soil Families.

Each of the soil Forms in the classification is a class at the upper level, defined by a unique vertical sequence of diagnostic horizons and materials.

All soil forms are subdivided into two or more families, which have in common the properties of the Form, but are differentiated within the Form on the basis of their defined properties.

In this way, standardised soil identification and communication is allowed by use of the names and numbers given to both Form and Family.

The procedure adopted in field when classifying the soil profiles is as follows:

- Demarcate master horizons;
- Identify applicable diagnostic horizons by visually noting the physical properties:
  - ✓ Depth (below surface)
  - ✓ Texture (Grain size, roundness etc.)
  - ✓ Structure (Controlling clay types)
  - ✓ Mottling (Alterations due to continued exposure to wetness)
  - ✓ Visible pores (Spacing and packing of peds)
  - ✓ Concretions (cohesion of minerals and/or peds)
  - ✓ Compaction (from surface)
- Determine from i) and ii) the appropriate Soil Form
- Establishing provisionally the most likely Soil Family

Table 2.1.4 Explanation - Arrangement of Master Horizons in Soil Profile

<table>
<tr><td rowspan="11">SOLUM</td><td rowspan="11">(Zone in which the soil forming processes are maximally expressed)</td><td colspan="5">Arrangement of master horizons</td><td>Comments on Layers</td></tr>
<tr><td rowspan="10">O - Organic</td><td rowspan="5">C - Regic Sands (C), Stratified Alluvium (C), Man - Made Soil Deposits (C).</td><td rowspan="2">A</td><td rowspan="2">Humic,Vertic, Melanic, Orthic</td><td rowspan="10">G</td><td>Loose leaves and organic debris, largely undecomposed</td></tr>
<tr><td>Organic debris, partially decomposed or matted</td></tr>
<tr><td rowspan="3">B</td><td rowspan="3">Red Apedel, Yellow-brown Apedel, Soft Plinthic, Hard Plinthic, Prismacutanic, Pedocutanic, Lithocutanic, Neocutanic, Neocarbonate, Podzol, Podzol with placic pan</td><td>Dark coloured due to admixture of humified organic matter with the mineral fraction</td></tr>
<tr><td>Light coloured mineral horizon</td></tr>
<tr><td>Transitional to B but more like A than B</td></tr>
<tr><td rowspan="4">C</td><td colspan="2" rowspan="4">Dorbank, Soft Carbonate horizon, Hard Carbonate Horizon, Saprolite, Unconsolidated materials without signs of wetness, Unconsolidated materials with signs of wetness, Unspecified materials with signs of wetness</td><td>Transitional to A but more like B than A</td></tr>
<tr><td>Maximum expression of B-horizon character</td></tr>
<tr><td>Transitional to C</td></tr>
<tr><td>Unconsolidated material</td></tr>
<tr><td colspan="3">R - Hard Rock</td><td>Hard rock</td></tr>
</table>

2.1.5 Sample Analysis

Sampling of representative soils was carried out and submitted for analysis.

Factors that were considered in the laboratory included:

- Determination of the pH
- Exchangeable bases
- C.E.C. (cation exchange capacity)
- Texture (% clay)
- Nutrient status and
- Any potential pollutants

The methods employed in the determination of the above variables are:

i) The Spectro Atomic Analyser for the determination of the basic elements

ii) The titration method for the determination of Organic Carbon contents, and

iii) The use of a density meter for the determination of the clay contents.

Analytical results are given for the extractable quantities available from the soil (Refer to Tables 2.1.7.1).

2.1.6 Description

Soil Characterisation

The soils encountered over the general area (underground and infrastructure) can be broadly categorised into four major groupings, with a number of dominant and sub dominant forms that have been grouped and that characterise the area of concern (Refer to Figure 2.1.6b – Total Area Inclusive of Conveyer and Mine Infrastructure, and 2.1.6c – Decline Adit Complex and associated infrastructure).

The major soil forms are closely associated with the lithologies from which the soils are derived (in-situ formation) as well as the topography and general geomorphology of the site, with the effects of slope and the attitude of the land forms affecting the pedogenetic processes and in turn the soil forms mapped.

The generally flat to slightly undulating topography has resulted in the in-situ formation of many of the soils, and a moderately predictable pedogenisis for the site, albeit that the retention of soil water within the vadose zone (lack of preferred horizontal flow) has resulted in the creation of an inhibiting layer (calcrete/ferricrete) within some of the soil profile and wetness features. This inhibiting layer or barrier to water movement enhances the inhibiting character to vertical flow within the profile, a factor that is considered important to the ecology and biodiversity of the area.

It is hypothesised that, the ferricrete layer forms an inhibiting or restrictive layer that holds water within the soil profile and vadose zone, a factor that often results in the development of moderately extensive areas of wet based soils. The restriction of water movement vertically through the soil profile compounds the process of iron precipitation and the development of the evaporites, something common to the semi-arid environment.

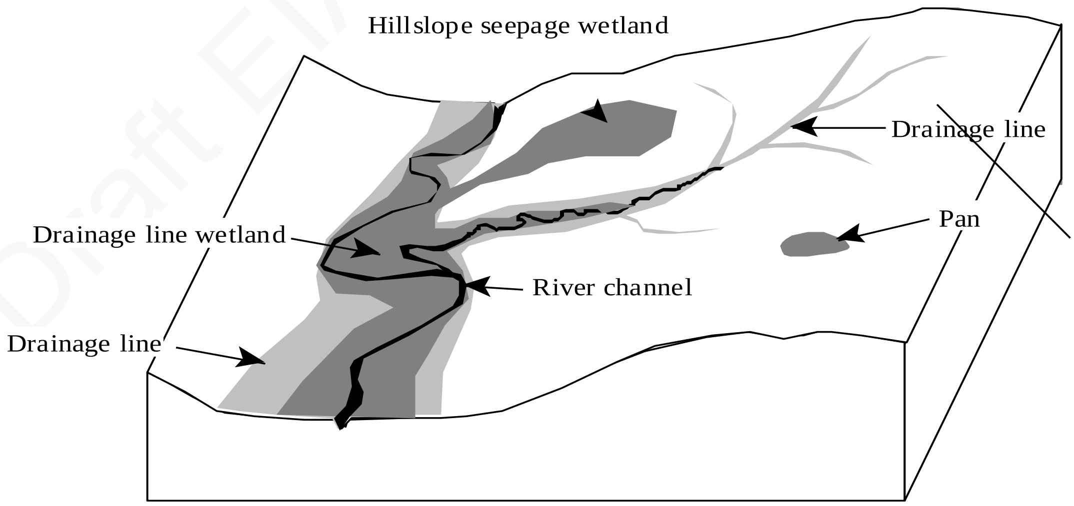

Figure 2.1.6a Schematic of the Wet Lands and their relation to Topography

The occurrence of zones or banks of ferricrete within the soil profile classify as "relic" land forms for the most part, albeit that significant areas of more recent laterite development were mapped in association with the large alluvial floodplains, waterways and the wetlands that make up many of the soils associated with the Vlakuile and Jouburtspruit.

The relic land forms are commonly associated with hillside seeps and "sponge zones" (Refer to Figure 2.1.6a), both of which are associated with possible wetland development. These ferricrete layers occasionally outcrop at surface as ouklip or hardpan ferricrete and are the basis for many of the pan structures found within the sedimentary profile and landscape of the coalfields in this region. These features are important to the ecological and biodiversity cycle, and are regarded as sensitive to highly sensitive features. In addition, and as part of these sensitive systems, are the "transition zones" that contribute (soils within the pan catchment) to the wetland catchment systems. These areas also need to be evaluated as part of the sites of high sensitivity.

The dominant soils classified are described in terms of their physical and chemical similarities and to some extent their topographic position and resultant pedogenisis, with their spatial distribution being of importance to the management recommendations (Refer to Figure 2.1.6b and 2.1.6c – Dominant Soils). The major soil groupings are described in more detail later in this section.

The soils mapped range from shallow sub-outcrop and outcrop of hard plinthite and parent materials (Sediments and intrusive dolerite) to moderately deep sandy loams and sandy clay loams, all of which are associated with either a rocky outcrop of sedimentary parent rock, or ferricrete/laterite "C" horizon at differing depths. The saprolitic horizons are generally quite thin, with soil occurring on hard bedrock in most instances mapped.

When considering the sensitivity of a wet based soil, the depth to the inhibiting layer and the amount of redox reaction present (noted in the degree of mottling and more importantly the greyness of the matrix soil) within the profile dictates the degree of wetness in terms of the "wetland delineation classification" and will have an effect on the ecological sensitivity of the site.

The shallow, to very shallow soil profiles are generally associated with an inhibiting layer at or close to surface, and as already alluded to, is the defining feature that controls the ability (or not) of water to flow vertically down and through the profile (restrictive layer).

The degree to which the plinthite layer has been cemented (friability of the ferricrete) will determine the effectiveness of the layer as a barrier to infiltration, while the depth of overlying soil will dictate how easily or difficult it is for the soil water to be accessed by the fauna and flora, and in the extreme case weather water is held at surface as a pan.

The friability of the ferricrete will also have an effect on the amount of clay mineralisation that the soil contains within this horizon, and will in turn influence the water holding characteristics of the soil and the degree of structure. In addition to the soil system of classification, a specific system has been developed for the describing and classification of ferricrete (Refer to Appendix 2). This has been used in better understanding the land forms that result from their presence.

In contrast, the deeper and more sandy profiles, although associated with a similar lithological system have distinctly differing pedogenetic processes that are associated with lower clay contents, better drainage of the soils and a deeper weathering profile.

As with any natural system, the transition from one system to another is often complex with multiple facets and variations over relatively small/short distances. However, in simplifying the trends mapped, the following major soil groupings pertain:

- The deeper and more sandy loams are considered ***High Potential*** materials and are distinguished by the better than average depth of relatively free draining soil to a greater depth (> 1,200mm). This group are recognisable by the subtleness of the mottling (water within the profile for less than 30% of the season), are noted at greater depths within the profile (>500mm) and the land capability is rated as moderate intensity grazing and/or arable depending on their production potential.

  These soils are generally significantly lower in clay than the associated wet based soils and more structured colluvial derived materials, have a distinctly weaker structure and are deeper and better drained (better permeability). The ability for water to permeate through these profiles is significantly better. The more sandy texture of this soil group renders them more easily worked and renders then of a lower sensitivity (Deep >500mm).

- In contrast, the shallower and more structured materials are considered to be more ***sensitive*** and will require greater management if disturbed. This group of ***shallower and more sensitive soils*** (< 500mm) are associated almost exclusively with the sub outcropping of the parent materials (Karoo Sediments) (geology) at surface, and although they constitute a relatively small percentage of the overall area of study they have a relatively large and important function in the sustainability of the overall biodiversity of the area.

- The third group of soils comprise those that are associated with the hard pan ferricrete layer and perched soil water. This group of soils have a set of distinctive characteristics and nature that are separated out due to their inherently much more difficult management characteristics. These soils are characterised by relatively much higher clay contents (often of a swelling nature), poor intake rates, poor drainage, generally poor liberation of soil water and a restricted depth – often due to the inhibiting barrier within the top 700mm of the soil profile. These soils are generally associated with a ***wet base***.

  These soils will be more difficult to work in the wet state, store and re-instate at closure. This group of soils comprise the pan like structures and waterholes.

  Groundwater is generally relatively deep (>15m) for the majority of the area of study and is reported (hydrogeologists) to have little to no influence on the soil water and water found within the vadose zone.

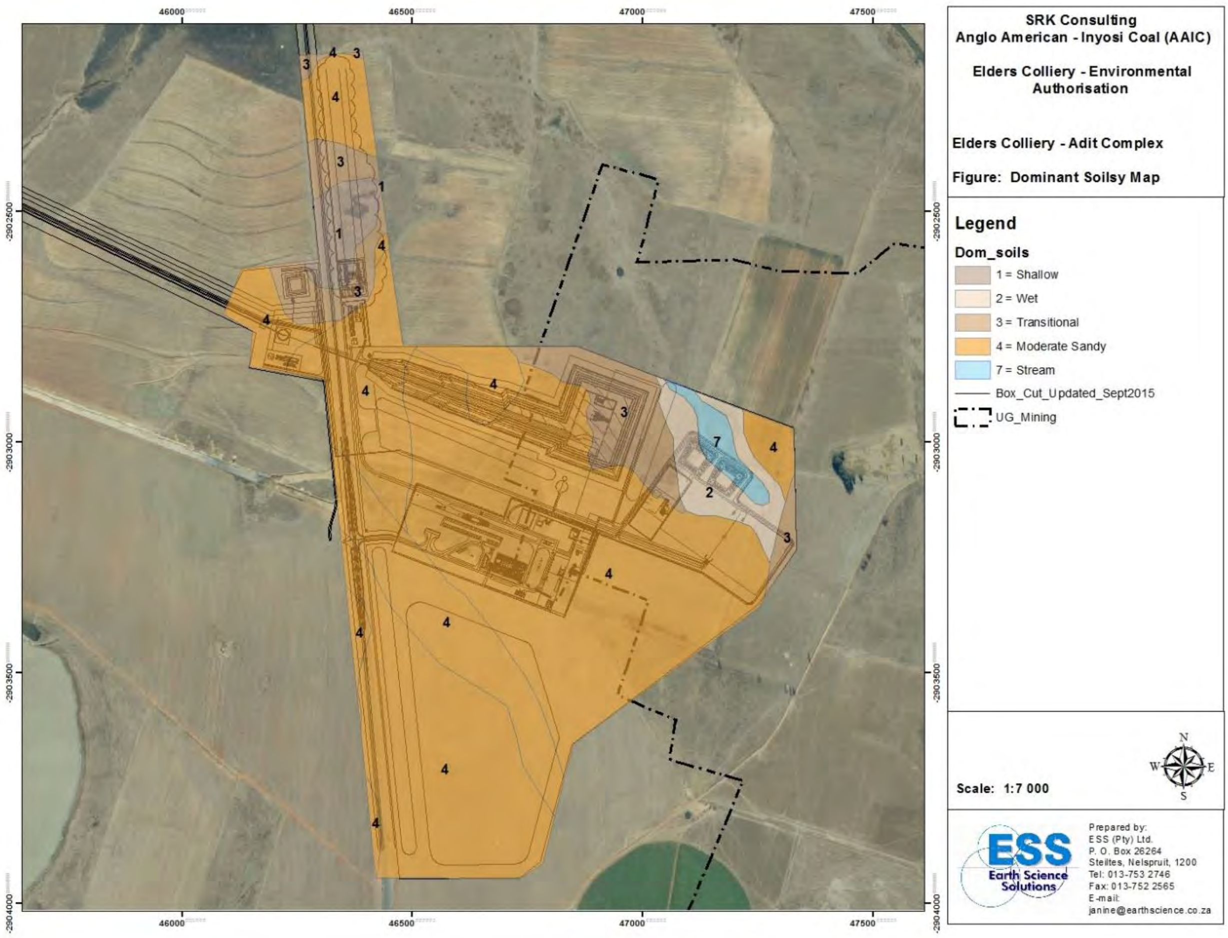

Figure 2.1.6b Dominant Soils Map – Decline Adit Complex and Associated Infrastructure

No perched aquifers (groundwater) are reported, albeit that a significant area of well-developed ferricrete was mapped within the vadose zone. The development of wet based soils and moist grassland environments are mapped in association with these soil forms.

Again, it is noted as important to the baseline study, that these soil groupings are moderately extensive in spatial area, and cover a moderately large and sensitive area in terms of the proposed development/mining plan.

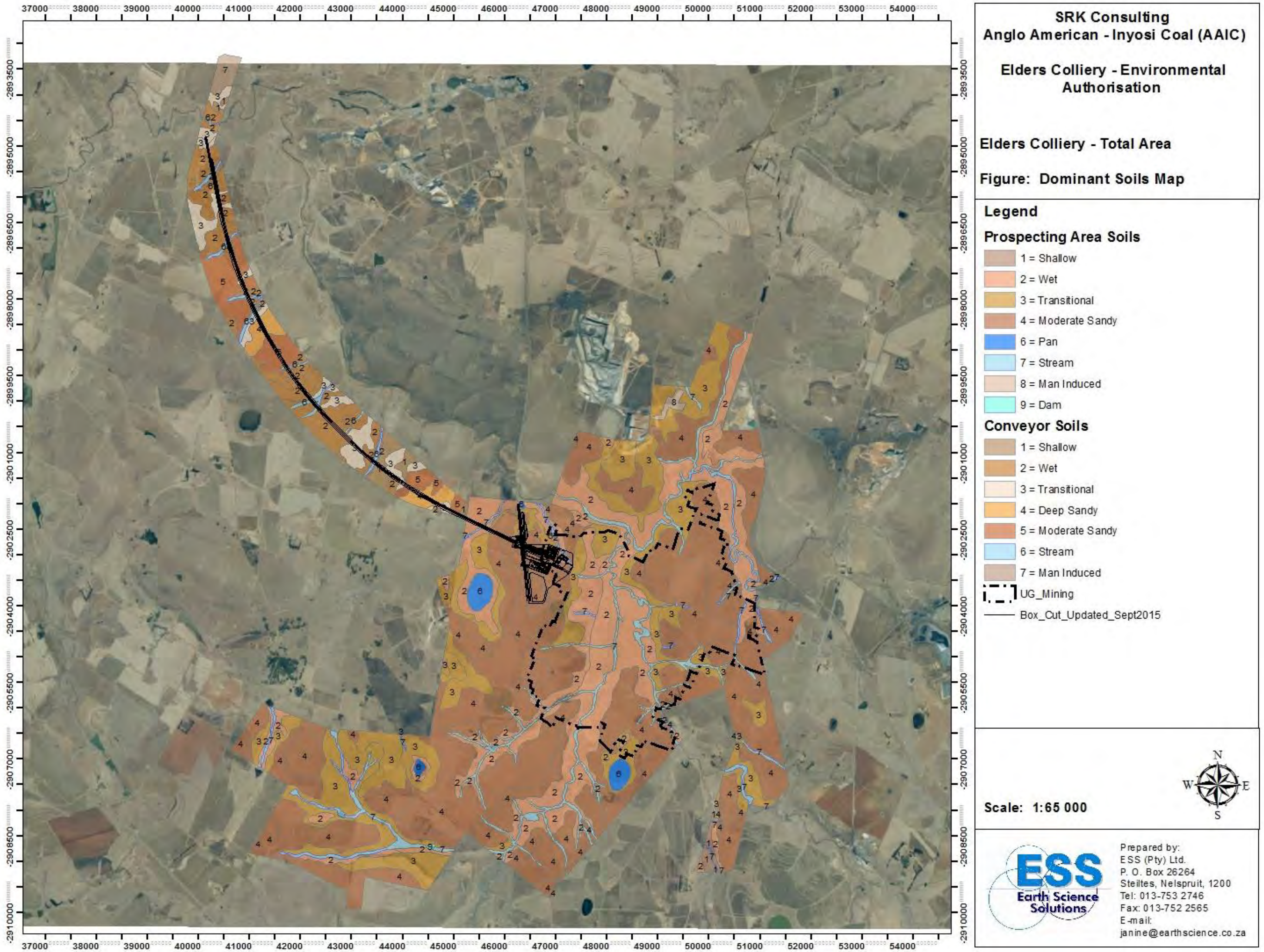

Figure 2.1.6c Dominant Soils Map – Total Area of Underground Mining and Conveyencing Route

In addition, but not separated from the wet based structured soils are the group of materials that reflect ***wetness*** (wet based soils) within the top 500mm. These soils are easily recognised by the mottled red and yellow colours on low chroma background colours within the near surface profile. These soils are regarded as ***highly sensitive*** zones that will require authorisation/permission (water use license will be needed) if they are to be impacted by development.

The concentrations of natural salts and stores of nutrients within these soils are a sensitive balance that will be influenced by the soil water balance (rainfall and evaporation). The ability of a soil to retain moisture and nutrients, will influence the sustainability of vegetative growth which in turn will affect the overall ecology biodiversity of an area.

These conditions and associated sensitivities to the bio-diversity cycle need to be understood if the sustainability equation is to be managed and mitigation engineered. Seep zones, wetlands and associated Pan structures are important contributors to the ecological cycle. The hard plinthic horizons form one extreme within the vadose zone where water is held within the shallow rooting zone out of the effects of evaporation, but available for plant and animal use.

Mapping of the study area has been captured in a GIS format and using the Taxonomic soil classification nomenclature and soil depth (decimetres), while soils with similar characteristics have been grouped and mapped as dominant groupings for ease of management.

2.1.7 Soil Chemical and Physical Characteristics

A suite of representative samples from the differing soil forms were taken and sent for analyses for both chemical and physical parameters Refer to Table 2.1.7.1. A number of samples were submitted for analysis, each sample containing a number of sub samples from a particular soil form.

A “composite sample” is considered representative of the Soil form rather than a specific point sampled.

2.1.7.1 Soil Chemical Characteristics

Sampling of the soils for nutrient status was confined where possible to areas of undisturbed land. However, some of the better soil exposure is associated with land that has, or could have been disturbed by farming activities. These results are representative indications of the pre-construction conditions, albeit that they are at best a reconnaissance representation of the baseline conditions and will need to be verified for particular sites as and when decommissioning and rehabilitation are considered.

The results of the laboratory analysis returned a variety of materials that range from very well sorted sandy loams with lower than average nutrient stores and moderate clay percentages (<20% - B2/1) to soils with a moderately stratified to weak blocky structure, sandy loam to clay loam texture and varying degrees of utilisable nutrient. The higher clay and more structured soils are generally confined to the lower slopes and depositional zone and associated with colluvial derived materials, while the wet based and wetland soils are confined to isolated midslope seepage areas and the alluvial flood plains.

The pH of the major soil forms ranges from acid at 5.8 to neutral and slightly alkaline at 7.5, a base status ranging from 3me% to 7me% (Eutrophic (slight leaching status) to Mesotrophic (moderate leaching status)), and nutrient levels reflecting generally high levels of calcium and sodium, but deficiencies in the levels of magnesium, potassium, phosphorous, copper, aluminium and zinc, with low stores of organic carbon matter.

The growth potential on soils with these nutrient characteristics is at best moderate to poor and additions of nutrient and compost are necessary if commercial returns are to be achieved from these soils. They are at best moderate to good grazing lands.

The more structured (moderate blocky) soils returned values that are indicative of the more iron rich materials and more basic lithologies. They are inherently high in iron and magnesium and low in potassium reserves, and returned lower levels of zinc and phosphorous.

Table 2.1.7.1 Analytical Results

Sample No.	EEP1	EEP2	EEP3	EEP4	EEP5	EEP6	EEP7	EEP8	EEP9	EEP10
Soil Form	Cv	Av	Gc	Pn	Ka	Hu	Cv/Gf	Kd	Dr	We
Constituents mg/kg										
pH	6.25	6	5.5	6.5	5.2	6.4	5	6.4	6.1	6.4
"S" Value	11.2	8.9	22.1	14.8	31	11	3.8	22	5.2	5.8
Ca Ratio	59	70	66	65	62	65	66	49	70	65
Mg Ratio	16	24	30	32	34	22	22	28	28	10
K Ratio	18	4	1	1	7	4	5	8	0.6	12
Na Ratio	0.2	0.3	0.2	1.6	1.1	0.5	0.3	0.3	1.4	0.2
P	111	22	8	6	17	10	11	15	5	82
Zn	7.2	2	1	1.1	1.4	1.5	1.4	1.4	1	1.6
Sand	45	42	34	46	18	52	45	21	58	44
Silt	39	36	38	46	22	30	43	27	34	35
Clay	16	22	28	8	60	18	12	52	8	21

Sample No.	EEP11	EEP12	EEP13	EEP14	EEP15	EEP16	EEP17	EEP18	EEP19	EEP20
Soil Form	Gc	Pn	We	Pn	Sd/Hu	Av	Gc	Ka/Kd	Rg	Hu
Constituents mg/kg										
pH	6.4	6.5	5.5	6	6	7	5.8	7.1	5.5	6.5
"S" Value	5.6	18.2	11.6	10.2	22.8	12.1	4.1	22.4	33	5.2
Ca Ratio	72	65	58	72	68	72	66	54	62	58
Mg Ratio	33	33	20	26	34	30	22	33	34	12
K Ratio	0.7	2	22	4	4	7	5	10	9	12
Na Ratio	1.8	1.5	0.4	0.3	0.4	0.8	0.1	0.4	0.8	0.2
P	5	6	111	22	12	14	10	18	20	80
Zn	0.9	1.1	7	2	2	1.6	1.1	1.7	1.1	1.6
Sand	48	62	44	36	42	45	50	21	16	42
Silt	40	30	34	46	26	35	38	24	26	34
Clay	12	8	22	18	32	20	12	55	58	24

Soil fertility

The soils mapped returned at best moderate levels of some of the essential nutrients required for plant growth with sufficient stores of calcium and magnesium. However, levels of Na, Zn, P, and K are generally lower than the optimum required. These conditions are important in better understanding the land capability ratings that are recorded, with the majority of the study area being rated as low intensity grazing land even where the soil depth rates the land as arable.

A significantly large area of the soils mapped have a lower than acceptable level of plant nutrition. These poor conditions for growth are further compounded by the low organic carbon (<1.0%).

There are no indications of any toxic elements that are likely to limit natural plant growth in the soils mapped within the study area

Nutrient Storage and Cation Exchange Capacity (CEC)

The potential for a soil to retain and supply nutrients can be assessed by measuring the cation exchange capacity (CEC) of the soils.

The inherently low organic carbon content is detrimental to the exchange mechanisms, as it is these elements which naturally provide exchange sites that serve as nutrient stores. The moderate clay contents will temper this situation somewhat with at best a moderate to low retention and supply of nutrients for plant growth.

Low CEC values are an indication of soils lacking organic matter and clay minerals. Typically a soil rich in humus will have a CEC of 300 me/100g (>30 me/%), while a soil low in organic matter and clay may have a CEC of 1-5 me/100g (<5 me/%).

Generally, the CEC values for the soils mapped in the area are moderate.

Soil organic matter

As already alluded to, the soils mapped are low in organic carbon. This factor coupled with the moderate to high clay contents for the majority of the soils mapped will adversely affect the erosion indices for the soils an issue that will require innovative planning and engineered solutions from an early stage in the project. Contamination of the receiving environment and the water bodies in particular by soil and sediment will seriously impact on the sustainability of the project. International best practice highlights the need for erosion control and management.

2.1.7.2 Soil Physical Characteristics

The majority of the soils mapped exhibit apedal to weak crumby structure, low to moderate clay content and a dystrophic leaching status. The texture comprises sandy to silty sands for the most part, with much finer silty loams and clay loams associated with the colluvial and alluvial derived materials associated with the lower slope and bottom land stream and river environs.

Of significance to this study, and a feature that is moderately common across the site where the soils are associated with the sedimentary host rocks (albeit that it often occurs below the 1.5m auger depth on the deeper soils) is the presence of a hard pan ferricrete (plinthite) layer within the soil profile.

The semi-arid climate (negative water balance) combined with the geochemistry of the host rock geology are conducive to the formation of evaporites, with the development of ferruginous layers or zones within the vadose zone.

The accumulation of concentrations of iron and manganese rich fluids in the soil water will, in the presence of high evaporation result in the precipitation of the salts and metals within the soil profile. Over time, this process results in the development of a restrictive or inhibiting iron/magnesium rich layer/zone (cementing of the concretions into a hard pan ferricrete or Ouklip layer).

The negative water balance is evidenced by the generally low rainfall of 700mm/year or less, and the high evaporation that averages 1,350mm/year. These are the driving mechanisms behind the ouklip or hard pan ferricrete mapped.

The degree of hardness of the evaporite is gradational, with soft plinthic horizons (very friable and easily *dug with a spade or shovel),* through hard plinthite soil *(varying in particle size from sand to gravel – but no cementation)* to nodular and hard pan ferricrete or hard plinthic *(cementation of iron and manganese into nodules)* that are not possible to free dig or brake with a shovel.

This classification is taken from - Petrological and Geochemical Classification of Laterites -*Yves Tardy, Jean-Lou, Novikoff and Claude Roquid,* and forms the basis for classify the hard pan ferricrete or lateritic portion of the soil horizon in terms of its workability (engineering properties) and storage sensitivities.

The soil classification system takes cognisance of ferricrete and has specific nomenclature for these occurrences (Refer to The South African Taxonomic Soil Classification – See list of references).

The variation in the consistency of the evaporite layer, its thickness and extent of influence across/under the site are all important to the concept of a restrictive horizon or barrier layer that is formed at the base of the soil profile and/or close to the soil surface. Where this horizon develops to a nodular form or harder (Nodular, Honeycomb and Hard Pan) the movement of water within the soil profile is restrict from vertical movement and is forced to move laterally or perch within the profile. It is this accumulation of soil water and the precipitation of the metals from the metal and salt rich water that adds progressively to the ferricrete layer over time.

Important to an understanding of the development of the ferricrete is the geological time they take to form and the presence of the specific soil and water chemistry under which the horizon forms. This situation will be very difficult to emulate or recreate if impacted or destroyed.

2.1.8 Soil Erosion and Compaction

Erodibility is defined as the vulnerability or susceptibility of a soil to erosion. It is a function of both the physical characteristics of a particular soil as well as the treatment of the soil and the topographic slope.

The resistance to, or ease of erosion of a soil is expressed by an erodibility factor ("K"), which is determined from soil texture/clay content, permeability, organic matter content and soil structure. The Soil Erodibility Nomograph (*Wischmeier et al,* 1971) was used to calculate the "K" value.

With the "K" value in hand, the index of erosion (I.O.E.) for a soil can then be determined by multiplying the "K" value by the "slope" measured as a percentage. Erosion problems may be experienced when the Index of Erosion (I.O.E) is greater than 2.

The majority of the soils mapped can be classified as having a moderate to high erodibility index in terms of their organic carbon content and texture (clay content), albeit that this rating is off-set and tempered by the undulating to flat terrain to an index of moderate or resistant.

However, the vulnerability of the "B" horizon to erosion once the topsoil and/or vegetation is removed must not be under estimated when working with or on these soils. These horizons (B2/1) are vulnerable and rate as medium to high when exposed.

The concerns around erosion and inter alia compaction, are directly related to the disturbance of the protective vegetation cover and topsoil that will be disturbed during any construction and operational phases of a mining venture. Once disturbed, the effects and actions of wind and water are increased.

Loss of soil (topsoil and subsoil) is extremely costly to any operation, and is generally only evident at closure or when rehabilitation operations are compromised, while the impact of sedimentation on the receiving environment and the streams, dams and rivers in particular is detrimental to the systems health and functionality.

Well planned management actions during the planning, construction and operational phases will save time and money in the long run, and will have an impact on the ability to successfully "close" an operation once completed. International guidelines for best practice and the IFC require that erosion is managed and that the receiving environment is protected.

2.2 Pre-Construction Land Capability

2.2.1 Data Collection

Based on a well-developed and scientifically founded baseline of information, the South African Chamber of Mines (1991) Land Capability Rating System in conjunction with the Canadian Land Inventory System has been used as the basis for the land capability study.

Table 2.2.1 Criteria for Pre-Construction Land Capability (S.A. Chamber of Mines 1991)

Criteria for Wetland

- Land with organic soils or supporting hygrophilous vegetation where soil and vegetation processes are water determined.

Criteria for Arable Land

- Land, which does not qualify as having wetland soils.
- The soil is readily permeable to a depth of 750mm.
- The soil has a pH value of between 4.0 and 8.4.
- The soil has a low salinity and SAR
- The soil has less than 10% (by volume) rocks or pedocrete fragments larger than 100mm in the upper 750mm.
- Has a slope (in %) and erodibility factor (“K”) such that their product is <2.0
- Occurs under a climate of crop yields that are at least equal to the current national average for these crops.

Criteria for Grazing Land

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

Criteria for Conservation of Land

- Land, which does not qualify as having wetland soils, arable land or grazing land, and as a result is regarded as requiring conservation practise/actions.

Using these systems, the land capability of the study area was classified into four distinctly different and recognisable classes, namely, wet land or lands with wet based soils, arable land, grazing land and wilderness or conservation land. The criteria for this classification are set out in Table 2.2.1.

2.2.2 Land Capability Distribution

The "land capability classification" as described above was used to characterise and classify the soil polygons or units of land identified during the pedological survey.

These combined with the geomorphological aspects (ground roughness, topography, climate etc.) of the site were then employed to rate the capability of the land in question.

The area to be disturbed by the open cast mining and surface infrastructure development comprises a range of land capability classes, with significant areas of friable and good grazing potential class soil, smaller but highly sensitive sites that returned wet based soils, and a significant area of highly structured and sensitive materials that occur within the planned development footprint. These colluvial derived soils are at best considered to have a low intensity grazing land potential or wilderness status. The underground workings are overlain by the full suite of soil sensitivities and land capability, with a significantly large spatial area of the highly sensitive wetland soil ratings associated with the rivers and associated transition zone wet based soils, sensitive to moderately sensitive sandy loams and sandy clay loams associated with the middle and upper midslope positions and the more sensitive to high sensitivity shallow soils associated with the ridge slopes and erosive environment.

Figure 2.2.2a and 2.2.2b illustrates the distribution of land capability classes across the Decline Adit Complex area and the underground mining and conveyer route areas respectively.

Arable Land

There are little to no grazing land potential soils associated with this area. Although some soil depths are reflective of a arable status (>750mm), the growth potential (nutrient status and soil water capabilities) and ability of these soils to return a cropping yield equal to or better than the national average is lacking. This is due mainly to the poor rainfall. These variables reflect the natural conditions, and do not include any man induced additives such as fertilizers or water.

Grazing Land

The classification of grazing land is generally confined to the shallower and transitional zones that are well drained. These soils are generally darker in colour, and are not always free draining to a depth of 750mm but are capable of sustaining palatable plant species on a sustainable basis, especially since only the subsoil's (at a depth of >500mm) are periodically wetted. In addition, there should be no rocks or pedocrete fragments in the upper horizons of this soil group. If present it will limit the land capability to wilderness land.

The majority of the study area classifies as low intensity grazing land or wilderness status.

Wilderness / Conservation Land

The shallow rocky areas and soils with a structure stronger than strong blocky (vertic etc.) are characteristically poorly rooted and support at best very low intensity grazing, or more realistically are of a Wilderness character and rating.

Wetland (Areas with wetland status soils)

Wetland areas in this document (soils and land capability) are defined in terms of the wetland delineation guidelines, which use both soil characteristics, the topography as well as floral and faunal criteria to define the domain limits (Separate Wetland Delineation has been undertaken). Only the soils are described here.

These zones (wetlands) are dominated by hydromorphic soils (wet based) that often show signs of structure, and have plant life (vegetation) that is associated with seasonal wetting or permanent wetting of the soil profile (separate study).

The wetland soils are generally characterised by dark grey to black (organic carbon) in the topsoil horizons and are often high in transported clays and show variegated signs of mottling on gleyed backgrounds (pale grey colours) in the subsoil's. Wetland soils occur within the zone of soil water influence.

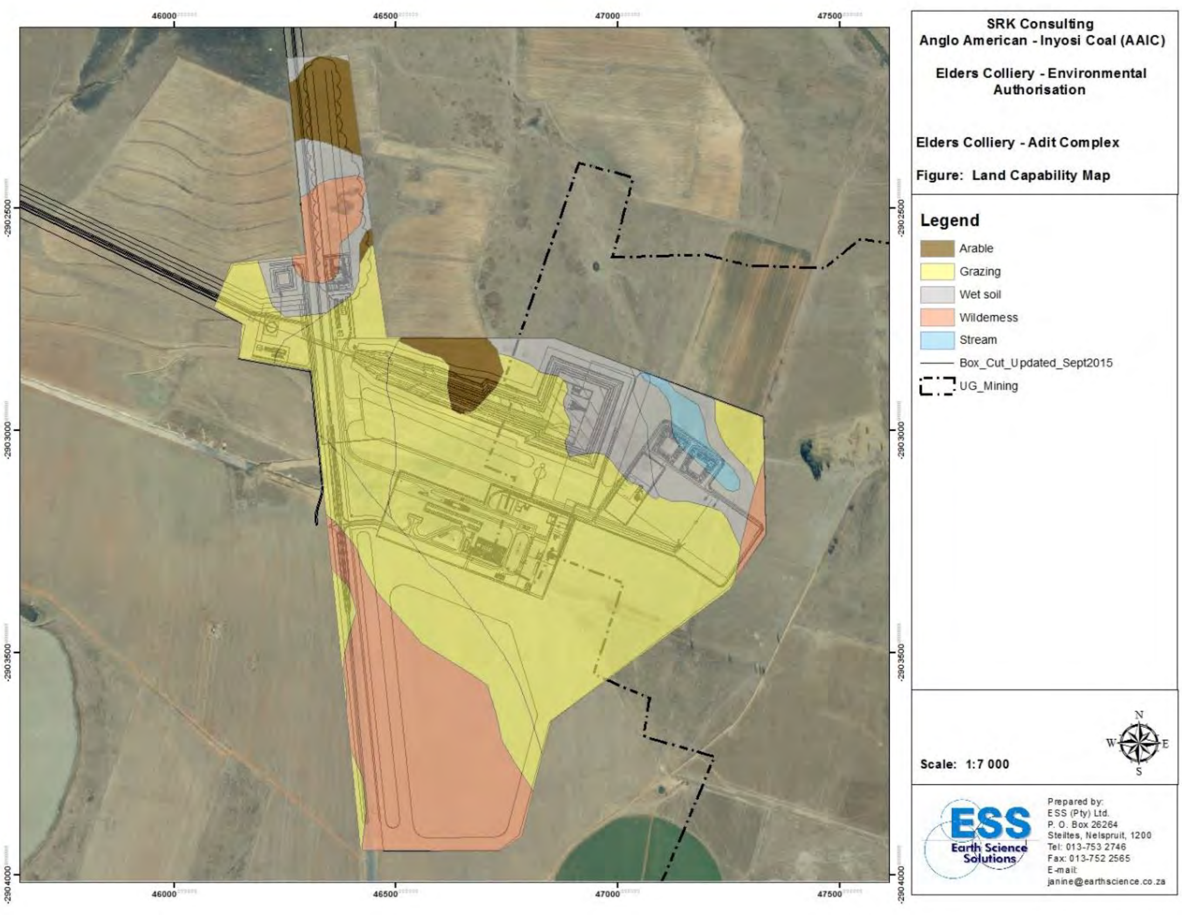

Figure 2.2.2a Land Capability Map – Decline Adit Complex and associated Infrastructure

A significant but relatively small proportion of the study area classifies as having wet based soils. However it is important to note that a significantly large area of the open pit and infrastructure development being planned encroaches on soils with a wet base.

These should not be mistaken as wetlands in terms of the delineation document, but should be highlighted as potential zones of sensitivity with the potential for highly sensitive areas associated with the prominent waterway that cross cut the mining development.

These zones are considered very important, highly sensitive and vulnerable due to their ability to contain and hold water for periods through the summers and into the dry winter seasons.

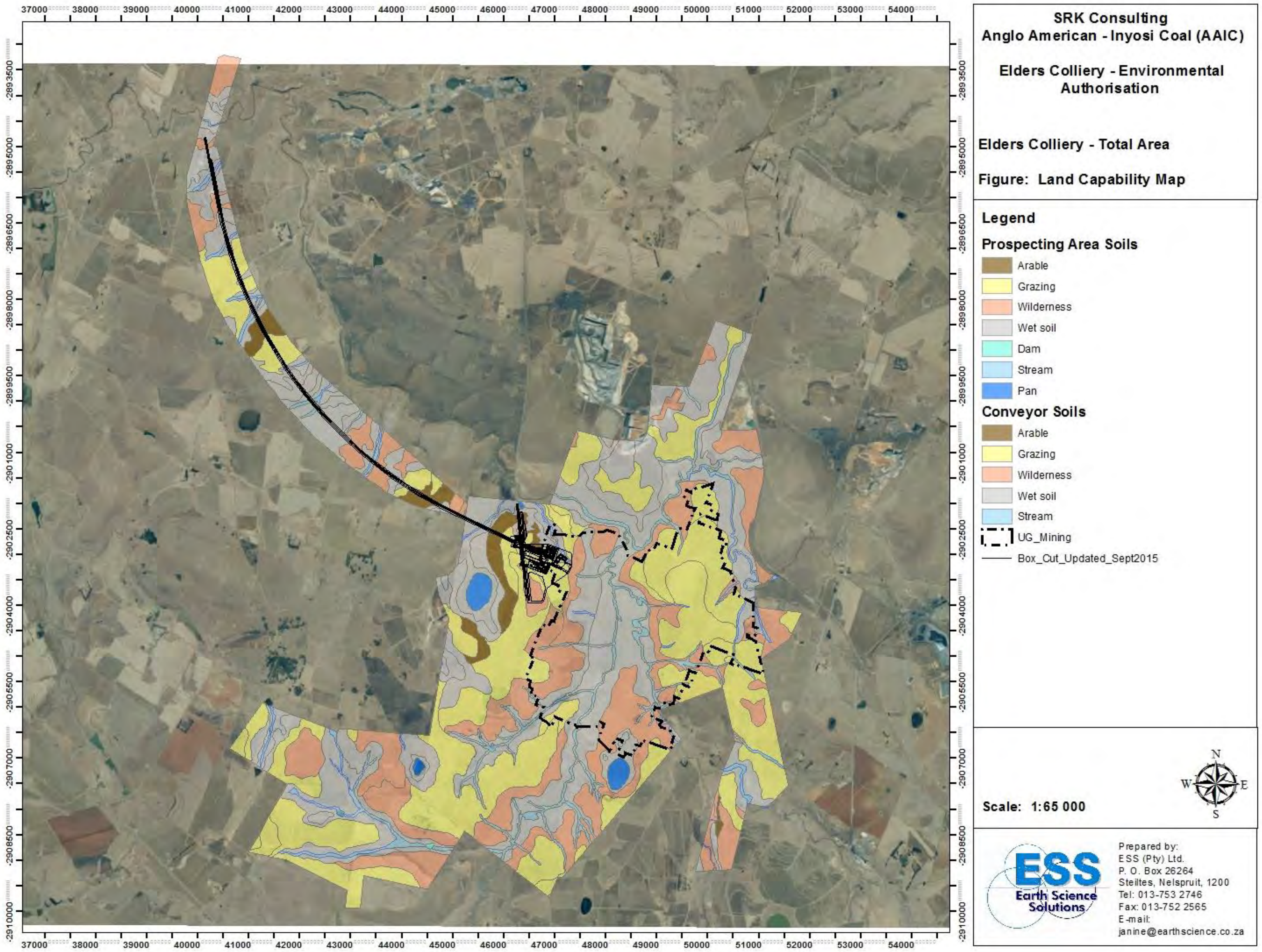

Figure 2.2.2a **Land Capability Map – Total Area**

2.3 Pre-Construction Land Use

The land use in the study area was assessed using a number of data sets, both historical as well as from recent studies, the aerial photographic coverage and discussions with the project team. In addition, the time spent in field while mapping the soils and classifying the land capability added to the understanding of the land use and land coverage (Refer to Figure 2.3 – Pre Development Land Use Map).

In general, the land use of the study area is considered to be altered, with a significant portion of the area having been changed from its original grassland biome to commercial farmlands.

The lower lying areas associated with the streams, rivers are for the most part unchanged, albeit that cultivation and utilisation of areas within this zone for livestock grazing and crop production are noted. On balance, the remainder of the site has been developed to either intensive grazing of the natural veld grasses or to commercial crops and cultivated pastures.

There is little to no subsistence farming practiced in the area, and no other commercial industry or urban dwellings exist.

A small area of existing coal mining is mapped in the north western corner of the site.

A more intensive study of the particular crop varieties and livestock ventures has not been undertaken, with the socio economic study having better access to these information and data sets.

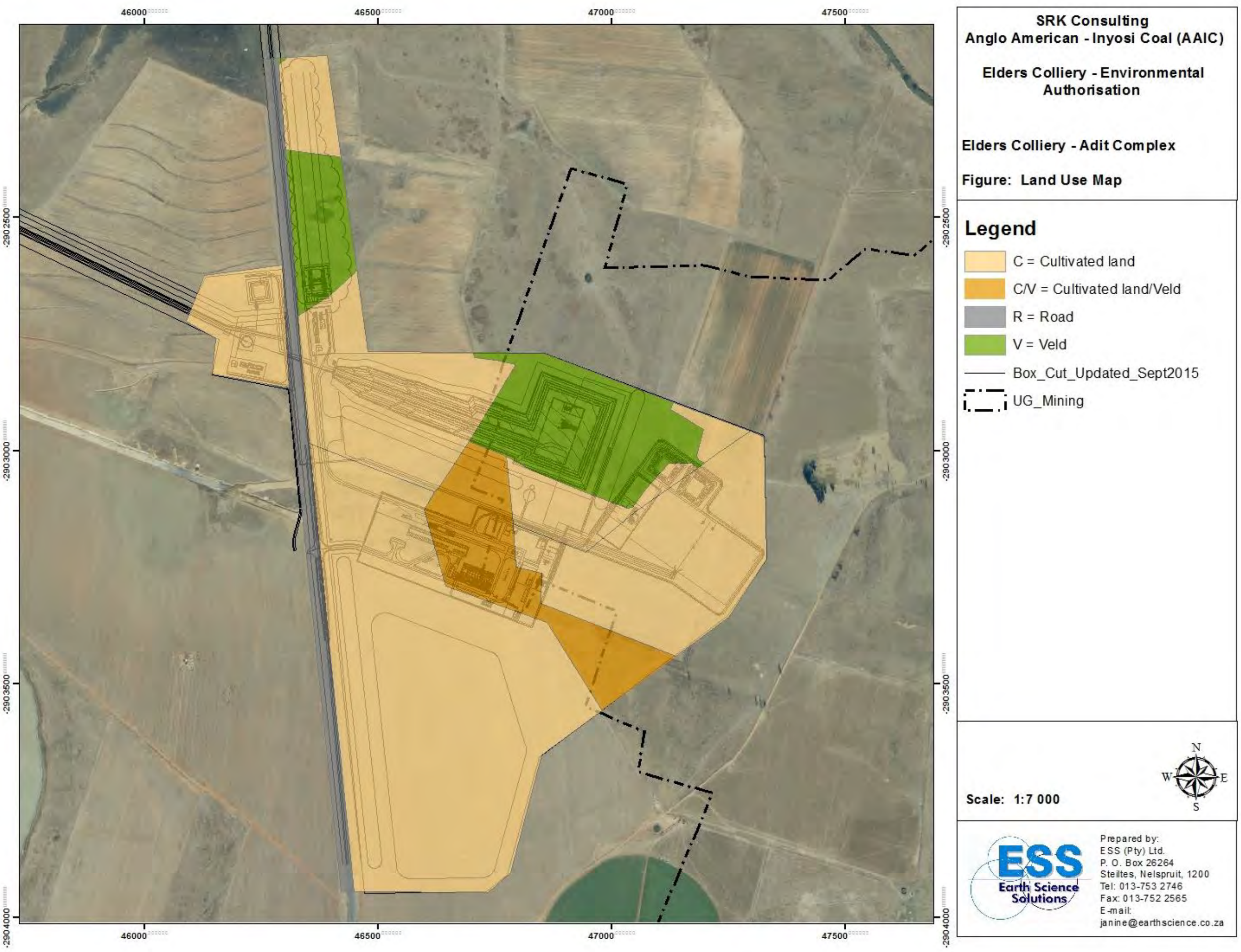

Figure 2.2.2a Decline Adit Complex and associated infrastructure

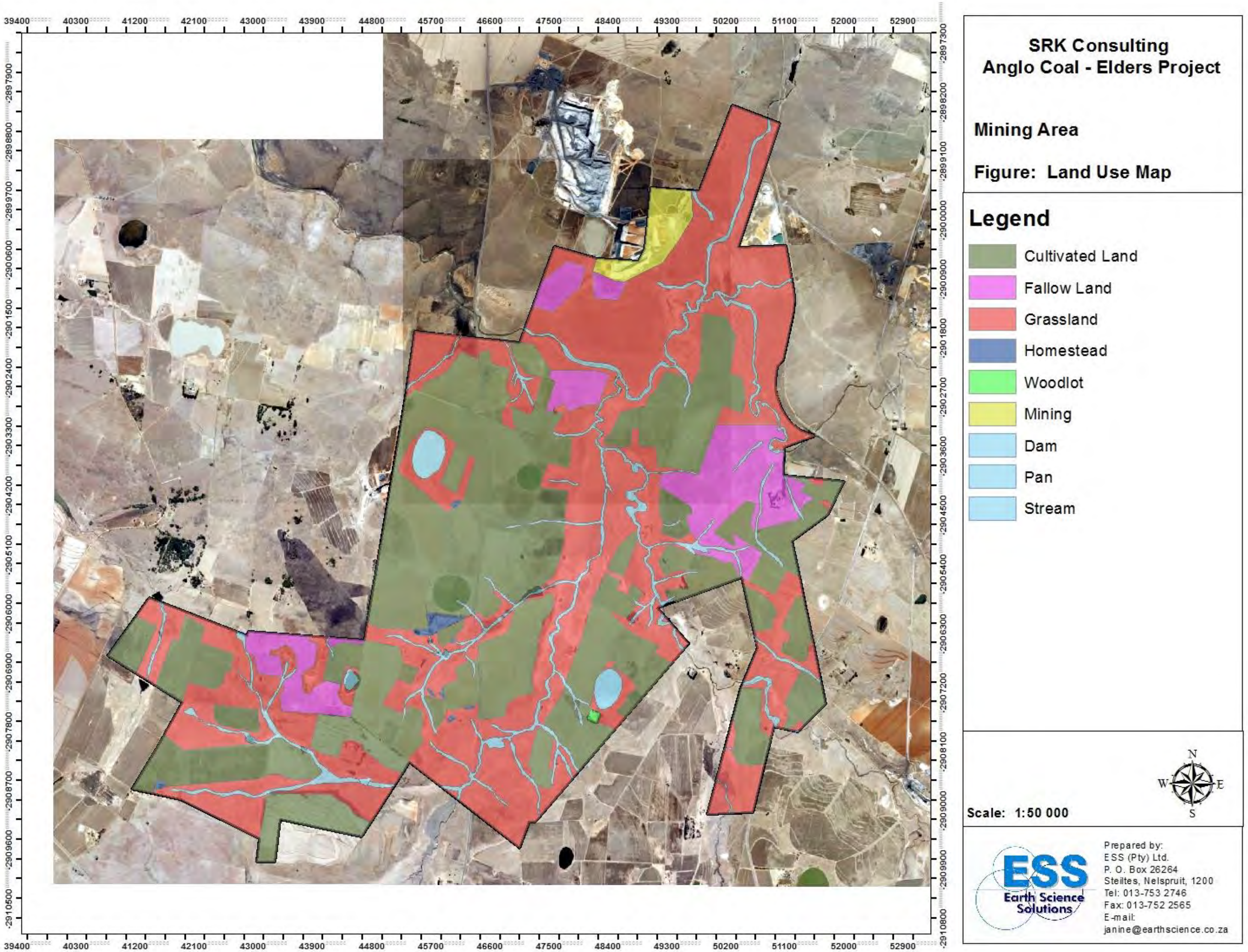

Figure 2.2.2b Pre Mining and Development Land Use Map – Underground development and conveyencing route

3. ENVIRONMENTAL IMPACT ASSESSMENT - PHILOSOPHY

With the baseline assessment in hand, and the determination of the existing state of the environment covered, the relative sensitivities and areas of concern have been highlighted and used as the basis for the Environmental Impact Assessment of the greater Elders Mine management plan inclusive of the decline adit complex and the conveyer route.

This report has been compiled in line with the South African Integrated Environmental Management Information Series (DEAT 2002), a guideline to the Impact Assessment Philosophy and Significance Rating System (Hacking Method).

This system aims to identify and quantify the environmental and/or social aspects of the proposed activities inclusive of any alternatives, to assess how these aspects will affect the existing state, and link the aspects to variables that have been defined in terms of the baseline study.

In addition, the impact assessment has defined a maximum acceptable level of impact for each of the activities or variables, inclusive of any standards, limits and/or thresholds, and has assessed the impact in terms of the significance rating as defined.

This included the assessment of cumulative effects where the required information was available, and where the common sources of impact are detailed.

The environmental aspects are not least of all part of the information that is needed in this decision making, with an understanding of how the soils and land capability will be affected being just part of the overall sustainability equation that needs to be balanced.

With the information available (historic and current) and the results of the comprehensive baseline studies (soils and land capability), and with the amended development proposals for the Elders Coal Mining Project in hand, the areas of concern have been assessed and management measures proposed to minimise and mitigate the impacts wherever possible (Section 6).

The principle of "No Net Loss" has been followed wherever possible. However, the development of the Decline Adit Development and Conveyencing System that makes up the overall mining complex and support infrastructure in the form of access roads and services (power and water) that link to the mining area will result in the surface area being disturbed for a significant period of time. This will result in the present land uses and land capabilities being altered, with losses of soil utilisation potential and eco system services being inevitable.

These activities will challenge the concept of "No Net Loss".

Based on the outcomes of the impact assessment, the site specific management planning and mitigation measures have been defined and detailed. These include defining what the mitigation will do to reduce the intensity and probability of the impact, specify a performance expectation for the mitigation proposed, and ensure that the prescriptive mitigation proposed is clear, site specific and practical.

In addition, and as part of the practical management plan, a monitoring system has been defined and any legal limits or provisions listed.

As part of understanding the variables and the maximum acceptable levels of impact that will be considered by the authorities, a summary of the national legislation that pertains to soils has been considered. These will aid in setting the permissible standards and limits that can be considered, albeit that there are no prescribed limits available.

The following section outlines a summary of the South African Environmental Legislation that needs to be considered for any new development with reference to management of soil:

- *The law on Conservation of Agricultural Resources (Act 43 of 1983) states that the degradation of the agricultural potential of soil is illegal.*
- *The Bill of Rights states that environmental rights exist primarily to ensure good health and wellbeing, and secondarily to protect the environment through reasonable legislation, ensuring the prevention of the degradation of resources.*
- *The Environmental right is furthered in the National Environmental Management Act (No. 107 of 1998), which prescribes three principles, namely the precautionary principle, the "polluter pays" principle and the preventive principle.*
- *It is stated in the above-mentioned Act that the individual/group responsible for the degradation/pollution of natural resources is required to rehabilitate the polluted source.*
- *Soils and land capability are protected under the National Environmental Management Act 107 of 1998, the Environmental Conservation Act 73 of 1989, the Minerals Act 50 of 1991 and the Conservation of Agricultural Resources Act 43 of 1983.*
- *The National Veld and Forest Fire Bill of 10 July 1998 and the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947 can also be applicable in some cases.*
- *The National Environmental Management Act 107 of 1998 requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimized and remedied.*
- *The Minerals Act of 1991 requires an EMPR, in which the soils and land capability be described.*
- *The Conservation of Agriculture Resources Act 43 of 1983 requires the protection of land against soil erosion and the prevention of water logging and salinization of soils by means of suitable soil conservation works to be constructed and maintained. The utilisation of marshes, water sponges and water courses are also addressed*.

In addition to the South African legal compliance, this development has also been assessed in terms of the International Performance Standards as detailed by the International Finance Corporation (IFC).

The IFC has developed a series of Performance Standards to assist developers and potential clients in assessing the environmental and social risks associated with a project and assisting the client in identifying and defining roles and responsibilities regarding the management of risk.

Performance Standard 1 establishes the importance of:

- Integrated assessment to identify the social and environmental impacts, risks, and opportunities of projects;
- Effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and
- The client's management of social and environmental performance throughout the life of the project.

Performance Standards 2 through 8 establish requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate.

While all relevant social and environmental risks and potential impacts should be considered as part of the assessment, Performance Standards 2 through 8 describe potential social and environmental impacts that require particular attention in emerging markets. Where social or environmental impacts are anticipated, the client is required to manage them through its Social and Environmental Management System consistent with Performance Standard 1.

Of importance to this report are:

- The requirements to collect adequate baseline data;
- The requirements of an impact/risk assessment;
- The requirements of a management program;
- The requirements of a monitoring program; and most importantly;
- To apply relevant standards (either host country or other).

With regard to the application of relevant standards (either host country or other) there are no specific guidelines relating to soils and land use/capability, either locally or within the World Bank's or IFC's suite of Environmental Health and Safety Guidelines. The World Bank's Mining and Milling, Underground guideline does state, however, that project sponsors are required to prepare and implement an erosion and sediment control plan. The plan should include measures appropriate to the situation to intercept, divert, or otherwise reduce the stormwater runoff from exposed soil surfaces, tailings dams, and waste rock dumps.

Project sponsors are encouraged to integrate vegetative and non-vegetative soil stabilisation measures in the erosion control plan.

Sediment control structures (e.g., detention/retention basins) should be installed to treat surface runoff prior to discharge to surface water bodies. All erosion control and sediment containment facilities must receive proper maintenance during their design life. This will be included in the appropriate management plans when they are developed at a later stage in the project's life cycle.

The variation in soil structure, texture and clay content of the soils combined with the presence of a prominent ferricrete (evaporite) layer at the base of many of the soil profile ("C" Horizon), all make for a complex of natural conditions that are going to be extremely difficult to replicate during the rehabilitation stage and at closure.

The potential and probable loss of soil water and the "perched" aquifer that is believed to occur as a result of the ferricrete inhibiting/barrier layer will need to be assessed and understood as a function of the ecological balance.

The low levels of organic carbon and relatively low nutrient stores noted for many of the soils will also require that a sound management plan is adopted based on the best impact assessment information.

The concept of "**utilisable soil**" storage will be tabled as a basic management tool, and a function of good environment practise.

All of the soils mapped are sensitive to erosion and compaction to varying degrees, and although tempered by the relative flatness of the terrain, they will need a well formulated management plan and adequate engineering if the soils are exposed and disturbed.

In addition, the variable depth profiles of the materials mapped are of concern as the depths of utilisable soil that can be stripped and stored will make for challenging management if all of the utilisable soils are to be harvested (large volumes). Management of this aspect has been dealt with as part of the soil management and utilisation plan (EMP – Section 6).

These soils are extremely important to the long term sustainability of the project. Soils will need to be stripped during construction, stored and maintained during the operational stage, and reinstated at closure (rehabilitation and emplacement of stored soils).

The impact of development on the soils and the resultant change in the land capability will be varied due to the unique differences associated with the soil forming processes and the resultant variation in the soil physical and chemical composition. The materials range from well-developed in-situ derived sandy and silty loams associated with the sedimentary lithologies to clay rich and well-structured sandy clays and clay loams associated with the more basic intrusive lithological units. These soils contrast with the younger/more recent colluvial and alluvial derived soils that return less well defined pedogenisis and comprise a range of structure, texture and chemistry.

These factors are important in the environmental assessment and final management plan that is tabled, with the potential for the separation and management of the differing materials at the removal stage (construction) forming the basis for economically and sustainable rehabilitation at closure.

The moderately complex nature of the geology (physical and chemical) and geomorphology of the area (ferricrete land form) and the semi-arid climate, all play a role in the soil forming process and have a bearing on the sensitivity and/or vulnerability of the materials when being worked or disturbed (Refer to Figure 3.1a and 3.1b).

These factors are important not only in planning the construction and operational activities, but will determine the success of the rehabilitation planning for the future.

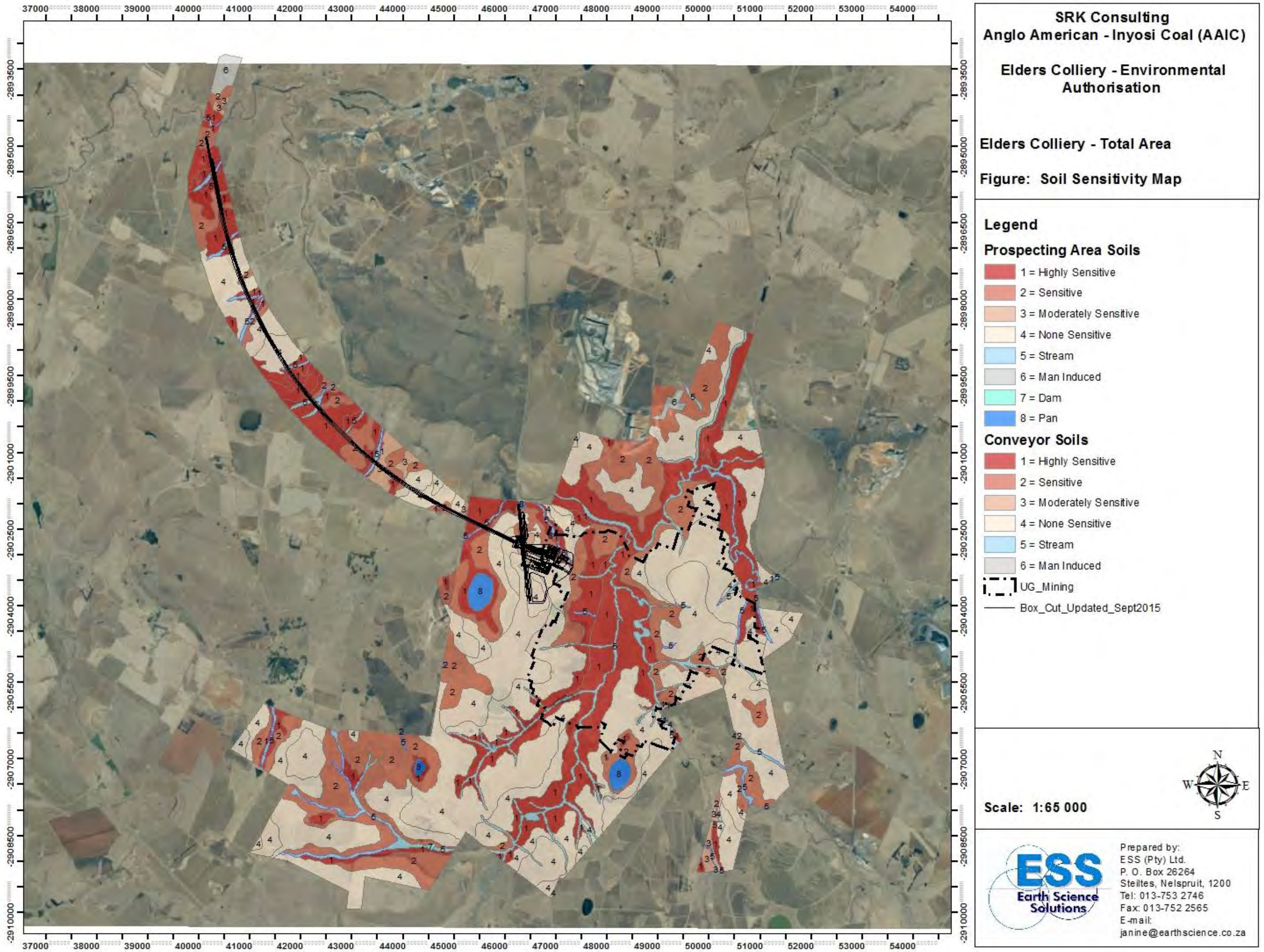

Figure 3.1a Soil Sensitivity of Total Area

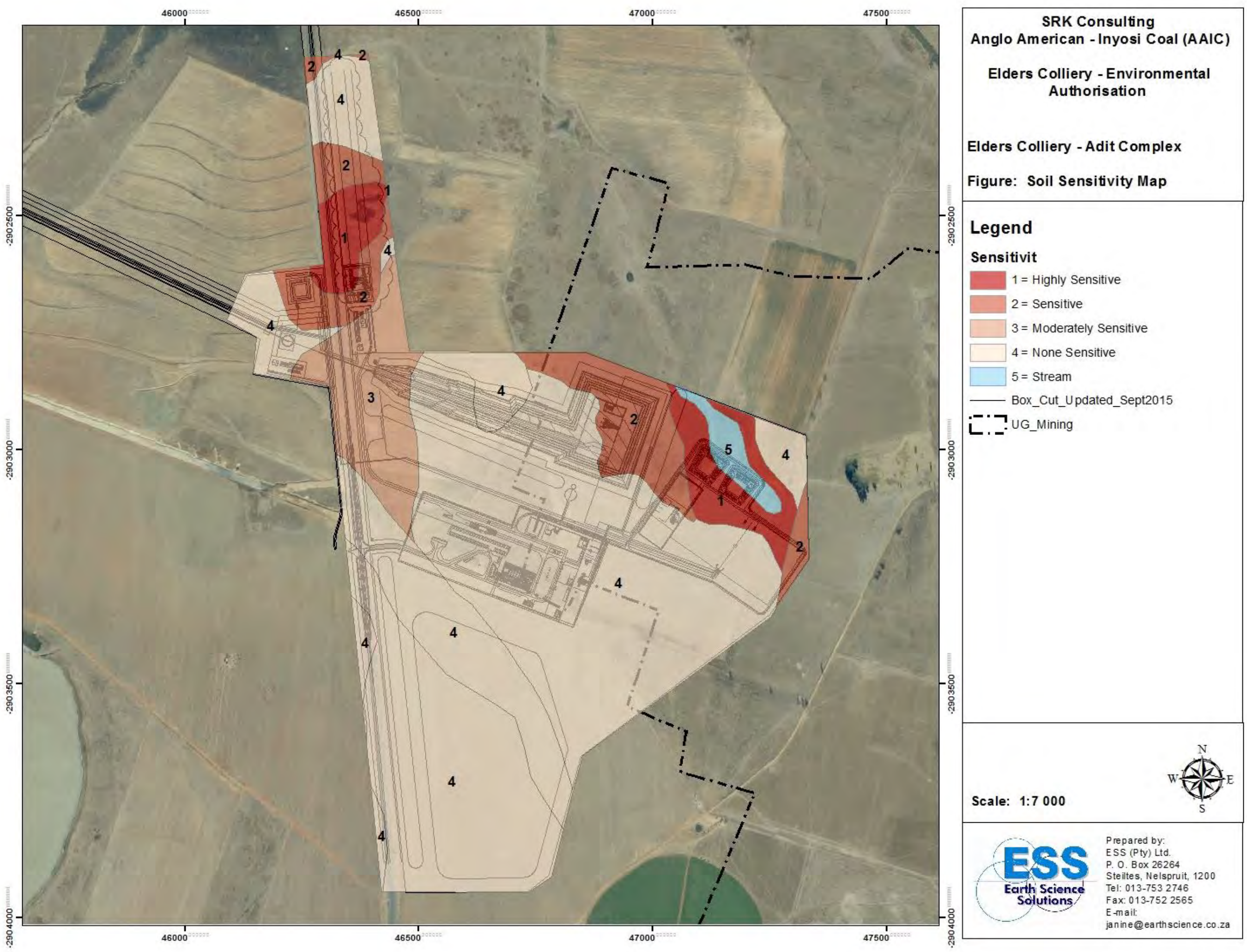

Figure 3.1b Soil Sensitivity for Decline Adit Site

4. SIGNIFICANCE RATING SYSTEM

4.1 Impact Assessment Methodology

The following Impact Assessment Methodology has been utilised when assessing the impacts of the proposed activities on each specialist fields of study.

Generally, impact assessment is divided into three parts:

- Issue identification - the evaluation of the 'aspects' arising from the project description and the identification of salient issues associated with the area of expertise;
- Impact definition – defining of the positive and negative impacts identified that are associated with the issues and activities as detailed in the project description as well as any others that the specialist might believe are pertinent;
- The definition statement should include the activity (source of impact), aspect and receptor as well as whether the impact is direct, indirect or cumulative. Fatal flaws should also be identified at this stage.
- Impact evaluation – this is not a purely objective and quantitative exercise. It has a subjective element, often using judgment and values as much as science-based criteria and standards. The need therefore exists to clearly explain how impacts have been interpreted so that others can see the weight attached to different factors and can understand the rationale of the assessment.

4.2 Impact significance rating

The impact significance rating system is presented in Table 4.1 and involves four parts:

- Part A: Define impact consequence using the three primary impact characteristics of magnitude, spatial scale/population and duration;
- Part B: Use the matrix to determine a rating for impact consequence based on the definitions identified in Part A;
- Part C: Use the matrix to determine the impact significance rating, which is a function of the impact consequence rating (from Part B) and the probability of occurrence; and
- Part D: Define the Confidence level.

This environmental impact assessment has been undertaken based on the RFP – Site Layout Plan for 2014 Elders Colliery Mine Plan, dated 20/10/2014 (Refer to Figure 4.1).

Table 4.1 Significance Rating System

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE *Use these definitions to define the consequence in Part B*		
Impact characteristics	**Definition**	**Criteria**
MAGNITUDE	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor+	Minor improvement; change not measurable; or threshold never exceeded
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction
	Major+	Substantial improvement; within or better than the threshold; or favourable publicity
DURATION	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years
SPATIAL SCALE OR POPULATION	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g. cadastral, catchment, topographic
	National/ International	Nationally or beyond

PART B: DETERMINING CONSEQUENCE RATING *Rate consequence based on definition of magnitude, spatial extent and duration*					
			SPATIAL SCALE/ POPULATION		
			Site or Local	**Regional**	**National/ international**
MAGNITUDE					
Minor	**DURATION**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**DURATION**	**Long term**	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**DURATION**	**Long term**	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING *Rate significance based on consequence and probability*				
		CONSEQUENCE		
		Low	**Medium**	**High**
PROBABILITY (of exposure to impacts)	**Definite**	Medium	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

PART D: CONFIDENCE LEVEL		
High	Medium	Low

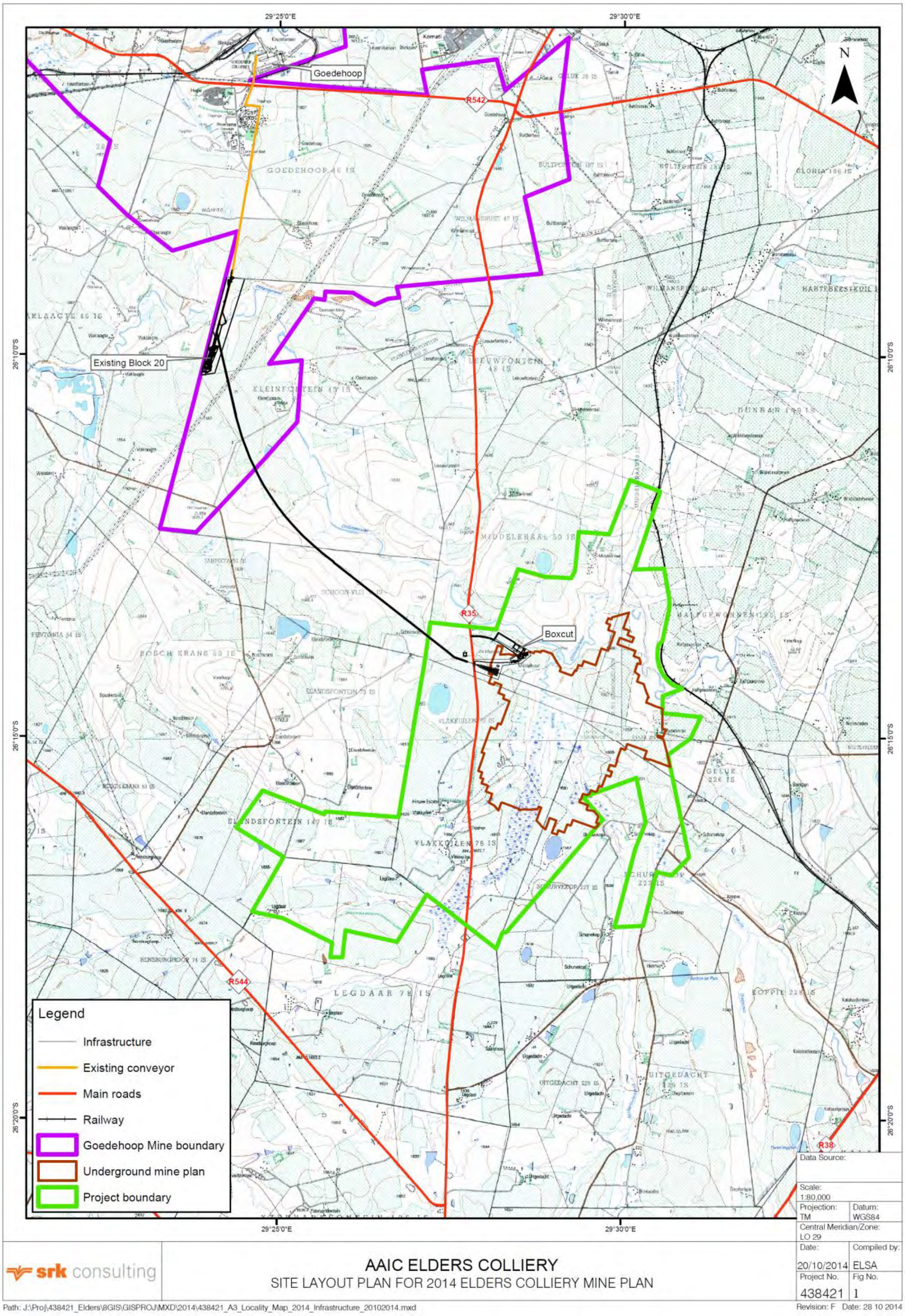

Figure 4.1 – Proposed Elders U/G Operation, Decline Adit & Conveyer Line

5. ENVIRONMENTAL IMPACT ASSESSMENT

5.1 Activities to Be Rated

The EIA methodology and philosophy is covered in the preceding section, while the activities that require assessment are listed in Table 5 below. This list is based on the Mine Plan as detailed 20th October 2014, refer to Figure 4.1.

Table 5 – Activities for Proposed Elders Project

Phase	Activities
Preconstruction	Site clearing and grubbing of the footprint areas associated with the boxcut, ventilation shafts, conveyor route servitude, roads and mini pit area
	Establishment of the contractor laydown area.
Construction	Construction of boxcut and associated infrastructure (including water treatment plant and sewage treatment plant)
	Blasting (boxcut and mini-pit)
	Construction of conveyor belt, pipeline, service road and two powerlines
Operational	Trucking of coal from mini-pit via trucks on the R35 for a period of 6 to 18 months.
	Open cast mining of mini-pit (including blasting)
	Underground mining
	Stockpiles, including run of mine (ROM), overburden and topsoils
	Conveying of coal to from Elders Colliery to Block 20
	Storage of water underground
	Operation of ventilation shafts
	Operation of water treatment plant (including storage of brine and controlled release of treated water)
	Operation of sewage treatment plant (including storage of sludge)
Closure/Rehabilitation	Demolish all surface infrastructure
	Rehabilitation of shaft area and conveyor route servitude
	Rehabilitation of mini-pit
Post - closure	Potential decant of groundwater

An assessment of the environmental impacts that the activities might produce has been carried out and measured against the existing environmental state using the significance rating supplied.

This section assesses and measures/quantifies the environmental aspects of the **activities** in terms of how they will affect the **existing state** and details where possible/available the maximum acceptable level of impact for each of the variables listed.

Based on these findings, the **significance** of the impact is rated in terms of its unmanaged and managed state, with the management recommendations forming the basis of the Environmental Management Plan (Chapter 6).

Of significance to the proposed development and the sustainability of any project are the relative sensitivities of the soils (Refer to Figure 3.1a and 3.1b). The occurrence of evaporite or a ferricrete layer is indicative of their having been, or the presence of wetness within a profile, and although many of the ferricrete mapped are believed to be associated with relic land forms, there are a number of areas where these features are associated with topographic low lying areas, pans and present day wetness within the profile.

These features are important to the biodiversity and ecology of the area and need to be understood in the context of the overall systems that sustain the pre development environment.

Soil structure, texture and the shallowness of soil rooting depths are also aspects considered when measuring the robustness or sensitivity of the soil.

In terms of the wetland delineation guidelines and the legal status of wetlands the highly sensitive areas need to be considered carefully if they are within the area of proposed impact.

The noted (baseline study) differences in the texture of the different soils, the soil depth variations, the composition of the "C" horizon (ferricrete), the relative wetness of subsoil's and the structure of the different soil groups is of importance in assessing the potential impacts and the relative sensitivity that is assigned to the soil groups and land capabilities that are to be effected. The difference in the significance of the expected impacts based on soil form or group will potentially influenced the design criteria and positioning of infrastructure.

There are no off-site activities included in this Environmental Impact Assessment. The assessment is confined to the project footprint and its immediate surroundings, and as such the "spatial extent is regarded as "Site Only" or at worst "Localised" depending on how far the effects of erosion are predicted to extend.

The infrastructure planned for the facility will include (Refer to Design Reports) deep excavations (boxcut and decline adit) and the use of heavy machinery over unprotected ground. These activities will require the removal of significant quantities of soil, and the complete removal of soil and soft overburden from the boxcut footprint and decline shaft. The placement and sinking of all/any ventilation shafts will also require that the soil and soft overburden is removed prior to shaft sinking or raise boring.

The access roads, conveyer line and general service ways will require less intensive engineering and the actions and effects will not be as invasive on the natural materials, albeit that the conveyer line will definitely impact some highly sensitive soils along its planned route.

The mining and associated activities will inevitably sterilise the soils and they will be lost from the system for the life of the operation and possibly beyond if the systems are to be utilised for future ventures and mining projects.

With an understanding of the activities and workings of the project (Refer to Project Description), the following impacts are considered:

- The loss of the soil resource due the **change in land use** and the removal of the resource from the existing system (Sterilisation). These are generally associated with the construction of the facilities and the use of the footprint area for industrial/mining activities and support infrastructure. These activities will potentially result in the complete loss of the soil resource for the life of the project and possibly for some time after closure. In addition, the management of waste could potentially sterilize the soils permanently (if soils are not removed), and if not well managed;
- The loss of the soil resource due to the **erosion** (wind and water) of unprotected materials (removal of vegetative cover and/or topsoil);
- The loss of the utilisation potential of the soil and land capability due to **compaction** of areas adjacent to the constructed facilities;
- Loss of the resource due to **removal** of materials for use in other activities (borrow pits etc.);

- The **contamination** of the resource due to spillage of raw materials or final product and/or spillage of reagents transported to the site that are used in the process;
- The **contamination** of stored and/or in-situ materials due to dust deposition or dirty water from the project area and transport routes;
- The loss of the soil utilisation potential due to the **disturbance** of the soils and potential loss of nutrient stores through infiltration and de-nitrification of the stored or disturbed materials.

5.2 Impact Assessment

5.2.1 Preconstruction Phase

5.2.1.1 Site Clearing and Establishment of Contractors Laydown Areas

Issue – The Loss of utilisable resource (sterilisation and erosion), compaction and contamination or salinization.

The preconstruction phase will require:

- The clearing of the footprint and buffer zone of large trees and any existing infrastructure from sites of proposed new development at surface;
- Stripping and grubbing of utilisable soil and vegetation (Top 250mm to 700mm depending on activity) from the boxcut, ventilation shaft, conveyer servitude , roads and boxcut development footprint;
- The preparation (levelling and compaction) of lay-down areas, foundations and pad footprint areas for stockpiling of utilisable soil removed from the footprint to the adit complex and the associated support infrastructure and activities;
- The use of heavy machinery over unprotected soils;
- The creation of dust and loss of materials to wind and water erosion, and
- The possible contamination of the soils by dirty water, chemicals and hydrocarbons spills (dust and dirty water runoff);

<u>*Impact Significance*</u>

During the preconstruction phase the loss of the utilisation of the soil resource will impact the land use, reducing the land capability from low intensity grazing land to mining.

The construction for the mining and its support activities will, if un-managed and without mitigation:

- Have a definite negative impact on the environment due to the loss of the soil area and thus the use of the utilisable resource;
- Have the potential for contamination (hydrocarbon and reagent chemical spills, raw materials and spillage of coal, etc.), compaction of working/laydown areas and storage facility footprint and the potential for erosion (wind and water – dust and suspended solids) over unprotected areas;
- Have a moderate negative intensity potential ranking based on the confined (limited to footprint of impact) and compact nature of the infrastructure for the relative size of the infrastructure;

- Will be permanent but reversible (can be broken down and rehabilitated), and
- Is confined to the site only - localised.

However, with management, the loss, degree of contamination, compaction and erosion of this resource can be mitigated and reduced to a level that is more acceptable.

The reduction in the significance of the impact can be achieved by:

- Limiting the area of impact to as small a footprint as possible inclusive of resource stockpiles and the length of servitudes, access and haulage ways and conveyencing systems wherever possible;
- Construction of the facility and associated infrastructure over the less sensitive soil groups (reduce impact over wetlands and soils sensitive to erosion and/or compaction – refer to Figures 3.1a and 3.1b);
- An awareness of the length of time that the resource will need to be stored and managed;
- The development and inclusion of soil management as part of the general housekeeping operations, and the independent auditing of this management;
- Concurrent rehabilitation of all affected sites that are not required for the operation – rehabilitation of temporary structures and footprint areas used during the feasibility investigation (geotechnical pits, trenching etc.);
- Effective soil stripping during the less windy months and during the dry periods when the soils are less susceptible to erosion;
- Restriction of vehicle movement over unprotected or sensitive areas, this will reduce compaction;

It is evident in the industry, that failure to manage the impacts on this important resource (soil) will result in the total loss of the resource, with a resultant much higher significance rating.

Residual Impact

The above management procedures will likely reduce the significance of the impacts to medium and/or low in the medium term (Refer to Table 5.2.1.1 for summary).

Table 5.2.1.1 - Preconstruction Phase Impact Significance

PRECONSTRUCTION PHASE									
Activity	Site Clearing and Grubbing of the Footprint areas associated with the boxcut and adit complex, conveyer route servitude and associated support infrastructure								
Project Phase	Preconstruction Phase								
Impact Summary	Loss of soil resource due to soil stripping where mining and associated infrastructure is to be constructed								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Long Term	High	Definite	**Medium**	-ve	High
Management Measures	Limit the size of area of impact to a minimum.								
	Site selection for infrastructure on less sensitive soils, restriction on No Go and highly sensitive materials								
	Stripping of soils during less windy and drier months and concurrent rehabilitation of areas that are nolonger needed for the project (trenches, exploration pads etc., and/or utilisation of erosion control mechanisums.								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Long Term	Medium	Possible	**Medium**	-ve	Medium
Activity	Establishment of Contarctors Laydown area								
Project Phase	Preconstruction Phase								
Impact Summary	Loss of soil resource due to soil stripping of soil from the Contractors Yard footprint.								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Moderate	Site or Loc	Short Term	Low	Definite	**Medium**	-ve	High
Management Measures	Limit the area of impact to a minimum								
	Site selection for infrastructure on less sensitive soils, restriction on No Go and highly sensitive materials								
	Stripping of soils during less windy and drier months if possible to limit erosion, and/or utilisation of erosion controls.								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Minor	Site	Short Term	Low	Possible	**Low**	-ve	Medium

5.2.1 Construction Phase

5.2.1.1 Construction of Boxcut, Decline Adit, Primary Crusher and Screening Plant, Associated Shaft Complex activities and RoM Coal Stockpile

Issue – The Loss of utilisable resource (sterilisation and erosion), compaction and contamination or salinisation.

The construction phase will require:

- The stripping of all utilisable soil (Top 500mm to 750mm depending on activity) from the areas that are to be impacted by infrastructural development and or mining;
- The preparation (levelling and compaction) of lay-down areas, pad footprint areas for stockpiling of utilisable soil removed from the footprint to the Decline Adit Complex, Boxcut, the Crushing and Screening area, the Conveyer plinths, pipeline trenches, power lines, service road and the Run of Mine Coal Stockpile pad;
- The excavation of foundations for the stormwater management system (Dams, Water Reservoir etc.) and infrastructure associated with the stormwater management, the foundations for the Decline Adit Complex/Boxcut, and the conveyer system plinths;
- Removal of soil from access and service roads and all/any haulage ways;
- The use of heavy machinery over unprotected soils;
- The creation of dust and loss of materials to wind and water erosion, and
- The possible contamination of the soils by dirty water, chemicals and hydrocarbons spills (dust and dirty water runoff);

<u>*Impact Significance*</u>

The loss of the utilisation of the soil resource will impact the land use practice of low to moderate intensity livestock grazing and commercial cultivation of cereal crops that are the major activities on the dryland soils at present.

These activities are perceived to be of great economic benefit to the local economy and land owners and contribute to the ecosystem services.

The construction for the mining and its support activities will, if un-managed and without mitigation:

- Have a definite negative impact on the environment due to the loss of the soil area and thus the use of the utilisable resource – eco system services;
- Have the potential for contamination (hydrocarbon and reagent chemical spills, raw materials and spillage of coal, etc.), compaction of working/laydown areas and storage facility footprint and the potential for erosion (wind and water – dust and suspended solids) over unprotected areas,
- Have a medium/moderate negative intensity potential ranking based on the confined (limited to footprint of impact) and compact nature of the infrastructure for the relative size of the mining venture and its associated infrastructure (significant proportion of the development is underground;
- Will continue throughout the construction phase and into the operational phase;
- Will be permanent but reversible (can be broken down or backfilled and rehabilitated), and

- Is confined to the site only, or at worst is localised (off site effects of erosion by wind and water).

However, with management, the relative loss of eco system services (soil), the degree of contamination, compaction and erosion of this resource can be mitigated and reduced to a level that is more acceptable.

The reduction in the significance of the impact can be achieved by:

- Limiting the area of impact to as small a footprint as possible, inclusive of waste management facilities, resource stockpiles and the length of servitudes, access and haulage ways and conveyencing systems wherever possible;
- Construction of the facility and associated infrastructure over the less sensitive soil groups (reduce impact over wetlands and soils sensitive to erosion and/or compaction);
- An awareness of the length of time that the resource will need to be stored and managed;
- The development and inclusion of soil management as part of the general housekeeping operations, and the independent auditing of this management;
- Concurrent rehabilitation of all affected sites that are not required for the operation – rehabilitation of temporary structures and footprint areas used during the feasibility investigation (geotechnical pits, trenching etc.) and the construction phase;
- Effective soil stripping during the less windy months when the soils are less susceptible to erosion;
- Separation of the utilisable soils and ferricrete base materials from each other and from the soft overburden;
- Effective cladding of the berms and soil, ferricrete stockpiles/heaps with vegetation or large rock fragments, and the minimising of the height of storage facilities to 15m and soil berms to 1,5m wherever possible;
- Restriction of vehicle movement over unprotected or sensitive areas, this will reduce compaction;
- Soil amelioration (cultivation) to enhance the oxygenation and growing capability (germination) of natural regeneration and/or seed within the stockpiled soils (maintain the soils viability during storage) and areas of concurrent rehabilitation.

It is evident within the industry, that failure to manage the impacts on this important resource (soil) will/has resulted in the total loss of the resource, with a resultant much higher significance rating.

Residual Impact

The above management procedures will likely reduce the significance of the impacts to moderate in the medium term.

Table 5.2.1.1 - Construction Phase Impact Significance – Boxcut and Waste Water Treatment Works

CONSTRUCTION PHASE									
Activity	Construction of boxcut and associated infrastructure (including stormwater controls, waste water treatment plant and sewage treatment plant)								
Project Phase	Construction Phase								
Impact Summary	Loss of resource and eco system services (soil resource), erosion, compaction, sterilisation and contamination of in-situ and stored resouce (stockpiles)								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Moderate	Site or Loc	Medium Term	Midium	Definite	**Midium**	-ve	High
Management Measures	Restriction of activities to as small an area as possible, and restriction to less sensitive soil forms								
	Use of erosion control systems as part of design criteria, concurrent rehabilitation and awarness of climatic conditions during construction (limiting of earthworks during very wet or very windy conditions)								
	Inclusion of soil utilisation and management as part of management operations and auditable activities (general housekeeping)								
	Management of vehicle movement over unprotected soils								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Medium Term	Medium	Possible	**Medium**	-ve	Medium

5.2.1.2 Construction of Conveyer belt, Pipeline, Service Road and two Power Lines

Issue – The Loss of utilisable resource (sterilisation and erosion), compaction and contamination or salinisation.

The construction phase will require:

- The stripping of all utilisable soil (Top 250mm to 500mm depending on activity) from the areas that are to be impacted by infrastructural development and associated activities;
- The preparation (levelling and compaction) of lay-down areas, pad footprint areas for stockpiling of utilisable soil removed from the footprint to the access road, plinths for conveyer belt infrastructure, pipeline trenches and/or support, power line foundations and all support infrastructure and activities;
- The excavation of foundations for the stormwater management system (Silt traps and water runoff controls, berms etc.) and conveyer system plinths, pipeline and electrical supply supports;
- Removal of soil from access/service roads;
- Compaction due to the use of heavy machinery over unprotected soils during construction;
- The creation of dust and loss of materials to wind and water erosion, and
- The possible contamination of the soils by dirty water, chemicals and hydrocarbons spills (dust and dirty water runoff).

<u>Impact Significance</u>

The loss of the utilisation of the soil resource will impact the land use practice of low to moderate intensity livestock grazing and commercial cultivation of crops that are the major activities on the dryland soils at present.

These activities are perceived to be of great economic benefit to the local economy and land owners and contribute to the ecosystem services.

The construction for the mining and its support activities will, if un-managed and without mitigation:

- Have a definite negative impact on the environment due to the loss of the soil area and thus the use of the utilisable resource – eco system services;
- Have the potential for contamination (hydrocarbon and reagent chemical spills, raw materials and spillage of coal, etc.), compaction of working/laydown areas and storage facility footprint and the potential for erosion (wind and water – dust and suspended solids) over unprotected areas,
- Have a medium/moderate negative intensity potential ranking based on the confined (limited to footprint of impact) and compact nature of the infrastructure for the relative size of the mining venture and its associated infrastructure (all of the mining is underground);
- Will continue throughout the construction phase and into the operational phase;
- Will be permanent but reversible (can be broken down or backfilled and rehabilitated), and
- Is confined to the site only, or at worst is localised (off site effects of erosion by wind and water).

However, with management, the relative loss of eco system services (soil), the degree of contamination, compaction and erosion of this resource can be mitigated and reduced to a level that is more acceptable.

The reduction in the significance of the impact can be achieved by:

- Limiting the area of impact to as small a footprint as possible, inclusive of resource stockpiles and the length of servitudes, access and haulage ways and conveyencing systems wherever possible;
- Construction of the facility and associated infrastructure over the less sensitive soil groups (reduce impact over wetlands and soils sensitive to erosion and/or compaction);
- An awareness of the length of time that the resource will need to be stored and managed;
- The development and inclusion of soil management as part of the general housekeeping operations, and the independent auditing of this management;
- Concurrent rehabilitation of all affected sites that are not required for the operation – rehabilitation of temporary structures and footprint areas used during the feasibility investigation (geotechnical pits, trenching etc.) and the construction phase;
- Effective soil stripping during the less windy months when the soils are less susceptible to erosion;
- Separation of the utilisable soils and ferricrete base materials from each other and from the soft overburden;
- Effective cladding of the berms and soil, ferricrete stockpiles/heaps with vegetation or large rock fragments, and the minimising of the height of storage facilities to 15m and soil berms to 1,5m wherever possible;
- Restriction of vehicle movement over unprotected or sensitive areas, this will reduce compaction;
- Soil amelioration (cultivation) to enhance the oxygenation and growing capability (germination) of natural regeneration and/or seed within the stockpiled soils (maintain the soils viability during storage) and areas of concurrent rehabilitation.

It is evident in the industry, that failure to manage the impacts on this important resource (soil) will result in the total loss of the resource, with a resultant much higher significance rating.

Residual Impact

The above management procedures will likely reduce the significance of the impacts to medium in the medium to long term.

Table 5.2.1.2 - Construction Phase Impact Significance – Conveyer Line and Associated Infrastructure

Activity	Construction of Conveyer line, service road, electrical reticulation and two pipelines								
Project Phase	Construction Phase								
Impact Summary	Loss of resource and eco system services (soil resource), erosion, compaction, sterilisation and contamination of in-situ and stored resouce (stockpiles)								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Medium Term	Medium	Definite	**Medium**	-ve	High
Management Measures	Restriction of activities to as small an area as possible, and restriction to less sensitive soil forms								
	Use of erosion control systems as part of design criteria (vegetative cover - vetiver intervention), concurrent rehabilitation and awarness of climatic conditions during construction (limiting of earthworks during very wet or very windy conditions)								
	Inclusion of soil utilisation and management as part of engineering designs, management operations and auditable activities (general housekeeping)								
After management Measures	Management of vehicle movement over unprotected soils								
	Managed	Moderate	Site	Long Term	Medium	Possible	**Medium**	-ve	Medium

5.2.2 Operational Phase

5.2.1.1 Boxcut and Decline Adit Complex

Issue: Loss of utilisable resource (Sterilisation and erosion), compaction, de-nutrification and contamination or salinisation.

The operation of the mining venture (Underground Bord and Pillar) and its associated activities (haulage and stockpiling of RoM materials) will see the impact of transportation of materials into and out of the complex, the potential for spillage and contamination of the in-situ and stockpiled materials, contamination due to dirty water run-off and/or contaminated dust deposition/dispersion, the de-nutrification of the stockpiled soils due to excessive through flow of rain water on unconsolidated and poorly protected soils and the flushing of the nutrient pool from the stockpiled materials if not well protected.

While the potential for compaction of the in-situ materials by uncontrolled vehicle movement and the loss to the environment (down-wind and downstream) of soil by wind and water erosion over un-protected ground are also possible if not well managed.

In summary, the operation will potentially result in:

- The sterilisation of the soil resource on which the facilities are constructed. This will be an on-going loss for the duration of the operation;
- The creation of dust and the possible loss (erosion) of utilisable soil down-wind and/or downstream, and the potential for contamination of the soils from dust fallout and dirty water runoff;
- The compaction of the in-situ and stored soils and the potential loss of utilisable materials from the system;
- The contamination of the soils by dirty water run-off and or spillage of hydrocarbons from vehicle and machinery;
- Contamination of soils by use of dirty water for road wetting (dust suppression) and irrigation of the stockpile vegetation;
- Potential contamination of soils by chemical spills of reagents being transported to site;
- Sterilization and loss of soil nutrient pool, organic carbon stores and fertility of stored soils;
- Impact on soil structure and soil water balance.

Un-managed soil stockpiles and soil that is left uncovered/unprotected will be lost to wind and water erosion, will loss the all-important, albeit moderately poor nutrient content and organic carbon stores (fertility) and will be prone to compaction.

Of a positive impact, will be the rehabilitation of the temporary infrastructure used during the start-up and construction phase.

<u>Impact Significance</u>

The result of the operation on the soil resource will have a negative impact rating potential that is major in magnitude, that will last for the life of the operation (permanent to irreversible if not rehabilitated) and be confined to the immediate site.

In the un-managed scenario the frequency is likely to be continuous resulting in a significance rating of high

It is inevitable that some of the soils will be lost during the operational phase if they are not well managed and a mitigation plan is not made part of the general management schedule.

However, these impacts may be mitigated with well initiated management procedures.

These should include:

- Minimisation of the area that can potentially be impacted (eroded, compacted, sterilised or de-nutrified);
- Timeous replacement of the soils so as to minimise/reduce the area of affect and disturbance;
- Effective soil cover and adequate protection from wind (dust) and dirty water contamination – vegetate and/or rock cladding;
- Regular servicing of all vehicles in well-constructed and bunded areas to reduce spillage and contamination;
- Regular cleaning and maintenance of all haulage ways, conveyencing routes and service ways, drains and storm water control facilities;
- Containment and management of spillage;
- Soil replacement and the preparation of a seed bed to facilitate and accelerate the re-vegetation program and to limit potential erosion on all areas that become available for rehabilitation (temporary servitudes), and
- Soil amelioration (rehabilitated and stockpiled) to enhance the growth capability of the soils and sustain the soils ability to retain oxygen and nutrients, thus sustaining vegetative material during the storage stage.

It will be necessary as part of the development plan to maintain the integrity of the stored soils so that they are available for rehabilitation at decommissioning and closure. If the soil quantities and qualities are (utilisable soils) managed well throughout the operational phase, rehabilitation costs will be reduced and natural attenuation will more easily and readily take effect. This will result in a more sustainable "End Land Use" being achieved.

Residual Impact

In the long term (Life of the operation) and if implemented correctly, the above mitigation measures will reduce the impact on the utilisable soil reserves (erosion, contamination, sterilization) to a significance rating of medium.

However, if the soils are not retained/stored and managed, and a workable management plan is not implemented the residual impact will definitely incur additional costs and result in the impacting of secondary areas (Borrow Pits etc.) in order to obtain cover materials etc.

Table 5.2.1.1 Operational Phase – Impact Significance – Boxcut and Decline Adit Complex

OPERATIONAL PHASE									
Activity	Underground mining from Boxcut via decline adit (bord and pillar mining), development of RoM Stockpiles and Management of stored resource(soils and soft overburden)								
Project Phase	Operational Phase								
Impact Summary	Loss of soil resource and eco system services (erosion), sterilisation of stockpiled materials (loss of soil nutrients) , contamination and salinisation of in-situ and stored materials by dirty water and wind blown dust, and the compaction of materials exposed to unprotected utilisation								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Long Term	High	Definite	**High**	-ve	High
Management Measures	Minimisation of area of footprint								
	Concurent and timeous replacement of the soils after mining and as part of rehabilitation								
	Effective soil and vegetative cover to in-situ and stored materials, restriction on heights of soil dumps, and								
	Control and auditing of vehicle movements and regular servicing of equipment								
	Storm water and dirty water management of all facilities - runoff and ponding								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Long Term	Medium	Possible	**Medium**	-ve	Medium

5.2.1.2 Conveyencing of Coal from Elders Colliery to Block 20

Issue: Loss of utilisable resource (Sterilisation and erosion), compaction, de-nutrification and contamination or salinisation.

The operation of the Conveyer System and its associated infrastructure and activities (RoM Stockpile, service/access road, pipeline and electrical reticulation) will see the impact of soil loss and eco system services reduced and lost, contamination due to spillage of raw product and hydrocarbons, compaction of adjoining unprotected soils, and contamination of the in-situ and stockpiled materials from dust and dirty water runoff. In addition, the stored materials will undergo de-nutrification due to excessive through flow of rain water on unconsolidated and poorly protected soils and the flushing of the nutrient pool from the stockpiled materials if not well protected.

In summary, the operation will potentially result in:

- The sterilisation of the soil resource on which the facilities are constructed. This will be an on-going loss for the duration of the operation;
- The creation of dust and the possible loss (erosion) of utilisable soil down-wind and/or downstream, and the potential for contamination of the soils (in-situ and as stockpiled – berms etc) from dust fallout and/or dirty water runoff;
- The compaction of the in-situ and stored soils and the potential loss of utilisable materials from adjoining unprotected soils – zone of influence;
- The contamination of the soils by dirty water run-off and or spillage of hydrocarbons from vehicle and machinery;
- Contamination of soils by use of dirty water for road wetting (dust suppression) and irrigation of the stockpile vegetation;
- Potential contamination of soils by spillage of raw product from the conveyer system;
- Sterilization and loss of soil nutrient pool, organic carbon stores and fertility of stored soils;
- Impact on soil structure and soil water balance.

Of a positive impact, will be the rehabilitation of the temporary infrastructure used during the start-up and construction phase.

Impact Significance

The result of the operation on the soil resource will have a negative impact rating potential that is major in magnitude, that will last for the life of the operation (permanent to irreversible if not rehabilitated) and be confined to the immediate site or local environment (water or wind transportation of dust or dirty water downstream/downwind).

In the un-managed scenario the frequency is likely to be continuous resulting in a significance rating of high

It is inevitable that some of the soils will be lost during the operational phase if they are not well managed and a mitigation plan is not made part of the general management schedule.

The impacts on the soils can be mitigated with well initiated management procedures.

These should include:

- Minimisation of the area that can potentially be impacted (eroded, compacted, sterilized or de-nutrified);
- Timeous replacement of the soils so as to minimise/reduce the area of affect and disturbance;
- Effective soil cover and adequate protection from wind (dust) and dirty water contamination – vegetate and/or rock cladding;
- Regular servicing of all vehicles in well-constructed and bunded areas;
- Regular cleaning and maintenance of all haulage ways, conveyencing routes and service ways, drains and storm water control facilities;
- Containment and management of spillage;
- Soil replacement and the preparation of a seed bed to facilitate and accelerate the re-vegetation program and to limit potential erosion on all areas that become available for rehabilitation (temporary servitudes), and
- Soil amelioration (rehabilitated and stockpiled) to enhance the growth capability of the soils and sustain the soils ability to retain oxygen and nutrients, thus sustaining vegetative material during the storage stage.

It will be necessary as part of the development plan to maintain the integrity of the stored soils so that they are available for rehabilitation at decommissioning and closure. If the soil quantities and qualities are (utilisable soils) managed well throughout the operational phase, rehabilitation costs will be reduced and natural attenuation will more easily and readily take effect. This will result in a more sustainable "End Land Use" being achieved.

Residual Impact

In the long term (Life of the operation) and if implemented correctly, the above mitigation measures will reduce the impact on the utilisable soil reserves (erosion, contamination, sterilisation) to a significance rating of medium or possibly low.

However, if the soils are not retained/stored and managed, and a workable management plan is not implemented the residual impact will definitely incur additional costs and result in the impacting of secondary areas (Borrow Pits etc.) in order to obtain cover materials etc.

Table 5.2.1.2 Operational Phase – Impact Significance – Conveyencing System

Activity	Conveyencing of coal from Elders Decline Adit Complex to Block 20, transfer to existing conveyencing system.								
Project Phase	Operational Phase								
Impact Summary	Loss of resource and eco system services, sterilisation of soils and loss of soil utilisation potential, salinisation and/or contamination due to spillage of raw materials, dust and/or dirty water or hydrocarbons from vehicles and machinery. Compaction of peripheral soils if unprotected.								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Long Term	High	Definite	**High**	-ve	High
Management Measures	Minimisation of area of potential impact and concurrent rehabilitation of areas that are nolonger needed for the activity								
	Effective soil and vegitative cover and timeous replacement of soils onto areas that can be rehabilitated								
	Regular cleaning and maintenance of systems and containment of spillage. Adequate stormwater controls.								
	Maintenance of integrety of stored soils, monitoring of nutrient store etc.								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Long Term	Medium	Possible	**Medium**	-ve	Medium

5.2.1.3 Operation of Water Treatment Plant and Sewage Works

Issue: Potential Sterilisation and erosion, de-nutrification and contamination or salinisation of in-situ and stored materials.

The operation of the Water Treatment Plant and Sewage Treatment Facility, inclusive of the release water and sludge containment associated with each of these activities respectively, will potentially have an impact on both the in-situ soils downslope of these facilities as well as on any stored materials that are stockpiled within the zone of influence (berms and soil stockpiles)

The placement of these facilities will inherently sterilise the soils for the life of the facilities operation and render them lost from the resource pool.

The effects of both released water (managed discharge), dirty water runoff from leakage or accumulated deposits and/or dust from dried sludge or salts could affect the soil resources.

In addition, and although of less risk to the soils are the reagents and chemicals used in the operation of the waste treatment facilities under discussion. Contamination through spillage or accidental leakage from the stores, or spillage from the operation of reagents or while in transit, are all considered potential risks.

In summary, the operation will potentially result in:

- The sterilisation of the soil resource on which the facilities are constructed. This will be an on-going loss for the duration of the operation;
- Contamination and salinisation of in-situ and/or stored soils by release of un-treated water, slippage or leakage from raw water dams or sewage works and or impacts of dried sewage sludge and/or salts from unprotected waste storage piles by wind.
- The contamination of the soils by dirty water run-off and or spillage of reagents and hydrocarbons from the stores or vehicles while in transit and from the machinery respectively;
- Contamination of soils by use of dirty water for irrigation of the stockpile vegetation;
- Sterilization and loss of soil nutrient pool, organic carbon stores and fertility of stored soils due to length of time stored, and
- Impact on soil structure and soil water balance for both in-situ soils within the zone of influence as well as the stored materials.

Un-managed soil stockpiles and soil that is left uncovered/unprotected will be lost to wind and water erosion, will loss the all-important, albeit moderately poor nutrient content and organic carbon stores (fertility) and will be prone to contamination of dirty water.

Of a positive impact, will be the rehabilitation of the temporary infrastructure used during the start-up and construction phase.

Impact Significance

The result of these operations on the soil resource will have a negative impact rating that has a magnitude of major, that will last for the life of the operation (permanent to irreversible if not rehabilitated) and will be confined to the immediate site or localised area (possibility of off-site flow – zone of influence).

In the un-managed scenario the frequency is likely to be continuous resulting in a significance rating of medium.

The impacts on the soils during the operational phase can be mitigated with well initiated management procedures.

These should include:

- Minimisation of the area that can potentially be impacted (eroded, compacted, sterilized or de-nutrified);
- Timeous replacement of the soils so as to minimise/reduce the area of affect and disturbance;
- Effective soil cover and adequate protection from wind (dust) and dirty water contamination – vegetate and/or rock cladding;
- Regular servicing of all vehicles in well-constructed and bunded areas;
- Regular cleaning and maintenance of all haulage ways, conveyencing routes and service ways, drains and storm water control facilities;
- Containment and management of spillage;
- Soil replacement and the preparation of a seed bed to facilitate and accelerate the re-vegetation program and to limit potential erosion on all areas that become available for rehabilitation (temporary servitudes), and
- Soil amelioration (rehabilitated and stockpiled) to enhance the growth capability of the soils and sustain the soils ability to retain oxygen and nutrients, thus sustaining vegetative material during the storage stage.

It will be necessary as part of the development plan to maintain the integrity of the stored soils so that they are available for rehabilitation at decommissioning and closure. If the soil quantities and qualities are (utilisable soils) managed well throughout the operational phase, rehabilitation costs will be reduced and natural attenuation will more easily and readily take effect. This will result in a more sustainable "End Land Use" being achieved.

Residual Impact

In the long term (Life of the operation) and if implemented correctly, the above mitigation measures will reduce the impact on the utilisable soil reserves (erosion, contamination, sterilisation) to a significance rating of moderate or possibly low.

However, if the soils are not retained/stored and managed, and a workable management plan is not implemented the residual impact will definitely incur additional costs and result in the impacting of secondary areas (Borrow Pits etc.) in order to obtain cover materials etc.

Table 5.2.2 Operational Phase – Impact Significance – Water and Sewage Treatment Facilities

Activity	Operation of Water Treatment Plant (including the storage of brine and controlled release of treated water)								
Project Phase	Operational Phase								
Impact Summary	Loss of resource and eco system services, plus potential for contamination/salinisation by salts and reagents, dirty water from controlled release from treatment works amd/or sewage works and/or leakage, possible dust impact from drie sewage sludge and/or salts (treatment works), and de-nutrification of stored soils (long time in storage), and loss of nutrient pool. Possible compaction of peripheral soils if unprotected.								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Long Term	High	Definite	**High**	-ve	High
Management Measures	Minimisation/limiting of footprint of impact and concurrent rehabilitation of completed activities								
	Effective soil/rock cladding and adequate protection of soils (in-situ and stored) from water ingress and wind - limiting of erosion and compaction								
	Effective containment of reagents and hydrocarbons, maintenance of vehicles and machinery and auditing of spillage.								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Long Term	Medium	Definite	**Medium**	-ve	High

5.2.3 Decommissioning & Closure Phase

5.2.3.1 Demolishing of all Infrastructure

Issue: Potential for compaction and contamination from heavy vehicles usage and spillage of hydrocarbons, reagents (from infrastructure and machinery), raw materials and dirty water runoff, and the loss of soil due to erosion by wind and or water.

The impacts on the soil resource during the decommissioning and closure phase will have both a positive and a negative effect, with:

- The potential for compaction of peripheral soils around infrastructure being demolished and use of heavy machinery;
- Contamination and salinisation of soils, hydrocarbon and reagent spillage from machinery on site and spillage from dismantled infrastructure, dirty water outflows and dust from demolishing activities;

<u>Impact Significance</u>

The impact will remain the net loss of the soil resource if no intervention or mitigating strategy is implemented. The magnitude of impact will remain moderate and negative for all of the activities if there is no active management (rehabilitation and intervention) in the decommissioning phase, and closure will not be possible.

This will result in an irreversible impact that is continuous.

However, with interventions and well planned management, there will be a net positive impact on the rehabilitated area (soils are replaced and fertilization of the soils is implemented after removal of the infrastructure). The land capability will likely be reduced to grazing status.

The intensity potential of the initial activities during rehabilitation and closure will be moderate and negative due to the necessity for vehicle movement while removing the demolished infrastructure and rehabilitating the operational footprint(s). Dust will potentially be generated and soil will probably be contaminated, compacted and eroded to differing extents depending on the degree of management implemented.

The positive impacts of rehabilitation on the area are the reduction in the footprint of disturbance, the amelioration of the affected soils and oxygenation of the growing medium, the stabilising of slopes and the revegetation of disturbed areas.

<u>Residual Impacts</u>

On closure of the surface infrastructure and operational activities the long-term negative impact on the soils will be reduced from a significance ranking of medium to low if the management plan set out in the Environmental Management Plan is effectively implemented.

Table 5.2.3a Decommissioning Phase – Impact Significance – Demolition of all Infrastructure

CLOSURE/REHABILITATION PHASE									
Activity	Demolishing and rehabilitation of all surface infrastructure								
Project Phase	Closure/Rehabilitation								
Impact Summary	Net Loss of soil volume and utilisation potential due to change in material status (physical and chemical) and loss of nutrient base (de-nutrification), potential for compaction, erosion and contamination by hydrocarbon, reagents and dirty water spills, while reinstatement will increase the footprint of rehabilitated grazing land potential.								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Medium Term	Medium	Definite	**Medium**	+ve/-ve	High
Management Measures	Re-instaement of the stored soils onto areas of disturbance where infrastructure has been demolished and removed.								
	Contour and stabilise slopes to be free draining and limit/control vehicle movement and dirty water outflows, vehicle maintenance and assessment of risk of contamination from infrastructure prior to demolishion								
	Cultivate, amelioration and oxygenation of growing medium, the planting of required vegetative cover and irrigation if required, will reduce/mange erosion, decrease compaction and stabilise the land form. This will once cover has been obtained, effectivily see the sites returned to a grazing land capability rating.								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Medium Term	Medium	Possible	**Low**	+ve/-ve	Medium

5.2.3.12 Rehabilitation of Shaft areas and Conveyer Route Servitude

Issue: Net loss of soil volumes and utilisation potential due to change in material status (Physical and Chemical) and loss of nutrient base.

The impacts on the soil resource during the decommissioning and closure phase will potentially have both a positive and a negative effect, with:

- The loss of the soils original nutrient store and organic carbon by leaching of the soils while in storage;
- Erosion and de-oxygenation of materials while stockpiled;
- Compaction and dust contamination due to vehicle movement while rehabilitating the shaft site and conveyer servitude;
- Contamination of replaced soils by use of dirty water for plant watering and dust suppression on roadways;
- Hydrocarbon or chemical spillage from contractor and supply vehicles.
- areas;
- Positive impacts of reduction in areas of disturbance and return of soil utilisation potential, uncovering of areas of storage and rehabilitation of compacted materials.
- Erosion management/reduction due to slope stabilization and re-vegetation of disturbed

Impact Significance

The impact will remain the net loss of the soil resource if no intervention or mitigating strategy is implemented. The magnitude will remain moderate and negative for all of the activities if there is no active management (rehabilitation and intervention) in the decommissioning phase, and closure will not be possible. This will result in an irreversible impact that is continuous.

However, with interventions and well planned management, there will be a medium to low positive impact, albeit that the effects of heavy machinery and the movement of the soils will potentially have a low negative effect on erosion, contamination and compaction until the rehabilitation process has been completed. Dust will potentially also be generated depending on the degree of management implemented.

The positive impacts of rehabilitation on the area are the reduction in the footprint of disturbance, the amelioration of the affected soils and oxygenation of the growing medium, the stabilizing of slopes land form contouring (free draining slopes) and the revegetation of disturbed areas. These actions will likely reduce the significance rating to low or medium positive, while the land capability will likely be returned to a grazing status.

Residual Impacts

On closure of the mining operation the long-term negative impact on the soils will be reduced from a significance ranking of moderate to low if the management plan set out in the Environmental Management Plan is effectively implemented.

Re-creation of the ferricrete layer effect (inhibiting layer) will require both environmental as well as engineering inputs.

This conclusion supposes that the utilisable soils will be available (had been stripped and stored), and the ferricrete layer (where present) had been removed and stored separately from the sandy loams and sandy clay loams.

Chemical amelioration of the soils will have a low but positive impact on the nutrient status (only) of the soils in the medium term.

Table 5.2.3a Decommissioning Phase – Impact Significance – Rehabilitation of Shaft Area and Conveyer Route Servitude

Activity	Rehabilitation of Decline Adit/Shaft Complex and Conveyer System and associated infrastructure								
Project Phase	Closure/Rehabilitation								
Impact Summary	Net Loss of soil volume and utilisation potential due to change in material status (physical and chemical) and loss of nutrient base (de-nutrification), potential for compaction, erosion, contamination and ponding of surface water, while reinstatement will increase the footprint of rehabilitated grazing land potential.								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Medium Term	Medium	Definite	**Medium**	+ve/-ve	High
Management Measures	Re-instaement of the stored soils onto areas of disturbance where infrastructure has been demolished and removed.								
	Contour and stabilise slopes to be free draining								
	Cultivate, amelioration and oxygenation of growing medium, the planting of required vegetative cover and irrigation if required, will reduce/mange erosion, decrease compaction and stabilise the land form. This will once cover has been obtained, effectivily see the sites returned to a grazing land capability rating.								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Medium Term	Medium	Possible	**Low**	+ve/-ve	Medium

5.2.3.3 Rehabilitation of Decline Adit/Boxcut Complex Site

Issue: Net loss of soil volumes and utilisation potential, bulking factor and the potential for ponding over rehabilitated areas (free draining landscape).

The impacts on the soil resource during the decommissioning and closure phase will have both positive and negative effects. These could include:

- The loss of the soils original nutrient store and organic carbon by leaching of the soils while in storage;
- Erosion and de-oxygenation of materials while stockpiled;
- Compaction and dust contamination due to vehicle movement while rehabilitating the boxcut area;
- Contamination of replaced soils by use of dirty water for plant watering and dust suppression on roadways;
- Hydrocarbon or chemical spillage from contractor and supply vehicles.
- Positive impacts of reduction in areas of disturbance and return of soil utilisation potential, uncovering of areas of storage and rehabilitation of compacted materials
- Erosion due to slope stabilization and re-vegetation of disturbed areas.

<u>*Impact Significance*</u>

The impact will remain the net loss of the soil resource if no intervention or mitigating strategy is implemented. The magnitude of the impact is considered to be moderate and negative for all of the activities if there is no active management (rehabilitation and intervention) in the decommissioning phase, and closure will not be possible. This will potentially result in an irreversible impact that is continuous.

However, with interventions and well planned management, there will be moderate to minor magnitude as the soils are replaced and fertilisation of the soils is implemented. The roll over method of mining and concurrent rehabilitation that is implemented will also reduce the affected footprint to a minimum.

Ongoing rehabilitation during the operational and decommissioning phases will bring about a net long-term positive impact on the soils, albeit that the land capability will likely return to grazing status.

The intensity potential of the initial activities during rehabilitation and closure will be moderate and negative due to the necessity for vehicle movement while rehabilitating the operational footprint(s). Dust will potentially be generated and soil will possibly be contaminated, compacted and eroded to differing extents depending on the degree of management implemented.

The positive impacts of rehabilitation on the area are the reduction in the footprint of disturbance, the amelioration of the affected soils and oxygenation of the growing medium, the stabilising of slopes and the revegetation of disturbed areas.

Residual Impacts

On closure of the mining operation the long-term negative impact on the soils will be reduced from a significance ranking of moderate to low if the management plan set out in the Environmental Management Plan is effectively implemented.

Re-creation of the ferricrete layer effect (inhibiting layer) will require both environmental as well as engineering inputs. This conclusion supposes that the utilisable soils will be available (had been stripped and stored), and the ferricrete layer (where present) had been removed and stored separately from the sandy loams and sandy clay loams.

In the unmanaged state, the impacts will be high and long term. However, if the concerns are well managed as part of the mining plan, and monitored, then the impacts should be moderate to low.

Table 5.2.3a Decommissioning Phase – Impact Significance – Rehabilitation of Boxcut

Activity	Rehabilitation of Boxcut								
Project Phase	Closure/Rehabilitation								
Impact Summary	Net Loss of soil volume and utilisation potential due to change in material status (physical and chemical) and loss of nutrient base (de-nutrification), potential for compaction, erosion, contamination and ponding of surface water, while reinstatement will increase the footprint of rehabilitated grazing land potential.								
Potential Impact Rating	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Unmanaged	Major	Site or Loc	Long Term	Medium	Definite	**Medium**	+ve/-ve	High
Management Measures	Re-instaement of the stored soils backfilled boxcut footprint.								
	Contour and stabilise slopes to be free draining								
	Cultivate, amelioration and oxygenation of growing medium, the planting of required vegetative cover and irrigation if required, will reduce/mange erosion, decrease compaction and stabilise the land form. This will once cover has been obtained, effectivily see the sites returned to a grazing land capability rating.								
After management Measures	**Management**	**Magnitude**	**Spatial Scale**	**Duration**	**Consequence**	**Probability**	**Significance**	**Pos/Neg**	**Conf. Level**
	Managed	Moderate	Site	Long Term	Medium	Possible	**Low**	+ve/-ve	Medium

6. ENVIRONMENTAL MANAGEMENT PLAN

6.1 General

In accordance with the Equator Principles (IFC Performance Principles), and the concept of sustainability, it is incumbent on any developer to not only assess and understand the possible impacts that a development might cause, but to also propose and table management measures that will aid in minimising and where possible mitigate the effects.

The management of the natural resources (soils, land use and land capability) have been assessed on a phase basis (preconstruction, construction, operation and decommissioning/closure) in keeping with the impact assessment (EIA) philosophy, while the Environmental Management Plan (EMP) has been designed as a working plan and utilisation guide for soil and land management.

The results tabled are based on the site specific soil characterisation and classification in conjunction with the geomorphology (topography, altitude, attitude, climate and ground roughness) of the sites that will be impacted or affected.

The plan gives recommendations on the stripping and handling of the soils throughout the life of the development along with recommendations for the utilisation of the soils for rehabilitation at closure.

It has been assumed that all infrastructure will be removed and that the areas that were affected will be returned to as close as possible their pre-construction state (topographic levels, wilderness/conservation or low intensity grazing status – Refer to the Chamber of Mines Land Classification System (Refer to Section 2 - Table 2.2.1 of the Baseline Study).

The concept of stripping, stockpiling and storage of all “Utilisable” soil is recommended as a minimum requirement and as part of the overall Soil Utilisation Philosophy (Refer to Table 6.1 – Soil Stripping Volumes).

In terms of the “Minimum Requirements”, **usable or utilisable soil** is defined here as all soil above an agreed subterranean cut-off depth defined by the project soil scientist, and will vary for different forms of soil encountered in a project area and the type of project being considered. It does not differentiate between topsoil (orthic horizon) and other subsoil horizons necessarily.

The following soil utilisation guidelines **(*all be they generic*)** should be adhered to wherever possible:

- Over areas of deep excavation (Open Pit Mining or Deep excavations/foundations where the majority or all of the soil profile is to be impacted) *strip all usable soil* as defined (750mm) in terms of the soil classification and stockpile as berms or low, terraced dumps. Alluvial soils should be stockpiled separately from the colluvial (shallower) and in-situ derived materials, which in turn should be stored separately from any calcrete material, while the soft overburden is stored as a separate unit, as a defined dump of less than 15m in height preferably.

  Protect from contamination and erosion by rock cladding or vegetation cover and adequate drainage of surface runoff.
  At *rehabilitation* replace the soft overburden followed by the calcrete, compact followed by the soil to appropriate soil depths, and cover areas to achieve an appropriate topographic aspect and attitude to achieve a free draining landscape as close as possible the pre-mining/construction land capability rating.

- Over areas planned for less invasive Structures (Offices, Workshops etc) and any material stockpile or storage, *strip the top 500 mm* of usable soil over all affected areas including terraces and *strip remaining usable soil and calcrete (if present in profile)* where founding conditions require further soil removal.

  Store the soil in stockpiles or berms of not more than 1.5 m around infrastructure area ready for closure rehabilitation purposes. Stockpile hydromorphic (wet) soils separately from the dry materials, and the "calcrete" separately from all other materials.
  Protect all stockpiles from water and wind erosion (loss of materials) and contamination by dust and runoff water. Clad stockpiles with larger rock or vegetate the stored materials.
  At closure/rehabilitation, remove all large boulders and gravel from the rehabilitated landscape and place at the base/bottom of the open pit or rehabilitation profile so that they do not interfere with the tillage and cultivation of the final surface. Remove foundations to a maximum depth of 1m. Replace soil to appropriate soil depths, and over disturbed areas and in appropriate topographic position to achieve pre-development land capability and land form where possible.

- Over area of Tailings Storage Facilities, Waste Rock Dumps and all Heavy Vehicle Haulage Roads and Major Access Routes, *strip usable soil* to a *depth of 750 mm where possible and/or* in areas of *arable soils* and *between 300mm and 500mm* in areas of *soils with grazing land capability.* Stockpile hydromorphic soils separately from the dry and friable materials.

  Before *rehabilitation* remove all gravel and other rocky material and recycle as construction material or place in open voids. Remove foundations to a maximum depth of 1m. Replace soil to appropriate soil depths and in appropriate topographic position so as to achieve pre-mining land capability. Protect the stored materials from erosion and contamination using vegetation or rock cladding.
- Over areas to be utilized for General Access Roads (light delivery vehicles), Laydown Pads and any Conveyencing servitudes (Above ground pipelines and power line servitudes) *strip the top 150 mm* of usable soil over all affected areas and stockpile in longitudinal stockpile or berms upslope of the facilities. Protect from erosion and contamination.

Table 6.1 – Soil Stripping Volumes

Soil Code	Soil Name	Utilisable Soil Depth (m)	Area (Ha)	Area (m2)	% of Area	Stripping Volume (m3)
<4We	Westleigh	0.20	3.92	39 204.75	4.02%	7 841
2-6Dr/Gc	Dresden/Glencoe	0.20	2.56	25 638.27	2.63%	5 128
4-6Av	Avalon	0.40	9.10	90 986.50	9.33%	36 395
4-6Pn	Pinedene	0.40	0.72	7 194.60	0.74%	2 878
6-10Cv	Clovelly	0.80	2.63	26 338.53	2.70%	21 071
6-8Cv	Clovelly	0.70	38.91	389 117.69	39.89%	272 382
6-8Cv/Gc	Clovelly/Glencoe	0.70	1.25	12 459.35	1.28%	8 722
6-8Gf	Griffin	0.70	9.54	95 445.52	9.79%	66 812
6-8Pn/Gc	Pinedene/Glencoe	0.70	17.55	175 482.23	17.99%	122 838
8-10Cv/Pn	Clovelly/Pinedene	0.70	2.19	21 889.13	2.24%	15 322
8-10Pn/Gc	Pinedene/Glencoe	0.70	7.65	76 458.01	7.84%	53 521
Stream	River/Pan	0.00	1.52	15 196.83	1.56%	0
	Total Area (Ha)		**97.54**		**100.00%**	612 908

Table 6.2 – Soil Stripping Volumes per depth

Soil Code	Utilisable Soil Depth (m)	Area (m2)	Volume by Depth (m3)
4-6Av	0.40	90 986.50	49 363
8-10Pn/Gc	0.70	76 458.01	563 545
l Area (Ha)			

The shallow materials are for the most part associated with a hardpan ferricrete and should be stockpiled separately.

6.2 Preconstruction and Construction Phase

The construction methods and final end land use are important in deciding if the utilisable soils need to be stripped and retained, and ultimately how much of the materials will be needed for the rehabilitation (stripping volumes). However, it should be noted that failure to remove and store the utilisable materials will result in the permanent loss of the growth medium.

Making provision for retention of utilisable material for the decommissioning and/or during rehabilitation will not only save significant costs at closure, but will ensure that additional impacts to the environment are reduced.

The depths of utilisable materials vary between 300mm and greater than 1,500mm.

Due to the shallow soil depths on the more rocky areas it is recommended that sufficient materials are removed from the areas were adequate soil depths are present and do exist, so that the shallow areas can be adequately resorted during rehabilitation and at closure.

For the Boxcut and Decline Adit/Shaft Complex as a whole, the nature of the activities that will take place and the infrastructure that is to be constructed (Deep excavations, Dirty Water and Workshops, RoM Stockpiles and heavy machinery) it is recommended that at least 750mm of soil should be removed/stripped wherever possible.

The conveyencing route and access roads/ways will require that at least 500mm of soil is removed and stored where it is available.

The sites rated as low sensitivity are sufficiently similar that they can be stored as one soil group (Refer to Figure 3 – Soil Sensitivity Map). However, the Highly Sensitive and "No Go" areas (hydromorphic soils) should not be impacted unless absolutely necessary, and then only if the necessary permissions have been obtained (licenses etc.). The ferricrete mentioned as part of the baseline study are also considered more sensitive sites that are generally both shallow as well as associated with wetness (either relic or of a recent nature), and should be wherever possible, these layers should have been stripped and stored separately from the utilisable topsoil and underlying soft rock.

Table 6.2 describes the proposed utilisation of the soils during the preconstruction and construction phase.

Table 6.2 Construction Phase – Soil Utilisation Plan

Phase	Step	Factors to Consider	Comments
Construction	Delineation of areas to be stripped		Stripping will only occur where soils are to be disturbed by activities that are described in the design report, and where a clearly defined end rehabilitation use for the stripped soil has been identified.
	Reference to biodiversity action plan		It is recommened that all vegetation is stripped and stored as part of the utilisable soil. However, the requirements for moving and preserving fauna and flora according to the biodiversity action plan should be consulted.
	Stripping and Handling of soils	Handling	Soils will be handled in dry weather conditions so as to cause as little compaction as possible. Utilisable soil (Topsoil and upper portion of subsoil B2/1) must be removed and stockpiled separately from the lower "B" horizon, with the ferricrete layer being seperated from the soft/decomposed rock, and wet based soils seperated from the dry soils if they are to be impacted.
		Stripping	The "Utilisable" soil will be stripped to a depth of 750mm or until hard rock/ferricrete is encountered. These soils will be stockpiled together with any vegetation cover present (only large vegetation to be removed prior to stripping). The total stripped depth should be 750mm, wherever possible.
	Delineation of Stockpiling areas	Location	Stockpiling areas will be identified in close proximity to the source of the soil to limit handling and to promote reuse of soils in the correct areas. All stockpiles will be founded on stabilized and well engineered "pads"
		Designation of Areas	Soils stockpiles will be demarcated, and clearly marked to identify both the soil type and the intended area of rehabilitation.

This "Soil Utilisation Plan" is intimately linked to the "development plan", and it should be understood that if the plan of construction changes, these recommendations will probably have to change as well.

6.3 Operational Phase

The operational phase will see very little change in the development requirements, with the footprint of disturbance remaining constant, albeit that the temporary infrastructure might become redundant and rehabilitation of these features might be possible.

Maintenance and care of the soil and land resources will be the main management activity and objective required during the operational phase. Management of material loss, compact and contamination are the main issues of consideration. Table 6.3 details recommendations for the care and maintenance of the resource during the operational phase.

The semi-arid climate and unique character of the soils in these areas require that the site specific and unique natural phenomena should be used to the advantage of the project.

Working with or on the differing soil materials (all of which occur within the areas that are to be disturbed) will require better than average management and careful planning if rehabilitation is to be successful, and it is important that the sensitive and highly sensitive materials are avoided wherever possible.

Care in removal and stockpiling or storage of the "Utilisable" soils, and protection of materials which are derived from the "hardpan ferricrete" layer is imperative to the success of sustainable rehabilitation in these areas, with the soil water (near surface water) held within the profile by the inhibiting layer believed to be integral to the success of the biodiversity and ecological systems.

Table 6.3 Operational Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Operation	Stockpile management	Vegetation establishment and erosion control	Enhanced growth of vegetation on the Soil Stockpiles and berms will be promoted (e.g. by means of watering and/or fertilisation), or a system of rock cladding will be employed. The purpose of this exercise will be to protect the soils and combat erosion by water and wind.
		Storm Water Control	Stockpiles will be established/engineered with storm water diversion berms in place to prevent run off erosion.
		Stockpile Height and Slope Stability	Soil stockpile and berm heights will be restricted where possible to <1.5m so as to avoid compaction and damage to the soil seed pool. Where stockpiles higher than 1.5m cannot be avoided, these will be benched to a maximum height of 15m. Each bench should ideally be 1.5m high and 2m wide. For storage periods greater than 3 years, vegetative (vetiver hedges and native grass species - refer to Appendix 1) or rock cover will be essential, and should be encouraged using fertilization and induced seeding with water and/or the placement of waste rock. The stockpile side slopes should be stabilized at a slope of 1 in 6. This will promote vegetation growth and reduce run-off related erosion.
		Waste	Only inert waste rock material will be placed on the soil stockpiles if the vegetative growth is impractical or not viable (due to lack of water for irrigation etc.). This will aid in protecting the stockpiles from wind and water erosion until the natural vegetative cover can take effect.
		Vehicles	Equipment, human and animal movement on the soil stockpiles will be limited to avoid topsoil compaction and subsequent damage to the soils and seedbank.

6.4 Decommissioning and Closure

The decommissioning and closure phase will see:

- The removal of all infrastructure;
- The demolishing of all concrete slabs/plinths and the ripping of any hard/compacted surfaces;
- The backfilling of all voids and deep foundations and the reconstruction of the required barrier layer (compaction of ferricrete and clay rich materials) wherever feasible and possible;
- Topdressing of the disturbed and backfilled areas with the stored “utilisable” soil ready for re-vegetation;
- Fertilisation and stabilisation of the backfilled materials and final cover materials (soil and vegetation) and
- The landscaping of the replaced soils to be free draining.

There will be a positive impact on the soil and land capability environments as the area of disturbance is reduced, and the soils are returned to a state that can support low intensity wildlife grazing or sustainable conservation.

Table 6.4 is a summary of the proposed management and mitigation actions recommended.

Table 6.4 Decommissioning and Closure Phase – Soil Conservation Plan

Phase	Step	Factors to Consider	Comments
Decommissioning & Closure	Rehabilitation of Disturbed land & Restoration of Soil Utilization	Placement of Soils	Stockpiled soil will be used to rehabilitate disturbed sites either ongoing as disturbed areas become available for rehabilitation and/or at closure. The utilisable soil (500mm to 750mm) removed during the construction phase, must be redistributed in a manner that achieves an approximate uniform stable thickness consistent with the approved post development end land use (Conservation land capability and/or Low intensity grazing), and will attain a free draining surface profile. A minimum layer of 300mm of soil will be replaced.
		Fertilization	A representative sampling of the stripped and stockpiled soils will be analysed to determine the nutrient status and chemistry of the utilizable materials. As a minimum the following elements will be tested for: EC, CEC, pH, Ca, Mg, K, Na, P, Zn, Clay% and Organic Carbon. These elements provide the basis for determining the fertility of soil. based on the analysis, fertilisers will be applied if necessary.
		Erosion Control	Erosion control measures will be implemented to ensure that the soil is not washed away and that erosion gulleys do not develop prior to vegetation establishment.
	Pollution of Soils	In-situ Remediation	If soil (whether stockpiled or in its undisturbed natural state) is polluted, the first management priority is to treat the pollution by means of in situ bioremediation. The acceptability of this option must be verified by an appropriate soils expert and by the local water authority on a case by case basis, before it is implemented.
		Off site disposal of soils.	If in situ treatment is not possible or acceptable then the polluted soil must be classified according to the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (Local Dept of Water Affairs) and disposed of at an appropriate, permitted, off-site waste facility.

6.5 Monitoring and Maintenance

Nutrient requirements reported herein are based on the monitoring and sampling of the soils at the time of the baseline survey. These values will definitely alter during the storage stage and will need to be re-evaluated before being used during rehabilitation. Ongoing evaluation of the nutrient status of the growth medium will be needed throughout the life of the project and into the rehabilitation phase.

During the rehabilitation exercise preliminary soil quality monitoring should be carried out to accurately determine the fertiliser requirements that will be needed. Additional soil sampling should also be carried out annually until the levels of nutrients, specifically magnesium, phosphorus and potassium, are at the required levels for sustainable growth. Once the desired nutritional status has been achieved, it is recommended that the interval between sampling is increased. An annual environmental audit should be undertaken. If growth problems develop, ad hoc, sampling should be carried out to determine the problem.

Monitoring should always be carried out at the same time of the year and at least six weeks after the last application of fertilizer.

Soils should be sampled and analysed for the following parameters:

pH (H_2O)	Phosphorus (Bray I)	
Electrical conductivity	Calcium mg/kg	
Cation exchange capacity	Sodium mg/kg;	
Magnesium mg/kg;	Potassium mg/kg	Zinc mg/kg;
Clay	Organic matter content (C %)	

The following maintenance is recommended:

- The area must be fenced, and all animals kept off the area until the vegetation is self-sustaining;
- Newly seeded/planted areas must be protected against compaction and erosion (Vetiver hedges etc.);
- Traffic should be limited were possible while the vegetation is establishing itself;
- Plants should be watered and weeded as required on a regular and managed basis were possible and practical;
- Check for pests and diseases at least once every two weeks and treat if necessary;
- Replace unhealthy or dead plant material;
- Fertilise, hydro seeded and grassed areas soon after germination, and
- Repair any damage caused by erosion.

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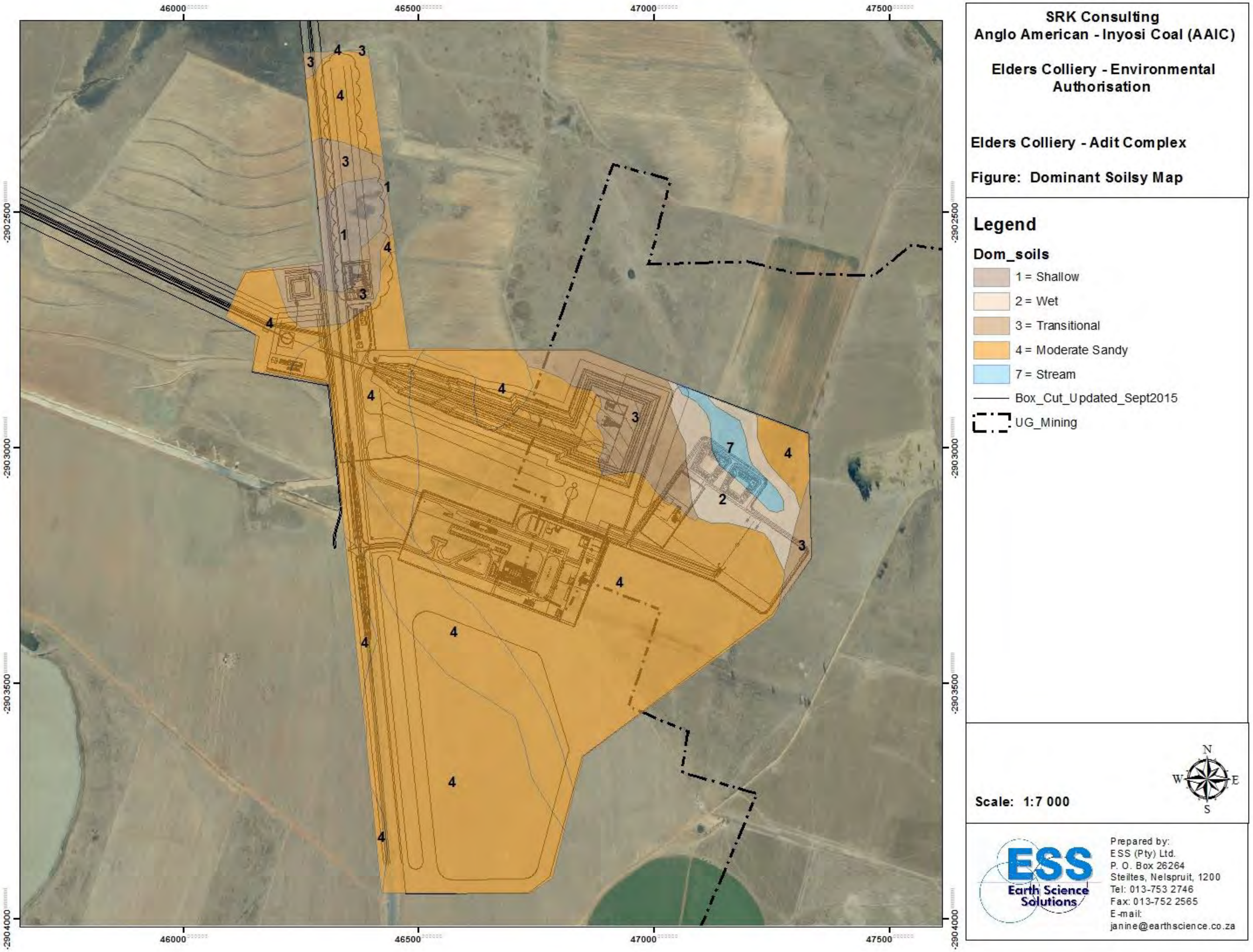
APPENDIX 1

SITE MAPS A3)

(Dominant Soils, Land Use and Land Capability)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Elders Colliery - Environmental Authorisation
Elders Colliery - Adit Complex
Figure: Dominant Soilsy Map
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1 = Shallow
2 = Wet
3 = Transitional
4 = Moderate Sandy
7 = Stream
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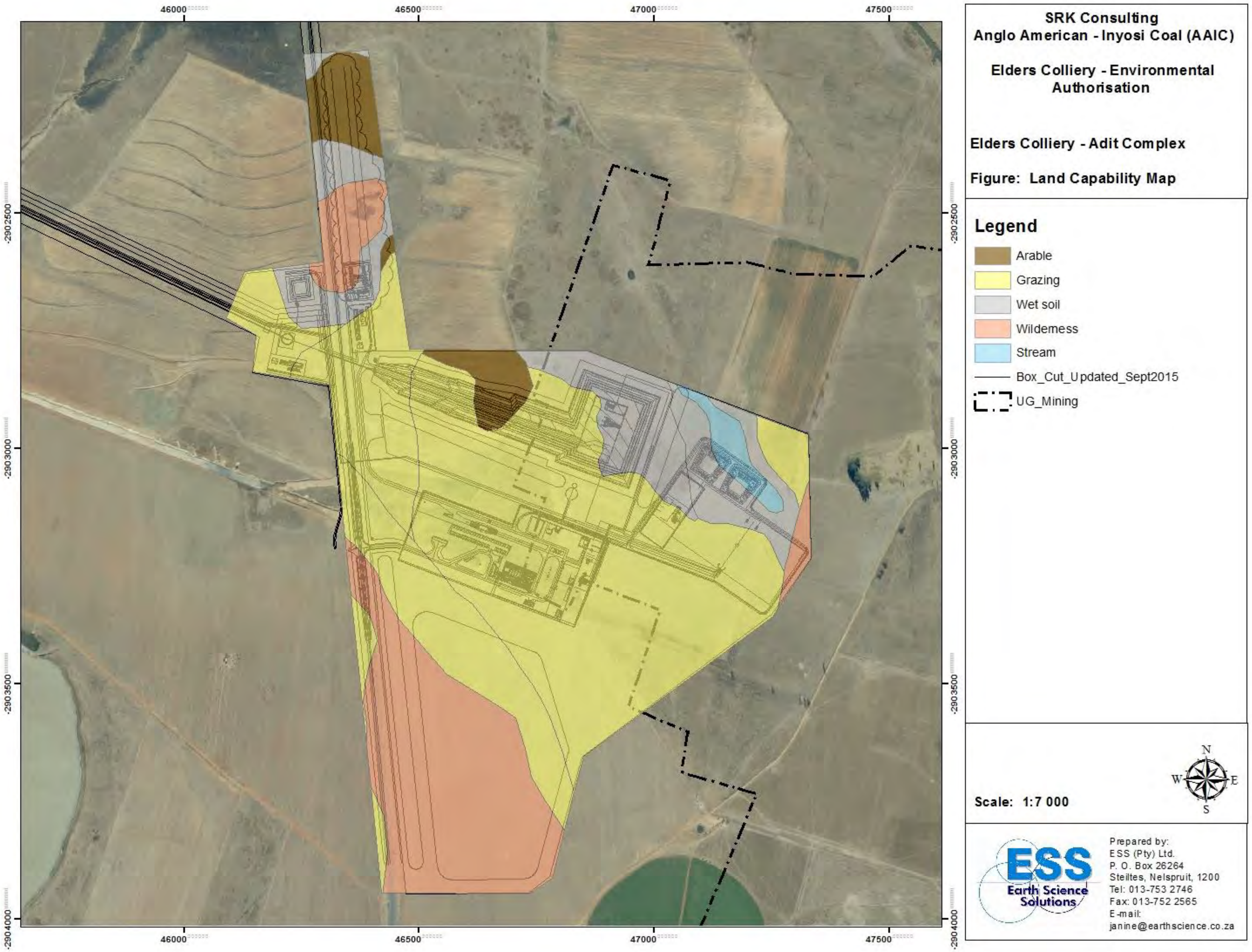
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Figure: Land Capability Map
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Wilderness
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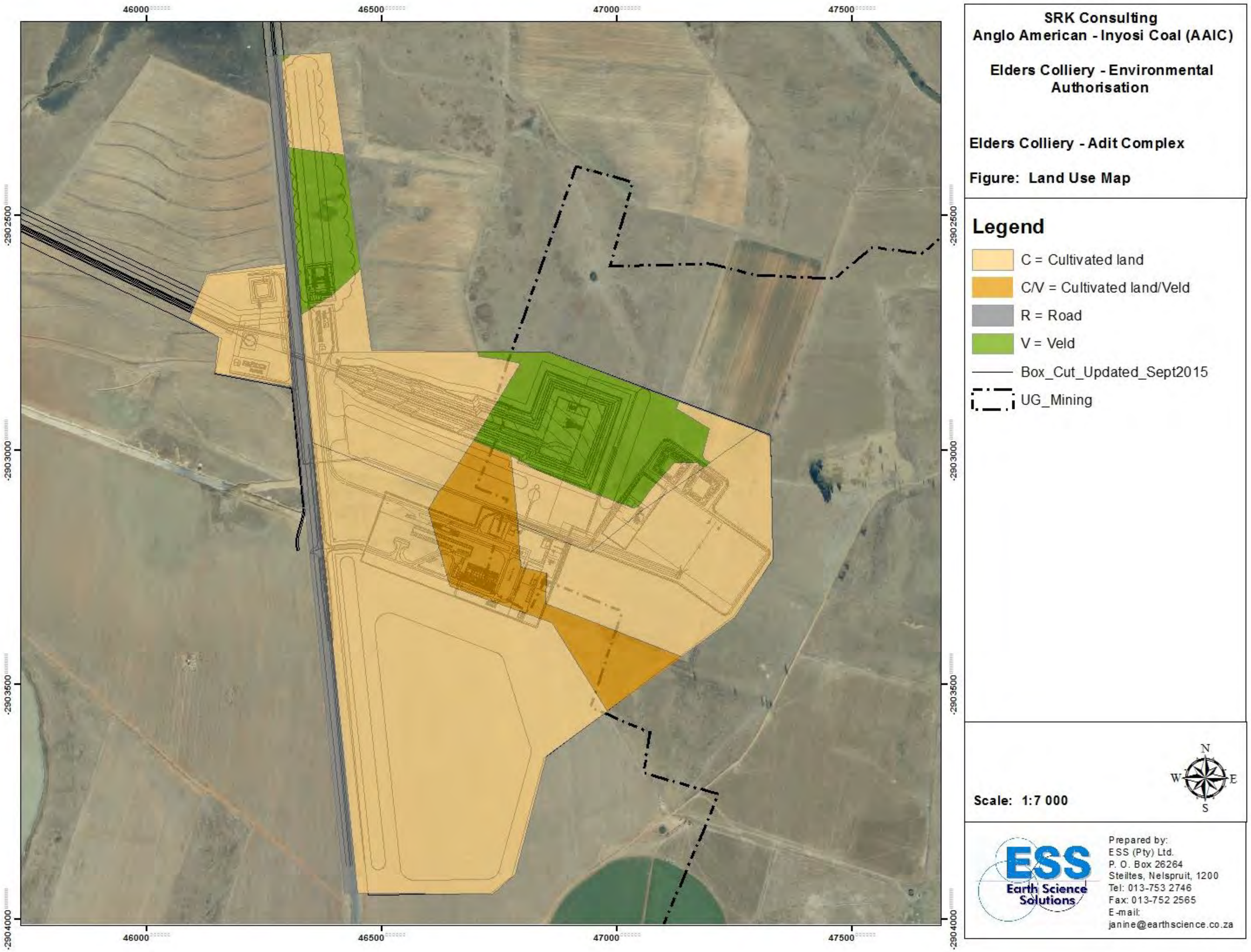
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Elders Colliery - Environmental Authorisation
Elders Colliery - Adit Complex
Figure: Land Use Map
Legend
C = Cultivated land
C/V = Cultivated land/Veld
R = Road
V = Veld
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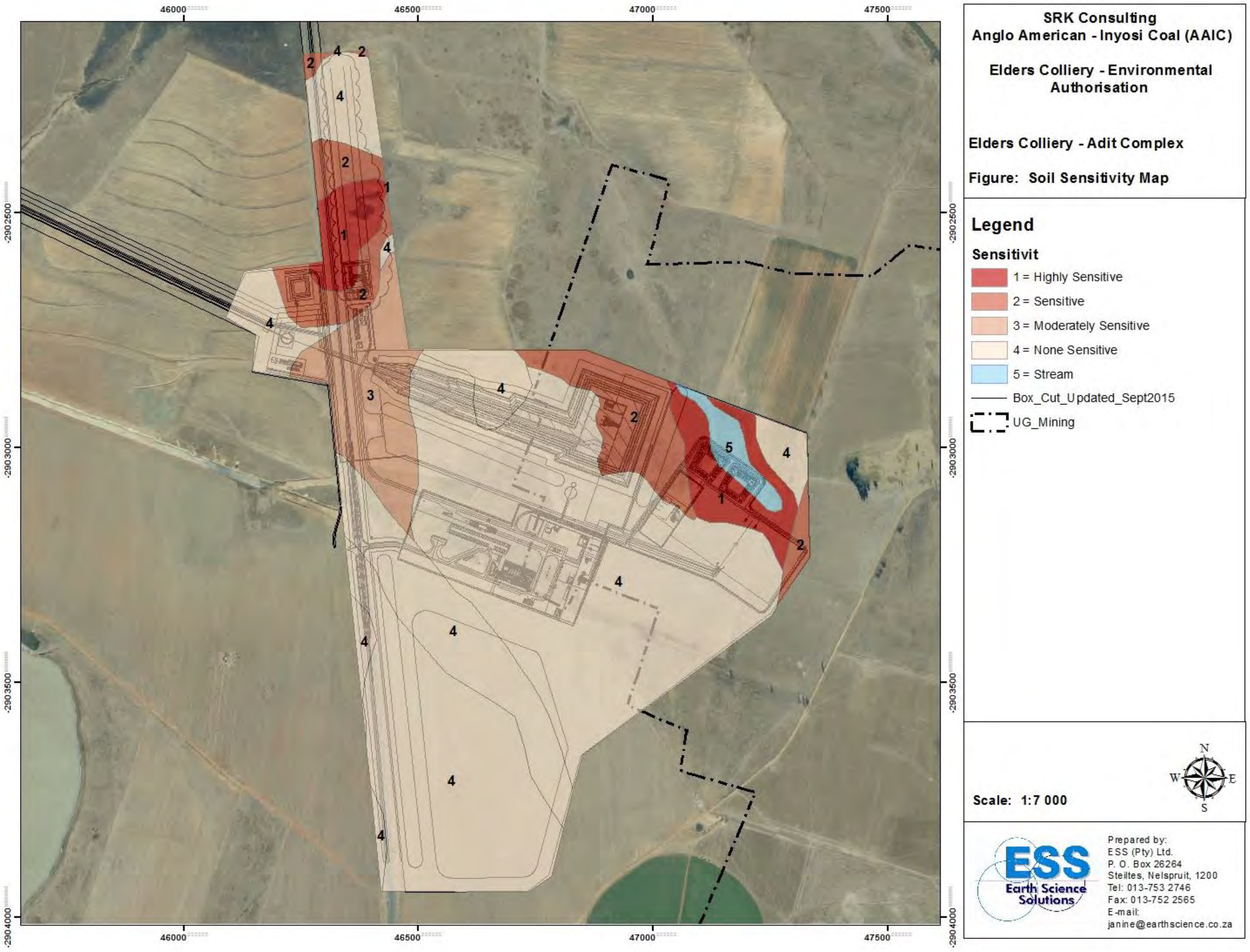
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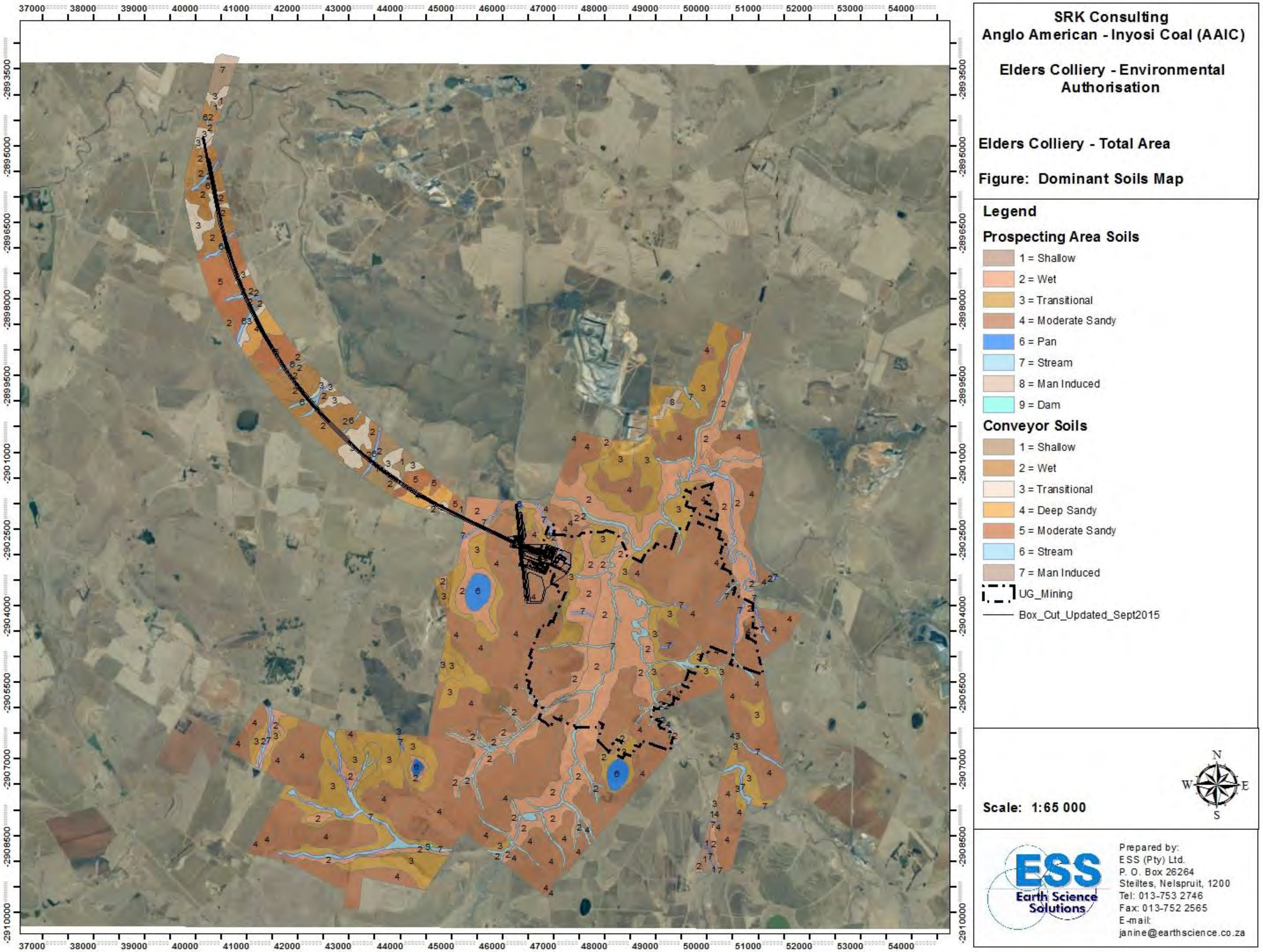
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Elders Colliery - Total Area
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Prospecting Area Soils
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3 = Transitional
4 = Moderate Sandy
6 = Pan
7 = Stream
8 = Man Induced
9 = Dam
Conveyor Soils
1 = Shallow
2 = Wet
3 = Transitional
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5 = Moderate Sandy
6 = Stream
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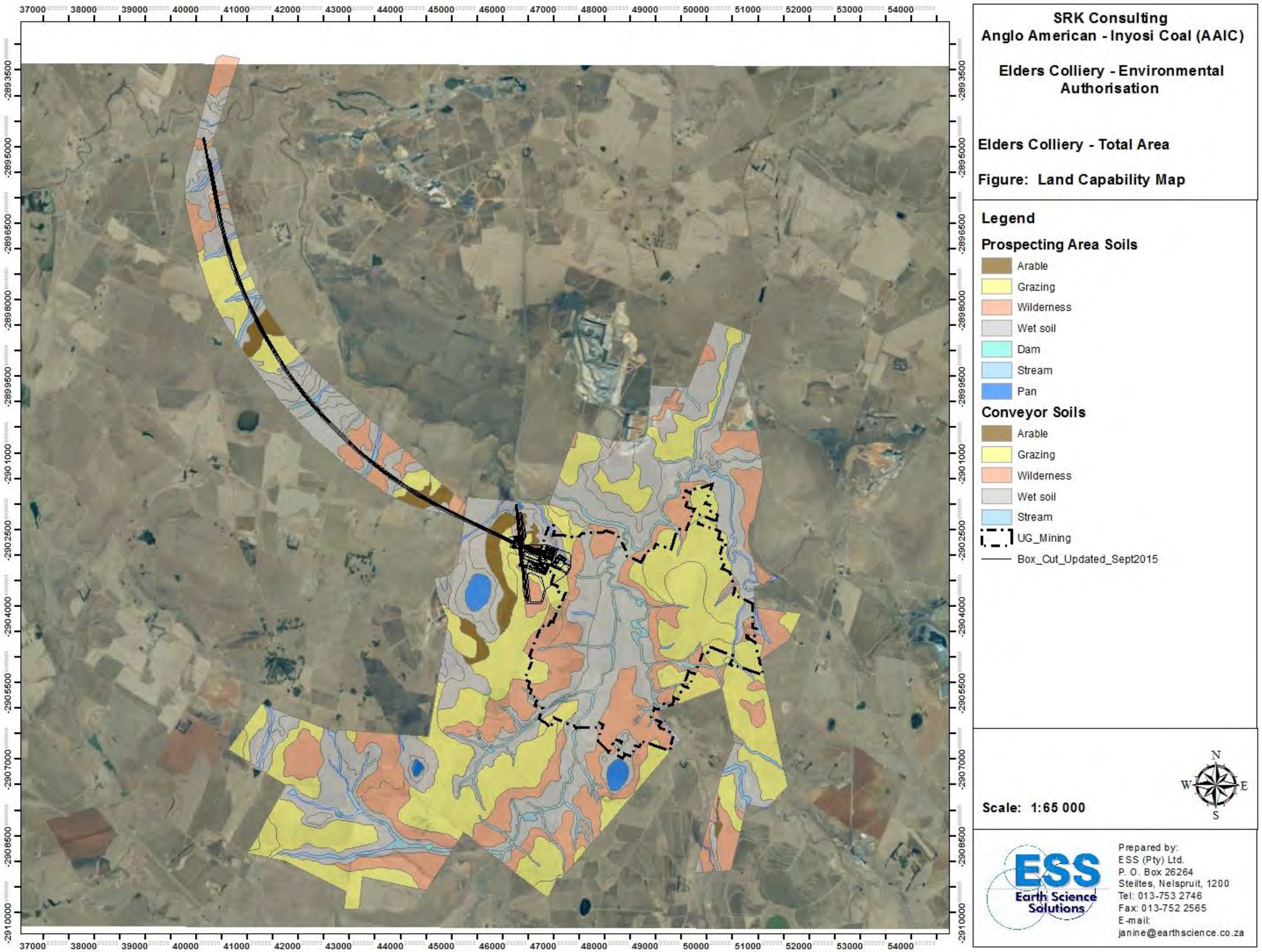
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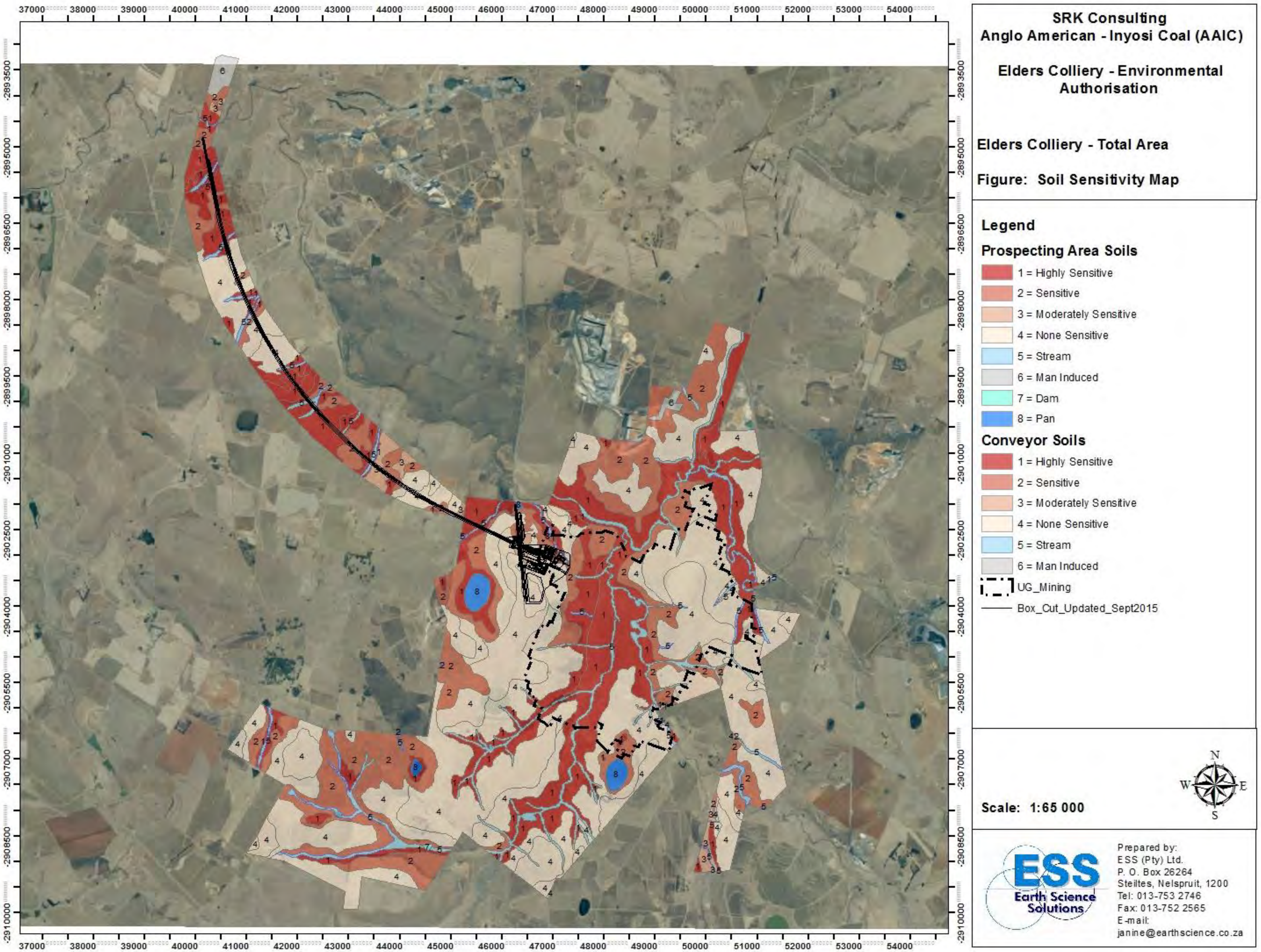
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APPENDIX 2

FERRICRETE CLASSIFICATION

Appendix G3: Biodiversity Specialist Study

Biodiversity Baseline Report For The Proposed Elders Colliery In Mpumalanga Province – Anglo Operations (Pty) Ltd

Commissioned by

SRK Consulting Pty (Ltd)

Compiled by

EkoInfo CC & Associates

September 2015

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20 Years

1995 - 2015

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Field of expertise	Flora, Ecology, Soil, Wetlands, GIS	Zoology, Ecology, Entomology	Herpetofauna & Mammalogy	Avifauna & Entomology
Years experience	15 – Full time	14 (11 full time)	9 years	9 years
Professional Registration	Pr.Sci.Nat. - Botany & Ecology (400100/02)	Pr.Sci.Nat. – Zoology & Ecology (400204/05)	Pr.Sci.Nat. - Zoology (400506/11)	Pr.Sci.Nat. - Zoology & Ecology (400095/06)
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Logo				

Report Status	**Version**	**File Route**
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1 EXECUTIVE SUMMARY

SRK appointed EkoInfo CC and its associates to update the existing flora data and compile it into a single biodiversity report which expand on the fauna information for the proposed Elders Colliery. The scope of work requested an update of the existing vegetation result from the November 2002 study, while completing a fauna study. The end result is single biodiversity document which reflects the terrestrial biodiversity, the wetland and aquatic components are dealt with in detail in separate documents.

SRK requested to update the existing document, as more than a a year has lapsed since the compilation of the February 2013 document. Willem de Frey and Dewald Kamffer as the principal botany and zoology ecologists updated the February 2013 document, during September 2015.

Environmental Overview

The original study completed in November 2002 covered a much larger area than the current footprint of the Elders Colliery. However the current study also had to consider the impacts of a proposed conveyor route between the proposed Elders Colliery and the existing Goedehoop Colliery, Block 20 shaft (currently on care and maintenance). Therefore this footprint extended across two quaternary catchments (B11A & B11B).

Therefore a review is provided of the environment covering the extent of the two quaternary catchments as is referred to as the regional area of influence.

The Elders area is located within the following regional vegetation unit, namely: Eastern Highveld Grassland. This regional vegetation unit is considered to be Endangered.

The extent of cultivated land within the regional area of influence (quaternary catchments – B11A & B11B) reflects the pressure that this vegetation unit is experiencing with cultivation covering 46% (main driver) and 48% of the regional area of influence being transformed in total due to cultivation, urbanisation, and mining.

Therefore the remaining natural vegetation within the regional area of influence is considered to be of very high conservation importance on both a national and regional level.

Flora component

Willem de Frey, a registered professional in the fields of botanical – and ecological science facilitated this vegetation component of the biodiversity report. He has more than 15 years experience completing vegetation studies in South Africa and its neighbouring countries.

The original data and results from the November 2002 study are provided as is, while the February 2013 study expanded on it. The objective of the current September 2015 survey was to update the results from the previous surveys (2002 and 2013), in terms of recent changes in spatial and species data.

<u>November 2002</u>

The survey was done during November 2002. This falls within the optimal period for vegetation surveys in the summer rainfall region between November and March. Rainfall was late, resulting in a poorly developed grasslayer, which hampered identification. The Braun-Blanquet approach was applied, which is the phytosociological standard for vegetation surveys in South Africa.

The TWINSPAN analysis and Braun-Blanquet table confirmed the presence of two plant communities and four sub communities, of which only the community stands that correspond with the soil map were mapped. The two communities and four sub communities are:

1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils
    1.1. *Verbena bonariensis - Eragrostis plana - Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils
    1.2. *Verbena bonariensis - Eragrostis plana - Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils

2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils
    2.1. *Themeda triandra - Senecio erubescens - Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils
    2.2. *Themeda triandra - Senecio erubescens - Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils

Soil texture, altitude and human influence determine the distribution and condition of these two communities and their sub communities.

Potential habitat for four red data species occurs in the study area. Only one of the three, a near threatened species was recorded during the survey. This was the geophyte *Hypoxis hemerocallidea* Fisch. & C.A.Mey. The only species with a vulnerable status is the geophyte *Nerine gracilis* R.A.Dyer which is associated with clayey soils. It should be noted that ALL of the species from the three genera *Gladiolus, Crinum* and *Cyrtanthus* are protected in terms of the Mpumalanga Conservation Act's list of protected flora. Representatives from all three taxa occur in the area. Two declared weeds and/ or invasive plant species from the Conservation of Agricultural Resources Act were present within the surveyed areas.

The conservation status of the *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils and the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils is 50% and 53% respectively. The slightly higher conservation status of the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils, in spite of its lower ecological status, is attributed to its smaller extent and association with drainage lines (riparian wetlands). Its lower ecological status reflects this association, as a result of its exploitation through over utilisation.

February 2013

An additional 12 plots were surveyed during February 2013 mainly within the areas beyond the original extent and along the conveyor route.

The results from the November 2002 study was used to classify the vegetation in conjunction with recently available Landsat 8 satellite imagery from April 2013.

Based on this refined classification, most of the Elders Colliery proposed infrastructure footprint is located within a transformed fragmented area while the conveyor transects an area of intact natural vegetation with a high conservation priority.

With regards to species of concern (Red Data, protected, medicinal), five (5) species threatened Red Data plants (Vulnerable, Endangered, Critical Endangered) namely: *Anacampseros subnuda* Poelln. subsp. *lubbersii* (Bleck) Gerbaulet (Vulnerable), *Frithia humilis* Burgoyne (Endangered), *Khadia carolinensis* (L.Bolus) L.Bolus (Vulnerable), *Nerine gracilis* R.A.Dyer (Vulnerable), *Pachycarpus suaveolens* (Schltr.) Nicholas & Goyder (Vulnerable) had been recorded within the topocadastral grids associated with the study. However the probability of the occurrence of species of concern is low for the Elders footprint area, but high for the conveyor route.

Therefore based on the November 2002 results plus the latest national and regional assessments, the ecological sensitivity of the two vegetation communities were adjusted to high for the *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils and very high for the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils.

September 2015 Update

Since the February 2013 report, the Red Data flora list had been updated in September 2015; however a comparison of the 2009 list and the current 2015 list indicated no change with regards to the expected threatened Red Data plants to be expected within the study area. Therefore the *status quo* remains with regards to the ecosystem diversity and species diversity. However in October 2014, the National Environmental Management Biodiversity Act's alien invasive regulations were updated and three recorded species previously excluded, was included and needs to be eradicated, especially the **pompom weed** (Category 1b) should be prioritised.

During the September 2015 site visit, it was noticed that the remaining patches vegetation (natural or pastures) in the new location of the non-linear infrastructure (mining complex) correlates with wetland conditions, which would explain why they had not been ploughed. Furthermore, the intrusion of a 80 ha open cast mine in the large area of intact high conservation priority grassland through which the proposed conveyour route transects was noticed. The southernly shift of the conveyour route does not contribute to the conservation of flora species of concern, and therefore the risk and impact remains the same.

Fauna component

Dewald Kamffer, a registered professional in the fields of zoological – and ecological science facilitated this fauna component of the biodiversity report. He has more than 10 years experience completing fauna studies in South Africa and its neighbouring countries. He evaluated the results and compiled the report while being assisted by a multi-disciplinary team in the veld during the field surveys in February 2013 consisting of:

1. Luke Verburght – herpetologist
2. Samuel Laurence – mammalogist
3. Lukas Niemand – ornithologist

He was responsible for the collection of the invertebrate data.

February 2013

A total of 153 Red Data animals are known to occur in Mpumalanga (dragonflies, damselflies, butterflies, frogs, reptiles, birds and mammals). These include species listed as Data Deficient (22), Near Threatened (65), Vulnerable (43), Endangered (16), Critically Endangered (7) and Extinct (1). Based on size, location, connection, and status and diversity of the faunal habitats in the study area, it is estimated that 101 of these species have a low probability of occurrence (PoC). It is estimated that 9 species have a moderate-low PoC, 17 a moderate PoC, 6 a moderate-high PoC and 12 species a high PoC. **Eight red data species were confirmed to occur** in the study area: Greater Flamingo, Blue Korhaan, African Grass-Owl, Melodious Lark, Honey Badger, Brown Hyaena, Leopard and Serval. The presence of 172 animal species, including 33 invertebrates, 9 frogs, 8 reptiles, 99 birds and 23 mammals, were confirmed for the study area during the 2013 summer investigation. **The animals confirmed for the study area included eight red data species and 83 provincially protected species.** The faunal habitat sensitivity analyses revealed the following results: Cultivated lands, Road infrastructure and Mining areas have very low faunal sensitivities. *Verbena* grassland on coarse soils has a high faunal sensitivity and ***Themeda* grassland on fine soils and the wetland of the study area have very high faunal sensitivities.** At least seven wetland and eleven grassland Red Data species are expected to occur in the study area on a temporary or permanent basis.

September 2015 Update

The results obtained during the field investigation and desktop update of September 2015 supported the 2013 results. The grasslands and wetlands of the study area are considered to have high faunal sensitivities. These faunal habitats found in the study area are good quality faunal habitats that well connected to other large, untransformed areas in a generally transformed and fragmented landscape. The faunal species found to occur in the study area, both during field investigations and desktop update studies, support the assigned high sensitivity of the natural faunal habitats of the study area.

Total Ecological Sensitivity

February 2013

The total ecological sensitivity was derived from the flora and fauna sensitivity. It should be note that the wetlands (pans, seeps, drainage areas) were rated lower in the total ecological sensitivity than compared to the fauna sensitivity. This is due to the influence of the flora sensitivity, but the wetlands will have an higher conservation significance when the information from the detailed wetland and aquatics studies are incorporated with it.

From, the total ecological assessment it is evident that the northern section of the prospecting area and most of the area transected by the conveyor is very high sensitive with regards to the conservation of biodiversity in the area and should therefore present the core of the proposed mine's biodiversity action plan.

September 2015 Update

No change has occurred with regards to the total ecological sensitivity as documented during the February 2013 assessment, except for the intrusion of an open cast mine along the western end of the conveyour route. The open cast mine resulted in the transformation of 80 ha previously untransformed grassland, which included both high and very high total ecological sensitivity areas. The intrusion of this mine plus the development of the proposed conveyour route will increasingly contribute to habitat loss and habitat fragmentation of this large area of intact grassland, eventually eroding the ecological sensitivity of the area.

Impact Assessment And Mitigation

February 2013

For the purpose of this section the proposed mining activity was divided into two categories, namely non-linear and linear. The non-linear component concerned the shaft and mini pit areas and related infrastructure for the proposed Elders Colliery. The total footprint of the non-linear infrastructure is 212 ha. The linear component concerned the proposed conveyor of 10 km with a 36 m servitude which would link the proposed Elders Colliery with the existing Goedehoop Colliery. It total footprint is 36 ha.

The main biodiversity impacts concernerd with the proposed mining activity are:

1. Habitat loss
2. Habitat fragmentation
3. Loss of species of concern
4. Cumulative or indirect impacts.

The impacts and proposed mitigation is discussed per category.

Based on the impact assessment, it is concluded that the regional and local significance of the non-linear infrastructure is low, due to the small footprint and already transformed/ fragmented nature of the local area. However, the same is not true for the linear infrastructure because although its footprint is small, it transects such a large intact natural area that it has a high probability of influence the local and regional biodiversity negatively.

Therefore a recommendation is made that the post mining environment should be optimised to reduce the cumulative/ indirect impacts of the proposed mining activity especially with regards to habitat loss and habitat fragmentation, while alternatives should be considered for the conveyor route which is currently not the case.

September 2015 Update

A significant reduction in impact, especially on a regional scale comes from the current mine plan which exclude the open cast area, with only underground mining to take place. This will reduce the transformation ripple effect within the landscape, as existing cultivated land can be kept in production.

The new location of the non-linear infrastructure (mining complex/ area) remains mainly within a highly fragmented farming environment, and therefore the impacts remain the same as documented during the February 2013.

Although the conveyour route has shifted slightly to the southwest, the impacts remain exactly the same as documented during the February 2013 assessment and therefore the proposed mitigation remains the same.

It is recognised that the removal of the open cast mining has reduced the ripple effect of transformation on a regional scale, however the current conveyor route remains a stumble block and more alternatives should be evaluated.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF PHOTOS

LIST OF TABLES

2 INTRODUCTION

2.1 Previous assessments – 2009 & 2013

SRK requested EkoInfo CC to update the existing vegetation report compiled for Oryx Environmental cc in 2002, to a single biodiversity report which includes a fauna component. The original vegetation study took place during November 2002, which falls within the optimal flowering period of the summer rainfall region of South Africa, which is from November to March. The Braun-Blanquet method was used to assess the vegetation, which has become a phytosociological standard for vegetation description and mapping in South Africa (Mentis & Huntley 1982, de Frey 1999). The new study occurred during February 2013 and involved a multi-disciplinary team of zoologists collecting information on herpetofauna (frogs & reptiles), mammals, avifauna and invertebrates.

This document focus mainly on the terrestrial biodiversity, the wetland and aquatic components are dealt with in separate documents.

The vegetation component under the auspices of Willem de Frey, a registered professional in the fields of botanical - and ecological science, expands on the November 2002 results with regards to the proposed Elders Colliery. The fauna component under the auspices of Dewald Kamffer, a registered professional in the fields of zoological – and ecological science, presents and discusses the latest results from the February 2013 multi-disciplinary team with regards to the proposed Elders Colliery and the conveyor route.

2.2 Current assessment - 2015

The current assessment which took place during September 2015, builds on the previous assessments in 2009 and 2013. The main objectives of the current assessment are:

1. To assess changes in the conservation status of both habitat/ ecosystems and species, both flora and fauna, previously recorded,
2. To assess the potential impact of the changes in the mining plan on these ecosystems and species.

The team, who reviewed the status of these habitats and species, is the same principal ecologists who facilitated the February 2013 assessment, namely:

1. Willem de Frey – flora component
2. Dewald Kamffer – fauna component

The review was done during September 2015, and consisted of the following components:

1. Literature – and desktop review
2. Site visit
3. Integration meeting
4. Report update

3 LOCATION

The original study area, surveyed in November 2002 was situated to the north of the town of Trichardt and Bethal in the Mpumalanga Province (Figure 1). It includes portions of the original farms Middelkraal 50, Halfgewonnen 190, Bosch Krans 53, Elandsfontein 75, Vlakkuilen 76, Vlakfontein 72, Schurwekop 227, Geluk 226, Rensburghoop 74, Legdaar 78, Witbank 80 and Kafferstad 79. The current study area (prospecting area), surveyed in February 2013 represents the eastern section of the original study area.

A broad environmental overview is provided to assist in determining the environmental factors, which influence the distribution of the vegetation in the area, as well as to evaluate the conservation status of the vegetation within the study area.

3.1 Geological attributes

Two stratigraphic units underlay the area. Sedimentary arenite[1], and shale of the Vryheid Formation within the Ecca Group of the Karoo sequence, form a mosaic with younger igneous dolerites. These dolerites are known as the Karoo dolerites (Figure 2). Depending on their sequence and manner of exposure, these lithological units will have an influence on the regional soil texture.

Both the dolerites and shales are sources of fine textured soils. It is therefore expected that clayey soils would be common in the area.

3.2 Pedological attributes

The Elders area of the Goedehoop Kriel South Project area transects three land types (Figure 2Figure 3). The Bb4 land type covers 71% of the area, the Ea20 land type 28% and the Fa8 approximately 1%. Land types belonging to the Bb soil patterns are associated with soils in which plinthic soils cover more than 10% of the land scape and dystrophic or mesotrophic red soils less than one third of the area, with upland duplex and margalitic soils being rare. In the case of Ea land types, one or more vertic, melanic or red structured diagnostic soils covers more than half of the landscape. The Fa land types represent pedologically young landscapes, dominated by Mispah and Glensrosa soil forms.

Therefore it is expected that the area will comprise of a mosaic of fine to coarse textured soils reflecting the influence of the underlaying geology and surrounding topography (Figure 2Figure 4).

[1] Coarse textured sandstone

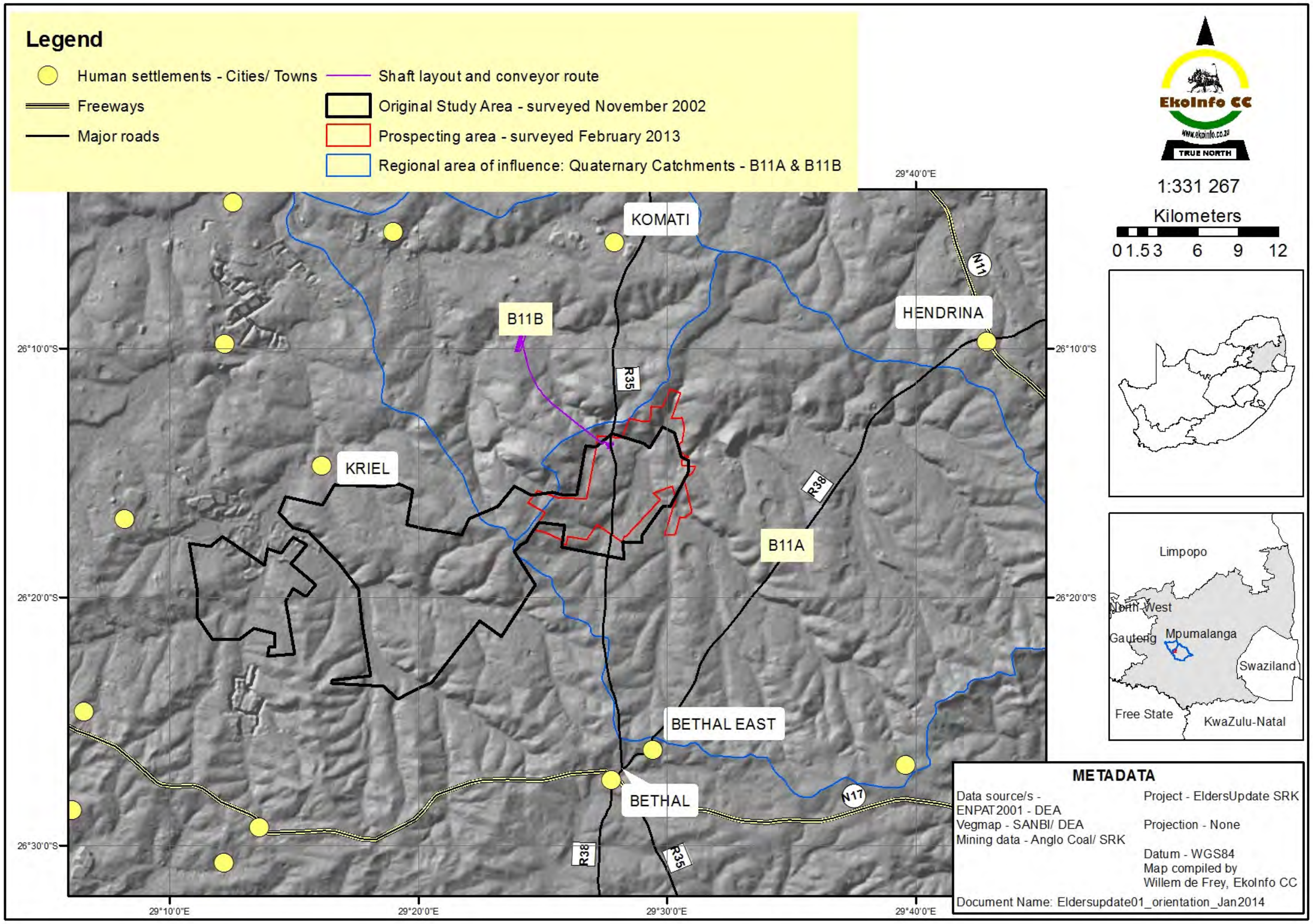


Figure 1: Regional orientation of the Elders EMPR area (prospecting area) and conveyor route

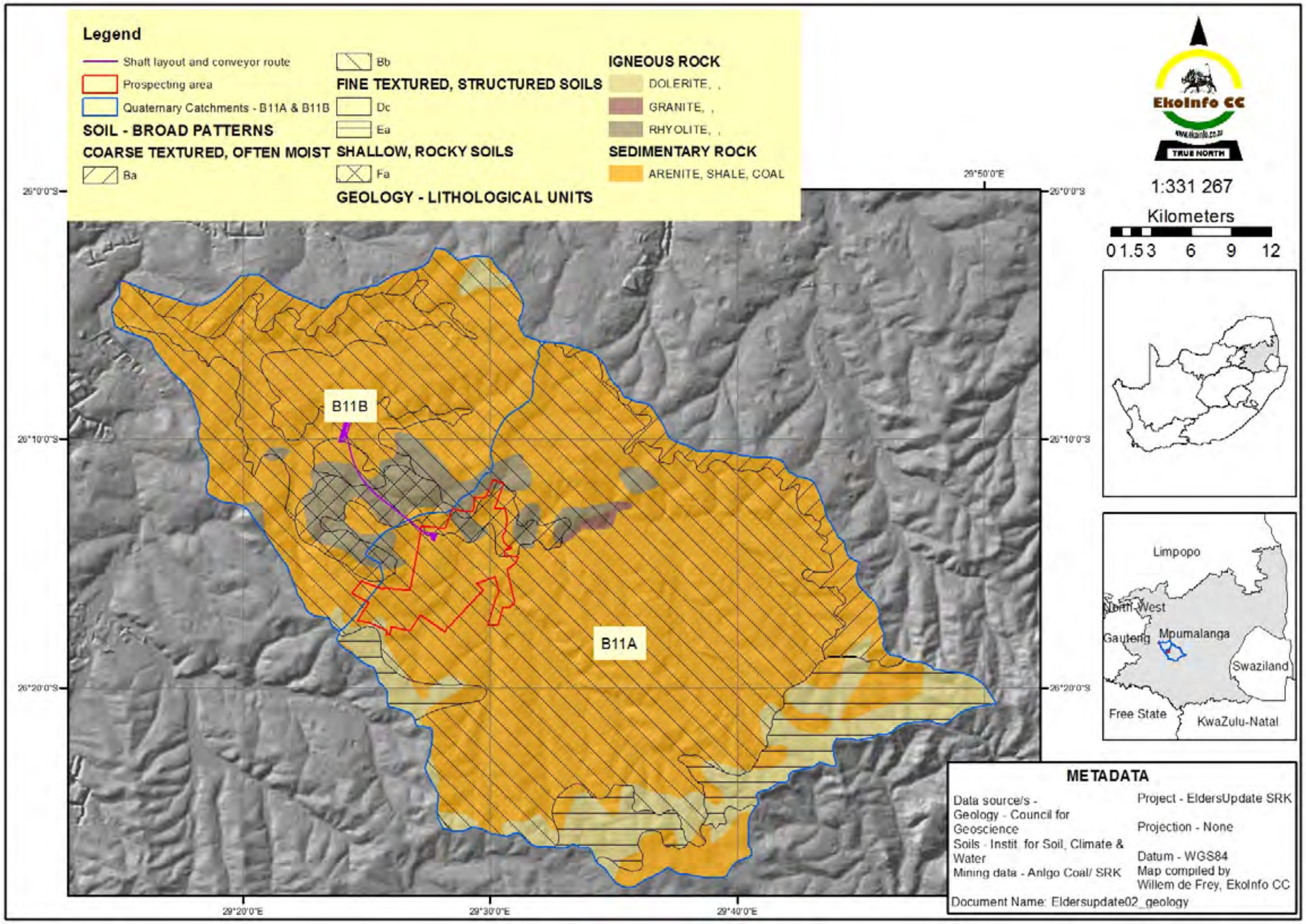


Figure 2: An environmental overview of the geology and broad soil patterns associated with the study area

3.3 Topographic attributes

The landscape consists of slightly irregular plains and hills (Figure 3). Slopes in the 5° range dominate the area.

The climate tends to be the same across the plains. Soil develops from residual parent material. Soil from transported material is restricted to the drainage areas

3.4 Vegetation attributes

The study area is located within the grassland biome of South Africa. The grassland biome is one of the most threatened biomes in South Africa, due to agricultural and mining activities. According to the publication "THE BIODIVERSITY OF SOUTH AFRICA" (Le Roux 2002), 60-80% of the grassland biome is irreversibly transformed, while only 2% is formally conserved. It lists the geophyte *Hypoxis hemerocallidea* (Star Flower) as a flagship species. This species is under pressure as a medicinal plant and it status needs to be revised every five years.

According to the latest national vegetation study of South Africa (Mucina & Rutherford 2006) (Figure 4) the Elders area is located within the following regional vegetation unit, namely: Eastern Highveld Grassland. This regional vegetation unit is considered to be Endangered.

The Eastern Highveld Grassland is associated with:
"Slightly to moderately undulating plains, including some low hills and pan depressions. The vegetation is short dense grassland dominated by the usual Highveld grass composition (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya* etc.) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Acacia caffra*, *Celtis africana*, *Diospyros lycioides* subsp *lycioides*, *Parinari capensis*, *Protea caffra*, *P. welwitschii* and *Rhus magalismontanum*).

It is Endangered, with a 24% conservation target. Only a very small fraction is conserved in statutory reserves (Nooitgedacht Dam and Jericho am Nature Reserves) and in private reserves (Holkranse, Kransbank, Morgenstond). Some 44% transformed primarily by cultivation, plantations, mines, urbanisation and by building of dams. Cultivation may have had a more extensive impact, indicated by land cover data. No serious aline invasions are reported, but Acacia mearnsii can become dominant in disturbed sites. Erosion is very low."(Mucina & Rutherford 2006)

The extent of cultivated land within the regional area of influence (quaternary catchments – B11A & B11B) (Figure 4) supports the statement with regards to its impact on the vegetation. Cultivation covers 46% of the regional area of influence with 48% of the area being transformed (Table 1).

In similar studies to the north west, it was found that soil texture, soil moisture and human influence determine the distribution of communities and/ or variations within this vegetation unit (de Frey 2002a, de Frey 2002b). While in phytosociological studies to the south west in the Moist Clay Highveld regional vegetation unit, it was found that soil texture, altitude and human influence determine the distribution of plant communities (de Frey 2002c).

Therefore, soil texture seems to be a key factor influencing vegetation distribution, followed by either altitude or soil moisture content, which is reflected in human influences such as over utilisation and poor land use planning.

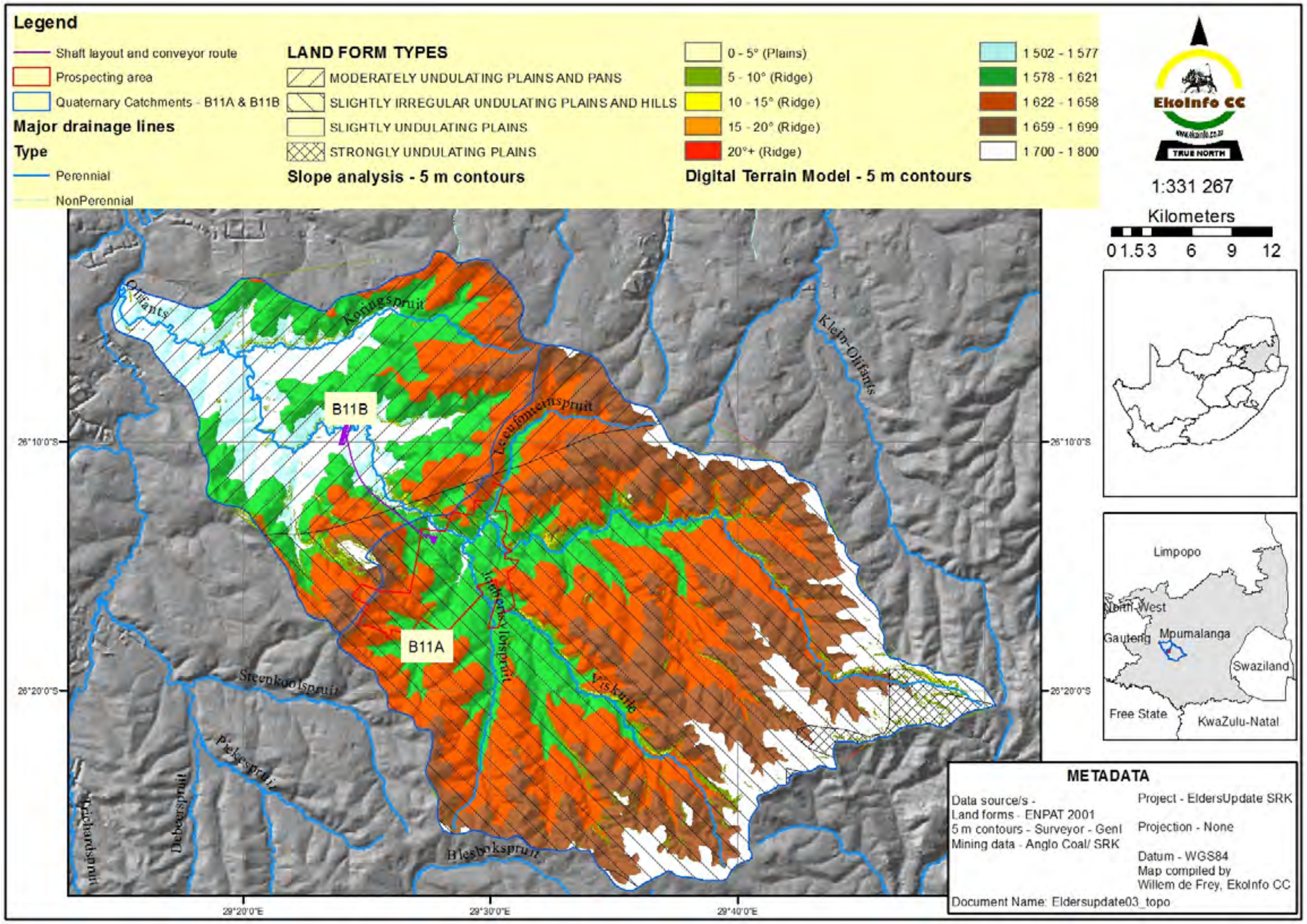


Figure 3: An environmental overview of the altitudinal variation, land forms, ridges and drainage systems associated with the study area

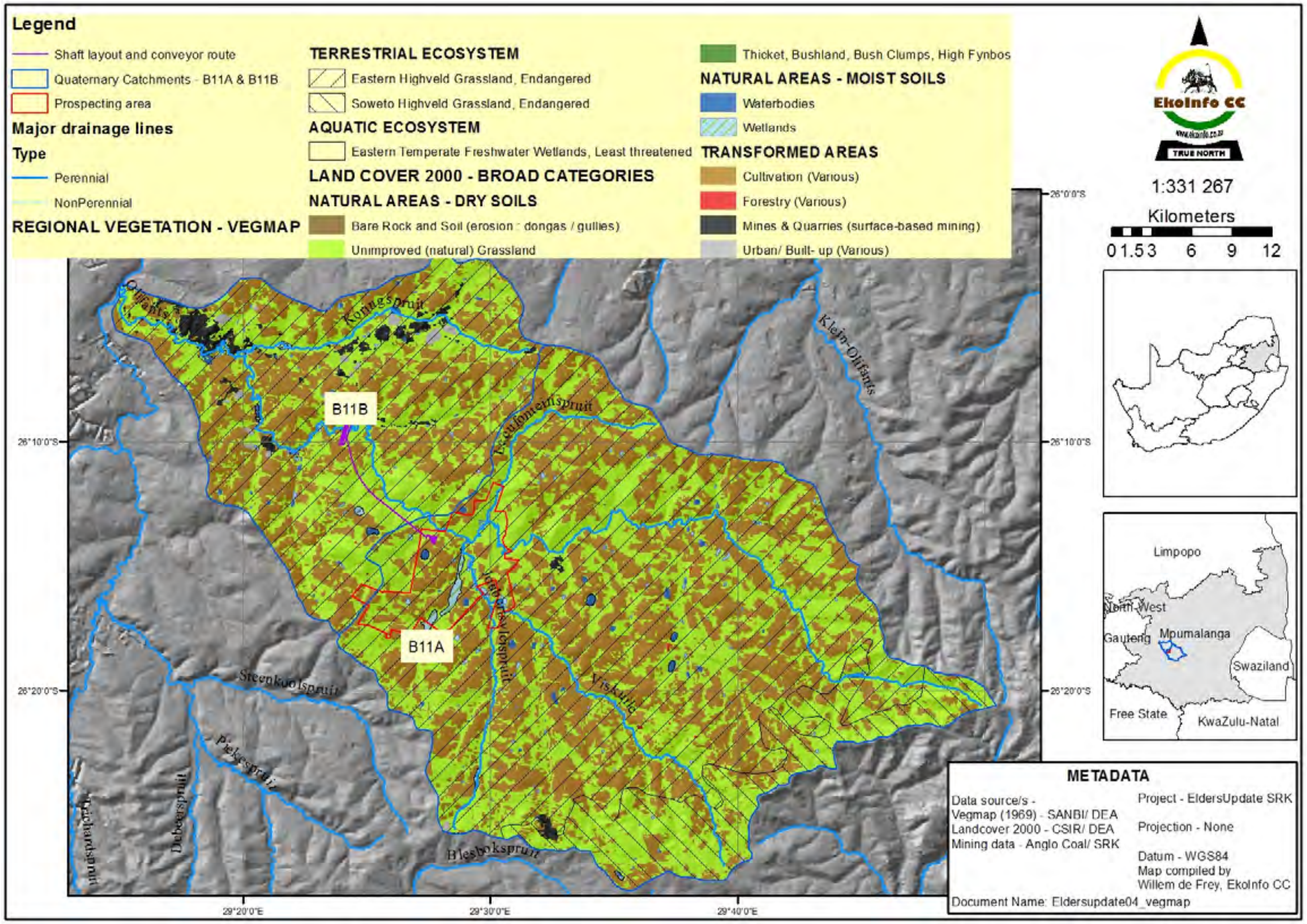


Figure 4: An environmental overview of the regional vegetation units and land cover from 2000 associated with the study area

Table 1: Overview of the derived ecological status of the vegetation present within the regional area of influence (quaternary catchments B11A & B11B) in which the study area is located

Broad Land Cover 2000 Categories	Derived Ecological Status		Grand Total	% Cover
	Natural	Transformed		
Bare Rock and Soil (erosion : dongas / gullies)	66		66	0%
Cultivation (Various)		63838	63838	46%
Forestry (Various)		70	70	0%
Mines & Quarries (surface-based mining)		2064	2064	1%
Thicket, Bushland, Bush Clumps, High Fynbos	1		1	0%
Unimproved (natural) Grassland	69836		69836	51%
Urban/ Built- up (Various)		467	467	0%
Waterbodies	731		731	1%
Wetlands	1006		1006	1%
Grand Total	71640	66439	138080	100%
	52%	48%		

3.5 Conservation significance

It is evident that the remaining natural vegetation (Figure 4) within the regional area of influence varies between moderate and the highest biodiversity priority on a national level (Figure 5). The areas to the northwest which will mainly be influenced by the conveyor are considered to be highly significant on a provincial level. On a provincial level, the latest Mpumalanga Biodiversity Sector Plan (2013) (Figure 6), indicates the presence of both Critical Biodiversity Areas (CBA) and Ecological Support Areas (ESA), of which the conveyor transects a section of irreplaceable CBA.

These results highlight the significance of remaining large intact, natural areas within the landscape and the importance of maintaining connectivity (Hilty, Lidicker Jr & Merenlender 2006, Lindenmayer & Fischer 2006)

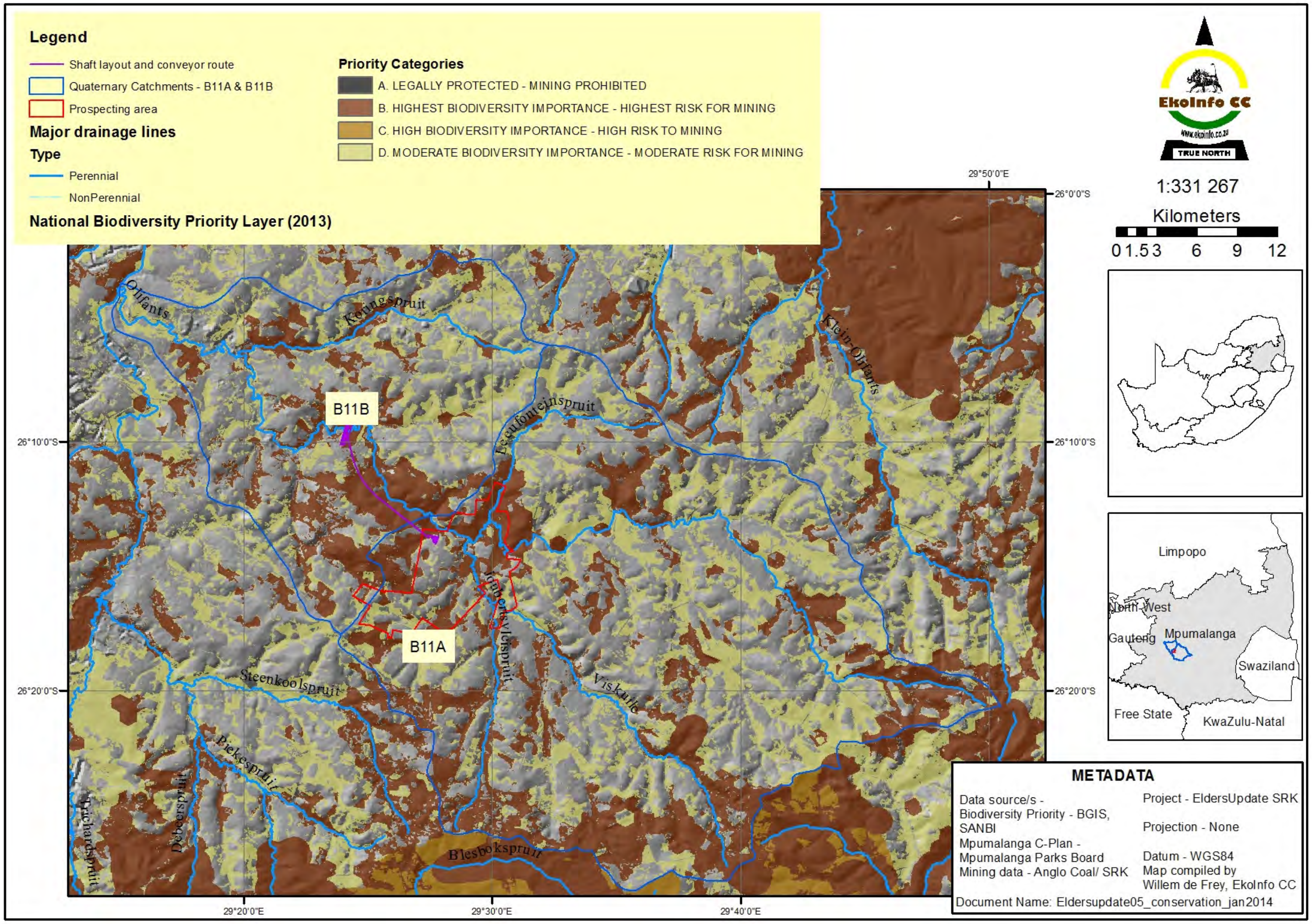


Figure 5: A regional overview of the national conservation priority areas (Mining and Biodiversity Guideline Document 2013)

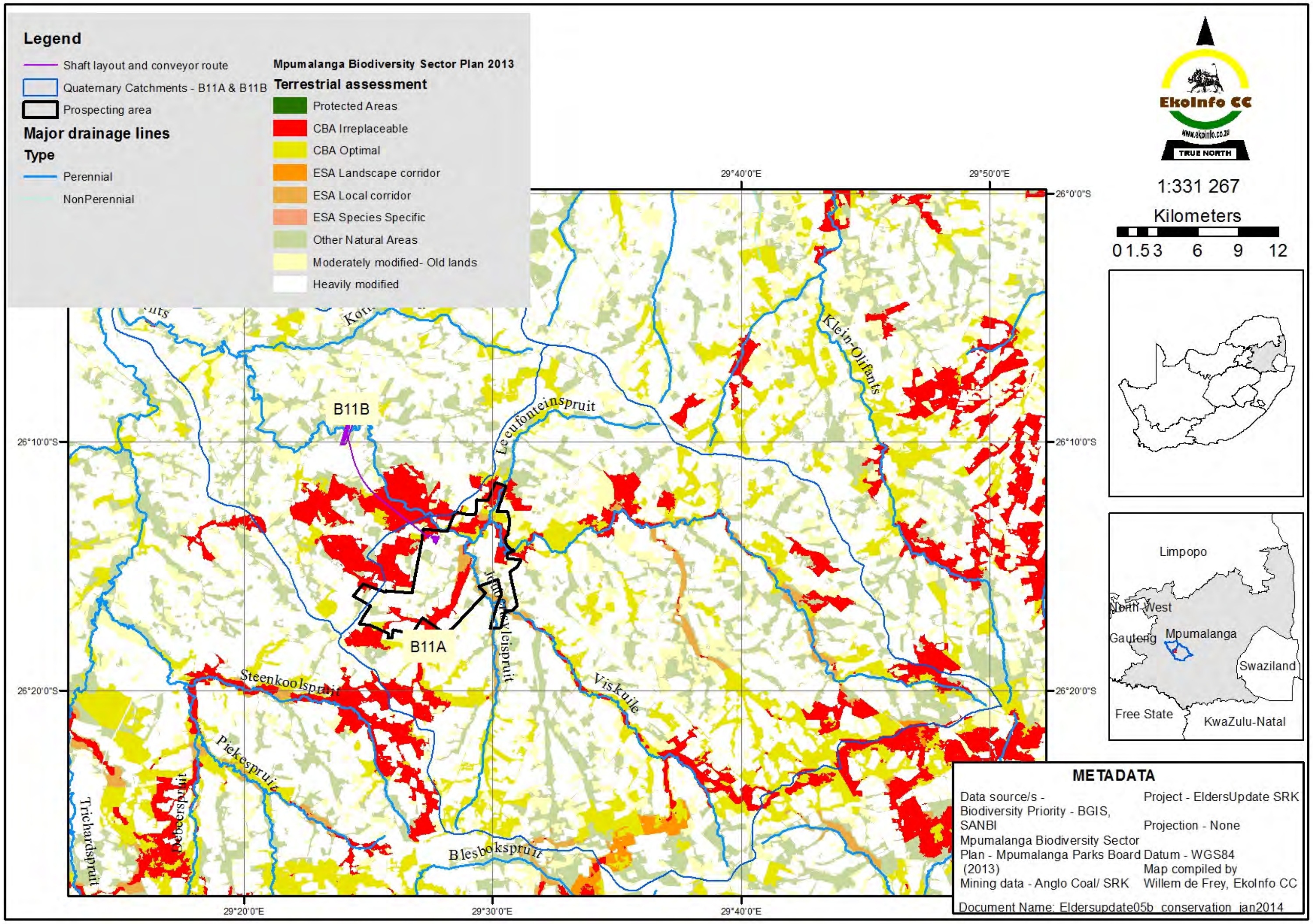


Figure 6: A regional overview of the provincial conservation priority areas (Mpumalanga Biodiversity Sector Plan 2013/ 2014)

4 FLORA COMPONENT

The terms of reference/ scope of work with regards to the vegetation component were to update the existing vegetation information from the previous studies completed in November 2002 (Figure 7). Therefore this section contains two sub-sections:

1. Results from 2002
2. Results from 2013

The same method and approach were used during the 2013 survey which enables the integration of the two datasets.

4.1 Results from 2002

4.1.1 Methodology

Literature surveys and Internet and Geographic Information System (GIS) reviews were completed to obtain a broad environmental overview of the area. A preliminary species list was obtained from the National Botanical Institute based on the relevant quarter degree map. This information was used to determine whether any rare or endangered species had been collected from the area. The results of this assessment were used to compile an identity kit of any rare or endangered species.

In the absence of detailed soil information, the sampling plots were placed *pro rata*, randomly based on the distribution of the two land types, the available land cover information and 1: 10 000 aerial photographs. The placement of the sampling plots was facilited with the aid of a Geographic Information System (GIS)[2]. The co-ordinates of the plots were then exported to FUGAWI[3] and downloaded to a GARMIN MAP76 Global Positioning System (GPS) receiver for navigation in the field. Actual location in the field was recorded within a 5 m accuracy interval.

At each plot, the following abiotic attributes were documented:

a. Topography – altitude, terrain unit, percentage slope
b. Soil – soil form, soil depth (mm), erosion, estimated percentage clay of A horizon
c. Estimated percentage rock cover – gravel, small, medium, large

The following overall vegetation characteristics were documented:

1. Vegetation cover – total, trees, shrubs, herbs, open water, rock
2. Estimated average height of trees, shrubs and herbs – highest and lowest categories

A list of all species within an approximate 200 m^2 area was recorded in the following growth form categories: grasses, forbs and woodies. Cover abundance values were estimated for each species within the plot. Unknown species or potential red data species were identified using field guides (Van Oudtshoorn 1991, Van Wyk & Malan 1988), the University of Pretoria's herbarium and specialists from the National Botanical Institute.

The survey results were entered into a relational database[4] for record purposes and analysis of the abiotic and vegetation characteristics. The species data was entered into TURBOVEG (Hennekens 1996) and analysed with MEGATAB (Hennekens 1996). A vegetation map was compiled, based on the results of the phytosociological table and boundaries of the homogenous units.

4.1.1.1 Limitations

The Braun-Blanquet method was developed to record ninety-five percent (95%) of the species within a specific plot size. Therefore, the species list will be more comprehensive with more plots surveyed.

Sites were placed randomly within the largest of natural areas. Therefore the actual vegetation mapping involves extra-polation and assumption.

[2] Arc-View 3.2a
[3] Interface software between personal computer and GPS receiver
[4] MS Office 2000 Access

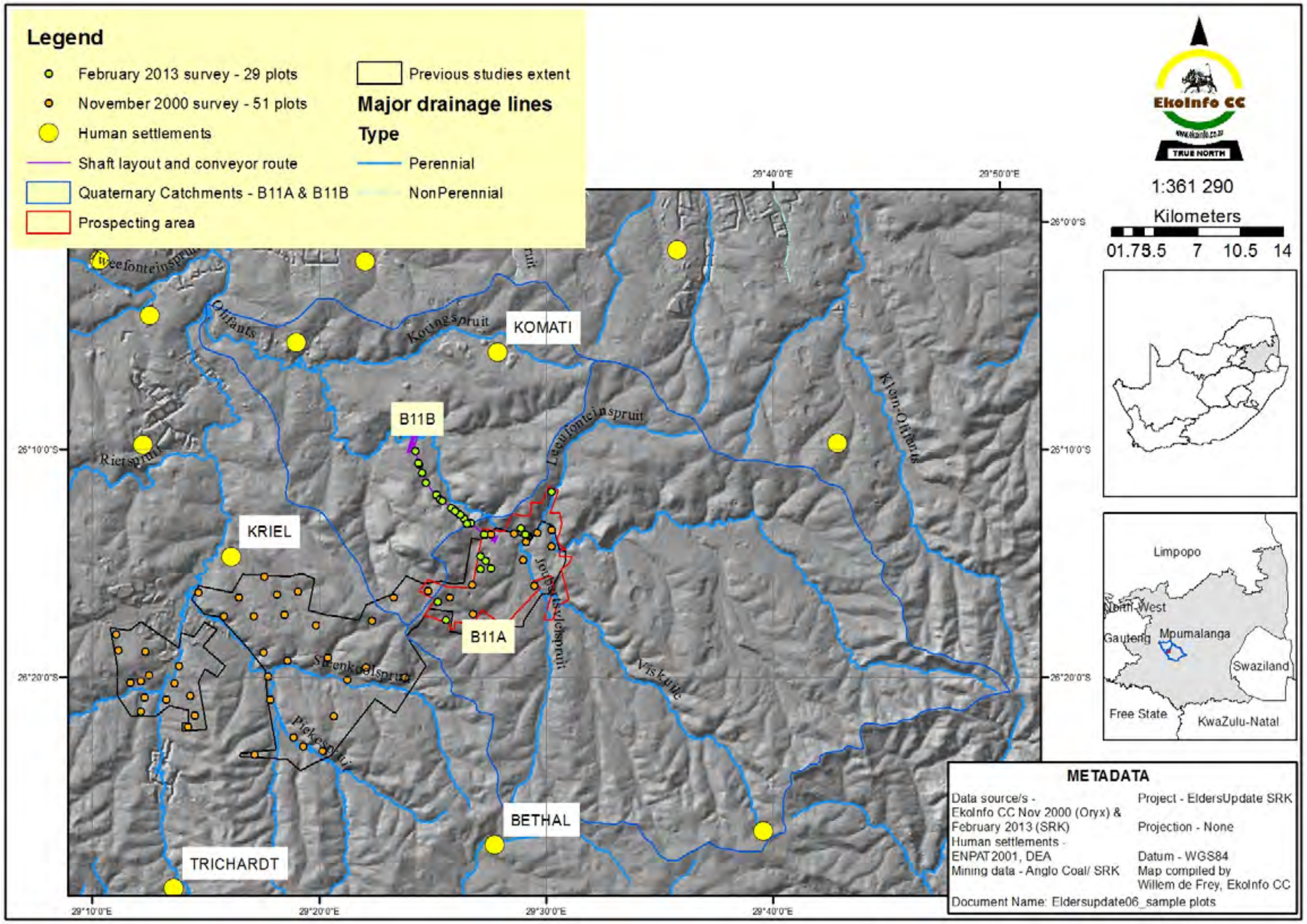


Figure 7: Overview of the distribution and extent of the previous and current vegetation studies completed in the regional area of influence

Rain had occurred late and therefore the grass layer was poorly developed, which hampered the indentification of grass species

The following levels of confidence are attributed to different taxa of the vegetation:

1. A ninety-five percent (95%+) plus interval for the plant families
2. A ninety-five percent (95%) interval for the genera, excluding the sedges which are a very difficult group
3. An eighty-five percent (85%) interval for the species and/ or variations, except in cases where the samples were sent for identification at the National Botanical Institute's Herbarium in Pretoria

4.1.2 Results

During the survey, the vegetation within the study area was classified using the Braun-Blanquet approach and the area assessed for the presence of potential rare and/ or endangered species or their habitat.

4.1.2.1 Ecosystem Diversity

The TWINSPAN analysis of the vegetation data resulted in 12 clusters. Based on the environmental attributes and general description of the vegetation, it was decided that only four clusters could be attributed to two communities and four sub-communities for the scale of this survey (Figure 8).

A Braun-Blanquet table was created to determine the species characteristics of these two communities and their four sub-communities (Appendix A.1). A species was considered to belong to a specific community if it had percentage constancy of equal or above 30% (Species groups A to G). Species groups H to P contain those species, which had a percentage constancy of less than thirty but could be associated with specific ecological conditions, environmental factors or environmental legislation. Based on their species composition and ecological status, each community and sub community[5] was assigned a name (Figure 9):

1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils
    - 2.3. *Verbena bonariensis - Eragrostis plana - Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils
    - 2.4. *Verbena bonariensis - Eragrostis plana - Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils
3. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils
    - 3.1. *Themeda triandra - Senecio erubescens - Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils
    - 3.2. *Themeda triandra - Senecio erubescens - Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils

1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils

This community is associated with coarse textured soils; higher up in the landscape with relatively deep soils (Figure 8, Table 2), and represents one of the two clusters on cutlevel one of the TWINSPAN classification. Analsysis of Variance (ANOVA) confirmed that the difference between the two clusters in terms of average estimated % clay in the A-horizon is statistical significant (Table 4). This confirms the ecological trend that coarse textured material generally occurs higher up in the landscape than fine textured material, due to the lateral movement of clay and silt particles towards the valley bottoms. A plot of the average altitude per cluster also supports the statement that altitude influences the distribution of the species (Figure 10).

Species Group A (Appendix A.1) contains the characteristic species of this community; they are *Eragrostis curvula* and *Verbena bonariensis*. Common species from Species Group G which has an average frequency of more than 50% are: *Hypochaeris radicata* and *Eragrostis plana*. Both these species are associated with over utilised or disturbed areas (Van Wyk & Malan 1988, Van Oudtshoorn 1991). Based on the species composition and soil attributes, it is concluded that this community is associated with the seepage areas on sandy soils. The following factors support this statement:

[5] A vegetation unit is considered to be a sub community if it differs from the community in terms of species composition and certain physical attributes (eg altitude), a variation differs mainly in species composition

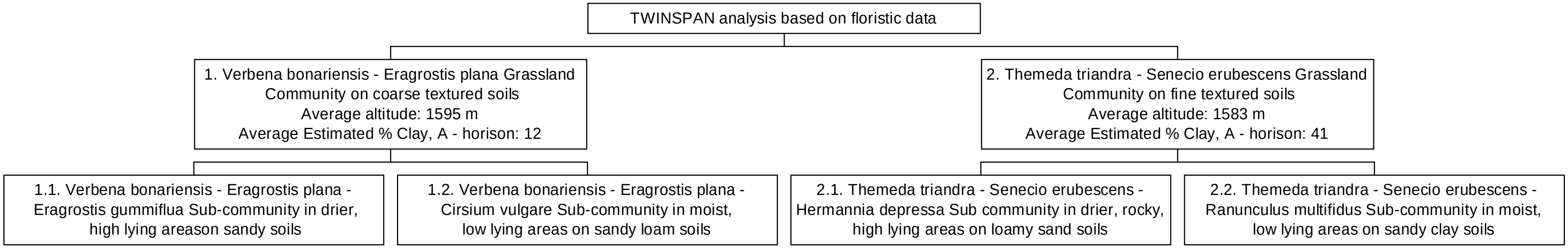


Table 2: Average abiotic attribute values of the two major vegetation units within the Goedehoop Kriel South study area

Community	Number of plots	Average altitude	Average estimated % slope	Average soil depth (mm)	Average estimated % clay: A - horison
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	19	1595	4	953	12
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	32	1583	4	902	41

Table 3: Average abiotic attribute values of the four sub-communities within the Goedehoop Kriel South study area

Sub community	Number of plots	Average altitude (m)	Average estimated % slope	Average soil depth (mm)	Average estimated % clay
1.1. *Verbena bonariensis - Eragrostis plana - Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils	13	1598	3	967	10
1.2. *Verbena bonariensis - Eragrostis plana - Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils	5	1591	2	1033	19
2.1. *Themeda triandra - Senecio erubescens - Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils	11	1592	9	776	16
2.2. *Themeda triandra - Senecio erubescens - Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils	22	1578	2	941	51

Figure 8: TWINSPAN dendrogram of floristic data for all of the Goedehoop Kriel South Project area showing four clusters and their environmental attributes

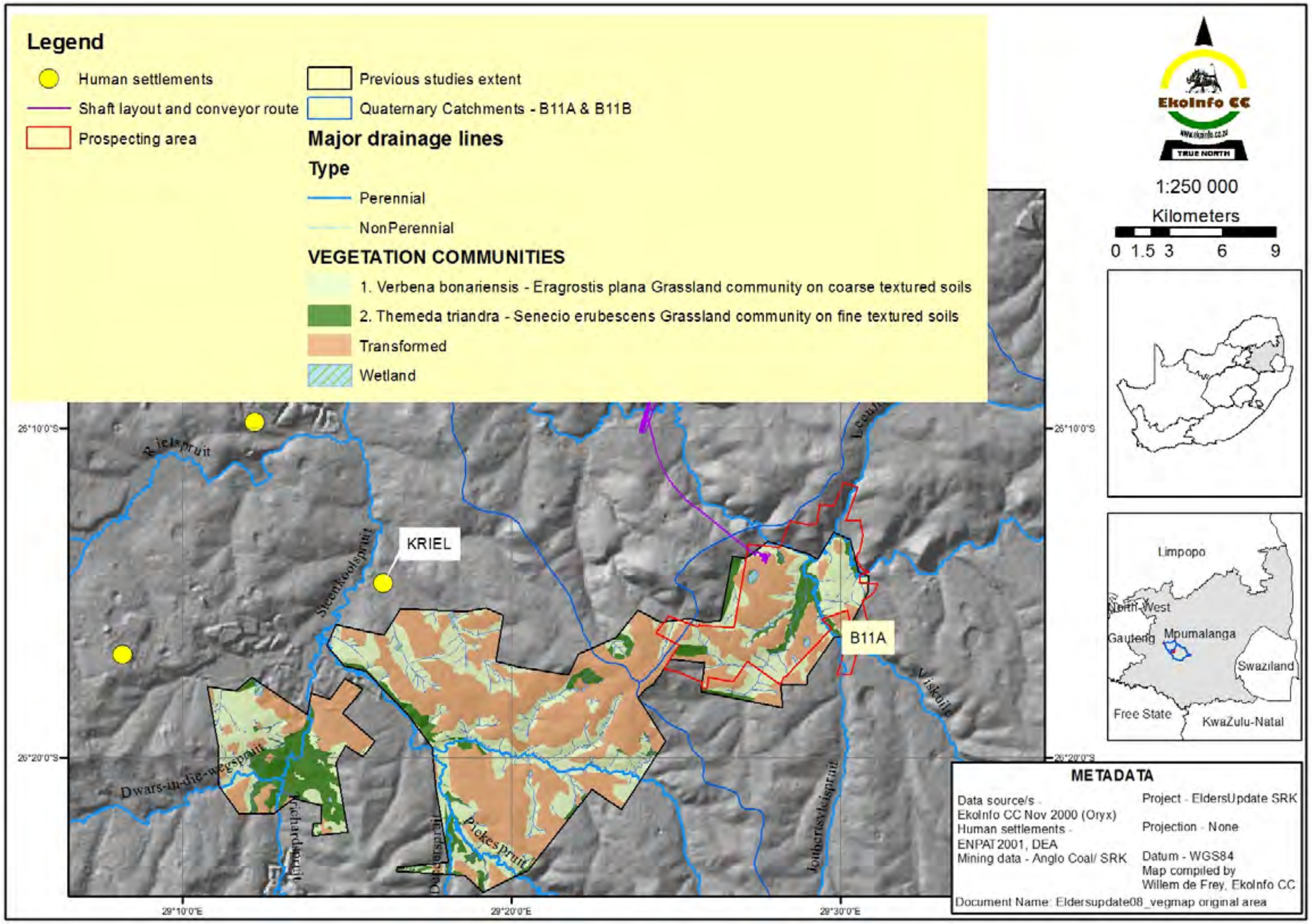


Figure 9: Approximate distribution of Elders EMPR's major vegetation units based on soil texture

Table 4: Analysis of Variance (ANOVA) results for the estimated % clay in the A – horizon between the two main communities within the Goedehoop Kriel South area

1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	
5	6	Note:
5	10	Fifteen randomly sampled estimated % clay values for the A – horizon from each cluster
5	18	
6	35	
6	35	
6	40	
10	55	
10	55	
10	55	
12	55	
12	55	
15	55	
20	55	
20	55	
45	55	

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	15	187	12.46667	106.4095
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	15	639	42.6	322.4

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6810.133	1	6810.133	31.76298	4.9E-06	4.195982
Within Groups	6003.333	28	214.4048			
Total	12813.47	29				

F >= Fcrit and P<Alpha @ 0.05 thus the average estimated percentage clay does differ statistical significantly between the two clusters on level one and therefore for the communities

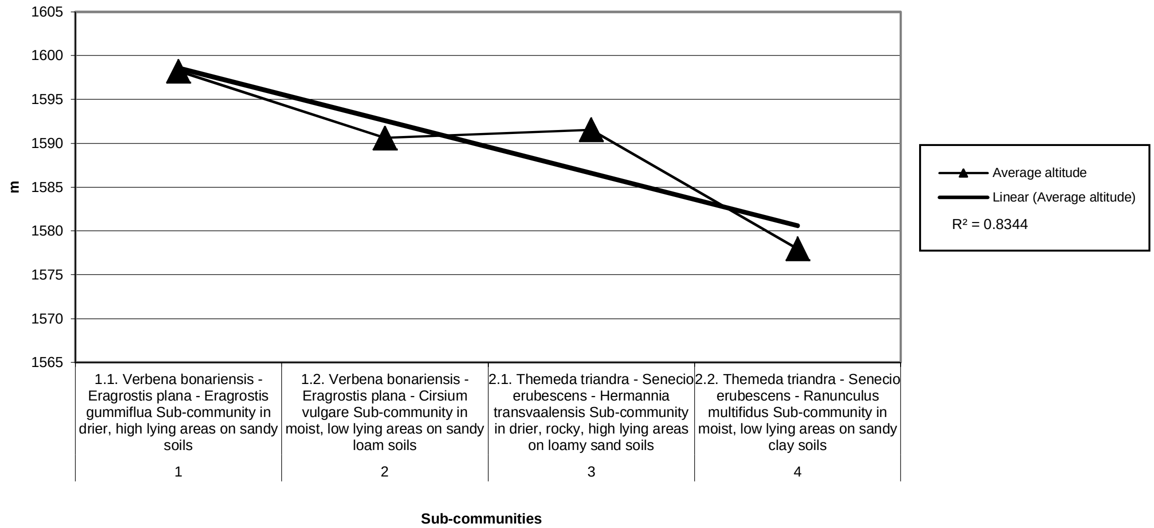


Figure 10: Line graph showing the linear correlation between the sub communities and average altitude

Table 5: Soil attributes per sub community

Community		1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils		2.Themeda triandra - Senecio erubescens Grassland community on fine textured soils	
Sub communities		1.1. Verbena bonariensis – Eragrostis plana – Eragrostis gummiflua Sub-community in drier, high lying areas on sandy soils	1.2. Verbena bonariensis – Eragrostis plana – Cirsium vulgare Sub-community in moist, low lying areas on sandy loam soils	2.1. Themeda triandra – Senecio erubescens – Hermannia transvaalensis Sub-community in drier, rocky, high lying areas on loamy sand soils	2.2. Themeda triandra – Senecio erubescens – Ranunculus multifidus Sub-community in moist, low lying areas on sandy clay soils
	Total Of Count Of Sub community				
Topsoil (A – horizon)					
Orthic	26	13	4	8	1
Vertic	21		1	1	19
Melanic	4			2	2
B-horizon					
unspecified	15			2	13
E horizon	14	11	2	1	
G horizon	10		1		9
yellow-brown apedal B	9	1	2	6	
lithocutanic B	1			1	
pedocutanic B	1			1	
red apedal B	1	1			

- The characteristic forb *Verbena bonariensis* is associated with moist conditions (Van Wyk & Malan 1988)
- The dominance of orthic A-horizons in the topsoil and E-horizons in the sub soil (Table 5)

The presence of the E-horizons explains why these areas have not been ploughed and if ploughed why they had been abandoned, because E-horizons are the result of lateral water movement, which often become saturated to over-saturated.

Two sub-communities occur within this community:

1.1. *Verbena bonariensis* - *Eragrostis plana* - *Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils

This sub-community is found mainly on those terrain units associated with the high lying areas, namely crests and midslopes (Table 6). The soils surveyed within this variation had on average the lowest estimated percentage clay at 10%. This is typical of high lying areas because fine sediments tend to be removed from them. The lower average soil depth (967 mm) supports this statement.

The characteristic species (Species Group B) of this sub-community are *Eragrostis gummiflua, Stoebe vulgaris, Helichrysum aureonitens, Haplocarpha scaposa, Conyza podocephala, Helictotrichon turgidulum Cynodon dactylon* and *Helichrysum coriaceum.* These species confirm the presence of the associated environmental factors. According to Van Oudtshoorn (1991), *Eragrostis gummiflua* prefers sandy and rocky soils. The presence of the shrub *Stoebe vulgaris* and the forb *Conyza podocephala* indicates that this sub-community is often disturbed (Van Wyk & Malan 1988, Van Oudtshoorn 1991).

1.2. *Verbena bonariensis* - *Eragrostis plana* - *Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils

This sub-community occurs in areas lower than the previous sub-community in the vicinity of drainage lines, as indicated by the higher percentage of footslopes compared to the previous sub-communities percentages (Table 6). The on average lower altitude, deeper soil and higher % clay content (Table 3) supports this statement. It should be emphasised that the footslopes are those areas between the midslopes and the valley bottoms, which are not as steep as the midslopes, but not as flat or close to drainage lines to be permanently inundated.

Species Group C contains its characteristic species: *Cirsium vulgare, Pimpinella transvaalensis* and *Senecio achilleifolius*. The absence of the species from Species Group B distinguishes this sub-community from the previous sub-community. This sub-community has the lowest forbs to grass ratio and lowest number of species (Table 7). This is attributed to the following extreme factors occurring in the area:

- Waterlogging due to the accumulation of runoff or flooding
- Poor water retention capabilities of the sandy soils resulting in drought conditions
- Livestock's over utilisation of the area on their way to the drainage lines

Few species are adapted to survive in such conditions.

Therefore the source of disturbance in this sub community is from over utilisation and/ or trampling in areas along the drainage lines to wet to plough compared to over utilisation and/or transformation (abandoned old fields and/or pastures) of the previous sub community.

2. *Themeda triandra* - *Senecio erubescens* Grassland community on fine textured soils

This community is associated with fine textured soils (Figure 8, Table 2 and Table 4) in association with the low-lying areas in the study area (Figure 9). On average the soils are shallower than that of the *Verbena bonariensis* - *Eragrostis plana* Grassland community on coarse textured soils; this is attributed to the presence of mainly vertic soils in the community with an average depth of 824 mm. This would seem to be a contradiction as deeper soils are expected to occur within the low-lying areas, but where

Table 6: Distribution of high lying and low lying areas across the four sub communities

Sub communities	Terrain units	Count of terrain units	No of plots associated with		% of sub community	% of all plots
			High lying areas	*Low lying areas*		
1.1. *Verbena bonariensis - Eragrostis plana – Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils	Crest	2	10		**77**	20
	Midslope	8				
	Footslope	3		3	*23*	6
1.2. *Verbena bonariensis - Eragrostis plana – Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils	Crest	1	3		**60**	6
	Midslope	2				
	Footslope	2		2	*40*	4
2.1. *Themeda triandra - Senecio erubescens – Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils	Crest	1	9		**82**	18
	Scarp	1				
	Midslope	7				
	Footslope	2		2	*18*	4
2.2. *Themeda triandra - Senecio erubescens – Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils	Crest	1	8		**36**	16
	Midslope	7				
	Footslope	12				
	Valley bottom	2		14	*64*	27

Table 7: Growth form and species statistic per sub-community

Growth Form	Total Of Count Of Growth Form	Sub-communties			
		1.1. *Verbena bonariensis - Eragrostis plana – Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils	1.2. *Verbena bonariensis - Eragrostis plana – Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils	2.1. *Themeda triandra - Senecio erubescens – Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils	2.2. *Themeda triandra - Senecio erubescens – Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils
Fern	2			2	
Forb - bulb	40	4	6	14	16
Forb - creeper	22	3		11	8
Forb - erect	105	24	9	41	31
Forb - roset	68	16	7	23	22
Forb - succulent	7	1	1	3	2
Sedge	11	2	1	4	4
Grass	65	19	11	22	13
Woody - shrub	16	3	1	8	4
Species per sub-community		72	36	126	100
Forbs to grass ratio		3	2	4	6

the Arcadia[6] soil form is concerned, soil depth is only measured up to the depth were the vertic A-horizon ends and the sub soils begins.

Species Group D contains this community's characteristic species: *Themeda triandra, Scabiosa columbaria, Ledebouria ovatifolia, Berkheya carlinopsis, Elionurus muticus* and *Hypoxis rigidula*. Its general species from Species Group G is *Senecio erubescens*, a species associated with moist conditions (Van Wyk & Malan 1988). Another species with an occurrence of more than 50% on average in this community is *Hypochaeris radicata*, an exotic forb associated with disturbance (Van Wyk & Malan 1988).

This disturbance is the result of over utilisation (explotation) and is attributed to

- The preference of livestock for vegetation of fine textured soils due to its higher nutrient content
- These areas represent islands of natural vegetation in a sea of cultivated fields

Two sub communities occur within this community:

2.1. *Themeda triandra* - *Senecio erubescens* - *Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils

This sub community is located on steeper slopes (Table 2), higher up in the landscape (Table 5), often in association with outcrops and scarps (Table 7), especially towards the southwest of the study area. On average it has the shallowest soils, which is due to the presence of the rocks. The average estimated % clay for the A-horizon is lower than that of the community and is attributed to

- The local influence of the outcrops, which consist mainly of sandstone.
- The highest number of soil forms (Table 8) of which only three are associated with fine textured soils.

The following species from Species Group E are its characteristic species: *<u>Hermannia transvaalensis</u>, <u>Eragrostis capensis</u>, <u>Hermannia depressa</u>, <u>Kohautia amatymbica</u>, Berkheya radula, Euphorbia striata, Ajuga ophrydis, Becium obovatum, Berkheya setifera, Chlorophytum fasciculatum, Crabbea hirsuta, Gnidia capitata, Harpochloa falx, Helichrysum callicomum, Helichrysum rugulosum, Heteropogon contortus* and *Solanum panduriforme*. All of the underlined species as well as the following species had a percentage constancy of more than 50% within this sub community: *Themeda triandra, Scabiosa columbaria, Ledebouria ovatifolia, Hypochaeris radicata* and *Senecio erubescens*. The following woody species from Species Group P is often found in association with the outcrops: *Diospyros austro-africana, Diospyros lycioides, Rhus krebsiana* and *Rhus pentheri*. When present these shrubs cover on average 5% of the area (Table 8). The rocks act as moist traps. The irregular surface of the rocks limits runoff and increase infiltration, while the runoff from the rocks is captured within the soil filled crevices and pockets. This additional moisture enables woody species to grow in assocation with rocks. The steeper environment also reduces peripendiclar insolation, which results in a further increase in soil moisture (de Frey 1999).

It should be noted that if more plots were surveyed, these woody elements would most probably have represented a separate community or sub community. These wooded outcrops have a very limited distribution within the study area, as only three plots out a total of 51 randomly selected plots contained these woody elements. These rocky areas (outcrops) are biodiversity hot spots and potential habitat for red data species (de Frey 2002d). The fact that this sub community contains the highest number of species, support this statement (Table 8).

[6] Arcadia soil form: vertic A-horizon on unspecified

Table 8: Average cover values for abiotic and biotic components per sub community

Sub community	No of plots	Average % cover values of				
		Large stones	Bare rock	All vegetation	Shrubs	Herbs
1.1. Verbena bonariensis - Eragrostis plana – Eragrostis gummiflua Sub-community in drier, high lying areas on sandy soils	13	0	0	77	5	72
1.2. Verbena bonariensis - Eragrostis plana – Cirsium vulgare Sub-community in moist, low lying areas on sandy loam soils	5	0	0	77	0	77
2.1. Themeda triandra - Senecio erubescens – Hermannia transvaalensis Sub-community in drier, rocky, high lying areas on loamy sand soils	11	2	14	71	5	67
2.2. Themeda triandra - Senecio erubescens – Ranunculus multifidus Sub-community in moist, low lying areas on sandy clay soils	22	0	0	80	0	79

Table 9: Soil form diversity per sub community

Sub community	Soil form	Occurence	No of soil forms
1.1. Verbena bonariensis - Eragrostis plana – Eragrostis gummiflua Sub-community in drier, high lying areas on sandy soils	Longlands	9	4
	Kroonstad	2	
	Clovelly	1	
	Hutton	1	
1.2. Verbena bonariensis - Eragrostis plana – Cirsium vulgare Sub-community in moist, low lying areas on sandy loam soils	Avalon	2	4
	Fernwood	1	
	Longlands	1	
	Rensburg	1	
2.1. Themeda triandra - Senecio erubescens – Hermannia transvaalensis Sub-community in drier, rocky, high lying areas on loamy sand soils	Avalon	3	7
	Clovelly	3	
	Arcadia	1	
	Bonheim	1	
	Estcourt	1	
	Glenrosa	1	
	Inhoek	1	
2.2. Themeda triandra - Senecio erubescens – Ranunculus multifidus Sub-community in moist, low lying areas on sandy clay soils	Arcadia	13	4
	Rensburg	6	
	Willowbrook	2	
	Katspruit	1	

2.2. *Themeda triandra* - *Senecio erubescens* - *Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils

This sub community has the widest distribution of all the sub communities; approximately 43% out of a total of 51 plots is associated with this sub community. It is definitely associated with low-lying areas (Figure 9, Table 6). It has on average the highest percentage clay as would be expected for a low-lying area. The following factors support this statement:

- Average estimated % clay for the A-horizon is 51% (Figure 8, Table 3)
- The dominance of vertic soils (Table 5)
- The high frequency of Arcadia and Rensburg soil forms (Table 9)

As would be expected being associated with the lowest areas in the landscape, it should also be the moistest. The presence of 90% of the G-horizons recorded during the survey, confirms this statement (Table 5). G-horizons are associated with soils, which become waterlogged for long periods of the year (Soil Classification Workgroup 1991).

Three forbs are considered to be characteristic of this sub community; they are *Ranunculus multifidus, Falckia oblonga* and *Hermannia erodioides* (Species Group F). All three these species are associated with moist conditions (Van Wyk & Malan 1988). The following species had a percentage constancy of more than 50%: *Themeda triandra, Scabiosa columbaria, Berkheya carlinopsis, Eragrostis plana* and *Senecio erubescens*.

Species Group G contains all the general species, which occurs in all or most of the four clusters or sub communities. These species are *Hypochaeris radicata, Eragrostis plana, Senecio erubescens* and *Oenothera rosea*. Of the four species only *Senecio erubescens* is not primarily associated with over utilised areas but with moist conditions (Van Wyk & Malan 1988, Van Oudtshoorn 1991).

Species Group H contains the following two ferns, who is associated with the *Themeda triandra - Senecio erubescens – Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils: *Cheilanthes viridis* and *Pellaea calomelanos*.

Figure 11 displays the number of species associated with different ecological indicators for those species, which had a percentage constancy of less than 50% (Species Group I – P). It is apparent from the line graphs that species, which prefers or are adapted to moisture conditions, increase from the sandy communities to the clayey communities and from the high lying to the low-lying areas. The majority of species, who are associated with rockiness, do occur in sub community 2.1. (the *Themeda triandra - Senecio erubescens – Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils). The presence of rocks increases the species diversity (total number of **species per sub community**). Species associated with disturbance and/ or over utilisations occur throughout the area, but:

- Increases from the sandy communities to the clayey communities as would be expected, fine textured soils are known as sweet veld and livestock tends to over utilise it.
- sub community 1.2 (the *Verbena bonariensis - Eragrostis plana – Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils) is the most disturbed as it contains more species associated with disturbance than species associated with climax grassland.

Based on the results of this survey, it is concluded that the vegetation of the study area does stretches across the two regional vegetation units of which the one is associated with sandy soils (the Moist Sandy Highveld Grassland Unit) and the other with clay soils (the Moist Clay Higveld Grassland Unit). The two communities described during this survey support this statement. On a larger scale, these two communities with their respective sub communities form a mosaic of which their distribution and extent are determined by:

- ✓ Soil texture
- ✓ Altitude
- ✓ Human influences.

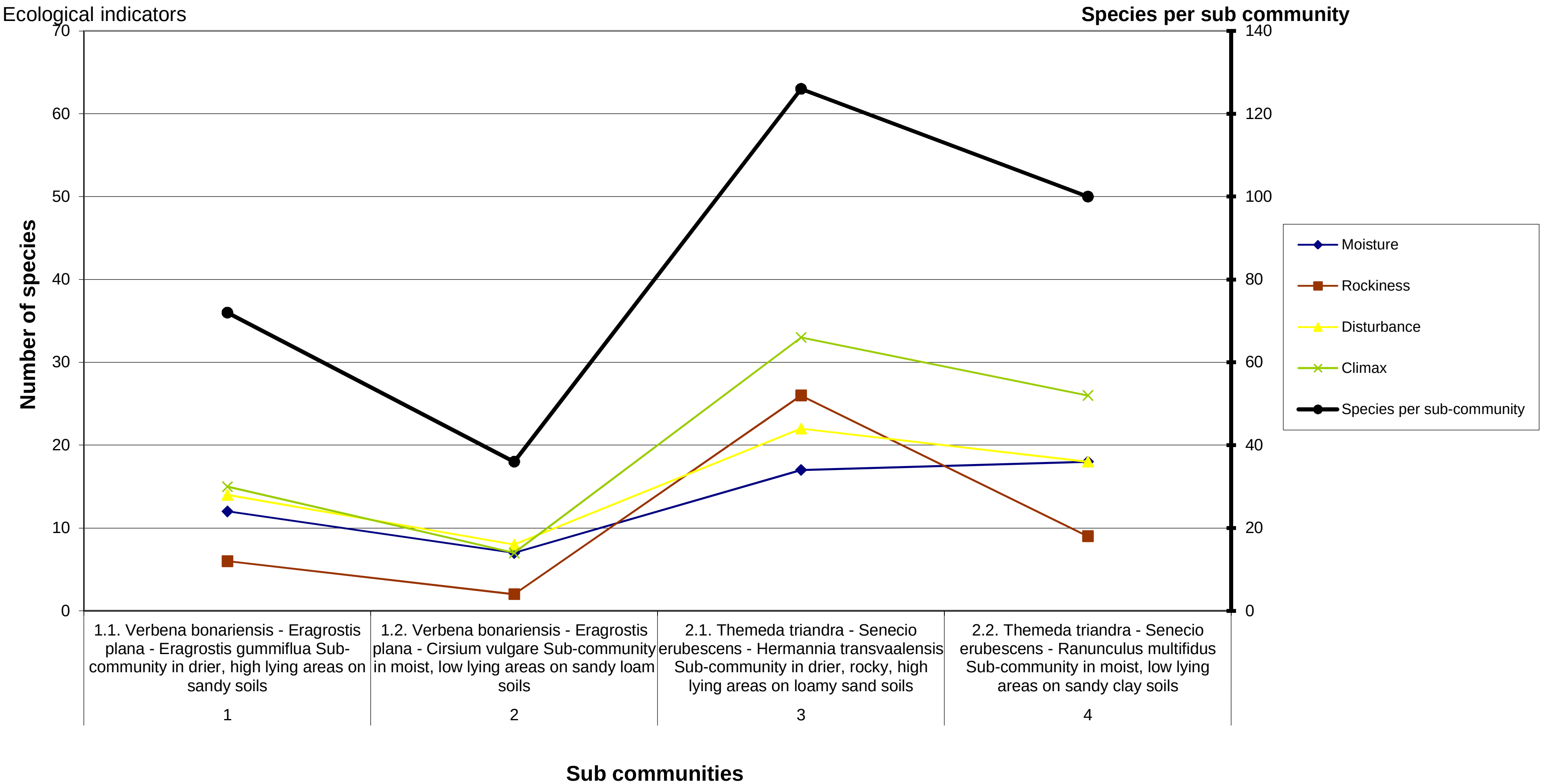


Figure 11: General trends of species with less than 50% constancy (Appendix A, Species Groups I - P)

As it was not possible during the survey to visit all the stands of either the sandy soils or claye soils in the area and to model the distribution of the sub communities, only the distribution of the two main communities based on the distribution of the sandy and clayey soils in the study area were mapped (Figure 9).

A detailed study of the wetland vegetation within the study area was beyond the scope of this survey. A detailed specialist study of the wetlands was completed during the same period as the vegetation study. It was however noted during the survey of the terrestrial vegetation that the dominant wetlands are riparian wetlands. Floodplain vleis occurred mainly in the areas of human activities (bridges, mines, dams) while the grass and sedge dominated riparian fringes occurs in between the floodplain vlei areas and storage floodplains.

- ✓ Floodplain vleis comprise a riverine area (either a reedbed marsh or reedswamp) and a grassy floodplain of varying width on either side. The riverine area may be permanently or seasonally inundated but the grassy floodplain is only inundated by occasional floods.
- ✓ A riparian fringe is the band of distinctive vegetation along every watercourse, growing in hydromorphic soils, which are, at least periodically influenced by high water tables, or flooding. The higher the local rainfall the less obvious this band of vegetation, particularly on the highveld where grasses and sedges predominate.
- ✓ Storage floodplains also comprise a riverine area and adjacent seasonally inundated floodplain, but they retain standing water in oxbow lakes and back swamps for periods between floods (Cowan 1995).

The perceived ecological status of these riparian wetlands varied from landowner to landowner, although based on the results from the vegetation study in adjacent areas most of these wetlands are over utilised. Livestock are allowed to trample the levees resulting in accelerated erosion. *Phragmites australis* and *Typha capensis* dominates the floodplain vleis, while the grasses and forbs of the terrestrial vegetation grows onto the edge of the streambeds along the riparian fringes and storage plains. The distribution of oxbow lakes is visible due to a sharp contrast between the terrestrial vegetation and sedges found within and along the oxbow lakes of the storage floodplains. The following aesthetic species were observed in the vicinity of the streambeds on the floodplains the geophytes *Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.* and *Haemanthus montanus* Bak. An exceptionally large stand of *Crinum*'s was seen towards the northeast of the study area, in the vicinity of plot 49.

Only 50% of the study area is transformed which is less than the 60-80% on national level of the Grassland Biome or the 55% of the regional vegetation unit (Environmental overview, Vegetation attributes), but it should be considered that the national information is based on data, which is more than six years old, and the land cover of the study area was based on aerial photographs taken in 1976.

It is therefore more than likely that the actual transformed surface area of the study area is closer to the national value of 60 – 80%.

A 182 species were recorded during the survey (Appendix A.2).

4.1.2.2 Vegetation description of the Elders EMPR area

More than 50% of the 51 plots surveyed within the study area, are associated with community 2 (the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils) (Table 10). Eighteen of the 51 plots occur within the Elders area of which the majority (14 plots or 78%) are also associated with community 2 (Table 10).

In terms of the sub communities, eight of the 18 plots or 44% are associated with sub community 2.1 (the *Themeda triandra - Senecio erubescens – Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils).

Table 10: Percentage of plots surveyed that are associated with the Elders Area

	Study Area		Elders Area		
Community	No of plots	% of Total	No of plots	% of Elders area	% of study area
1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils	18	35	4	22	8
2. Themeda triandra - Senecio erubescens Grassland community on fine textured soils	33	65	14	78	27
Total	51		18		
Sub-communty					
1.1. Verbena bonariensis - Eragrostis plana – Eragrostis gummiflua Sub-community in drier, high lying areas on sandy soils	13	25	3	17	6
1.2. Verbena bonariensis - Eragrostis plana – Cirsium vulgare Sub-community in moist, low lying areas on sandy loam soils	5	10	1	6	2
2.1. Themeda triandra - Senecio erubescens – Hermannia transvaalensis Sub-community in drier, rocky, high lying areas on loamy sand soils	11	22	6	33	12
2.2. Themeda triandra - Senecio erubescens – Ranunculus multifidus Sub-community in moist, low lying areas on sandy clay soils	22	43	8	44	16
Total	51		18		

It is concluded that most of the remaining natural vegetation within the Elders area are associated with fine textured soils in low-lying areas. These areas represent corridors of vegetation between large areas of cultivated fields, because they are:

- ✓ To clayey to plough
- ✓ To close to the drainage lines
- ✓ And often waterlogged.

The influence of these environmental factors, allows the vegetation to be more palatable and nutrient rich for longer periods of the year, resulting in the livestock utilising it as sweetveld. This preference results in over utilisation.

This seems to contradict the statement made in the environmental overview (Vegetation attributes), where it was stated that the Elders area falls within the Moist Sandy Highveld Grassland regional vegetation, but it should be considered that at the scale of this study, the two communities and four sub communities identified during the study represent smaller, more distinctive plant communities within the larger regional vegetation unit. It should also be considered that 55% of the regional vegetation unit has already been transformed, with only the area not suitable for cultivation being used for grazing, which are the low lying areas with fine textured soils.

4.1.3 Species Diversity

4.1.3.1 Rare and endangered species assessment

An attempt was made to confirm the potential presence of red data species before commencing with the survey. This was achieved by obtaining the PRECIS[7] list for the quarter degree grids (2629AB, 2629AC, 2629AD), in which the study area occurs, from the National Herbarium Institute in Pretoria. The combined list contained 286 species, which was compared with the list of rare to extinct[8] species for the former Transvaal from the SABONET[9] Red Data database and the preliminary Red Data list from Mpumalanga's Directorate Nature Conservation.

To assist in the field identification of the red data species an identity kit was compiled. The identity kit contained the following characteristics of the species:

1. Scientific name
2. Family
3. Growth form
4. Flowering season
5. Preferred habitat
6. Preferred habitat present
7. Species observed
8. Genera or comparative species observed
9. Pictures of actual or similar species

This process was repeated on the completion of the field survey, when the 182 species recorded during the survey was compared with both lists. Resulting in a combined list of four red data species for which habitat potentially occurs or occurred in the study (Table 11).

Of the four potential red data species only one near threatened species were recorded during the survey. This was the geophyte *Hypoxis hemerocallidea* Fisch. & C.A.Mey.

No similar species of the vulnerable species *Nerine gracilis* R.A.Dyer was recorded. This species is associated with clayey soils (de Frey 2002d)

It should be noticed that *Hypoxis hemerocallidea* (Star Flower) is considered to be a flagship species for the Grassland Biome. This species is utilised for medicinal purpose and is under severe pressure. Its conservation status is reviewed every five years (Le Roux, 2002).

[7] PRECIS (National Herbarium **Pret**oria (**PRE**) **C**omputerised **I**nformation **S**ystem) http://posa.sanbi.org/intro_precis.php
[8] Appendix A.3 contains the definitions of the Red Data categories
[9] http://www.sabonet.org/

Table 11: Derived list of Red Data species recorded in the study area and surrounding areas

Botanical name	Family	Source					Suitable habitat	Observed species		Ranking
		Mpumalanga Nature Conservation				EkoInfo CC				
		Old South Africa Red Data List	Old Transvaal Conservation Status	Natal Red Data List	Mpumalanga Red Data List	Derived status		Actual	Similar	
Nerine gracilis R.A.Dyer	Amaryllidaceae	Rare			VU B2abi,ii,iii	Rare	Yes	No	No	4
Boophane disticha (L.f.) Herb.	Amaryllidaceae				NT	Near Threatened	Yes	No	No	7
Eucomis autumnalis (Mill.) Chitt. subsp. clavata (Baker) Reyneke	Hyacinthaceae	K	nt	VU	NT	Near Threatened	Yes	No	No	7
Hypoxis hemerocallidea Fisch. & C.A.Mey.	Hypoxidaceae				NT	Near Threatened	Yes	Yes	Yes	7

4.1.3.2 Protected species

A comparison of the survey species list and the Mpumalanga Conservation Act's list of protected flora indicated that the following species recorded during the survey have protected status:

1. *Crinum bulbispermum* (Burm.f.) Milne-Redh. & Schweick.
2. *Cyrtanthus tuckii*
3. *Gladiolus crassifolius* Baker
4. *Gladiolus longicollis* Baker var. *longicollis*

It should be noted that ALL of the species from the three genera *Gladiolus, Crinum* and *Cyrtanthus* are protected in terms of the Mpumalanga Conservation Act's list of protected flora.

4.1.4 Ecological and conservation status of natural vegetation

The conservation status of a habitat is based on three attributes:

1. Condition
2. Quantity
3. Social importance

The variables and/ or number of variables used to determine these attributes will vary according to the scale, time and funds available.

For the purpose of this study the following variables were used to determine the conservation status of the plant communities:

1. Ecological status
2. The surface area covered by each plant community
3. Relevant environmental legislation

The following positive and negative ecological indicators obtained from the vegetation assessment were used to determine the ecological status for each community: red data species recorded in area, protected species recorded in area, species richness of area, maximum cover of herbaceous layer, declared weeds and invaders recorded in area, forbs to grass ratio in area, maximum cover of woody layer and categories of erosion present in area (Appendix A.4).

As only the expected distribution of the two major communities were mapped, the ecological index and derived conservation status was calculated for them only.

The surface area for each community was calculated from the vegetation map.

The following environmental legislation was considered to regulate and control activities within these communities:

1. The National Environmental Management Act
2. The Environmental Conservation Act
3. The Conservation of Agricultural Resources Act
4. The National Water Act
5. The Mpumalanga Parks Boards Conservation Act

Of the five acts only the National Water Act places an emphasis on wetlands and wetland management, which is considered to be an indication of aquatic systems social importance, while the other four acts deal with the environment comprehensively.

These three variables (ecological status, surface area and environmental legislation) were expressed as percentages, added to obtain a total and divided by three to give a conservation status of between 0 and 100. (Appendix A.4).

The results are summarised in Table 12. Of the two communities, the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils has a slightly higher conservation status at 53% compared to the 50% of the *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils. This would appear to be a contradiction as the *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils ecological status is higher, but the *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils covers a smaller area of the study area.

Table 12: Derived ecological and conservation status of plant communities

Vegetation community	**Average ecological status (A)**	Surface area (ha)	% of study area	**Weight (100-% of total) (B)**	Applicable environmental legislation (5=100%)	**Percentage of applicable legislation (C)**	Total (D = A+B+C)	**Derived conservation status (E=D/3)**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	**4**	8455	34	**66**	4	**80**	150	**50**
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	**-8**	3276	14	**86**	4	**80**	158	**53**

The *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils is also associated with the drainage lines (riparian wetlands), which enhances its conservation importance. This community's lower ecological status reflects this association due to the explotation of this vegetation through poor veld management and over utilisation.

4.1.5 Part 2: Pre-mining environment – Natural Vegetation/ Plant life

The natural vegetation of the Elders area is associated with the Moist Sandy Highveld Grassland (Figure 3), of which less than one percent is officially conserved and approximately 55% transformed.

The vegetation survey identified two plant communities and four sub communities within the study area. The two communities and four sub communities are:

1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils
    - *1.1. Verbena bonariensis - Eragrostis plana - Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils
    - *1.2. Verbena bonariensis - Eragrostis plana - Cirsium vulgare* Sub-community in moist, low lying areas on sandy loam soils
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils
    - *2.1. Themeda triandra - Senecio erubescens - Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils
    - *2.2. Themeda triandra - Senecio erubescens - Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils

Soil texture, altitude and human influence determine the distribution and condition of these two communities and their sub communities.

As it was not possible to map the distribution of the four variations due to the extent of study area and the complexity of landscape, only the potential distribution of the two major communities were mapped based on the distribution of sandy and clayey soils (Figure 8)

The map also reflects the overall distribution of riparian wetlands within the area, of which only a general opinion was formed during the survey of the terrestrial vegetation.

The *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils covers approximately 8 455 ha of the study area and represents 34% of the study area and 67% of the natural vegetation. It is associated with sandy soils of which the average estimated clay content is 12%. This does not reflect the true distribution of the sandy soils nor the vegetation associated with the soils, as large areas of the sandy soils had been transformed for cultivation. Two sub communities were identified within this community during the survey of which the *Verbena bonariensis - Eragrostis plana - Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils (Photo 1) is associated with the crests and midslopes within the study areas. The *Verbena bonariensis - Eragrostis plana - Cirsium vulgare* Sub-community in moist, low-lying areas on sandy loam soils (Photo 2) is associated with the areas between the midslopes and valleybottoms. **The conservation status of this community is 50%.**

The *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils is associated with clayey soils of which the average estimated clay content is 41%. This community covers approximately 3 276 ha of the study area and represents 14% of the study area and 26% of the natural vegetation. The *Themeda triandra - Senecio erubescens - Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils are associated with crest and scarps. These scarps are often associated with sandstone outcrops, with a woody cover (Photo 3). The *Themeda triandra - Senecio erubescens - Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils (Photo 4) has widest distribution within the Elders area. Forty-four percent of the 18 plots sampled within the Elders area, are associated with this sub community. **The conservation status of this community is 53%.**

Photo 1: An example of the *Verbena bonariensis - Eragrostis plana - Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils (Plot 3, Direction south-west)

Photo 2: An example of the *Verbena bonariensis - Eragrostis plana - Cirsium vulgare* Sub-community in moist, low-lying areas on sandy loam soils (Plot 15, Direction north-northeast)

Photo 3: An example of the *Themeda triandra - Senecio erubescens - Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils (In the vicinity of Plot 21)

Photo 4: An example of the *Themeda triandra - Senecio erubescens - Ranunculus multifidus* Sub-community in moist, low-lying areas on sandy clay soils (Plot 17, Direction west)

The riparian wetlands found within this area are representative of floodplain vleis in the vicinity of human activities, linked through grass dominated riparian fringes to storage floodplains. The reed *Phragmites australis* and bulrush *Typha capensis* are characteristic of the floodplain vleis. The species composition of the riparian fringes is similar to terrestrial vegetation up to where the streambed starts or open water is found. The following aesthetic appealing species was found in the vicinity of the riparian wetlands: *Haemanthus montanus* Bak.

The three prominent factors influencing the terrestrial vegetation's distribution and status within the study area are:

1. soil texture
2. altitude
3. human influence

Of which human influence is the most significant and controllable.

4.1.5.1 Dominant species.

A total of 182 species was recorded during the survey (Appendix A.2) of which 18% are grasses, 79% forbs (cumulative), 4% sedges and 5% woody (cumulative).

The following species had an abundance cover of 25% or more in the different variations –

1.1. *Verbena bonariensis - Eragrostis plana - Eragrostis gummiflua* Sub-community in drier, high lying areas on sandy soils

Grasses
Cynodon dactylon
Eragrostis chloromelas
Eragrostis curvula
Eragrostis gummiflua
Eragrostis micrantha
Eragrostis plana
Helictotrichon turgidulum
Hyparrhenia hirta
Imperata cylindrica
Paspalum scrobiculatum
Forbs
Hypochoeris radicata
Sedges
None
Woody species
Stoebe vulgaris

1.2. *Verbena bonariensis - Eragrostis plana - Cirsium vulgare* Sub-community in moist, low-lying areas on sandy loam soils

Grasses
Eragrostis curvula
Eragrostis plana
Forbs
Cirsium vulgare
Sedges
None
Woody species
None

2.1. *Themeda triandra - Senecio erubescens - Hermannia transvaalensis* Sub-community in drier, rocky, high lying areas on loamy sand soils

Grasses
Hyparrhenia hirta
Themeda triandra
Tristachya leucothrix
Forbs
Berkheya carlinopsis
Sedges
None
Woody species
Diospyros lycioides
Erythrina zeyheri
Gnidia caffra
Rhus krebsiana
Rhus pentheri
Stoebe vulgaris

2.2. *Themeda triandra - Senecio erubescens - Ranunculus multifidus* Sub-community in moist, low lying areas on sandy clay soils

Grasses
Bromus catharticus
Cynodon dactylon
Elionurus muticus
Eragrostis curvula
Eragrostis plana
Themeda triandra
Forbs
Crinum bulbispermum
Ipomoea aquatica
Ranunculus multifidus
Scabiosa columbaria
Senecio erubescens
Sedges
Eleocharis dregeana
Woody species
Gomphocarpus fruticosus

4.1.5.2 Endangered or rare species.

Flora in South Africa is given a conservation status on two levels. Nationally in terms of red data status and provincially in terms of protected species. Red data flora includes those species considered to be threatened on a national level through either over-exploitation or habitat destruction but also include species with very limited distribution or low densities. These species are also very difficult to identify and known to but a few specialist or interested individuals. Protected species involve those species, which are exploited commercially for their medicinal or collectors value, are easily identified and known to more individuals. Theoretically the protected species list should include all red data species known to occur in the relevant province. To compensate for the fact that this would make the list very cumbersome and that these species are difficult to identify, genera or families known to contain many red data species are also included.

<u>Red data flora</u>

In the absence of a single authoritive list of Red Data Flora for the study area, a list was derived by comparing the PRECIS list of previously recorded species in the area and the actual species list of the current survey, with the preliminary Red Data Flora list from Mpumalanga's Directorate Nature Conservation and the regional SABONET Red Data Flora list.

From this comparison a list of four species, which occur in the grasslands of the study area, was obtained. The four species are *Nerine gracilis* R.A.Dyer (Family: Amaryllidaceae, Conservation status: Vulnerable), *Boophane disticha* (L.f.) Herb. (Family: Amaryllidaceae, Conservation status Near Threatened), *Eucomis autumnalis* (Mill.) Chitt. subsp. *clavata* (Baker) Reyneke (Family: Hyacinthaceae, Conservation status: Near Threatened) and *Hypoxis hemerocallidea* Fisch. & C.A.Mey. (Family: Hypoxidaceae, Conservatin status: Near Threatened)

Of the four potential red data species only one near threatened species were recorded during the survey. It was the geophyte *Hypoxis hemerocallidea* Fisch. & C.A.Mey. It should be noted that *Hypoxis hemerocallidea* is a flagship species for the Grassland Biome.

<u>Protected species</u>

A comparison of the survey species list and the Mpumalanga Conservation Act's list of protected flora indicated that the following species recorded during the survey have protected status:

5. *Crinum bulbispermum* (Burm.f.) Milne-Redh. & Schweick.
6. *Cyrtanthus tuckii*
7. *Gladiolus crassifolius* Baker
8. *Gladiolus longicollis* Baker var. *longicollis*

It should be noted that ALL of the species from the three genera *Gladiolus, Crinum* and *Cyrtanthus* are protected in terms of the Mpumalanga Conservation Act's list of protected flora.

Photo 5: A large stand of *Crinum bulbispermum* in the vicinity of plot 49

Photo 6: Another protected species *Haemanthus montanus* which occurs in close proximity to the streambeds on the adjacent floodplains.

A remarkable stand (Photo 5) of *Crinum bulbispermum* was observered in the northeastern corner of the study area in association with a large floodplain. Another protected species, which was seen during the surveys but did not occur in any of the plots, was the geophyte *Haemanthus montanus* (Photo 6). All species of the genus *Haemanthus* is also proteced in terms of the Mpumalanga Conservation Act.

4.1.5.3 Intruder or exotic species.

The following two declared weeds and/ invasive species were recorded during the survey within the actual plots.:

1. *Cirsium vulgare (Savi) Ten. (=C. lanceolatum Scop.)* (Scotch thistle, Spear thistle)
2. *Solanum elaeagnifolium* Cav. (Silver-leaf bitter apple)

Both these species are declared weeds within category one, which mean they serve no useful economic purpose, and possess characteristics that are harmful to humans, animals or the environment.

Outside these plots, along the roads, along the skylines and on the fringes of the drainage lines, the presence of the following exotic trees were noticed,

- Wattles (*Acacia* species)
- Bluegums (*Eucalyptus* species)
- Weeping willow (*Salix babylonica* L.)

Both the Environmental Conservation Act and Conservation of Agricultural Resources Act require the control and removal of weeds and invaders, and therefore failure to do so, constitutes a contravention of both these acts.

4.2 Results from 2013

Since the completion of the original study in 2000, the status of ecosystems was evaluated on a national level, as well as with regards to species of concern (Red Data, nationally protected and alien invasive species). Therefore this section aims to review the existing information against these update regulatory frameworks.

Furthermore the fieldwork completed during February 2013, was used to assess those areas outside of the original boundaries of the November 2000 study, as well as to assess the status of the vegetation along the proposed conveyor route.

4.2.1 Ecosystem Diversity

On a regional scale, 41% (2 370 ha) of the prospecting area is associated with areas of highest biodiversity importance (Section 3.5) at a national level (Table 13) and 16% associated with moderate biodiversity important areas. Within the 36 m servitude of the 10 km long conveyor route, 82% (29 ha) is associated with the highest biodiversity important areas (Table 13) and 1% with moderate biodiversity areas. Thus the proposed mining activities do has the potential impact upon or influence areas of national biodiversity importance.

At provincial level, based on the Mpumalanga Biodiversity Sector Plan (Section 3.5); 30% (1 706 ha) of the prospecting area represents areas of conservation priority, which include 1 412 ha (24%) critical biodiversity area (Table 14). Approximately 70% represents heavily or moderately modified areas as well as other natural areas. Within the 36 m conveyor route servitude, 41% (15 ha) is of conservation priority (Table 14), namely Critical Biodiversity Area, with less than 21 ha representing heavily or moderately modified areas as well as other natural areas.

Therefore it is evident that the conveyor route is transecting an area of critical biodiversity on both a national and provincial level, while there is abundant opportunity (43% - nationally, 70% - provincially) to place infrastructure out of areas of conservation priority within the prospecting area.

Table 13: Overview of the percentage cover of moderate and highest biodiversity priority areas within the study area

Prospecting Area		
National Biodiversity Priority Layer Categories	**Hectares**	Total Area (5 772 ha = 100%)
D. Moderate Biodiversity Importance	922.6202	16%
B. Highest Biodiversity Importance	2370.209	41%
TOTALS	3292.829	57%
Conveyor Route (36 m servitude, 10 km length)		
National Biodiversity Priority Layer Categories	**Hectares**	**Total Area (36 ha = 100%)**
D. Moderate Biodiversity Importance	0.3865	1%
B. Highest Biodiversity Importance	29.6153	82%
TOTALS	30.0018	83%

Table 14: Overview of the percentage cover of Mpumalanga Biodiversity Sector Plan Consevation Priority Areas within the study area

Prospecting Area	**Hectares**	**% Cover**	**Conservation Priority**	
Mpumalanga Biodiversity Sector Plan			**Yes**	**No**
Critical Biodiversity Area	1412	24%	1412	
Ecological Support Area	295	5%	295	
Heavily or moderately modified	3459	60%		3459
Other Natural Areas	606	11%		606
TOTALS	5772	100%	1706	4065
			30%	70%
Conveyor Route (36 m servitude, 10 km length)				
Mpumalanga Biodiversity Sector Plan	**Hectares**	**% Cover**	**Yes**	**No**
Critical Biodiversity Area	15	41%	15	
Heavily or moderately modified	19	53%		19
Other Natural Areas	2	6%		2
TOTALS	36	100%	15	21
			41%	59%

On a local scale (Figure 12), 36% (2 095 ha) (Table 15) of the vegetation had been transformed with cultivation driving 35% of the transformation. The remaining 64% (3 677 ha) of the natural vegetation consists of almost equal parts of the two communities identified during the November 2000 studies. These areas most probably do not present optimal land for cultivation due to soil restriction related to soil depth, soil moisture and soil texture.

With regards to the conveyor route, 91% (33 ha) of the vegetation represents natural vegetation with the *Themeda triandra – Senecio erubesscens* Grassland on fine textured soils dominating at 73%, less than 10% (3 ha) of the vegetation within the conveyor route is considered to be transformed (Table 15).

4.2.2 Species Diversity

4.2.2.1 Species richness

The PRECIS data available from the South African National Biodiversity Institute's (SANBI) website was extracted for the nine topocadastral grids associated with the study area (conveyor route & prospecting area) (Figure 13). These nine topocadastral grids in total contained 889 species, with the grids overlapping with the study area containing 99 and 180 species respectively (Table 16).

During the February 2013 survey, 127 species were recorded across 12 plots (Appendix A.6). These 127 species represents 37 plant families, of which the following ten families contains more than 70% of the species recorded during the study (Table 17): Poaceae, Asteraceae, Fabaceae, Rubiaceae, Acanthaceae, Cyperaceae, Hypoxidaceae, Malvaceae, Amaranthaceae, Apiaceae. The 37 plant families contain a 100 genera of which the following ten genera contain 25% of the species recorded (Table 18): *Eragrostis, Berkheya, Helichrysum, Hypoxis, Senecio, Vernonia, Anthospermum, Aristida, Bidens, Ledebouria*. The 127 species represents 35 gramnoids (grass and sedge) (28%), 86 herbaceous species (forbs) (68%) and 6 woody species (trees and shrubs) (5%) (Table 19).

Therefore it should be evident that any rehabilitation plan which intends to only re-introduce grasses, is not complying with the principals contained in the National Environmental Management Biodiversity Act, because forbs occur in natural veld at a minimum ratio of 2:1 with regards to grasses (Table 19).

4.2.2.2 Red Data and protected species

Red Data – threatened species

A query of the 889 species recorded across the 9 topocadastral grids, indicated that five (5) species are classified as threatened Red Data[10] plants (Vulnerable, Endangered, Critical Endangered) (Table 20), namely: *Anacampseros subnuda* Poelln. subsp. *lubbersii* (Bleck) Gerbaulet (Vulnerable), *Frithia humilis* Burgoyne (Endangered), *Khadia carolinensis* (L.Bolus) L.Bolus (Vulnerable), *Nerine gracilis* R.A.Dyer (Vulnerable), *Pachycarpus suaveolens* (Schltr.) Nicholas & Goyder (Vulnerable) (Appendix A.7). None of these five species had been recorded within the plots sampled during the study; however it does not imply that they cannot occur within the area to be influenced by the proposed mining activities. The conveyor route was walked during the survey and none of the species were observed. It was however noted that most of the area is being extensively grazed which implies that the species can occur at lower densities than expected.

None of the species listed in the National Environmenal Management Biodiversity Act as being protected had been recorded within the plots during the survey.

The only provincially protected species in terms of the Mpumalanga Nature Conservation Act (No 10 of 1998) that had been recorded within the plots are *Gladiolus crassifolius*. It should be noted that all species in the genus *Gladiolus* is protected. **Please refer to section 4.1.3.2. Protected species for a list of the other provincially protected species which had been recorded in the remaining natural vegetation associated with the study area.**

[10] http://www.iucnredlist.org/

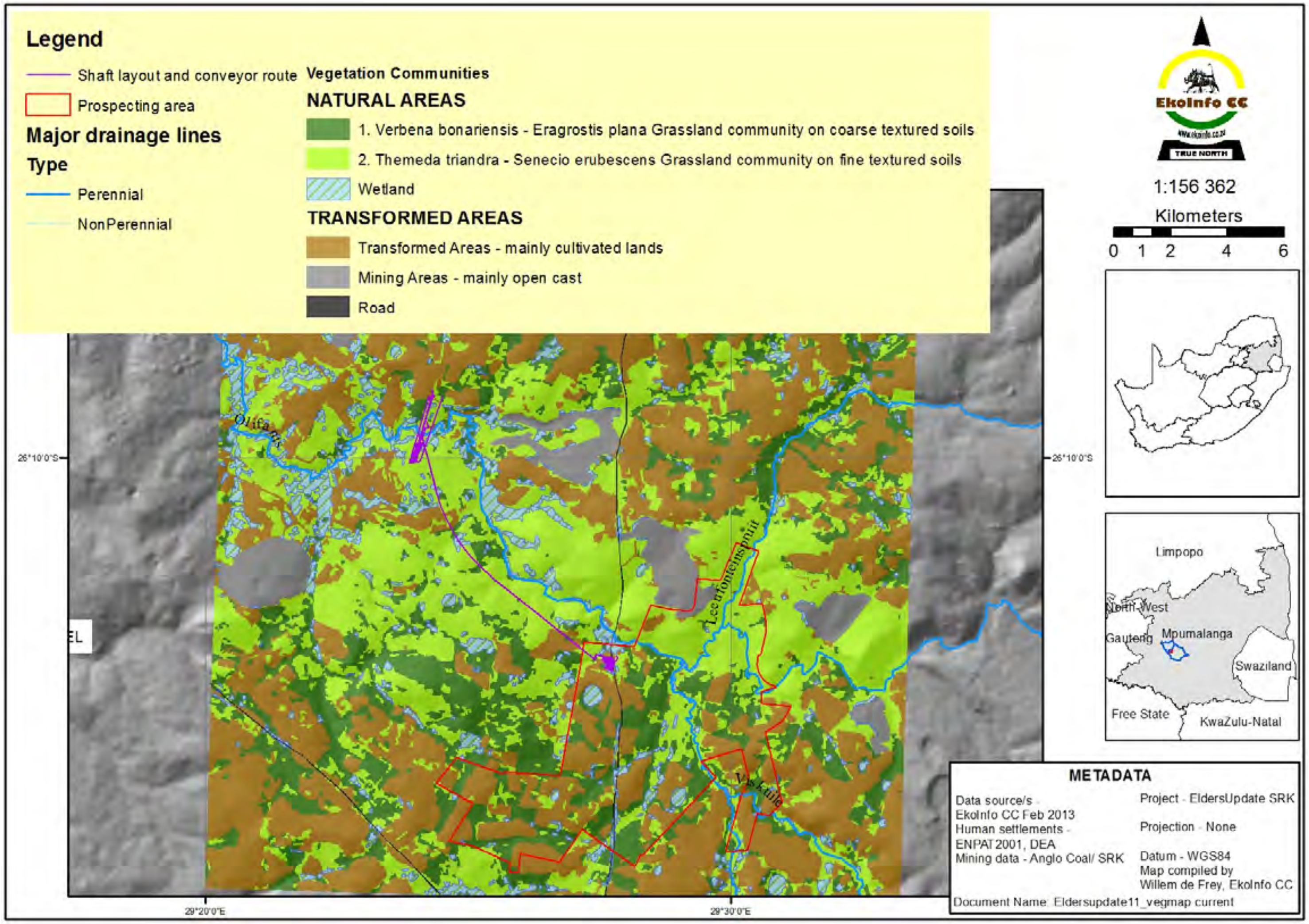


Figure 12: Overview of the vegetation communities present within the study area based on April 2013 satellite imagery

Table 15: Overview of the surface area and percentage cover of the vegetation communities within the prospecting area and conveyor route servitude

Prospecting Area	**Hectares**	**% Cover**	**Ecological Status**	
Vegetation Communities			**Natural Areas**	**Transformed Areas**
1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils	1642	28%	1642	
2. Themeda triandra - Senecio erubescens Grassland community on fine textured soils	1793	31%	1793	
Mining Areas - mainly open cast	63	1%		63
Road	29	1%		29
Transformed Areas - mainly cultivated lands	2003	35%		2003
Wetland	241	4%	241	
TOTALS	5772	100%	3677	2095
			64%	36%
Conveyor Route (36 m servitude, 10 km length)			**Ecological Status**	
Vegetation Communities	**Hectares**	**% Cover**	**Natural Areas**	**Transformed Areas**
1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils	4	10%	4	
2. Themeda triandra - Senecio erubescens Grassland community on fine textured soils	26	73%	26	
Transformed Areas - mainly cultivated lands	3	9%		3
Wetland	3	8%	3	
TOTALS	36	100%	33	3
			91%	9%

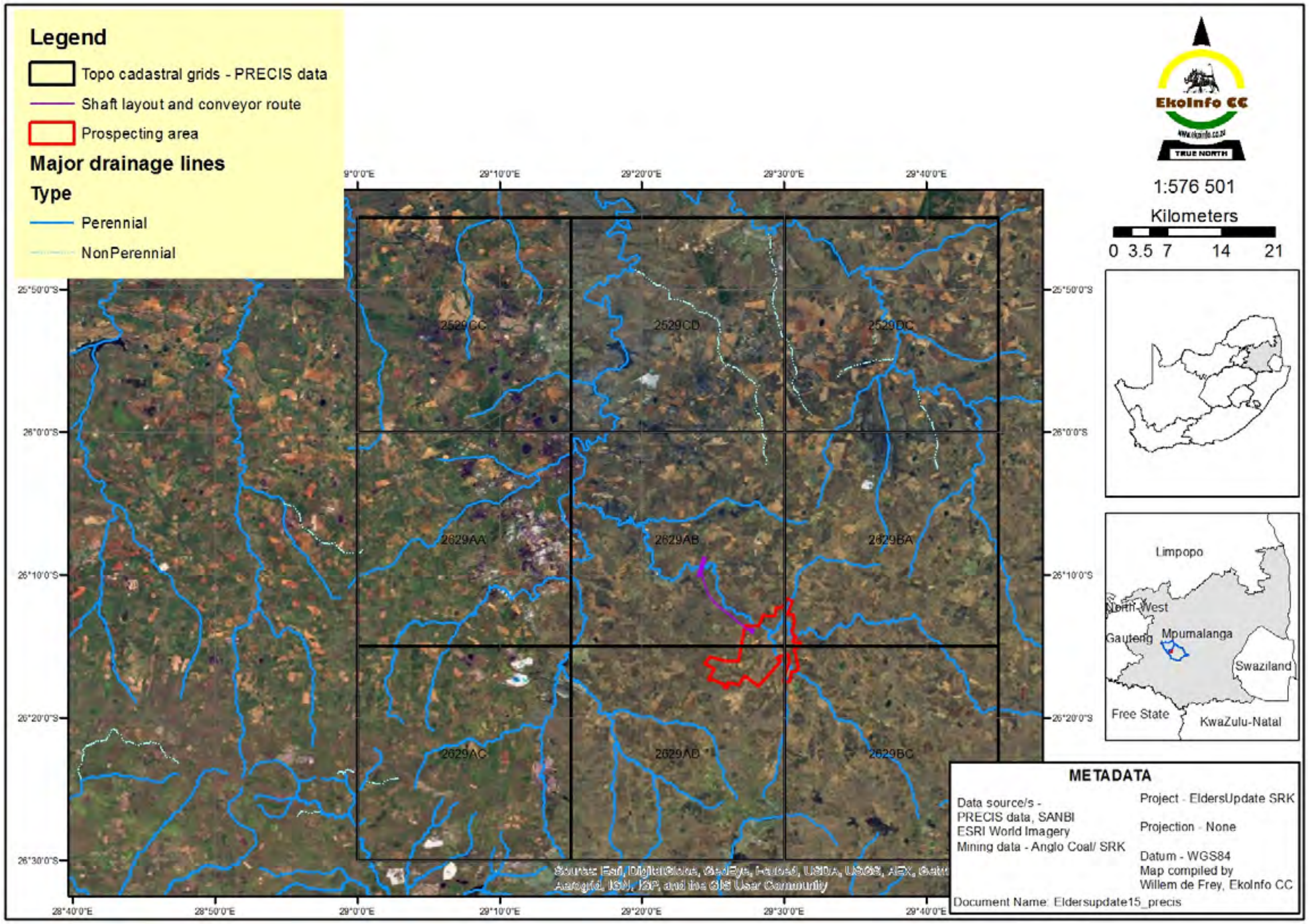


Figure 13: Distribution of the topocadastral grids for which PRECIS data was extracted from SANBI's website (http://posa.sanbi.org/searchspp.php)

Table 16: Overview of number of species recorded per topocadastral grid (Source: SANBI POSA)

Topocadastral Grid	No of species	Area of interest overlap
2529CC	250	
2529CD	490	
2529DC	101	
2629AA	81	
2629AB	99	Conveyor, Prospecting Area
2629AC	49	
2629AD	180	Prospecting Area
2629BA	38	
2629BC	66	

Table 17: Overview of the ten plant families which contains more than 70% of the species recorded during the February 2013 study

Family	No of species	% Frequency	Cumulative % Frequency
Poaceae	31	24%	24%
Asteraceae	29	23%	47%
Fabaceae	8	6%	54%
Rubiaceae	5	4%	57%
Acanthaceae	4	3%	61%
Cyperaceae	3	2%	63%
Hypoxidaceae	3	2%	65%
Malvaceae	3	2%	68%
Amaranthaceae	2	2%	69%
Apiaceae	2	2%	71%

Table 18: Overview of the ten plant genera which contains almost 25% of the species recorded during the February 2013 study

Genera	No of species	% Frequency	Cumulative % Frequency
Eragrostis	6	5%	5%
Berkheya	4	3%	8%
Helichrysum	4	3%	11%
Hypoxis	3	2%	13%
Senecio	3	2%	16%
Vernonia	3	2%	18%
Anthospermum	2	2%	20%
Aristida	2	2%	21%
Bidens	2	2%	23%
Ledebouria	2	2%	24%

Table 19: Overview of the percentage frequency of the major growth forms recorded during the study and the forb:grass ratio

Major Growth Forms	No of species	% frequency
Graminiod	35	28%
Herb	86	68%
Woody species	6	5%
	127	100%
Forb: Grass ratio	2	

Table 20: List of threatened Red Data plants which had been recorded within the nine topocadastral grid associated with the study area

Species	Family	Threat status	Growth forms	Altitude (m)		Habitat	Study area
				Minimum	Maximum		
Anacampseros subnuda Poelln. subsp. lubbersii (Bleck) Gerbaulet	Portulacaceae	Vulnerable	Herb, succulent	1200	1550	Rhyolite associated	Conveyor route
Frithia humilis Burgoyne	Mesembryanthemacea e	Endangered	Succulent	1400	1600	Very shallow soils derived from coarse sediments, Irrigasie Formation of the Ecca group.	Prospecting Area
Khadia carolinensis (L.Bolus) L.Bolus	Mesembryanthemacea e	Vulnerable	Succulent	1690	2015	Well-drained, sandy loam soils among rocky outcrops, or at the edges of sandstone sheets, Highveld Grassland, 1700 m.	Conveyor route
Nerine gracilis R.A.Dyer	Amaryllidaceae	Vulnerable	Geophyte	[?]		Undulating grasslands in damp areas	Prospecting Area
Pachycarpus suaveolens (Schltr.) Nicholas & Goyder	Apocynaceae	Vulnerable	Herb, succulent	1400	2000	Short or annually burnt grasslands, 1400-2000 m	Conveyor route

4.2.2.3 Medicinal species

Six plants with medicinal properties (Van Wyk, Van Oudtshoorn & Gericke 2000) were recorded within the plots sampled, namely: *Centella asiatica, Elephantorrhiza elephantina, Hypoxis hemerocallidea, Pelargonium luridum, Scabiosa columbaria, Vernonia oligocephala*. It should be noted that these plants occur throught the remaining natural vegetation within the study area at various densities depending on the local soil conditions and management strategies. The *Centella asiatica* and *Pelargonium luridum* will be present in the vicinity of wetlands, while the *Elephantorrhiza elephantine, Hypoxis hemerocallidea* and *Scabiosa columbaria* will be more common in well-drained terrestrial areas.

4.2.2.4 Alien invasive species

Three declared alien invasive species in terms of the Conservation of Agricultural Resource Act (No 43 of 1983) were recorded in the surveyed plots, namely: *Campuloclinium macrocephalum, Cirsium vulgare, Solanum elaeagnifolium*. All three species are category one species which implies that they are weeds and serve no useful economic purpose and possess characteristics that are harmful to humans, animals or the environment.

Of specific concern is the presence of *Campuloclinium macrocephalum*, commonly known as the Pom-Pom plant. This plant has spread extensively in the grassland the past years and is difficult to control, where the other two species recorded are often found in close proximity to feeding areas or in cultivated fields, *Campuloclinium macrocephalum* spreads into natural grassland irrespective of its condition. **To support this statement and concern it should be noted that *Campuloclinium macrocephalum* was not recorded in the 2002 study, while both *Cirsium vulgare* and, *Solanum elaeagnifolium* were recorded.**

In July 2013, the list of invasive species in terms of section 70(1)(a) of the National Environmental Management: Biodiversity Act, 2004 (Act No 10 of 2004) was published, however none of the species listed was recorded within the study area.

It should be noted that the following declared invasive trees in terms of the Conservation of Agricultural Resource Act do occur within the landscape associated with the study area, namely *Acacia mearnsii* (Black wattle – Category 2), E*ucalyptus* species (Blue gum – Category mainly category 2) and *Populus* species (Popular – Category 2) (Photo plate 1). These plants need to be controlled outside their permit zones.

4.3 <u>September 2015 update</u>

4.3.1 <u>Introduction</u>

Willem de Frey from EkoInfo CC in association with Dewald Kamffer of Ecocheck re-visited the study area on the 16th and 17th of September 2015. The main objective of the site visit was to evaluate the status of the vegetation to be impacted upon the new non-linear infrastructure (mining complex), which exclude the previous opencast areas (Figure 14). In total 29 sites were visited and more than 116 georeferenced digital photographs taken along the proposed infrastructure (Figure 15). Due to the timing of the survey, the emphasis was to assess the nature (natural or transformed) of the areas to be impacted upon and to observe early flowering species not previously documented. Large sections of the area was burned especially the remaining natural vegetation along the conveyor route (linear structure) (Photo 9, Photo 10).

4.3.2 <u>Ecosystem Diversity</u>

On a local scale, the main drivers of vegetation communities are topographic variation (altitude, slope, aspect) and soil conditions (soil texture, soil depth), as these factors had not changed since the previous assessments (2002/ 2013), it is logical that these communities stated the same. The only changes which could have occurred are:

1. Transformation/ vegetation removal
2. Veld condition due to changes in the grazing pressure

Photo 7: Alien invasive trees (*Acacia mearnsii*) visible in the background, the alien invasive forb *Cirsium vulgare* is visible in the foreground (Prospecting Area – GPS coordinates: S26.29151 E29.42615)

Photo 8: Alien invasive trees visible in the background in close proximity to the existing conveyor belt.

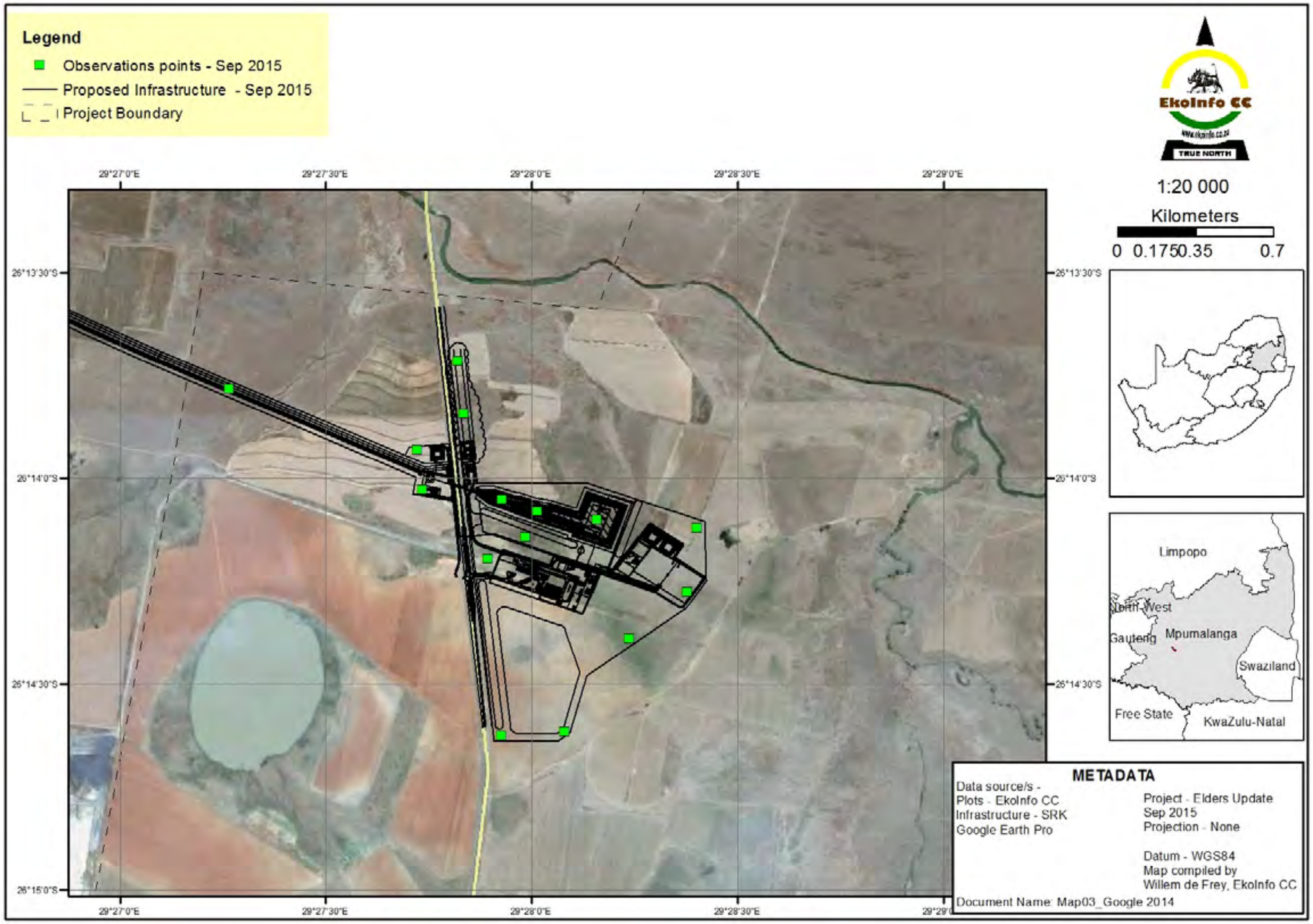


Figure 14: Overview of the new location of the non-linear infrastructure (mining complex) assessed during the September 2015 site visit

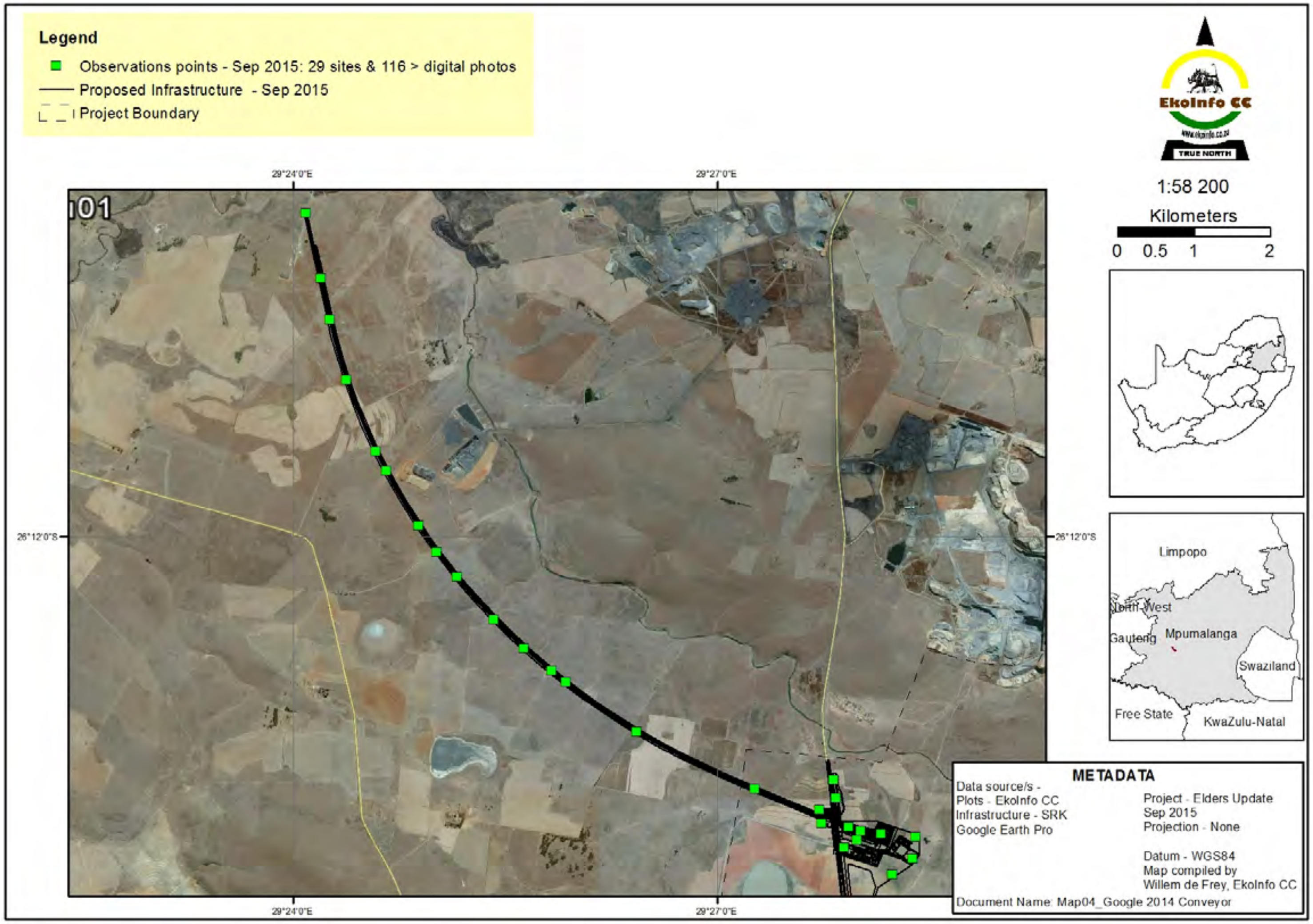


Figure 15: Overview of the location of the 29 observatin points visited during the proposed infrastructure in September 2015

Photo 9: Burned veld close to where the conveyor route commence in the east

Photo 10: Burned veld close to where the conveyor route ends in the west

During the site visit, it was noted that a new open cast mine was developed since the February 2013 assessment (Figure 16). This mine removed 80 ha of remaining natural vegetation within the landscape.

Assessing the change in veld condition is not within the scope of this assessment but should be considered as over grazing of the remaining natural vegetation can contribute significantly to a change in the species composition of the communities and their potential to support livestock (Bothma 1995, Tainton 1999, SANBI 2014). Figure 17 provides a schematic overview of the potential results of over grazing within the grasslands and its implication on biodiversity and production. The influence of fire should also be considered as to frequent fires would also have a negative impact on the local biodiversity and productivity.

4.3.3 Species Diversity

The national flora Red Data[11] list was updated in September 2015, however a review of of the species recorded within the Elders survey in February 2013 with the latest list still indicates that no currently threatened plant species had been recorded within the plots surveyed (Appendix A.8). It should however noted that 6 species were removed from the 2009 list, while 27 species were added to the 2015 list for Mpumalang Province, implying a nett increase of 21 threatened species for Mpumalanga Province. This clearly reflects the pressure on the remaining natural habitat for these species of concern.

In terms of the National Environmental Management Biodiversity Act (NEMBA), nothing had changed in terms of the protected species however in terms of declared invasive species; it has become law to apply for permits with regards to alien invasive species on one's property since the 1st of October 2014, with specific reference to Category 2 species[12]. The stands of *Acacia mearnsii* (Black Wattle) qualify as a Category 2 species and therefore requires a permit, it should be noted that the new regulations contains various conditions and therefore it is recommended that a detail alien invasive assessment be done to provide input into an alien invasive management plan. It should be noted that all three the forb species listed in 2013, namely: *Campuloclinium macrocephalum, Cirsium vulgare and Solanum elaeagnifolium*, had been included within the NEMBA alien invasive regulations of October 2014 and are category 1b, which implies:

> "Category 1b: Invasive species which must be controlled and wherever possible, removed and destroyed. Any form or trade or planting is strictly prohibited".

Of the three species ***Campuloclinium macrocephalum*** **(Pompom weed)** should be prioritised without delay!

In conclusion, it can be stated that although, a late winter/ early spring survey did provide the opportunity to observe an early flowering species such as *Cyrtanthus tuckii* (Photo 11), it did not contribute significantly to the existing species list, highlighting once again the importance of a system based survey during the optimal flowering period of the majority species, because although this species had not been recorded previously, its habitat was flagged to be of conservation importance, thereby providing it an opportunity to persist without necassarying having knowledge of its existence.

Once again it should be reiterated that habitat loss (transformation) is the main driver of species loss globally (Secretariat Of The Convention On Biological Diversity 2014) and should therefore be addressed locally by:

1. Leaving large areas of natural vegetation intact
2. Optimising post-mining landscapes to reduce unnecasary transformation of natural areas somewhere else in the landscape
3. Rehabilitating/ restorting marginal cultivated areas, thereby reducing habitat fragmentation and edge effects.

[11] http://redlist.sanbi.org/
[12] http://www.invasives.org.za/legislation.html

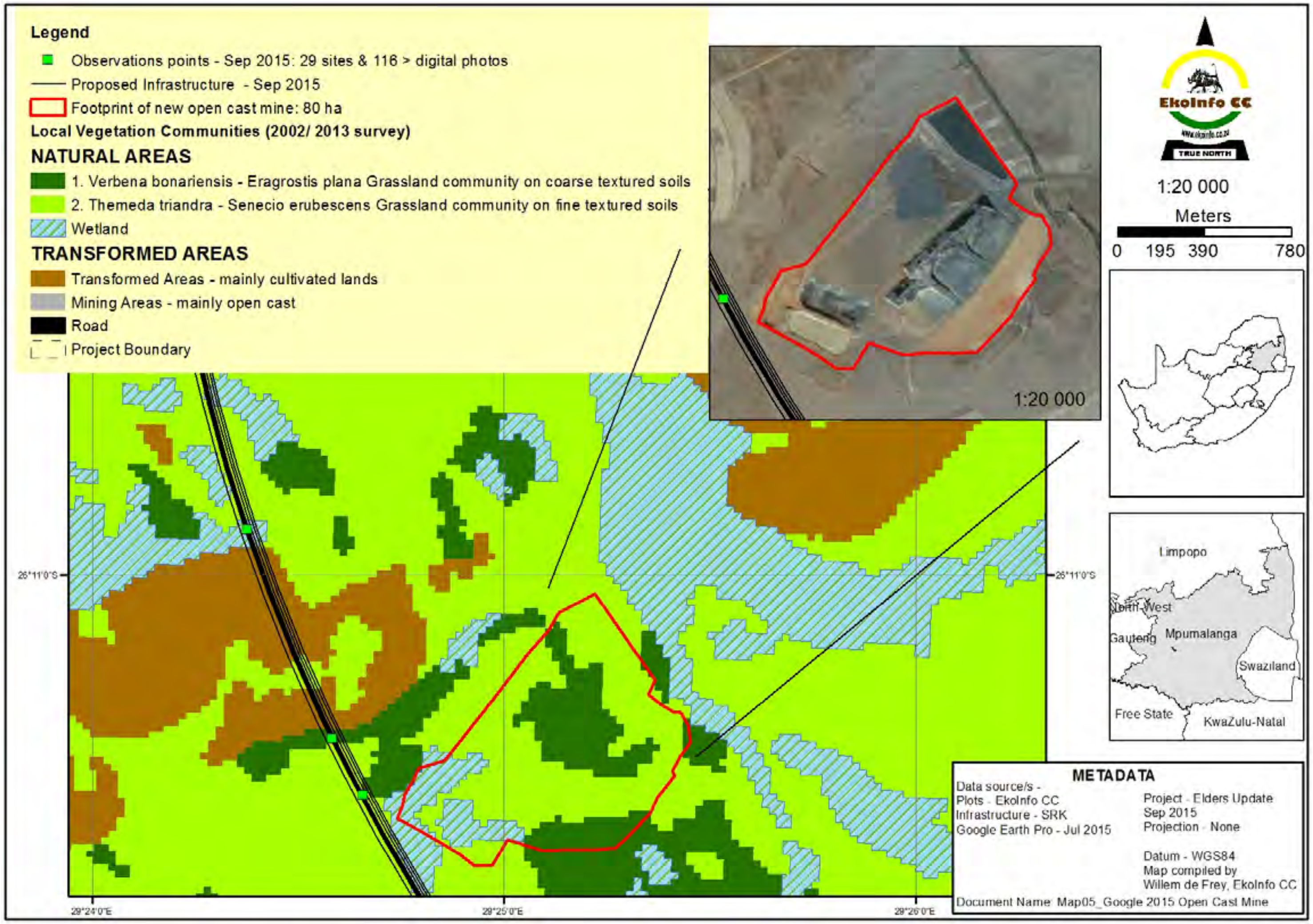


Figure 16: Location and exteng of the new open cast mine that was developed within the remaining natural vegetation along the conveyor route since February 2013

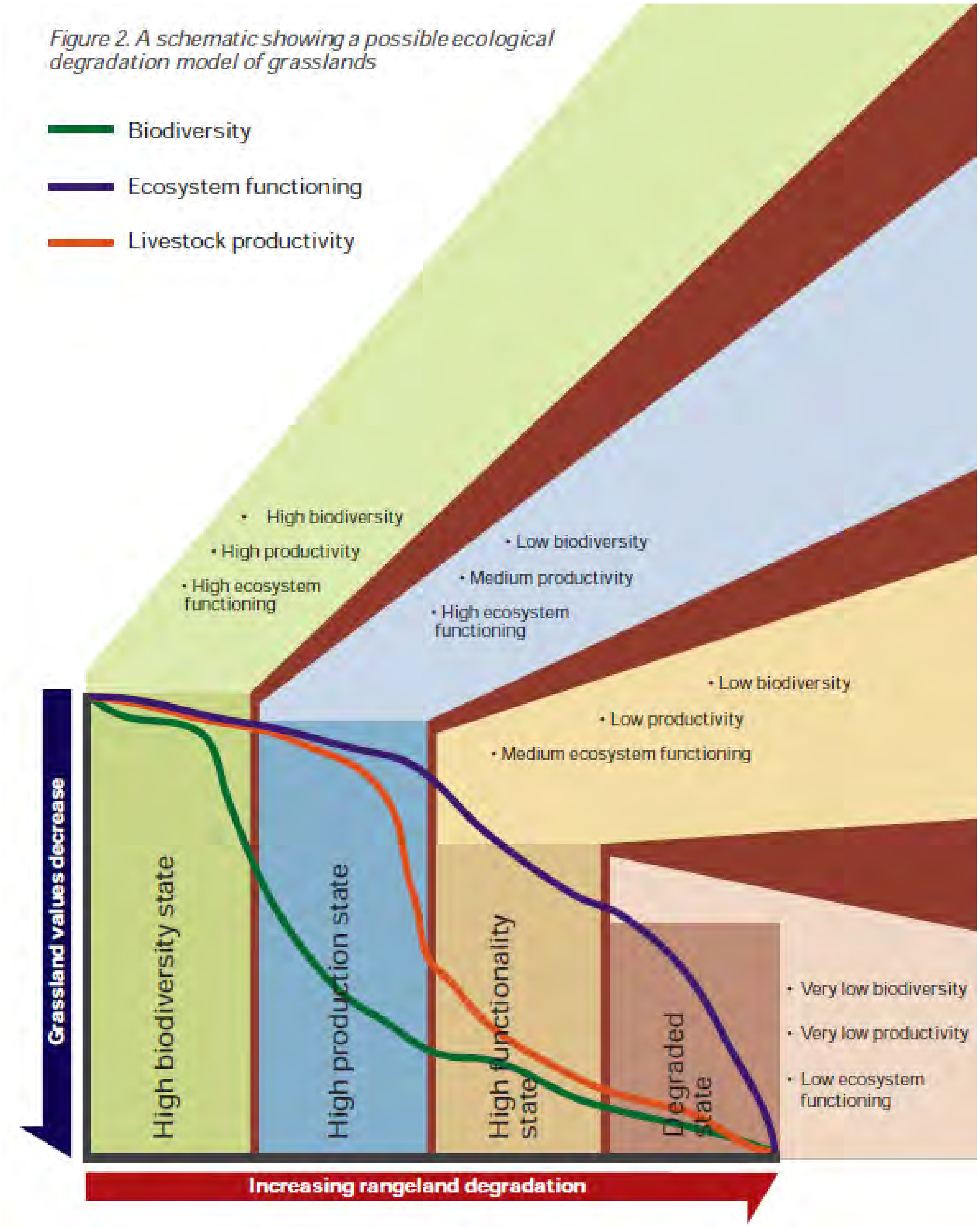


Figure 17: A schematic showing a possible ecological degradation model of grasslands (Extracted from SANBI 2014)

Photo 11: One of the locatlities where the rarely observed *Cyrtanthus tuckii* was documented

5 FAUNA COMPONENT

Biological diversity everywhere is at great risk as a direct result of an ever-expanding human population and its associated needs for energy, water, food and minerals. Landscape transformation that is needed to accommodate these activities inevitably leads to habitat loss and habitat fragmentation, resulting in the mosaical appearance of undisturbed habitat within a matrix of transformed areas. Remaining areas of natural habitat are frequently too small to support the biodiversity that previously occupied, consequently the area and the region is constantly losing its ecological integrity and diversity (Kamffer 2004). Grasslands of Mpumalanga are no exception and the presence of minerals such as coal has led to significant transformation, degradation and fragmentation of the region's grasslands. Agriculture and pastoral activities have similarly had a significant impact on the biodiversity of the region, in fact, farming is believed by some to be the most damaging sector of human activity affecting wild nature (Balmford *et al* 2012).

The area investigated is found in the Q-grids 2629AB, 2629BA, 2629AD and 2629BC between 1600 and 1700 mmasl (mean meters above sea level). It is found on the original farms Vaalkranz 29 (Witbank), Haasfontein 28 (Middelburg), Goedehoop 46 (Middelburg), Bultfontein 187 (Middelburg), Farm 47 (Middelburg), Gloria 186 (Middelburg), Hartebeestkuil 185 (Middelburg), Wilmansrust 47 (Middelburg), Leeuwfontein 48 (Middelburg), Kleinfontein 49 (Middelburg), Vlaklaagte 45 (Bethal), Welstand 55 (Bethal), Bosch Krans 53 (Bethal), Schoon-Vlei 52 (Bethal), Middelkraal 50 (Bethal), Dunbar 189 (Middelburg), Weltevreden 193 (Middelburg), Halfgewonnen 190 (Bethal), Bankpan 225 (Bethal), Geluk 226 (Bethal), Vlakkuilen 76 (Bethal), Elandsfontein 75 (Bethal), Fentonia 54 (Bethal), Dorsfontein 71 (Bethal), Vlakfontein 72 (Bethal), Witbank 80 (Bethal), Kafferstad 79 (Bethal), Rensburghoop 74 (Bethal), Legdaar 78 (Bethal), Schurwekop 227 (Bethal), Koppie 228 (Bethal), Uitgedacht 229 (Bethal) and Kalabasfontein 232 (Bethal). The Olifant, Diepsloot and Viskuile Rivers are found in the study area; it is located in the quaternary catchments B11A, B11B, B11C and B11D of the Olifants River primary catchment area.

The study area is situated within the regional vegetation community of Eastern Highveld Grassland (Mesic Highveld Grassland Bioregion: Grassland Biome – VegMap 2006). This ecological type is listed as Endangered (only 56% remains untransformed). The Grassland Biome (or eco-region) of South Africa is spatially represented in all nine provinces of the country. South African grasslands cover 26% of the country and include six major regions comprising 14 vegetation types.

Grasslands are the habitat of large herds of antelope, as well as many smaller animals, but are currently one of the most threatened in South Africa; forestry, mining and development industries have irreversibly transformed 60-80% of grasslands in South Africa – with only 2% formally conserved. Grasslands are characterised by high levels of species richness and endemism:

- Mammals: 89 species (18 endemic, 9 threatened);
- Reptiles: 84 species (17 endemic, 4 threatened);
- Amphibians: 36 species (18 endemic, 2 threatened); and
- Invertebrates: unknown (Unknown # endemic, 16 threatened).

5.1 Methods

Field investigations commonly employed for EIA studies are normally limited by time and budget and scientific approaches generally have to be adapted to allow for these limitations. Ecology and biodiversity are growing fields of science and much is still unknown. As always, information on the herpetofauna and invertebrates of the region and farms is lacking in detail and significant information gaps exist in this regard.

5.1.1 Invertebrates

Invertebrates are by far the most important animals present anywhere. They are very useful bio-indicators and include meaningful surrogates, flagships and diversity indicators. All invertebrate species that can be identified to species level was collected, photographed or identified on site depending on the species. These species are mostly included in the Lepidoptera (butterflies), Odonata (dragonflies and damselflies) and Coleoptera (beetles). Other species such as baboon – and trapdoor spiders and true bugs were potential inclusions.

5.1.2 Herpetofauna

Frogs was sampled using species-specific vocalizations of males as identification; also, active searches for active adults during early evenings. Snakes, lizards and other reptiles will be sampled by active searches in likely habitats (under rocks, in inactive termitaria etc.). Observed shed skins of snakes and lizards were also used as a means of identifying reptiles. *Ad hoc* sampling was performed by driving slowly on raods during both day and night in order to observe any active herpetofauna or identifiable fresh roadkills.

5.1.3 Birds

Assessing avifaunal diversity of an area includes three components:
- Visual sightings
- Bird vocalizations
- Habitat assessments

However, most bird species are highly visible and thus easily identifiable using visual observations. Binoculars are used to assist the observer in identifying smaller and more cryptic species as well as the type of habitat that they occur in. Many bird species are cryptically coloured and can only be identified by means of their calls; calls of many cryptic bird species are species-specific and very useful in compiling a species inventory list of the area under investigation.

Ideally, various field assessments during all seasons of the year are needed to start to create an “avifauna image” of the study area that supports the reality of bird communities in the area. Since this is never accomplished in reality, habitat assessments are used to create a “model” of the bird communities likely to be found in the area investigated. Fortunately, much data is available on the birds of Southern Africa; distribution records, habitat requirements etc. By assessing the available habitat within the study area (with focus on habitat characteristics available and diversity and quality of habitats present), all bird species (including Red List species) are assessed in terms of likelihood of occurring within the study area. The final stage of the avifaunal study is using the image created of the avifaunal communities of the study area in assessing the impacts of the proposed project on the avifauna of the study area. Impacts are weighed and mitigations measures proposed where possible.

During this study, bird occurrences were identified and noted according to the latest SABAP2 protocol (see http://sabaps.adu.org.za). Therefore, all observations were also submitted to the atlas project.

5.1.4 Mammals

Visual sightings as well as ecological indicators such as tracks, dung, calls and diggings were used to compile a species inventory of the mammals of the study area. Baited camera traps were used to assess the area in terms of the presence/absence of the medium and large carnivores. *Ad hoc* sampling was performed by driving slowly on raods during both day and night in order to observe any active roadkills or identifiable fresh roadkills.

5.1.5 Ecology

Species inventory lists and indications of species richness and -diversity recorded with the aid of above-mentioned methods will be used to interpret the relative ecological status of the study area/s and to compare areas and variations in faunal habitats present. These comparisons are done in liaison with the vegetation characteristic in order to gain an ecological understanding of the study area and the potential impacts of the study area/s.

5.1.6 Limitations

- Findings, results, observations, conclusions and recommendations presented in this report are based on the authors’ best scientific and professional knowledge as well as the interpretation of information available to them at the time of compiling this report.
- Due care and diligence is exercised by the authors, consultants and/or specialist investigators in rendering services and preparing this document. The consultants and/or specialist investigators

accepts no liability for conclusions, suggestions, limitations and recommendations made in good faith, based on available information, or based on data that was obtained from surveys.

- Results presented in this report are based on a snapshot investigation of the study area and not on detailed and long-term investigations of all environmental attributes and the varying degrees of biological diversity that may be present in the study area.
- Rare and endemic species normally do not occur in great densities and, because of customary limitations in the search and identification of Red Listed species, the detailed investigation of these species was not possible. Results are ultimately based on estimations and specialist interpretation of imperfect data.
- It is emphasised that information, as presented in this document, only have bearing on the site as indicated on accompanying maps. This information cannot be applied to any other area, however similar in appearance or any other aspect, without proper investigation.
- Furthermore, additional information may become known during a later stage of the process or development. The authors therefore reserve the right to modify aspects of the report including the recommendations should new information may become available from ongoing research or additional work in this particular area, or pertaining to this investigation.
- This report should always be considered as a whole. Reading and representing portions of the report in isolation could lead to incorrect conclusions and assumptions. In case of any uncertainty, the authors should be contacted to clarify any viewpoints, recommendations and/ or results.

5.1.7 <u>September 2015 Update</u>

For the purposes of the 2015 update, a short field investigation of the study area was completed on 16 and 17 September 2015. The field investigation included an ecological assessment of the area as well as observations of animal inhabitants of the study area. It did not include any trapping, physical sampling or remote sensing collection of data. Rather, the focus was on observations of animals (audio and visual) and species-specific ecological indications of fauna such as tracks, dung and diggings. Twenty-nine sampling plots were used to assess the current ecological condition of the faunal habitat diversity found in the study area (so-called “spot-checks”). The Olifants River was included in the field investigation as it is considered integral to the ecology of the study area and cannot be considered separately.

A desktop assessment was included in the assessment, to update the data in terms of species lists and red data statuses of species relevant to the study area. For the invertebrates, herpetofauna and mammals the Virtual Museum of the Animal Demography Unit (VMUS) was used for species lists and the regional statuses of red data species (vmus.adu.org.za). For birds, the South African Bird Atlas Project 2 (SABAP) was used for the same purposes (sabap2.adu.org.za).

The study area is located in four Q-degree grids (Figure 18), 2629AB, 2629BA, 2629BC and 2629AD (invertebrates, herpetofauna and mammals) and two pentads, 2610_2925 and 2615_2925 (birds). Data was collected for the following faunal groups:

- Frogs – VMUS;
- Lacewings – VMUS;
- Butterflies – VMUS;
- Mammals – VMUS;
- Dragonflies and Damselflies – VMUS;
- Reptiles – VMUS; and
- Birds – SABAP.

The following abbreviations and acronyms are used in the tables (Results Section) indicating species lists for the study area, including Red Data species and statuses:

- ST: STATUS: indicating the regional status of the species, as per VMUS and SABAP;
- DT: DESKTOP: indicating confirmation of the species for the Q-grid or pentad as per VMUS and SABAP;
- 2013: indicating confirmation of the species for the study area during the 2013 field investigation;
- 2015: indicating confirmation of the species for the study area during the 2015 field investigation;
- NL: Not Listed;
- LC: Least Concern;
- DD: Data Deficient;

- NT: Near Threatened;
- VU: Vulnerable;
- EN: Endangered; and
- CR: Critically Endangered.

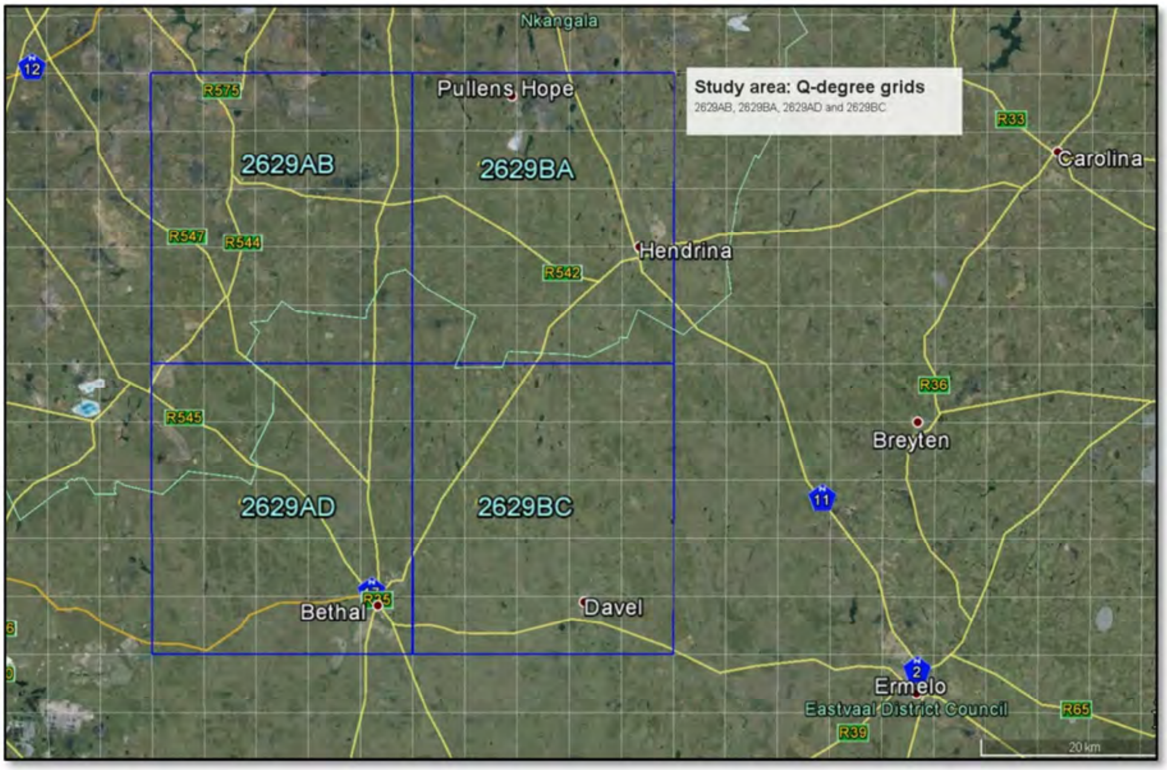


Figure 18: Q-degree grids of the study area

5.2 Results

5.2.1 Regional context

It is important to view the study area on an ecologically relevant scale; consequently, all sensitive animal species (specific faunal groups) known from Mpumalanga are included in this assessment. Data on all faunal groups are lacking (notably for most of the invertebrate groups), as a result, only data sets on specific faunal groups allow for habitat sensitivity analyses based on the presence/absence of sensitive faunal species (red data species) and their specific habitat requirements. At present, the following faunal groups are included in these analyses:

- Dragonflies and Damselflies (Invertebrata: Insecta: Odonata). References used include the IUCN Red List (2011) – http://www.iucnredlist.org and Field Guides to the Dragonflies and Damselflies of South Africa (Tarboton & Tarboton 2005).
- Butterflies (Invertebrata: Insecta: Lepidoptera – Nymphalidae, Lycaenidae, Hesperiidae, Pieridae and Papilionidae). References used include the IUCN Red List (2011) – http://www.iucnredlist.org, the South African Butterfly Conservation Assessment (SABCA, 2011) – http://sabca.adu.org.za and the Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas (Mecenero *et al* [eds.], 2013).
- Frogs (Amphibia: Anura). References used include the Atlas and Red Data Book of the South Africa, Lesotho and Swaziland, the Giant Bullfrog Conservation Group (2011) – http://www.up.ac.za/bullfrog and a Complete Guide to the Frogs of Southern Africa (du Preez & Carruthers, 2009).

- Reptiles (Reptilia: Testudines and Squamata). References used include the IUCN Red List (2011) and the South African Reptile Conservation Assessment (SARCA, 2011) – http://sarca.adu.org.za.
- Birds: The Southern African Bird Atlas Project 2 – http://sabap2.adu.org.za.
- Terrestrial Mammals (Mammalia: Insectivora, Chiroptera, Primates, Lagomorpha, Pholidota, Rodentia, Carnivora, Tubulidentata, Proboscidea, Hyracoidea, Perissodactyla and Artiodactyla). References used include the Red Data Book of the Mammals of South Africa: A Conservation Assessment (Endangered Wildlife Trust - 2004).

As more data become available, additional faunal groups are likely to be added to these assessments.

Red Data Fauna Assessment

A total of 153 Red Data animals are known to occur in Mpumalanga (dragonflies, damselflies, butterflies, frogs, reptiles, birds and mammals), indicated in Table 21**.** The following conservation categories are included:

- 22 species are listed as Data Deficient (DD);
- 65 species are listed as Near Threatened (NT);
- 43 species are listed as Vulnerable (VU);
- 16 species are listed as Endangered (EN);
- 7 species are listed as Critically Endangered (CR); and
- 1 species is listed as Extinct.

Estimated Probability of Occurrence (PoC) of the Red Data fauna assessment is based on:

- the size of the study area;
- the location of the study area;
- the diversity and status of each faunal habitat within the study area; and
- the connectivity of the study area to other untransformed faunal habitats.

An assessment of the PoC for these animals yielded the following probabilities (**refer Table 21**):

- 101 species have a low PoC;
- 9 species have a moderate-low PoC;
- 17 species have a moderate PoC;
- 6 species have a moderate-high PoC; and
- 12 species have a high PoC.

Eight red data species were recorded in the study area during the survey period (**refer Table 21**, indicated in **red**).

Table 21: Red Data fauna assessment for the study area

Species Details			Probability Assessment
Biological Name	**English Name**	**RD**	
Dragonflies and Damselflies			
Pseudagrion inopinatum Balinsky, 1971	Balinsky's Sprite	EN	low
Pseudagrion newtoni Pinhey, 1962	Newton's Sprite	VU	low
Butterflies			
Aloeides barbarae Henning S.F. & Henning G.A., 1994c	Barbara's Copper	EN	low
Aloeides nubilus Henning G.A. & Henning S.F., 1982	Cloud Copper	EN	low
Aloeides rossouwi Henning G.A. & Henning S.F., 1982	Rossouw's Copper	EN	low
Chrysoritis aureus (van Son, 1966)	Heidelberg Opal	EN	moderate-low
Dingana alaedeus Henning G.A. & Henning S.F., 1984	Wakkerstroom Widow	NT	low
Dingana fraterna Henning G.A. & Henning S.F., 1996a	Stoffberg Widow	CR	low
Lepidochrysops irvingi (Swanepoel, 1948)	Irving's Blue	EN	low
Lepidochrysops jefferyi (Swierstra, 1909)	Jeffrey's Blue	EN	low
Lepidochrysops swanepoeli (Pennington, 1948)	Swanepoel's Blue	EN	low
Orachrysops violescens Henning G.A. & Henning S.F., 1994i	Violescent Blue	VU	low
Frogs			
Breviceps sopranus Minter, 2003	Whistling Rain Frog	DD	low
Hemisus guttatus Rapp, 1842	Spotted Shovel-nosed Frog	VU	low
Strongylopus wageri Wager, 1961	Plain Stream Frog	NT	low
Reptiles			
Acontias breviceps Essex, 1925	Short-headed Legless Skink	NT	moderate-low
Afroedura pondolia major Onderstall, 1984	Swazi Flat Gecko	NT	low
Chamaesaura aenea Fitzinger, 1843	Coppery Grass Lizard	NT	moderate
Chamaesaura macrolepis Cope, 1862	Large-scaled Grass Lizard	NT	low
Homoroselaps dorsalis Smith, 1849	Striped Harlequin Snake	NT	moderate
Kininyx natalensis	Natal Hinged Tortoise	NT	low
Lamprophis fuscus Boulenger, 1893	Yellow-bellied House Snake	NT	low
Smaug giganteus (Smith, 1844)	Giant Girdled Lizard	VU	low
Tetradactylus breyeri Roux, 1907	Breyer's Long-tailed Seps	VU	moderate
Birds			

Pelecanus rufescens Gmelin, 1789	Pink-backed Pelican	VU	low
Pelecanus onocrotalus Linnaeus, 1758	Great White Pelican	NT	low
Gorsachius leuconotus (Wagler, 1827)	White-backed Night-Heron	VU	low
Leptoptilos crumeniferus (Lesson, 1831)	Marabou Stork	NT	low
Anastomus lamelligerus Temminck, 1823	African Openbill	NT	low
Ephippiorhynchus senegalensis (Shaw, 1800)	Saddle-billed Stork	EN	low
Mycteria ibis (Linnaeus, 1766)	Yellow-billed Stork	NT	moderate
Ciconia episcopus (Boddaert, 1783)	Woolly-necked Stork	NT	low
Ciconia nigra (Linnaeus, 1758)	Black Stork	NT	low
Geronticus calvus (Boddaert, 1783)	Southern Bald Ibis	VU	moderate-high
Phoenicopterus ruber Linnaeus, 1758	Greater Flamingo	NT	confirmed
Phoenicopterus minor E. Geoffroy Saint-Hilare, 1789	Lesser Flamingo	NT	moderate-high
Nettapus auritus (Boddaert, 1783)	African Pygmy-Goose	NT	low
Oxyura maccoa (Eyton, 1838)	Maccoa Duck	NT	moderate
Sagittarius serpentarius (J.F. Miller, 1779)	Secretarybird	NT	high
Gyps coprotheres (J.R. Forster, 1798)	Cape Vulture	VU	low
Gyps africanus Salvadori, 1865	White-backed Vulture	VU	low
Torgos tracheliotus (J.R. Forster, 1796)	Lappet-faced Vulture	VU	low
Trigonoceps occipitalis (Burchell, 1824)	White-headed Vulture	VU	low
Necrosyrtes monachus (Temminck, 1823)	Hooded Vulture	VU	low
Neophron percnopterus (Linnaeus, 1758)	Egyptian Vulture	EX	low
Falco peregrinus Tunstall, 1771	Peregrine Falcon	NT	moderate-low
Falco biarmicus Temminck, 1825	Lanner Falcon	NT	high
Falco vespertinus Linnaeus, 1766	Red-footed Falcon	NT	moderate-low
Macheiramphus alcinus Bonaparte, 1850	Bat Hawk	NT	low
Aquila rapax (Temminck, 1828)	Tawny Eagle	VU	low
Aquila ayresii (Gurney, 1862)	Ayres's Hawk-Eagle	NT	low
Polemaetus bellicosus (Daudin, 1800)	Martial Eagle	VU	low
Stephanoaetus coronatus (Linnaeus, 1766)	African Crowned Eagle	NT	low
Terathopius ecaudatus (Daudin, 1800)	Bateleur	VU	low
Circus ranivorus (Daudin, 1800)	African Marsh Harrier	VU	moderate-high
Circus macrourus (S.G. Gmelin, 1770)	Pallid Harrier	NT	high
Circus maurus (Temminck, 1828)	Black Harrier	NT	moderate-high
Crex crex (Linnaeus, 1758)	Corn Crake	VU	moderate

Sarothrura ayresi (Gurney, 1877)	White-winged Flufftail	CR	low
Sarothrura affinis (A. Smith, 1828)	Striped Flufftail	VU	low
Podica senegalensis (Vieillot, 1817)	African Finfoot	VU	low
Balearica regulorum (E.T. Bennett, 1834)	Grey Crowned Crane	VU	moderate
Bugeranus carunculatus (Gmelin, 1789)	Wattled Crane	CR	low
Anthropoides paradiseus (A.A.H. Lichtenstein, 1793)	Blue Crane	VU	moderate-low
Ardeotis kori (Burchell, 1822)	Kori Bustard	VU	low
Neotis denhami (Children & Vigors, 1826)	Denham's Bustard	VU	moderate
Eupodotis senegalensis (Vieillot, 1820)	White-bellied Korhaan	VU	low
Eupodotis caerulescens (Vieillot, 1820)	Blue Korhaan	NT	confirmed
Lissotis melanogaster (Rüppel, 1835)	Black-bellied Bustard	NT	low
Microparra capensis (A. Smith, 1839)	Lesser Jacana	NT	low
Rostratula benghalensis (Linnaeus, 1758)	Greater Painted-snipe	NT	low
Charadrius pallidus Strickland, 1853	Chestnut-banded Plover	NT	low
Vanellus melanopterus (Cretzschmar, 1829)	Black-winged Lapwing	NT	low
Vanellus albiceps Gould, 1834	White-crowned Lapwing	NT	low
Glareola pratincola (Linnaeus, 1766)	Collared Pratincole	NT	low
Glareola nordmanni Fischer von Waldheim, 1842	Black-winged Pratincole	NT	moderate-high
Sterna caspia Pallas, 1770	Caspian Tern	NT	low
Centropus grillii Hartlaub, 1861	Black Coucal	NT	low
Tyto capensis (A. Smith, 1834)	African Grass-Owl	VU	confirmed
Scotopelia peli (Bonaparte, 1850)	Pel's Fishing-Owl	VU	low
Alcedo semitorquata Swainson, 1823	Half-collared Kingfisher	NT	high
Turnix nanus (Sundevall, 1850)	Black-rumped Buttonquail	EN	low
Bucorvus leadbeateri (Vigors, 1825)	Southern Ground-Hornbill	VU	low
Mirafra cheniana Smith, 1843	Melodious Lark	NT	confirmed
Spizocorys fringillaris (Sundevall, 1850)	Botha's Lark	EN	moderate-high
Heteromirafra ruddi (Grant, 1908)	Rudd's Lark	CR	low
Hirundo atrocaerulea Sundevall, 1850	Blue Swallow	CR	low
Lioptilus nigricapillus (Vieillot, 1818)	Bush Blackcap	NT	low
Zoothera gurneyi (Hartlaub, 1864)	Orange Ground-Thrush	NT	low
Schoenicola brevirostris (Sundevall, 1850)	Broad-tailed Warbler	NT	low
Apalis ruddi Grant, 1908	Rudd's Apalis	NT	low
Platysteira peltata Sundevall, 1850	Black-throated Wattle-eye	NT	low

Anthus brachyurus Sundevall, 1850	Short-tailed Pipit	VU	low
Anthus chloris Lichtenstein, 1842	Yellow-breasted Pipit	VU	low
Buphagus africanus Linnaeus, 1766	Yellow-billed Oxpecker	VU	low
Buphagus erythrorhynchus (Stanley, 1814)	Red-billed Oxpecker	NT	low
Spermestes fringilloides (Lafresnaye, 1835)	Magpie Mannikin	NT	low
Hypargos margaritatus (Strickland, 1844)	Pink-throated Twinspot	NT	low
Mammals			
Chrysospalax villosus (A. Smith, 1833)	Rough-haired Golden Mole	CR	low
Amblysomus hottentotus (A. Smith, 1829)	Hottentot's Golden Mole	DD	low
Amblysomus robustus Bronner, 2000	Robust Golden Mole	EN	low
Amblysomus septentrionalis Roberts, 1913	Higveld Golden Mole	NT	moderate
Neamblysomus juliane (Meester, 1972)	Juliana's Golden Mole	VU	low
Atelerix frontalis (A. Smith, 1831)	South African Hedgehog	NT	high
Elephantulus brachyrhynchus (A. Smith, 1836)	Short-snouted Elephant-shrew	DD	low
Myosorex cafer (Sundevall, 1846)	Dark-footed Forest Shrew	DD	high
Myosorex varius(Smuts, 1832)	Forest Shrew	DD	high
Crocidura cyanea(Duvernoy, 1838)	Reddish-grey Musk Shrew	DD	high
Crocidura flavescens (I. Geoffroy Saint-Hilaire, 1827)	Greater Musk Shrew	DD	moderate-low
Crocidura fuscomurina (Heuglin, 1865)	Tiny Musk Shrew	DD	moderate
Crocidura hirta Peters, 1852	Lesser Red Musk Shrew	DD	moderate
Crocidura maquassiensis Roberts, 1946	Maquassie Musk Shrew	VU	low
Crocidura mariquensis (A. Smith, 1844)	Swamp Musk Shrew	DD	moderate
Crocidura silacea Thomas, 1895	Lesser Grey-brown Musk Shrew	DD	moderate
Suncus infinitesimus (Heller, 1912)	Least Dwarf Shrew	DD	moderate
Suncus lixus (Thomas, 1898)	Greater Dwarf Shrew	DD	moderate
Suncus varilla (Thomas, 1895)	Lesser Dwarf Shrew	DD	moderate
Cloeotis percivali Thomas, 1901	Percival's Short-eared Trident Bat	VU	low
Rhinolophus blasii Peters, 1866	Blasius's Horseshoe Bat	NT	low
Rhinolophus swinnyi Gough, 1908	Swinny's Horseshoe Bat	NT	low
Miniopterus natalensis (A. Smith, 1834)	Natal Long-fingered Bat	NT	low
Scotophilus nigrita (Schreber, 1774)	Giant Yellow House Bat	NT	low
Manis temminckii Smuts, 1832	Ground Pangolin	VU	low
Graphiurus platyops Thomas, 1897	Rock Dormouse	DD	low
Mystromys albicaudatus (A. Smith, 1834)	White-tailed Rat	EN	moderate-low

Tatera leucogaster (Peters, 1852)	Bushveld Gerbil	DD	high
Lemniscomys rosalia (Thomas, 1904)	Single-striped Mouse	DD	high
Dasymys incomtus (Sundevall, 1847)	Water Rat	NT	high
Grammomys dolichurus (Smuts, 1832)	Woodland Mouse	DD	low
Otomys sloggetti Thomas, 1902	Sloggett's Rat	DD	low
Panthera leo (Linnaeus, 1758)	Lion	VU	low
Panthera pardus (Linnaeus, 1758)	Leopard	NT	confirmed
Leptailurus serval (Schreber, 1776)	Serval	NT	confirmed
Acinonyx jubatus (Schreber, 1775)	Cheetah	VU	low
Felis nigripes Burchell, 1824	Black-footed Cat	VU	moderate-low
Crocuta crocuta (Erxleben, 1777)	Spotted Hyaena	NT	low
Parahyaena brunnea (Thunberg, 1820)	Brown Hyaena	NT	confirmed
Paracynictis selousi (de Winton, 1896)	Selous' Mongoose	DD	low
Rhynchogale melleri (Gray, 1865)	Meller's Mongoose	DD	low
Canis adustus Sundevall, 1847	Side-striped Jackal	NT	moderate
Lycaon pictus (Temminck, 1820)	African Wild Dog	EN	low
Mellivora capensis (Schreber, 1776)	Honey Badger	NT	confirmed
Poecilogale albinucha (Gray, 1864)	African Striped Weasel	DD	low
Hydrictis maculicollis (Lichtenstein, 1835)	Spotted-necked Otter	NT	high
Loxodonta africana (Blumenbach, 1797)	African Savanna Elephant	VU	low
Diceros bicornis (Linnaeus, 1758)	Black Rhinoceros	CR	low
Ceratotherium simum (Burchell, 1817)	White Rhinoceros	NT	low
Hippopotamus amphibius Linnaeus, 1758	Common Hippopotamus	VU	low
Raphicerus sharpei Thomas, 1897	Sharp's Grysbok	NT	low
Ourebia ourebi (Zimmerman, 1783)	Southern Oribi	EN	moderate-low
Hippotragus equinus (Desmarest, 1804)	Roan Antelope	VU	low
Hippotragus niger (Harris, 1838)	Southern Sable Antelope	VU	low
Damaliscus lunatus (Burchell, 1823)	Western Tsessebe	EN	low

5.2.2 Local context

The presence of 172 animal species was confirmed during the 2013 summer investigation (**refer Table 22**). The following results were recorded:

- 33 invertebrate species;
- 9 frog species;
- 8 reptile species;
- 99 bird species; and
- 23 mammals.

The diversity of animals recorded in the study area included eight Red Data species, namely:

- Greater Flamingo (*Phoenicopterus ruber* Linnaeus, 1758);
- Blue Korhaan (*Eupodotis caerulescens* (Vieillot, 1820));
- African Grass-Owl (*Tyto capensis* (A. Smith, 1834));
- Melodius Lark (*Mirafra cheniana* Smith, 1843);
- Serval (*Leptailurus serval* (Schreber, 1776));
- Leopard (*Panthera pardus* (Linnaeus, 1758));
- Brown Hyaena (*Parahyaena brunnea* (Thunberg, 1820)); and
- Honey Badger (*Mellivora capensis* (Schreber, 1776)).

The diversity of animals recorded in the study area included 83 Provincially Protected species, listed in Table 22 in green (please refer to Appendix B1).

The diversity of animals recorded in the study area included one Alien and Invasive species, namely:

- Spotted Maize Beetle (*Astylus atromaculatus*).

5.2.3 September 2015 Update

Invertebrates:

Forty-eight invertebrate species (Table 23) are known from the study area, including seven dragonflies and damselflies, one termite, two grasshoppers, one antlion, six beetles, twenty-eight butterflies and one bee. Fifteen of the species are known from desktop only, twenty-seven of the species from field observations only and six species from both desktop and field observations. No red data invertebrates are included in the list of forty-eight species. One alien and invasive species was found to occur (indicated in blue in Table 22): *Astylus atromaculatus*, the Spotted Maize Beetle (Coleoptera: Melyridae).

Herpetofauna:

Thirty-nine herpetofauna species (Table 24) are known from the study area, including three toads, thirteen frogs, seventeen snakes, one agama, two skinks, two geckos and one monitor. Twenty-two of the species are known from desktop only, two of the species from field observations only and fifteen species from both desktop and field observations. No red data herpetofauna are included in the list of thirty-nine species.

Table 22: Animal species confirmed for the study area

Class	Order	Family	*Genus species*	English Name
Insecta	Odonata	Aeshnidae	*Anax imperator* Leach, 1815	Blue Emperor
	Isoptera	Termitidae	*Trinervitermes* species	Snouted Harvester Termite
	Mantodea	Mantidae	*Pyrgomantis rhodesica* Giglio-Tos, 1917	Grass Mantid
	Orthoptera	Tettigoniidae	*Conocephalus caudalis* (Walker, F., 1869)	Meadow Katydid
		Pyrgomorphidae	*Zonocerus elegans* (Thunberg, 1815)	Elegant Grasshopper
	Hemiptera	Lygaeidae	*Spilostethus pandurus*	Milkweed Bug
	Neuroptera	Myrmeleontidae	*Palpares caffer* (Burmeister, 1839)	Mottled Veld Antlion
	Coleoptera	Scarabaeidae	*Popillia biguttata* (Wiedemann, 1821)	Yellow Shining Leaf Chafer
			Porphyronota hebreae	Marbled Fruit Chafer
		Coccinellidae	*Cheilomenes lunata*	Lunate Ladybird
			Exochomus flavipes (Thunberg, 1781)	Black Mealy Bug Predator
		Tenebrionidae	*Lagria* species	Hairy Darkling Beetle
		Melyridae	*Astylus atromaculatus*	Spotted Maize Beetle
	Lepidoptera	Hesperiidae	*Metisella meninx* (Trimen, 1873)	Marsh Sylph
		Pieridae	*Catopsilla florella* (Fabricius, 1775)	African Migrant
			Eurema brigitta brigitta (Stoll, [1780])	Broad-bordered Grass Yellow
			Pontia helice helice (Linnaeus, 1764)	Common Meadow White
		Nymphalidae	*Acraea neobule neobule* Doubleday, [1847a]	Wandering Donkey Acraea
			Byblia ilithyia (Drury, [1773])	Spotted Joker
			Catacroptera cloanthe cloanthe (Stoll, [1781])	Pirate
			Danaus chryssipus orientis (Aurivillius, 1909)	African Monarch
			Hypolimnas missipus (Linnaeus, 1764)	Common Diadem
			Junonia hierta cebrene Trimen, 1870	Yellow Pansy
			Junonia oenone oenone (Linnaeus, 1758)	Blue Pansy
			Phalanta phalantha aethiopica (Rotschild & Jordan, 1903)	African Leopard
			Physcaeneura panda (Boisduval, 1847)	Dark-webbed Ringlet
			Telchinia rahira rahira (Boisduval, 1833a)	Marsh Acraea
			Vanessa cardui (Linnaeus, 1758)	Painted Lady
		Lycaenidae	*Aloeides henningi* Tite & Dickson, 1973	Henning's Copper

			Eicochrysops messapus mahallakoaena (Wallengren, 1857)	Cupreous Blue
			Lampides boeticus (Linnaeus, 1767)	Pea Blue
			Zizula hylax (Fabricius, 1775)	Gaika Blue
	Hymenoptera	Apidae	*Apis mellifera* Linnaeus, 1758	Honey Bee
Amphibia	Anura	Bufonidae	*Amietophrynus gutturalis* Power, 1927	Guttural Toad
		Hyperoliidae	*Kassina senegalensis* Duméril & Bibron, 1841	Bubbling Kassina
			Semnodactylus wealii (Boulenger, 1882)	Rattling Frog
		Pipidae	*Xenopus laevis* Daudin, 1802	Common Platanna
		Pyxicephalidae	*Cacosternum boettgeri* (Boulenger, 1882)	Boettger's Caco
			Amietia angolensis (Bocage, 1866)	Common River Frog
			Amietia fuscigula Duméril & Bibron, 1841	Cape River Frog
			Strongylopus fasciatus Smith, 1849	Striped Stream Frog
			Strongylopus grayii Smith, 1849	Clicking Stream Frog
Reptilia	Squamata	Typhlopidae	*Afrotyphlops bibronii* (Smith, 1846)	Bibron's Blind Snake
		Leptotyphlopidae	*Leptotyphlops scutifrons* Peters, 1854	Peters' Thread Snake
		Colubridae	*Psammophylax rhombeatus* (Linnaeus, 1758)	Spotted Grass Snake
			Crotaphopeltis hotamboeia Laurenti, 1768	Red-lipped Snake
		Elapidae	*Hemachatus haemachatus* Lacépède, 1789	Rinkhals
		Scincidae	*Trachylepis punctatissima* Smith, 1849	Speckled Rock Skink
		Varanidae	*Varanus niloticus* Linnaeus, 1758	Water Monitor
		Gekkonidae	*Pachydactylus affinis* Boulenger, 1896	Transvaal Gecko
Aves	Galliformes	Numididae	*Numida meleagris* (Linnaeus, 1758)	Helmeted Guineafowl
		Phasianidae	*Coturnix coturnix* (Linnaeus, 1758)	Common Quail
			Pternistis swainsonii (A.Smith, 1836)	Swainson's Spurfowl
	Anseriformes	Anatidae	*Alopochen aegyptiaca* (Linnaeus, 1766)	Egyptian Goose
			Anas capensis Gmelin, 1789	Cape Teal
			Anas erythrorhyncha Gmelin, 1789	Red-billed Teal
			Anas smithii (Hartert, 1891)	Cape Shoveler
			Anas undulata C.F. Dubois, 1839	Yellow-billed Duck
			Netta erythrophthalma (Wied-Neuwied, 1833)	Southern Pochard
			Plectropterus gambensis (Linnaeus, 1766)	Spur-winged Goose
	Podicipediformes	Podicipedidae	*Tachybaptus ruficollis*	Little Grebe
	Ciconiiformes	Phoenicopteridae	*Phoenicopterus ruber* Linnaeus, 1758	Greater Flamingo
		Treshkiornithidae	*Bostrychia hagedash* (Latham, 1790)	Hadeda Ibis

			Platalea alba Scopoli, 1786	African Spoonbill
			Threskiornis aethiopicus (Latham, 1790)	African Sacred Ibis
		Ardeidae	*Ardea cinerea* Linnaeus, 1758	Grey Heron
			Ardea melanocephala Children & Vigors, 1826	Black-headed Heron
			Bubulcus ibis (Linnaeus, 1758)	Cattle Egret
		Scopidae	*Scopus umbretta* Gmelin, 1789	Hamerkop
	Suliformes	Phalacrocoracidae	*Microcarbo africanus* (Gmelin, 1789)	Reed Cormorant
			Phalacrocorax lucidus (Lichtenstein, 1823)	White-breasted Cormorant
	Accipitiriformes	Accipitridae	*Buteo vulpinus*	Steppe Buzzard
			Circus pygargus (Linnaeus, 1758)	Montagu's Harrier
			Elanus caeruleus (Desfontaines, 1789)	Black-shouldered Kite
			Haliaeetus vocifer (Daudin, 1800)	African Fish-Eagle
	Falconiformes	Falconidae	*Falco amurensis* Radde, 1863	Amur Falcon
	Gruiformes	Oditidae	*Afrotis afraoides* (A. Smith, 1831)	Northern Black Korhaan
			Eupodotis caerulescens (Vieillot, 1820)	Blue Korhaan
		Rallidae	*Fulica cristata* Gmelin, 1789	Red-knobbed Coot
	Charadriiformes	Burhinidae	*Burhinus capensis* (Lichtenstein, 1823)	Spotted Thick-knee
		Recurvirostridae	*Himantopus himantopus* (Linnaeus, 1758)	Black-winged Stilt
			Recurvirostra avosetta Linnaeus, 1758	Pied Avocet
		Charadridae	*Charadrius tricollaris* Vieillot, 1818	Three-banded Plover
			Vanellus armatus (Burchell, 1822)	Blacksmith Lapwing
			Vanellus coronatus (Boddaert, 1783)	Crowned Lapwing
		Scolopacidae	*Actitis hypoleucos* (Linnaeus, 1758)	Common Sandpiper
			Gallinago nigripennis Bonaparte, 1839	African Snipe
			Philomachus pugnax (Linnaeus, 1758)	Ruff
			Tringa glareola Linnaeus, 1758	Wood Sandpiper
			Tringa nebularia (Gunnerus, 1767)	Common Greenshank
	Columbiformes	Columbidae	*Columba guinea* Linnaeus, 1758	Speckled Pigeon
			Spilopelia senegalensis	Laughing Dove
			Streptopelia capicola (Sundevall, 1857)	Cape Turtle-Dove
			Streptopelia semitorquata (Ruppell, 1837)	Red-eyed Dove
	Cuculiformes	Cuculidae	*Chrysococcyx caprius* (Boddaert, 1783)	Diderick Cuckoo
	Strigiformes	Tytonidae	*Tyto capensis* (A. Smith, 1834)	African Grass-Owl
		Strigidae	*Asio capensis* (A. Smith, 1834)	Marsh Owl

			Bubo africanus (Temminck, 1821)	Spotted Eagle-Owl
	Apodiformes	Apodidae	*Apus affinis* (J.E. Gray, 1830)	Little Swift
			Apus caffer (Lichtenstein, 1823)	White-rumped Swift
	Piciformes	Picidae	*Geocolaptes olivaceus* (Gmelin, 1788)	Ground Woodpecker
	Passeriformes	Laniidae	*Lanius collaris* Linnaeus, 1766	Common Fiscal
		Corvidae	*Corvus albus* Müller, 1776	Pied Crow
		Alaudidae	*Calandrella cinerea* (J.F. Gmelin, 1789)	Red-capped Lark
			Chersomanes albofasciata (Lafresnaye, 1836)	Spike-heeled Lark
			Mirafra africana Smith, 1836	Rufous-naped Lark
			Mirafra cheniana Smith, 1843	Melodious Lark
			Spizocorys conirostris (Sundevall, 1850)	Pink-billed Lark
		Hirundinidae	*Hirundo albigularis* Strickland, 1849	White-throated Swallow
			Hirundo cucullata Boddaert, 1783	Greater Striped Swallow
			Hirundo rustica Linnaeus, 1758	Barn Swallow
			Hirundo spilodera Sundevall, 1850	South African Cliff-Swallow
			Riparia cincta (Boddaert, 1783)	Banded Martin
			Riparia paludicola (Vieillot, 1817)	Brown-throated Martin
			Riparia riparia (Linnaeus, 1758)	Sand Martin
		Cisticolidae	*Cisticola aridulus* Witherby, 1900	Desert Cisticola
			Cisticola ayresii Hartlaub, 1863	Wing-snapping Cisticola
			Cisticola cinnamomeus	Pale-crowned Cisticola
			Cisticola juncidis (Rafinesque, 1810)	Zitting Cisticola
			Cisticola lais (Hartlaub & Finsch, 1870)	Wailing Cisticola
			Cisticola textrix (Vieillot, 1817)	Cloud Cisticola
			Cisticola tinniens (Lichtenstein, 1842)	Levaillant's Cisticola
			Prinia flavicans (Vieillot, 1820)	Black-chested Prinia
			Prinia subflava (J.F. Gmelin, 1789)	Tawny-flanked Prinia
		Locustellidae	*Sphenoeacus afer* (J.F. Gmelin, 1789)	Cape Grassbird
		Acrocephalidae	*Acrocephalus baeticatus* (Vieillot, 1817)	African Reed-Warbler
			Acrocephalus gracilirostris (Hartlaub, 1864)	Lesser Swamp-Warbler
			Acrocephalus palustris (Bechstein, 1798)	Marsh Warbler
		Zosteropidae	*Zosterops capensis*	Cape White-eye
		Muscicapidae	*Cossypha caffra* (Linnaeus, 1771)	Cape Robin-Chat
			Myrmecocichla formicivora (Vieillot, 1818)	Anteating Chat

			Saxicola torquatus (Linnaeus, 1766)	African Stonechat
		Estrildidae	*Estrilda astrild* (Linnaeus, 1758)	Common Waxbill
			Ortygospiza atricollis (Vieillot, 1817)	African Quailfinch
		Ploceidae	*Euplectes afer* (J.F. Gmelin, 1789)	Yellow-crowned Bishop
			Euplectes albonotatus (Cassin, 1848)	White-winged Widowbird
			Euplectes axillaris (Smith, 1838)	Fan-tailed Widowbird
			Euplectes orix (Linnaeus, 1758)	Southern Red Bishop
			Euplectes progne (Boddaert, 1783)	Long-tailed Widowbird
			Ploceus velatus Vieillot, 1819	Southern Masked-Weaver
			Quelea quelea (Linnaeus, 1758)	Red-billed Quelea
		Passeridae	*Passer melanurus* (Müller, 1776)	Cape Sparrow
		Viduidae	*Vidua macroura* (Pallas, 1764)	Pin-tailed Whydah
		Motacillidae	*Anthus cinnamomeus* Rüppell, 1840	African Pipit
			Macronyx capensis (Linnaeus, 1766)	Cape Longclaw
			Motacilla capensis Linnaeus, 1766	Cape Wagtail
		Fringillidae	*Critagra flaviventris*	Yellow Canary
			Crithagra atrogularis	Black-throated Canary
			Crithagra mozambica	Yellow-fronted Canary
Mammalia	Lagomorpha	Leporidae	*Lepus saxatilis* F. Cuvier, 1823	Scrub Hare
	Rodentia	Bathyergidae	*Cryptomys hottentotus* (Lesson, 1826)	Common Mole-rat
		Hystricidae	*Hystrix africaeaustralis* Peters, 1852	Porcupine
		Muridae	*Tatera brantsii* (Smith, 1836)	Highveld Gerbil
	Carnivora	Felidae	*Caracal caracal* (Schreber, 1776)	Caracal
			Leptailurus serval (Schreber, 1776)	Serval
			Panthera pardus (Linnaeus, 1758)	Leopard
		Hyaenidae	*Parahyaena brunnea* (Thunberg, 1820)	Brown Hyaena
			Proteles cristatus (Sparrman, 1783)	Aardwolf
		Herpestidae	*Atilax paludinosus* (G. [Baron] Cuvier, 1829)	Marsh Mongoose
			Cynictis penicillata (G. [Baron] Cuvier, 1829)	Yellow Mongoose
			Galerella sanguinea (Rüppell, 1835)	Common Slender Mongoose
			Herpestes ichneumon (Linnaeus, 1758)	Egyptian Mongoose
		Canidae	*Canis mesomelas* Schreber, 1775	Black-backed Jackal
			Vulpes chama (A. Smith, 1833)	Cape Fox
		Mustelidae	*Aonyx capensis* (Schinz, 1821)	African Clawless Otter

			Mellivora capensis (Schreber, 1776)	Honey Badger
	Tubulidentata	Orycteropodidae	*Orycteropus afer* (Pallas, 1766)	Aardvark
	Artiodactyla	Suidae	*Phacochoerus africanus* (Gmelin, 1788)	Common Warthog
			Potamochoerus larvatus (F. Cuvier, 1822)	Bushpig
		Bovidae	*Raphicerus campestris* (Thunberg, 1811)	Steenbok
			Redunca arundinum (Boddaert, 1785)	Southern Reedbuck
			Sylvicapra grimmia (Linnaeus, 1758)	Bush Duiker

Birds:

Two hundred and seven bird species (Table 25) are known from the study area. The list includes birds from sixteen orders and fifty-six families. One hundred and five of the species are known from desktop only, one of the species from field observations only and one hundred and one species from both desktop and field observations. The birds known from the study area includes eleven red data species:

1. Greater Flamingo – Near Threatened;
2. Lesser Flamingo – Near Threatened;
3. Southern Bald Ibis - Vulnerable;
4. Secretarybird – Near Threatened;
5. African Marsh-Harrier - Vulnerable;
6. Lanner Falcon – Near Threatened;
7. Lesser Kestrel - Vulnerable;
8. Blue Korhaan – Near Threatened;
9. Black-winged Pratincole – Near Threatened;
10. African Grass-Owl - Vulnerable; and
11. Melodious Lark – Near Threatened.

The birds of the study area also include two alien and invasive species:

1. Rock Dove; and
2. Common Myna.

Mammals:

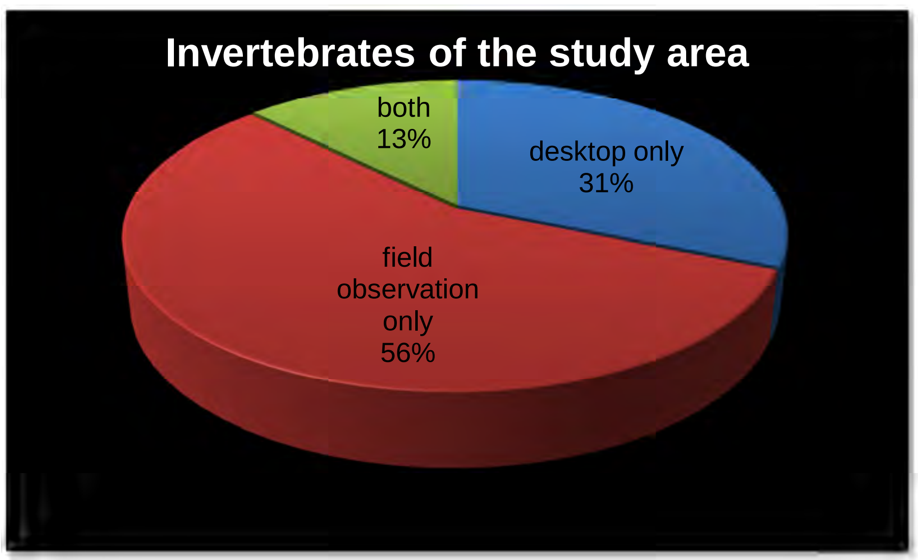
Forty-five mammal species (Table 26) are known from the study area. The list includes four insectivores, one hare, nine rodents, seventeen carnivores, one tubulidentate, one hyrax, two pigs and ten bovids. Sixteen of the species are known from desktop only, twelve of the species from field observations only and seventeen species from both desktop and field observations. The mammals known from the study area includes nine red data species:

1. Southern African Hedgehog – Near Threatened;
2. Swamp Musk Shrew – Data Deficient;
3. Dark-footed Forest Shrew – Data Deficient;
4. Forest Shrew – Data Deficient;
5. Serval – Near Threatened;
6. Leopard – Near Threatened;
7. Brown Hyaena;
8. Honey Badger; and
9. Oribi.

Table 23: Invertebrates of the study area

ORDER	FAMILY	*GENUS-SPECIES*	ENGLISH NAME	ST	DT	2013	2015
Odonata	Aeshnidae	*Anax imperator* Leach, 1815	Blue Emperor	NL	no	yes	yes
	Coenagrionidae	*Africallagma glaucum* Burmeister, 1839	Swamp Bluet	NL	yes	no	no
		Africallagma sapphirinum Pinhey, 1950	Sapphire Bluet	NL	yes	no	no
		Pseudagrion citricola Barnard, 1937	Yellow-Faced Sprite	NL	yes	no	no
	Lestidae	*Lestes plagiatus* Burmeister, 1839	Common Spreadwing	NL	yes	no	no
	Libellulidae	*Orthetrum caffrum* Burmeister, 1839	Two-striped Skimmer	NL	yes	no	no
		Trithemis dorsalis Rambur, 1842	Dorsal Dropwing	NL	yes	no	no
Isoptera	Termitidae	*Trinervitermes* species	Snouted Harvester Termite	NL	no	yes	no
Mantodea	Mantidae	*Pyrgomantis rhodesica* Giglio-Tos, 1917	Grass Mantid	NL	no	yes	no
Orthoptera	Tettigoniidae	*Conocephalus caudalis* (Walker, F., 1869)	Meadow Katydid	NL	no	yes	no
	Pyrgomorphidae	*Zonocerus elegans* (Thunberg, 1815)	Elegant Grasshopper	NL	no	yes	no
Hemiptera	Lygaeidae	*Spilostethus pandurus*	Milkweed Bug	NL	no	yes	no
Neuroptera	Myrmeleontidae	*Palpares caffer* (Burmeister, 1839)	Mottled Veld Antlion	NL	no	yes	no
Coleoptera	Scarabaeidae	*Popillia biguttata* (Wiedemann, 1821)	Yellow Shining Leaf Chafer	NL	no	yes	no
		Porphyronota hebreae	Marbled Fruit Chafer	NL	no	yes	no
	Coccinellidae	*Cheilomenes lunata*	Lunate Ladybird	NL	no	yes	no
		Exochomus flavipes (Thunberg, 1781)	Black Mealy Bug Predator	NL	no	yes	no
	Tenebrionidae	*Lagria* species	Hairy Darkling Beetle	NL	no	yes	no
	Melyridae	*Astylus atromaculatus*	Spotted Maize Beetle	NL	no	yes	no
Lepidoptera	Hesperiidae	*Gegenes niso niso* (Linnaeus, 1764)	Common Hottentot Skipper	LC	yes	no	no
		Metisella meninx (Trimen, 1873)	Marsh Sylph	LC	yes	yes	no
		Spialia asterodia (Trimen, 1864)	Star Sandman	LC	yes	no	no
	Lycaenidae	*Aloeides aranda* (Wallengren, 1857)	Aranda Copper	LC	yes	no	no
		Aloeides henningi Tite & Dickson, 1973	Henning's Copper	LC	no	yes	no
		Aloeides dentatis maseruna (Riley, 1938)	Roodepoort Copper	LC	yes	no	no
		Aloeides taikosama (Wallengren, 1857)	Dusky Copper	LC	yes	no	no
		Aloeides trimeni trimeni Tite & Dickson, 1973	Trimen's Copper	LC	yes	no	no
		Cacyreus virilis Stempffer, 1936	Mocker Bronze	LC	yes	no	no
		Eicochrysops messapus mahallakoaena (Wallengren, 1857)	Cupreous Blue	LC	no	yes	no
		Lampides boeticus (Linnaeus, 1767)	Pea Blue	LC	no	yes	no
		Zizeeria knysna knysna (Trimen, 1862a)	African Grass Blue	LC	yes	no	no
		Zizula hylax (Fabricius, 1775)	Gaika Blue	LC	no	yes	no

	Nymphalidae	*Acraea neobule neobule* Doubleday, [1847a]	Wandering Donkey Acraea	LC	no	yes	no
		Byblia ilithyia (Drury, [1773])	Spotted Joker	LC	no	yes	no
		Catacroptera cloanthe cloanthe (Stoll, [1781])	Pirate	LC	no	yes	no
		Danaus chryssipus orientis (Aurivillius, 1909)	African Monarch	LC	yes	yes	no
		Hypolimnas missipus (Linnaeus, 1764)	Common Diadem	LC	no	yes	no
		Junonia hierta cebrene Trimen, 1870	Yellow Pansy	LC	yes	yes	no
		Junonia oenone oenone (Linnaeus, 1758)	Blue Pansy	LC	no	yes	no
		Phalanta phalantha aethiopica (Rotschild & Jordan, 1903)	African Leopard	LC	no	yes	no
		Physcaeneura panda (Boisduval, 1847)	Dark-webbed Ringlet	LC	no	yes	no
		Telchinia rahira rahira (Boisduval, 1833a)	Marsh Acraea	LC	yes	yes	no
		Vanessa cardui (Linnaeus, 1758)	Painted Lady	LC	yes	yes	yes
	Pieridae	*Catopsilla florella* (Fabricius, 1775)	African Migrant	LC	no	yes	no
		Colias electo electo (Linnaeus, 1763)	African Clouded Yellow	LC	yes	no	no
		Eurema brigitta brigitta (Stoll, [1780])	Broad-bordered Grass Yellow	LC	yes	yes	no
		Pontia helice helice (Linnaeus, 1764)	Common Meadow White	LC	no	yes	no
Hymenoptera	Apidae	*Apis mellifera scutellata* Lepeletier, 1836	African Honey Bee	LC	no	yes	yes

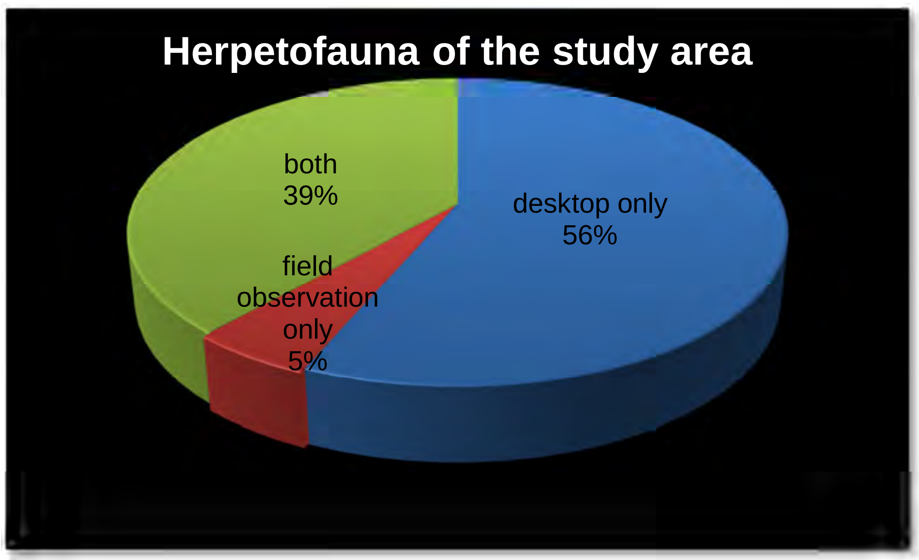


More than half of the invertebrates listed were recorded during field observations only - a clear indication of the information gaps regarding invertebrate species' distribution in South Africa

Table 24: Herpetofauna of the study area

ORDER	FAMILY	*GENUS-SPECIES*	ENGLISH NAME	ST	DT	2013	2015
Anura	Bufonidae	*Amietophrynus gutturalis* Power, 1927	Guttural Toad	LC	yes	yes	no
		Amietophrynus rangeri Hewitt, 1935	Raucous Toad	LC	yes	no	no
		Schismaderma carens Smith, 1848	Red Toad	LC	yes	no	no
	Hyperoliidae	*Kassina senegalensis* Duméril and Bibron, 1841	Bubbling Kassina	LC	yes	yes	no
		Semnodactylus wealii (Boulenger, 1882)	Rattling Frog	LC	yes	yes	no
	Phrynobatrachidae	*Phrynobatrachus natalensis* Smith, 1849	Snoring Puddle Frog	LC	yes	no	no
	Pipidae	*Xenopus laevis* Daudin, 1802	Common Platanna	LC	yes	yes	no
	Ptychadenidae	*Ptychadena porosissima* Steindachner, 1867	Striped Grass Frog	LC	yes	no	no
	Pyxicephalidae	*Amietia fuscigula* Duméril & Bibron, 1841	Cape River Frog	LC	yes	yes	no
		Amietia quecketti	Queckett's River Frog	LC	yes	yes	no
		Cacosternum boettgeri (Boulenger, 1882)	Common Caco	LC	yes	yes	no
		Strongylopus fasciatus Smith, 1849	Striped Stream Frog	LC	yes	yes	no
		Strongylopus grayii Smith, 1849	Clicking Stream Frog	LC	no	yes	no
		Tomopterna cryptotis Boulenger, 1907	Tremelo Sand Frog	LC	yes	no	no
		Tomopterna natalensis Smith, 1849	Natal Sand Frog	LC	yes	no	no
		Tomopterna tandyi Channing & Bogart, 1996	Tandy's Sand Frog	LC	yes	no	no
Squamata	Scincidae	*Acontias gracilicauda* Essex, 1925	Thin-tailed Legless Skink	LC	yes	no	no
	Agamidae	*Agama aculeata distanti* (Boulenger, 1902)	Distant's Ground Agama	LC	yes	no	no
	Atractaspididae	*Aparallactus capensis* Smith, 1849	Black-headed Centipede-eater	LC	yes	no	no
		Homoroselaps lacteus (Linnaeus, 1758)	Spotted Harlequin Snake	LC	yes	no	no
	Colubridae	*Lamprophis capensis* (Duméril & Bibron, 1854)	Brown House Snake	LC	yes	no	no
		Crotaphopeltis hotamboeia Laurenti, 1768	Red-lipped Snake	LC	yes	yes	no
		Dasypeltis scabra (Linnaeus, 1758)	Rhombic Egg-eater	LC	yes	no	no
		Duberria lutrix lutrix (Linnaeus, 1758)	South African Slug-eater	LC	yes	no	no
		Lycodonomorphus inornatus (Duméril and Bibron, 1854)	Olive House Snake	LC	yes	no	no
		Lycodonomorphus rufulus (Lichtenstein, 1823)	Brown Water Snake	LC	yes	no	no
		Lycophidion capense capense (Smith, 1831)	Cape Wolf Snake	LC	yes	no	no
		Psammophis crucifer (Daudin, 1803)	Cross-marked Grass Snake	LC	yes	no	no
		Psammophylax rhombeatus (Linnaeus, 1758)	Spotted Grass Snake	LC	yes	yes	no
		Pseudaspis cana (Linnaeus, 1758)	Mole Snake	LC	yes	no	no
	Elapidae	*Hemachatus haemachatus* Lacépède, 1789	Rinkhals	LC	yes	yes	no
		Naja mossambica Peters, 1854	Mozambique Spitting Cobra	LC	yes	no	no

	Gekkonidae	*Pachydactylus affinis* Boulenger, 1896	Transvaal Gecko	LC	yes	yes	no
		Pachydactylus vansoni Fitzsimons, 1933	Van Son's Gecko	LC	yes	no	no
	Leptotyphlopidae	*Leptotyphlops conjuctus* (Jan, 1861)	Eastern Thread Snake	NL	yes	yes	no
	Scincidae	*Trachylepis punctatissima* Smith, 1849	Speckled Rock Skink	LC	yes	yes	no
	Typhlopidae	*Afrotyphlops bibronii* (Smith, 1846)	Bibron's Blind Snake	LC	yes	yes	no
	Varanidae	*Varanus niloticus* Linnaeus, 1758	Water Monitor	LC	no	yes	no
	Viperidae	*Causus rhombeatus* (Lichtenstein, 1823)	Rhombic Night Adder	LC	yes	no	no



In contrast to the invertebrates, the distribution of herpetofauna species in South Africa is reasonably well known: only 5% of the species listed were not included in the desktop study list

Table 25: Birds of the study area

ORDER	FAMILY	*GENUS-SPECIES*	ENGLISH NAME	ST	DT	2013	2015
Struthioniformes	Struthionidae	*Struthio camelus* Linnaeus, 1758	Common Ostrich	LC	yes	no	no
Galliformes	Numididae	*Numida meleagris* (Linnaeus, 1758)	Helmeted Guineafowl	LC	yes	yes	yes
	Phasianidae	*Scleroptila levaillantoides* (A. Smith, 1836)	Orange River Francolin	LC	yes	no	no
		Scleroptila levaillantii (Valenciennes, 1825)	Red-winged Francolin	LC	yes	no	no
		Coturnix coturnix (Linnaeus, 1758)	Common Quail	LC	yes	yes	yes
		Pternistis swainsonii (A.Smith, 1836)	Swainson's Spurfowl	LC	yes	yes	yes
Anseriformes	Dendrocygnidae	*Thalassornis leuconotus* Eyton, 1838	White-backed Duck	LC	yes	no	no
		Dendrocygna viduata (Linnaeus, 1766)	White-faced Duck	LC	yes	no	no
	Anatidae	*Anas sparsa* Eyton, 1838	African Black Duck	LC	yes	no	no
		Sarkidiornis melanotus (Pennant, 1769)	Comb Duck	LC	yes	no	no
		Oxyura maccoa (Eyton, 1838)	Maccoa Duck	LC	yes	no	no
		Anas platyrhynchos Linnaeus, 1758	Mallard Duck	LC	yes	no	no
		Anas undulata C.F. Dubois, 1839	Yellow-billed Duck	LC	yes	yes	yes
		Alopochen aegyptiaca (Linnaeus, 1766)	Egyptian Goose	LC	yes	yes	yes
		Plectropterus gambensis (Linnaeus, 1766)	Spur-winged Goose	LC	yes	yes	no
		Netta erythrophthalma (Wied-Neuwied, 1833)	Southern Pochard	LC	yes	yes	no
		Tadorna cana (Gmelin, 1789)	South African Shelduck	LC	yes	no	no
		Anas smithii (Hartert, 1891)	Cape Shoveler	LC	yes	yes	no
		Anas capensis Gmelin, 1789	Cape Teal	LC	yes	yes	no
		Anas erythrorhyncha Gmelin, 1789	Red-billed Teal	LC	yes	yes	no
Ciconiiformes	Podicipedidae	*Podiceps nigricollis* C.L. Brehm, 1831	Black-necked Grebe	LC	yes	no	no
		Podiceps cristatus(Linnaeus, 1758)	Great Crested Grebe	LC	yes	no	no
		Tachybaptus ruficollis (Pallas, 1764)	Little Grebe	LC	yes	yes	no
	Phoenicopteridae	*Phoenicopterus roseus* Pallas, 1811	Greater Flamingo	NT	yes	yes	no
		Phoenicopterus minor E. Geoffroy Saint-Hilare, 1789	Lesser Flamingo	NT	yes	no	no
	Ciconiidae	*Ciconia ciconia* (Linnaeus, 1758)	White Stork	LC	yes	no	no
	Threskiornithidae	*Threskiornis aethiopicus* (Latham, 1790)	African Sacred Ibis	LC	yes	yes	no
		Plegadis falcinellus (Linnaeus, 1766)	Glossy Ibis	LC	yes	no	no
		Bostrychia hagedash (Latham, 1790)	Hadeda Ibis	LC	yes	yes	yes
		Geronticus calvus (Boddaert, 1783)	Southern Bald Ibis	VU	yes	no	no
		Platalea alba Scopoli, 1786	African Spoonbill	LC	yes	yes	no
	Ardeidae	*Ixobrychus minutus* (Linnaeus, 1766)	Little Bittern	LC	yes	no	no

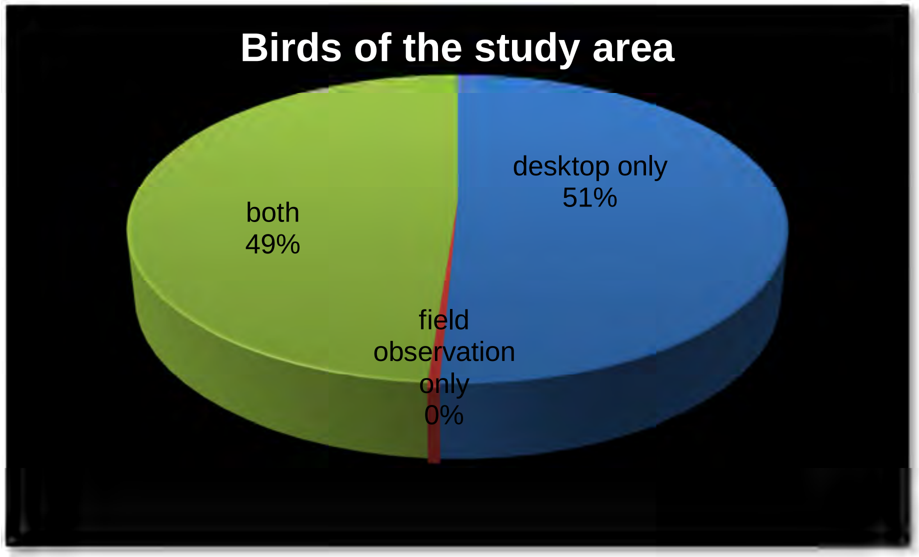
		Bubulcus ibis (Linnaeus, 1758)	Cattle Egret	LC	yes	yes	yes
		Ardea alba Linnaeus, 1758	Great Egret	LC	yes	no	no
		Egretta garzetta (Linnaeus, 1766)	Little Egret	LC	yes	no	no
		Egretta intermedia (Wagler, 1829)	Yellow-billed Egret	LC	yes	no	no
		Egretta ardesiaca (Wagler, 1827)	Black Heron	LC	yes	no	no
		Ardea melanocephala Children & Vigors, 1826	Black-headed Heron	LC	yes	yes	yes
		Ardea goliath Cretzschmar, 1829	Goliath Heron	LC	yes	no	no
		Ardea cinerea Linnaeus, 1758	Grey Heron	LC	yes	yes	no
		Ardea purpurea Linnaeus, 1766	Purple Heron	LC	yes	no	no
		Ardeola ralloides (Scopoli, 1769)	Squacco Heron	LC	yes	no	no
		Nycticorax nycticorax (Linnaeus, 1758)	Black-crowned Night-Heron	LC	yes	no	no
	Phalacrocoracidae	*Microcarbo africanus* (Gmelin, 1789)	Reed Cormorant	LC	yes	yes	no
		Phalacrocorax carbo (Linnaeus, 1758)	White-breasted Cormorant	LC	yes	yes	no
	Anhingidae	*Anhinga rufa* (Daudin, 1802)	African Darter	LC	yes	no	no
	Scopidae	*Scopus umbretta* Gmelin, 1789	Hamerkop	LC	yes	yes	no
Falconiformes	Sagittariidae	*Sagittarius serpentarius* (J.F. Miller, 1779)	Secretarybird	NT	yes	no	no
	Accipitridae	*Buteo rufofuscus* (J.R. Forster, 1798)	Jackal Buzzard	LC	yes	no	no
		Buteo vulpinus	Steppe Buzzard	LC	yes	yes	no
		Circus pygargus (Linnaeus, 1758)	Montagu's Harrier	LC	yes	yes	no
		Polyboroides typus A. Smith, 1829	African Harrier-Hawk	LC	yes	no	no
		Elanus caeruleus (Desfontaines, 1789)	Black-shouldered Kite	LC	yes	yes	yes
		Milvus aegyptius (Gmelin, 1788)	Yellow-billed Kite	LC	yes	no	no
		Circus ranivorus (Daudin, 1800)	African Marsh-Harrier	VU	yes	no	no
		Haliaeetus vocifer (Daudin, 1800)	African Fish-Eagle	LC	no	yes	no
	Falconidae	*Falco amurensis* Radde, 1863	Amur Falcon	LC	yes	yes	no
		Falco biarmicus Temminck, 1825	Lanner Falcon	NT	yes	no	no
		Falco rupicoloides A. Smith, 1829	Greater Kestrel	LC	yes	no	no
		Falco naumanni Fleischer, 1818	Lesser Kestrel	VU	yes	no	no
		Falco rupicolus Daudin, 1800	Rock Kestrel	LC	yes	no	no
Gruiformes	Otididae	*Eupodotis caerulescens* (Vieillot, 1820)	Blue Korhaan	NT	yes	yes	yes
		Afrotis afraoides (A. Smith, 1831)	Northern Black Korhaan	LC	yes	yes	no
	Rallidae	*Crex egregia* (W. Peters, 1854)	African Crake	LC	yes	no	no
		Amaurornis flavirostra (Swainson, 1837)	Black Crake	LC	yes	no	no
		Gallinula chloropus (Linnaeus, 1758)	Common Moorhen	LC	yes	no	no
		Gallinula angulata Sundevall, 1850	Lesser Moorhen	LC	yes	no	no
		Rallus caerulescens Gmelin, 1789	African Rail	LC	yes	no	no

		Porphyrio porphyrio madagascariensis (Latham, 1802)	African Swamphen	LC	yes	no	no
		Fulica cristata Gmelin, 1789	Red-knobbed Coot	LC	yes	yes	no
Charadriiformes	Burhinidae	*Burhinus capensis* (Lichtenstein, 1823)	Spotted Thick-knee	LC	yes	yes	yes
	Recurvirostridae	*Himantopus himantopus* (Linnaeus, 1758)	Black-winged Stilt	LC	yes	yes	no
		Recurvirostra avosetta Linnaeus, 1758	Pied Avocet	LC	yes	yes	no
	Charadriidae	*Vanellus senegallus* (Linnaeus, 1766)	African Wattled Lapwing	LC	yes	no	no
		Vanellus armatus (Burchell, 1822)	Blacksmith Lapwing	LC	yes	yes	yes
		Vanellus coronatus (Boddaert, 1783)	Crowned Lapwing	LC	yes	yes	yes
		Charadrius pecuarius Temminck, 1823	Kittlitz's Plover	LC	yes	no	no
		Charadrius tricollaris Vieillot, 1818	Three-banded Plover	LC	yes	yes	no
	Scolopacidae	*Philomachus pugnax* (Linnaeus, 1758)	Ruff	LC	yes	yes	no
		Actitis hypoleucos (Linnaeus, 1758)	Common Sandpiper	LC	yes	yes	no
		Calidris ferruginea (Pontoppidan, 1763)	Curlew Sandpiper	LC	yes	no	no
		Tringa stagnatilis (Bechstein, 1803)	Marsh Sandpiper	LC	yes	no	no
		Tringa glareola Linnaeus, 1758	Wood Sandpiper	LC	yes	yes	no
		Gallinago nigripennis Bonaparte, 1839	African Snipe	LC	yes	yes	no
		Calidris minuta (Leisler, 1812)	Little Stint	LC	yes	no	no
		Tringa nebularia (Gunnerus, 1767)	Common Greenshank	LC	yes	yes	no
	Glareolidae	*Glareola nordmanni* Fischer von Waldheim, 1842	Black-winged Pratincole	NT	yes	no	no
	Laridae	*Chroicocephalus cirrocephalus* (Vieillot, 1818)	Grey-hooded Gull	LC	yes	no	no
		Chlidonias hybrida (Pallas, 1811)	Whiskered Tern	LC	yes	no	no
Columbiformes	Columbidae	*Oena capensis* (Linnaeus, 1766)	Namaqua Dove	LC	yes	no	yes
		Columba guinea Linnaeus, 1758	Speckled Pigeon	LC	yes	yes	no
		Columba livia Gmelin, 1789	Rock Dove	LC	yes	no	no
		Streptopelia capicola (Sundevall, 1857)	Cape Turtle-Dove	LC	yes	yes	yes
		Streptopelia semitorquata (Ruppell, 1837)	Red-eyed Dove	LC	yes	yes	yes
		Streptopelia senegalensis (Linnaeus, 1766)	Laughing Dove	LC	yes	yes	yes
Cuculiformes	Cuculidae	*Chrysococcyx caprius* (Boddaert, 1783)	Diderick Cuckoo	LC	yes	yes	no
		Cuculus solitarius Stephens, 1815	Red-chested Cuckoo	LC	yes	no	no
Strigiformes	Tytonidae	*Tyto capensis* (A. Smith, 1834)	African Grass-Owl	VU	yes	yes	no
		Asio capensis (A. Smith, 1834)	Marsh Owl	LC	yes	yes	no
	Strigidae	*Bubo africanus* (Temminck, 1821)	Spotted Eagle-Owl	LC	yes	yes	no
Apodiformes	Apodidae	*Cypsiurus parvus* (Lichtenstein, 1823)	African Palm-Swift	LC	yes	no	no
		Apus barbatus (P.L. Sclater, 1866)	African Black Swift	LC	yes	no	no
		Apus horus (Heuglin, 1869)	Horus Swift	LC	yes	no	no
		Apus affinis (J.E. Gray, 1830)	Little Swift	LC	yes	yes	yes

		Apus caffer (Lichtenstein, 1823)	White-rumped Swift	LC	yes	yes	yes
Coliiformes	Coliidae	*Urocolius indicus* (Latham, 1790)	Red-faced Mousebird	LC	yes	no	no
		Colius striatus Gmelin, 1789	Speckled Mousebird	LC	yes	no	no
Coraciiformes	Alcedinidae	*Alcedo cristata* Pallas, 1764	Malachite Kingfisher	LC	yes	no	no
	Meropidae	*Merops apiaster* Linnaeus, 1758	European Bee-eater	LC	yes	no	no
	Cerylidae	*Megaceryle maxima* (Pallas, 1769)	Giant Kingfisher	LC	yes	no	no
		Ceryle rudis (Linnaeus, 1758)	Pied Kingfisher	LC	yes	no	no
Upupiformes	Upupidae	*Upupa africana* Bechstein, 1811	African Hoopoe	LC	yes	no	no
	Phoeniculdae	*Phoeniculus purpureus* (J.F. Miller, 1784)	Green Wood-Hoopoe	LC	yes	no	no
Piciformes	Lybiidae	*Lybius torquatus* (Dumont, 1816)	Black-collared Barbet	LC	yes	no	no
		Trachyphonus vaillantii Ranzani, 1821	Crested Barbet	LC	yes	no	no
	Indicatoridae	*Indicator minor* Stephens, 1815	Lesser Honeyguide	LC	yes	no	no
	Picidae	*Geocolaptes olivaceus* (Gmelin, 1788)	Ground Woodpecker	LC	yes	yes	no
		Jynx ruficollis Wagler, 1830	Red-throated Wryneck	LC	yes	no	no
Passeriformes	Laniidae	*Lanius collaris* Linnaeus, 1766	Common Fiscal	LC	yes	yes	yes
		Lanius minor J. F. Gmelin, 1788	Lesser Grey Shrike	LC	yes	no	no
	Monarchidae	*Terpsiphone viridis* (Müller, 1776)	African Paradise-flycatcher	LC	yes	no	no
	Corvidae	*Corvus albus* Müller, 1776	Pied Crow	LC	yes	yes	no
	Alaudidae	*Mirafra fasciolata* (Sundevall, 1850)	Eastern Clapper Lark	LC	yes	no	no
		Mirafra cheniana Smith, 1843	Melodious Lark	NT	yes	yes	no
		Spizocorys conirostris (Sundevall, 1850)	Pink-billed Lark	LC	yes	yes	no
		Calandrella cinerea (J.F. Gmelin, 1789)	Red-capped Lark	LC	yes	yes	no
		Mirafra africana Smith, 1836	Rufous-naped Lark	LC	yes	yes	no
		Calendulauda sabota (A. Smith, 1836)	Sabota Lark	LC	yes	no	no
		Chersomanes albofasciata (Lafresnaye, 1836)	Spike-heeled Lark	LC	yes	yes	no
	Pycnonotidae	*Pycnonotus tricolor* (Hartlaub, 1862)	Dark-capped Bulbul	LC	yes	no	no
	Sylviidae	*Sphenoeacus afer* (J.F. Gmelin, 1789)	Cape Grassbird	LC	yes	yes	no
		Acrocephalus baeticatus (Vieillot, 1817)	African Reed-Warbler	LC	yes	yes	no
		Acrocephalus arundinaceus (Linnaeus, 1758)	Great Reed-Warbler	LC	yes	no	no
		Bradypterus baboecala (Vieillot, 1817)	Little Rush-warbler	LC	yes	no	no
		Acrocephalus gracilirostris (Hartlaub, 1864)	Lesser Swamp-Warbler	LC	yes	yes	no
		Iduna natalensis (A. Smith, 1847)	Dark-capped Yellow Warbler	LC	yes	no	no
		Acrocephalus palustris (Bechstein, 1798)	Marsh Warbler	LC	yes	yes	no
		Acrocephalus schoenobaenus (Linnaeus, 1758)	Sedge Warbler	LC	yes	no	no
		Phylloscopus trochilus (Linnaeus, 1758)	Willow Warbler	LC	yes	no	no
	Hirundinidae	*Delichon urbicum* (Linnaeus, 1758)	Common House-Martin	LC	yes	no	no

		Hirundo abyssinica Guérin-Méneville, 1843	Lesser Striped Swallow	LC	yes	no	no
		Hirundo albigularis Strickland, 1849	White-throated Swallow	LC	yes	yes	no
		Hirundo cucullata Boddaert, 1783	Greater Striped Swallow	LC	yes	yes	no
		Hirundo fuligula Lichtenstein, 1842	Rock Martin	LC	yes	no	no
		Hirundo rustica Linnaeus, 1758	Barn Swallow	LC	yes	yes	yes
		Hirundo spilodera Sundevall, 1850	South African Cliff-Swallow	LC	yes	yes	no
		Riparia cincta (Boddaert, 1783)	Banded Martin	LC	yes	yes	no
		Riparia paludicola (Vieillot, 1817)	Brown-throated Martin	LC	yes	yes	no
		Riparia riparia (Linnaeus, 1758)	Sand Martin	LC	yes	yes	no
	Cisticolidae	*Cisticola textrix* (Vieillot, 1817)	Cloud Cisticola	LC	yes	yes	no
		Cisticola aridulus Witherby, 1900	Desert Cisticola	LC	yes	yes	no
		Cisticola tinniens (Lichtenstein, 1842)	Levaillant's Cisticola	LC	yes	yes	no
		Cisticola cinnamomeus Reichenow, 1904	Pale-crowned Cisticola	LC	yes	yes	no
		Cisticola lais (Hartlaub & Finsch, 1870)	Wailing Cisticola	LC	yes	yes	no
		Cisticola ayresii Hartlaub, 1863	Wing-snapping Cisticola	LC	yes	yes	no
		Cisticola juncidis (Rafinesque, 1810)	Zitting Cisticola	LC	yes	yes	no
		Cisticola fulvicapilla (Vieillot, 1817)	Neddicky	LC	yes	no	no
		Prinia flavicans (Vieillot, 1820)	Black-chested Prinia	LC	yes	yes	no
		Prinia subflava (J.F. Gmelin, 1789)	Tawny-flanked Prinia	LC	yes	yes	no
	Zosteropidae	*Zosterops capensis* Sundevall, 1850	Cape White-eye	LC	yes	yes	no
	Sturnidae	*Acridotheres tristis* (Linnaeus, 1766)	Common Myna	LC	yes	no	no
		Lamprotornis nitens (Linnaeus, 1766)	Cape Glossy Starling	LC	yes	no	no
		Lamprotornis bicolor (Gmelin, 1789)	Pied Starling	LC	yes	no	yes
		Onychognathus morio (Linnaeus, 1766)	Red-winged Starling	LC	yes	no	no
		Creatophora cinerea (Meuschen, 1787)	Wattled Starling	LC	yes	no	no
	Muscicapidae	*Myrmecocichla formicivora* (Vieillot, 1818)	Anteating Chat	LC	yes	yes	yes
		Cercomela familiaris (Stephens, 1826)	Familiar Chat	LC	yes	no	no
		Sigelus silens (Shaw, 1809)	Fiscal Flycatcher	LC	yes	no	no
		Muscicapa striata (Pallas, 1764)	Spotted Flycatcher	LC	yes	no	no
		Cossypha caffra (Linnaeus, 1771)	Cape Robin-Chat	LC	yes	yes	no
		Saxicola torquatus (Linnaeus, 1766)	African Stonechat	LC	yes	yes	yes
		Psophocichla litsipsirupa (Smith, 1836)	Groundscraper Thrush	LC	yes	no	no
		Turdus smithi Bonaparte, 1850	Thrush, Karoo	LC	yes	no	no
		Turdus olivaceus Linnaeus, 1766	Thrush, Olive	LC	yes	no	no
		Oenanthe pileata (J.F. Gmelin, 1789)	Capped Wheatear	LC	yes	no	yes
		Oenanthe monticola Vieillot, 1818	Mountain Wheatear	LC	yes	no	no

	Estrildidae	*Amadina erythrocephala* (Linnaeus, 1758)	Red-headed Finch	LC	yes	no	no
		Spermestes cucullatus	Mannikin, Bronze	LC	yes	no	no
		Ortygospiza atricollis (Vieillot, 1817)	African Quailfinch	LC	yes	yes	no
		Estrilda astrild (Linnaeus, 1758)	Common Waxbill	LC	yes	yes	no
		Amandava subflava (Vieillot, 1819)	Orange-breasted Waxbill	LC	yes	no	no
	Nectariniidae	*Chalcomitra amethystina* (Shaw, 1812)	Amethyst Sunbird	LC	yes	no	no
		Nectarinia famosa (Linnaeus, 1766)	Malachite Sunbird	LC	yes	no	no
	Passeridae	*Passer melanurus* (Müller, 1776)	Cape Sparrow	LC	yes	yes	yes
		Passer domesticus (Linnaeus, 1758)	House Sparrow	LC	yes	no	no
		Passer diffusus (A. Smith, 1836)	Southern Grey-headed Sparrow	LC	yes	no	no
	Ploceidae	*Ploceus velatus* Vieillot, 1819	Southern Masked-Weaver	LC	yes	yes	yes
		Quelea quelea (Linnaeus, 1758)	Red-billed Quelea	LC	yes	yes	yes
		Ploceus capensis (Linnaeus, 1766)	Cape Weaver	LC	yes	no	no
		Ploceus cucullatus (Müller, 1776)	Village Weaver	LC	yes	no	no
		Euplectes axillaris (Smith, 1838)	Fan-tailed Widowbird	LC	yes	yes	no
		Euplectes progne (Boddaert, 1783)	Long-tailed Widowbird	LC	yes	yes	yes
		Euplectes ardens (Boddaert, 1783)	Red-collared Widowbird	LC	yes	no	no
		Euplectes albonotatus (Cassin, 1848)	White-winged Widowbird	LC	yes	yes	no
		Euplectes orix (Linnaeus, 1758)	Southern Red Bishop	LC	yes	yes	no
		Euplectes afer (J.F. Gmelin, 1789)	Yellow-crowned Bishop	LC	yes	yes	no
	Viduidae	*Anomalospiza imberbis* (Cabanis, 1868)	Cuckoo Finch	LC	yes	no	no
		Vidua macroura (Pallas, 1764)	Pin-tailed Whydah	LC	yes	yes	no
	Motacillidae	*Macronyx capensis* (Linnaeus, 1766)	Cape Longclaw	LC	yes	yes	yes
		Anthus cinnamomeus Rüppell, 1840	African Pipit	LC	yes	yes	yes
		Anthus similis (Jerdon, 1840)	Long-billed Pipit	LC	yes	no	no
		Anthus leucophrys Vieillot, 1818	Plain-backed Pipit	LC	yes	no	no
		Motacilla capensis Linnaeus, 1766	Cape Wagtail	LC	yes	yes	yes
	Fringillidae	*Serinus atrogularis* (A. Smith, 1836)	Black-throated Canary	LC	yes	yes	no
		Serinus canicollis (Swainson, 1838)	Cape Canary	LC	yes	no	no
		Serinus flaviventris (Gmelin, 1789)	Yellow Canary	LC	yes	yes	no
		Serinus mozambicus (Statius Muller, 1776)	Yellow-fronted Canary	LC	yes	yes	no

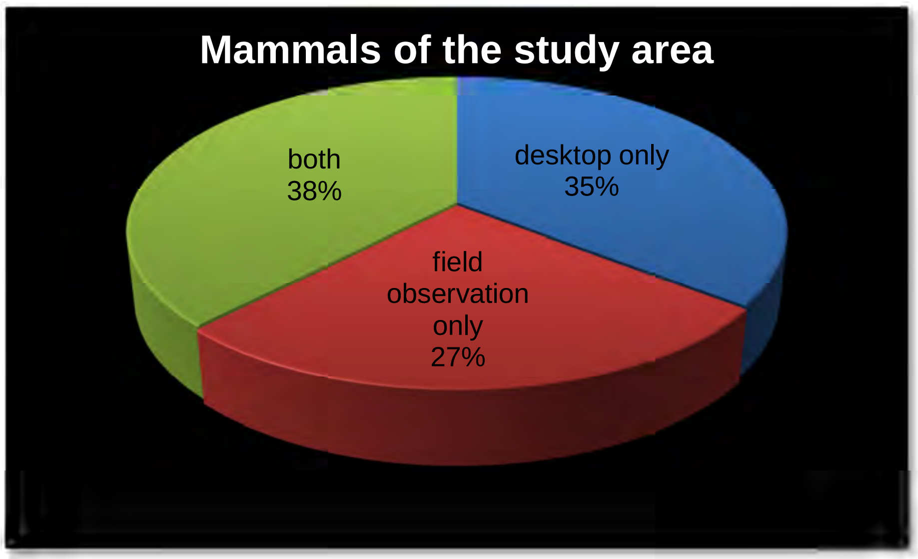


The distribution of South African birds is well known and documented – only one species was added during the field surveys of 2013 and 2015

Table 26: Mammals of the study area

ORDER	FAMILY	*GENUS-SPECIES*	ENGLISH NAME	ST	DT	2013	2015
Insectivora	Erinaceidae	*Atelerix frontalis* (A. Smith, 1831)	Southern African Hedgehog	NT	yes	no	no
	Soricidae	*Crocidura mariquensis* (A. Smith, 1844)	Swamp Musk Shrew	DD	yes	no	no
		Myosorex cafer (Sundevall, 1846)	Dark-footed Forest Shrew	DD	yes	no	no
		Myosorex varius (Smuts, 1832)	Forest Shrew	DD	no	yes	no
Lagomorpha	Leporidae	*Lepus saxatilis* F. Cuvier, 1823	Scrub Hare	LC	yes	yes	yes
Rodentia	Hystricidae	*Hystrix africaeaustralis* Peters, 1852	Cape Porcupine	LC	no	yes	yes
	Muridae	*Tatera brantsii* (Smith, 1836)	Highveld Gerbil	LC	no	yes	yes
		Mastomys coucha (Smith, 1834)	Southern African Mastomys	LC	no	yes	no
		Mus minutoides Smith, 1834	Southern African Pygmy Mouse	LC	no	yes	no
		Otomys auratus	Southern African Vlei Rat	NL	no	yes	no
		Rhabdomys pumilio (Sparrman, 1784)	Xeric Four-striped Grass Rat	LC	yes	no	no
	Nesomyidae	*Dendromus mystacalis* Heuglin, 1863	Chestnut African Climbing Mouse	LC	no	yes	no
		Steatomys pratensis Peters, 1846	Common African Fat Mouse	LC	no	yes	no
	Bathyergidae	*Cryptomys hottentotus* (Lesson, 1826)	Common Mole-rat	LC	no	yes	yes
Carnivora	Canidae	*Canis mesomelas* Schreber, 1775	Black-backed Jackal	LC	yes	yes	yes
		Vulpes chama (A. Smith, 1833)	Cape Fox	LC	yes	yes	no
	Felidae	*Felis nigripes* Burchell, 1824	Black-footed Cat	LC	yes	no	no
		Leptailurus serval (Schreber, 1776)	Serval	NT	yes	yes	yes
		Caracal caracal (Schreber, 1776)	Caracal	LC	yes	yes	no
		Panthera pardus (Linnaeus, 1758)	Leopard	NT	yes	no	no
	Herpestidae	*Cynictis penicillata* (G. [Baron] Cuvier, 1829)	Yellow Mongoose	LC	yes	no	yes
		Galerella sanguinea (Rüppell, 1835)	Common Slender Mongoose	LC	yes	no	no
		Suricata suricatta (Schreber, 1776)	Meerkat	LC	yes	no	no
		Atilax paludinosus (G. [Baron] Cuvier, 1829)	Marsh Mongoose	LC	yes	no	yes
		Herpestes ichneumon (Linnaeus, 1758)	Egyptian Mongoose	LC	yes	no	no
	Hyaenidae	*Parahyaena brunnea* (Thunberg, 1820)	Brown Hyaena	NT	yes	no	no
		Proteles cristatus (Sparrman, 1783)	Aardwolf	LC	yes	yes	no
	Mustelidae	*Aonyx capensis* (Schinz, 1821)	African Clawless Otter	LC	yes	no	yes
		Hydrictis maculicollis (Lichtenstein, 1835)	Spotted-necked Otter	LC	yes	no	no
		Ictonyx striatus (Perry, 1810)	Striped Polecat	LC	yes	no	no
		Mellivora capensis (Schreber, 1776)	Honey Badger	NT	no	yes	no
Tubulidentata	Orycteropodidae	*Orycteropus afer* (Pallas, 1766)	Aardvark	LC	no	yes	no
Hyracoidea	Procaviidae	*Procavia capensis* (Pallas, 1766)	Rock Hyrax	LC	no	yes	no

Artiodactyla	Suidae	*Phacochoerus africanus* (Gmelin, 1788)	Common Warthog	LC	yes	no	no
		Potamochoerus larvatus (F. Cuvier, 1822)	Bushpig	LC	yes	yes	no
	Bovidae	*Alcelaphus buselaphus* (Pallas, 1766)	Hartebeest	NL	yes	no	no
		Alcelaphus caama (Geoffroy Saint-Hilare, 1803)	Red Hartebeest	LC	yes	no	no
		Antidorcas marsupialis (Zimmermann, 1780)	Springbok	LC	yes	no	yes
		Connachaetes gnou (Zimmermann, 1777)	Black Wildebeest	LC	yes	no	no
		Damaliscus pygargus phillipsi Harper, 1939	Blesbok	LC	yes	no	yes
		Ourebia ourebi (Zimmerman, 1783)	Oribi	EN	yes	yes	no
		Raphicerus campestris (Thunberg, 1811)	Steenbok	LC	yes	yes	no
		Sylvicapra grimmia (Linnaeus, 1758)	Bush Duiker	LC	yes	no	yes
		Syncerus caffer (Sparrman, 1779)	African Buffalo	LC	yes	yes	no
		Redunca arundinum (Boddaert, 1785)	Southern Reedbuck	LC	yes	yes	no



The distribution of South African mammals on Q-degree level is poorly documented – almost a third of the species listed were not included in the desktop list

Red Data Animals of the study area:

Twenty red data species (Table 27) have been documented for the Q-grids of the study area. These include eleven birds and nine mammals. Eight of these species were confirmed to occur in the study area during the 2013 and 2015 field investigations. The regional statuses of the species were derived from the VMUS and SABAP databases:

- Least Concern: one species;
- Data Deficient: three species;
- Near Threatened: eleven species;
- Vulnerable: four species; and
- Endangered: one species.

The global statuses of the twenty species were obtained from the IUCN database:

- Least Concern: twelve species;
- Near Threatened: six species; and
- Vulnerable: two species.

Table 27: Red data animals of the study area

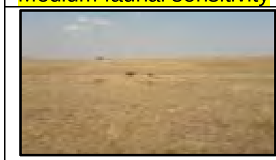
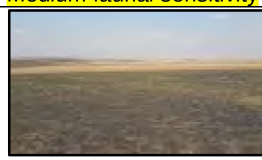
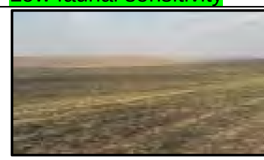
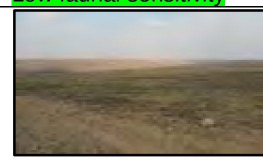
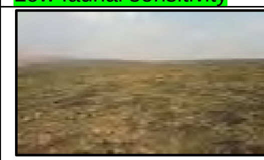
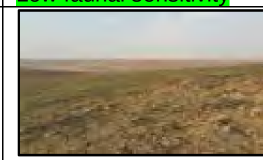
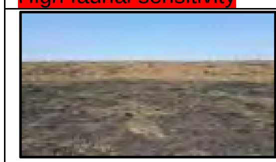
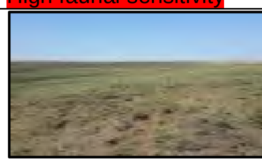
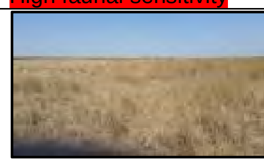
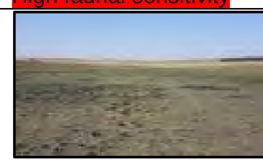
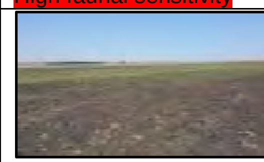
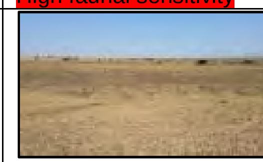
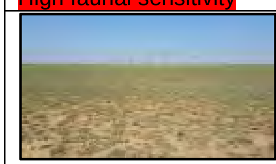
SPECIES DETAILS		**STATUS**		**CONFIRMATION**		
Genus-species	**English Name**	**Regional**	**Global**	**DT**	**2013**	**2015**
Crocidura mariquensis (A. Smith, 1844)	Swamp Musk Shrew	DD	LC	yes	no	no
Myosorex cafer (Sundevall, 1846)	Dark-footed Forest Shrew	DD	LC	yes	no	no
Myosorex varius(Smuts, 1832)	Forest Shrew	DD	LC	no	yes	no
Ourebia ourebi (Zimmerman, 1783)	Oribi	EN	LC	yes	yes	no
Falco biarmicus Temminck, 1825	Lanner Falcon	NT	LC	yes	no	no
Atelerix frontalis (A. Smith, 1831)	Southern African Hedgehog	NT	LC	yes	no	no
Phoenicopterus roseus Pallas, 1811	Greater Flamingo	NT	LC	yes	yes	no
Leptailurus serval (Schreber, 1776)	Serval	NT	LC	yes	yes	yes
Mellivora capensis (Schreber, 1776)	Honey Badger	NT	LC	no	yes	no
Circus ranivorus (Daudin, 1800)	African Marsh-Harrier	VU	LC	yes	no	no
Falco naumanni Fleischer, 1818	Lesser Kestrel	VU	LC	yes	no	no
Tyto capensis (A. Smith, 1834)	African Grass-Owl	VU	LC	yes	yes	no
Panthera pardus (Linnaeus, 1758)	Leopard	LC	NT	yes	no	no
Phoenicopterus minor Saint-Hilare, 1789	Lesser Flamingo	NT	NT	yes	no	no
Glareola nordmanni F. von Waldheim, 1842	Black-winged Pratincole	NT	NT	yes	no	no
Parahyaena brunnea (Thunberg, 1820)	Brown Hyaena	NT	NT	yes	no	no
Eupodotis caerulescens (Vieillot, 1820)	Blue Korhaan	NT	NT	yes	yes	yes
Mirafra cheniana Smith, 1843	Melodious Lark	NT	NT	yes	yes	no
Sagittarius serpentarius (J.F. Miller, 1779)	Secretarybird	NT	VU	yes	no	no
Geronticus calvus (Boddaert, 1783)	Southern Bald Ibis	VU	VU	yes	no	no

Faunal habitat sensitivity:

Twenty-seven sampling plots were visited during the September 2015 update field investigation (Table 28). Please refer to the Flora Section for a geographical representation of the sampling plots within the study area. The following faunal habitats of varying sensitivities were encountered at the sampling plots:

- Maize fields: eight plots – low faunal sensitivity;
- Artificial dam: one plot – medium faunal sensitivity;
- Pastures: three plots – medium faunal sensitivity;
- Secondary grassland: seven plots – medium faunal sensitivity;
- Moist grassland: one plot – high faunal sensitivity;
- Grassland: two plots – high faunal sensitivity; and
- Rocky grassland: five plots – high faunal sensitivity.

Table 28: Faunal habitats of the 2015 "spot-checks"

 Teu 01: maize field Low faunal sensitivity	 Teu 02: artificial dam Medium faunal sensitivity	 Teu 03: maize field Low faunal sensitivity	 Teu 04: maize field Low faunal sensitivity	 Teu 05: moist grassland High faunal sensitivity	 Teu 06: maize field Low faunal sensitivity
 Teu 07: pastures Medium faunal sensitivity	 Teu 08: pastures Medium faunal sensitivity	 Teu 10: maize fields Low faunal sensitivity	 Teu 11: maize fields Low faunal sensitivity	 Teu 12: maize fields Low faunal sensitivity	 Teu 13: maize fields Low faunal sensitivity
 Teu 15: rocky grassland High faunal sensitivity	 Teu 16: grassland High faunal sensitivity	 Teu 17: grassland High faunal sensitivity	 Teu 18: rocky grassland High faunal sensitivity	 Teu 19: rocky grassland High faunal sensitivity	 Teu 20: rocky grassland High faunal sensitivity
 Teu21: rocky grassland High faunal sensitivity	 Teu 22: sec. grassland Medium faunal sensitivity	 Teu 23: pastures Medium faunal sensitivity	 Teu 24: sec. grassland Medium faunal sensitivity	 Teu 25: sec. grassland Medium faunal sensitivity	 Teu 26: sec. grassland Medium faunal sensitivity
 Teu 27: sec. grassland Medium faunal sensitivity	 Teu 28: sec. grassland Medium faunal sensitivity	 Teu 29: sec. grassland Medium faunal sensitivity			

6 SENSITIVITY ANALYSIS

6.1 Flora

The flora sensitivity analysis (Table 29, Figure 19) was based on the results of the 2002 study (section 4.1.4) as well as the subsequent increase in conservation significance of the remaining natural vegetation in the area from 2002 to 2013, with the development of the following conservation management tools:

3. Mpumalanga Parks Board Conservation Plan (Section 3.5)
4. National Biodiversity Priority Areas (Section 3.5)

From these two conservation management tools it is evident that the remaining natural vegetation within the area is of high and very high conservation significance on both a provincial and national level (Section 3.5, Figure 5), therefore their conservation status of the two vegetation communities have changed from moderate to high and very high respectively (Table 29).

Within the prospecting area, very high sensitive flora areas cover 31% (1 793 ha) and high sensitive areas cover 28% (1 642 ha), with the two areas presenting cumulatively 60% of the prospecting area (Table 30).

The percentage of high to very high sensitive flora areas is even higher (83%) within the conveyor route (Table 31), reflecting the fact that the proposed conveyor route is transecting mainly natural vegetation rather than following transformed areas associated with cultivated fields and roads. Therefore the conveyor route is contributing to habitat loss and fragmentation, while increasing the risk that alien invasive species can be introduced into large natural areas with none or very low alien invasive infestation. Habitat loss and alien invasive species is considered globally to be the main drivers of biodiversity loss[13].

6.2 Fauna

Animals of terrestrial as well as aquatic ecosystems are closely linked to, and significantly influenced by, plant community structures and species diversities. Many aquatic macro invertebrates find refuge in extensive reedbeds that are frequently found within lowland wetland ecosystems (Sychra *et al* 2010). Furthermore, the structure and age of the vegetal formations of ponds and impounds play a significant role in selecting species traits related to the population dynamics and feeding habits of invertebrates (Céréghinoa *et al* 2008). Similarly, terrestrial animals' ecological reactions depend on plant community structure; studies on arthropod species richness have indicated that for spiders local processes are important, with assemblages in a particular patch being constrained by habitat structure (Borgesa & Browna 2004). Likewise, plant community structure is often influenced by primary consumers; herbivores are known key drivers of ecosystem function and nutrient dynamics within grazed plant communities (Duncan 2005).

As a result, faunal community structure and ecological diversity cannot be viewed in isolation without considering vegetation habitat diversity; therefore, the plant communities or macro habitat types described in this document (**refer Section 4**) are considered the main faunal habitats within the study area for the purposes of this EIA assessment. The reader is referred to **Figure 12** for an illustration of the vegetal communities of the respective study area.

6.2.1 Transformed Faunal Habitats

Atypical faunal habitats are areas of transformed nature - areas where the natural vegetation has been removed and replaced by various substitutes of either a sterile or an artificial nature. These substitutes include agricultural lands, stands of exotic trees and human structures such as buildings, roads, mining areas, etc. Atypical faunal habitats that were recorded in the study area include:

- Cultivated lands
- Road infrastructure; and
- Mining areas.

[13] http://www.unep.org/geo/pdfs/geo5/GEO5_report_full_en.pdf

Table 29: Overview of the sensitivity weighting per vegetation community for the flora, fauna and total ecological sensitivity

Vegetation community	Sensitivity weighting		
	Flora	Fauna	Total Ecological
1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils	4	4	4
2. Themeda triandra - Senecio erubescens Grassland community on fine textured soils	5	5	5
Mining Areas - mainly open cast	1	1	1
Road	1	1	1
Transformed Areas - mainly cultivated lands	1	1	1
Wetland	2	5	4

Qualitative sensitivity category	Weighting	Percentage range
Very low	1	0 - 20
Low	2	20 - 40
Moderate	3	40 - 60
High	4	60 - 80
Very high	5	80 - 100

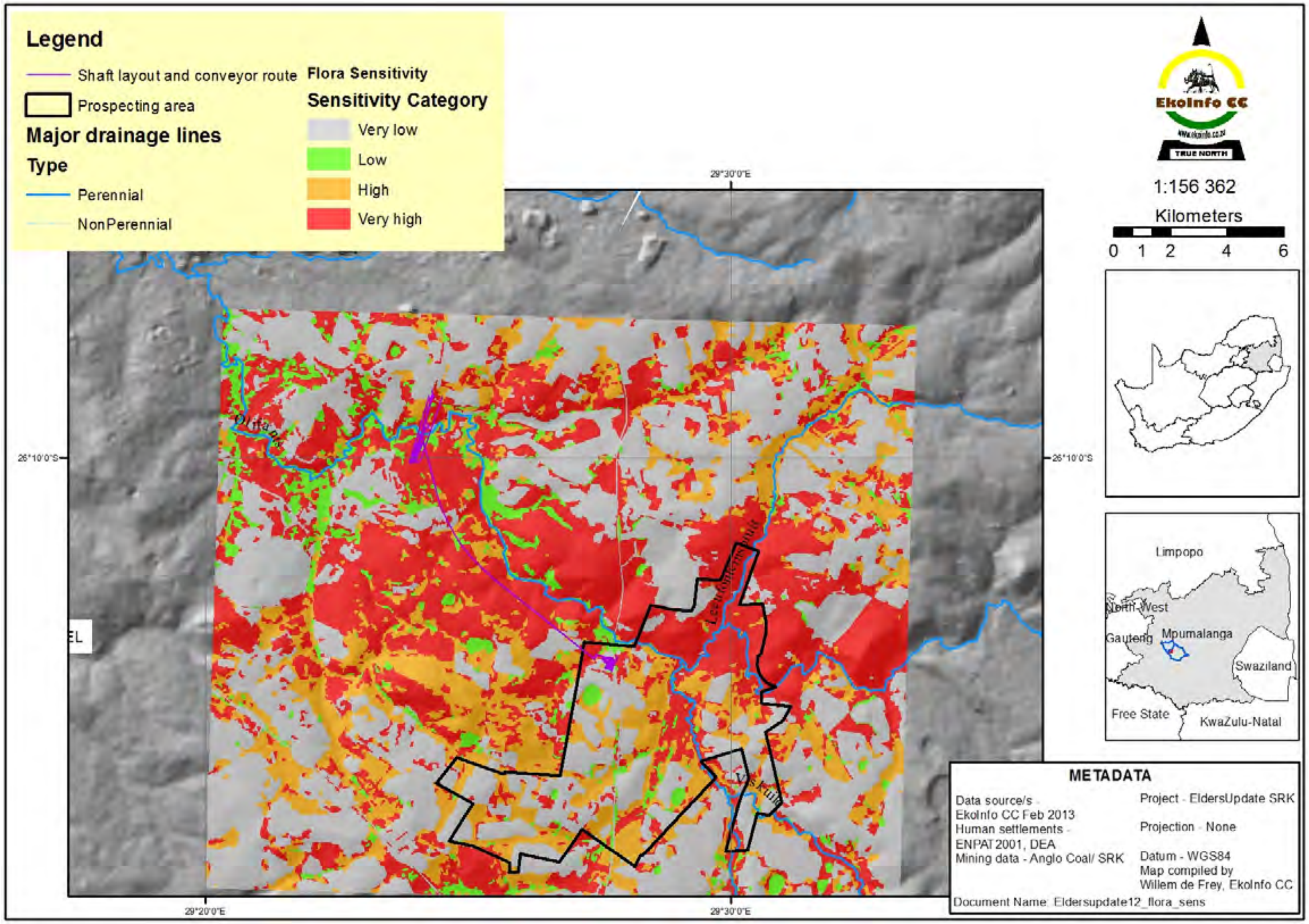


Figure 19: Flora sensitivity map

Table 30: Overview of the percentage cover per flora sensitivity category within the prospecting area

Vegetation Community - Land Cover	Flora sensitivity categories				
	Very low	**low**	**High**	**Very high**	**Grand Total**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils			1642		1642
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils				1793	1793
Mining Areas - mainly open cast	63				63
Road	29				29
Transformed Areas - mainly cultivated lands	2003				2003
Wetland		241			241
Grand Total	2095	241	1642	1793	5772
Percentage cover	36%	4%	28%	31%	100%
Very low – low to high – very high ratio		40%		60%	

Table 31: Overview of the percentage cover per flora sensitivity category within the conveyor route

Vegetation Community - Land Cover	Flora sensitivity categories				
	Very low	**low**	**High**	**Very high**	**Grand Total**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils			5		5
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils				37	37
Transformed Areas - mainly cultivated lands	5				5
Wetland		4			4
Grand Total	5	4	5	37	50
Percentage cover	9%	8%	10%	73%	100%
Very low – low to high – very high ratio		17%		83%	

Transformed faunal habitats have lost the ability to function ecologically and bear no biological resemblance to the original faunal habitat associated with the Mesic Highveld Grassland Bioregion's (Mucina and Rutherford 2004) grasslands and associated wetlands. These areas have little or no conservation value and it is highly unlikely that any threatened faunal taxa would persist in these areas (other than potentially passing through). Further transformation and degradation of the transformed faunal habitats is unlikely to lead to an accelerated loss of biodiversity or a significant negative impact on the faunal assemblages currently persisting in these areas. The following sensitivities are assigned to the transformed faunal habitats of the study area:

- Cultivated lands: very low faunal sensitivity;
- Road infrastructure: very low faunal sensitivity; and
- Mining areas: very low faunal sensitivity;

6.2.2 Wetland Faunal Habitats

Wetland faunal habitats of the study area are characterised by areas of permanent or temporary surface water and vegetation associated with such areas. Within the landscape of the study area, wetland habitat is fairly unique and uncommon (compared to terrestrial grassland). Because of the unique and scarce nature of wetland habitat, these areas of temporary and permanent surface water are at risk when changes in land use are considered. Wetlands often host a variety of sensitive and threatened faunal taxa; faunal wetland species are often particularly sensitive because of the pressures on the freshwater ecological systems of South Africa and especially the Mesic Highveld Grassland Bioregion of the country. Sensitive faunal wetland species considered likely to persist in the study area (including species recorded during the field investigation) include:

- Greater Flamingo (*Phoenicopterus ruber* Linnaeus, 1758 – Near Threatened);
- Serval (*Leptailurus serval* (Schreber, 1776) – Near Threatened);
- African Grass-Owl (*Tyto capensis* (A. Smith, 1834) – Vulnerable);
- Forest Shrew (*Myosorex varius* (Smuts, 1832) – Data Deficient);
- Half-collared Kingfisher (*Alcedo semitorquata* Swainson, 1823 – Near Threatened);
- Water Rat (*Dasymys incomtus* (Sundevall, 1847) – Near Threatened); and
- Spotted-necked Otter (*Hydrictis maculicollis* (Lichtenstein, 1835).

The wetlands of the study area therefore exhibit high conservation characteristics; the ecological functionality and biodiversity value of these wetlands are high and in dire need of formal protection. It is estimated that the faunal wetland habitat of the study area has a high faunal sensitivity.

6.2.3 Natural Faunal Grassland Habitats

The natural faunal grassland habitats of the study area comprises those parts that still exhibit (to varying degrees) a significant proportion of the functional ecological characteristics of the original (currently Endangered) Eastern Highveld Grassland (Mucina and Rutherford 2004). In other words, these areas currently constitute untransformed, functioning faunal grassland habitat characteristic of the Mesic Highveld Grassland Bioregion of South Africa. The natural (terrestrial) faunal grassland habitats of the study area include:

- *Verbena* grassland on coarse soils; and
- *Themeda* grassland on fine soils.

Ecological interaction of natural terrestrial faunal habitats is often very complex. Potentially, some grassland specialist species might be excluded from degraded grasslands and will only be limited to natural grasslands (depending on the level of degradation), while others might be unaffected by grassland habitat degradation (up to certain point). The level of habitat degradation that might be tolerated by grassland fauna species is different for each species; species loss rates compared to habitat degradation rates is also likely to differ between grassland habitat types. In a landscape matrix including fragments of natural, degraded and transformed terrestrial faunal habitats, it is often difficult to predict the faunal assemblages likely to persist in each fragment. Some fragments of a degraded (or even transformed) nature might (when considered in isolation) be of a poor ecological status or low biodiversity value, but when considered within the landscape matrix in relevance to other, natural habitat fragments, might be of considerable conservation value as a movement corridor or sink population source.

Sensitive faunal terrestrial faunal species likely to persist in the study area (but not necessarily recorded during the field investigation) include:

- Blue Korhaan (*Eupodotis caerulescens* (Vieillot, 1820) – Near Threatened);
- Secretarybird (*Sagittarius serpentarius* (J.F. Miller, 1779) – Near Threatened);
- Lanner Falcon (*Falco biarmicus* Temminck, 1825 – Near Threatened);
- Pallid Harrier (*Circus macrourus* (S.G. Gmelin, 1770) – Near Threatened);
- Reddish-grey Musk Shrew (*Crocidura cyanea* (Duvernoy, 1838) – Data Deficient);
- Brown Hyaena (*Parahyaena brunnea* – Near Threatened);
- Honey Badger (*Mellivora capensis* – Near Threatened);
- Melodius Lark (*Mirafra cheniana* Smith, 1843 – Near Threatened);
- Leopard (*Panthera pardus* (Linnaeus, 1758) – Near Threatened);
- Single-striped Mouse (*Lemniscomys rosalia* (Thomas, 1904) – Data Deficient); and
- South African Hedgehog (*Atelerix frontalis* (A. Smith, 1831).

The natural terrestrial faunal habitats of the study area therefore exhibit high conservation characteristics; ecological functionality and biodiversity value of these grasslands are high and changes in the land use are likely to influence a significant number of sensitive and threatened faunal taxa. Based on the level of degradation, the three grassland variations on the study area have varying faunal sensitivities:

- *Verbena* grassland on coarse soils: high faunal sensitivity; and
- *Themeda* grassland on fine soils: very high faunal sensitivity.

6.2.4 Faunal Habitat Sensitivity Analysis

The study area was investigated and the faunal sensitivity of respective habitat types assessed in terms of the following biodiversity attributes (**refer Table 32**):

- Habitat status (ST): level of habitat transformation and degradation vs. pristine faunal habitat;
- Habitat diversity (DV): the number of different faunal habitat types (both on micro- and macro-scale) found within the proposed site and bordering areas;
- Habitat linkage (LN): the degree to which the faunal habitat of the proposed site is linked to other natural areas enabling movement of animals to and from the habitat found on site;
- Red Data species (RD): the degree to which suitable habitat for the red data species likely to be found in the study area (larger study area) is located on each site; and
- Sensitive faunal habitat (SE): the relative presence of faunal sensitive habitat type elements such as surface rock associated with outcrops and hills as well as wetland elements.

Each biodiversity attribute was scored out of 10 and the equally ranked to provide a final average sensitivity % (Figure 20).

Table 32: Faunal habitat sensitivities study area

Habitat Type	ST	DV	LN	RD	SE	Ave	Sensitivity Class
Cultivated lands	2	2	3	1	1	18%	very low
Road infrastructure	1	1	1	1	1	10%	very low
Mining areas	1	2	2	1	1	14%	very low
Wetland	9	8	9	8	9	86%	very high
Verbena grassland on coarse soils	7	7	8	8	7	74%	high
Themeda grassland on fine soils	8	8	8	8	8	80%	very high

The percentage high to very high fauna sensitive areas is slightly higher for both the prospecting area (Table 33) and the conveyor route (Table 34) than for the flora sensitivity because of the significance of the wetland areas such as the pans for various fauna taxa for example birds, amphibians and fish.

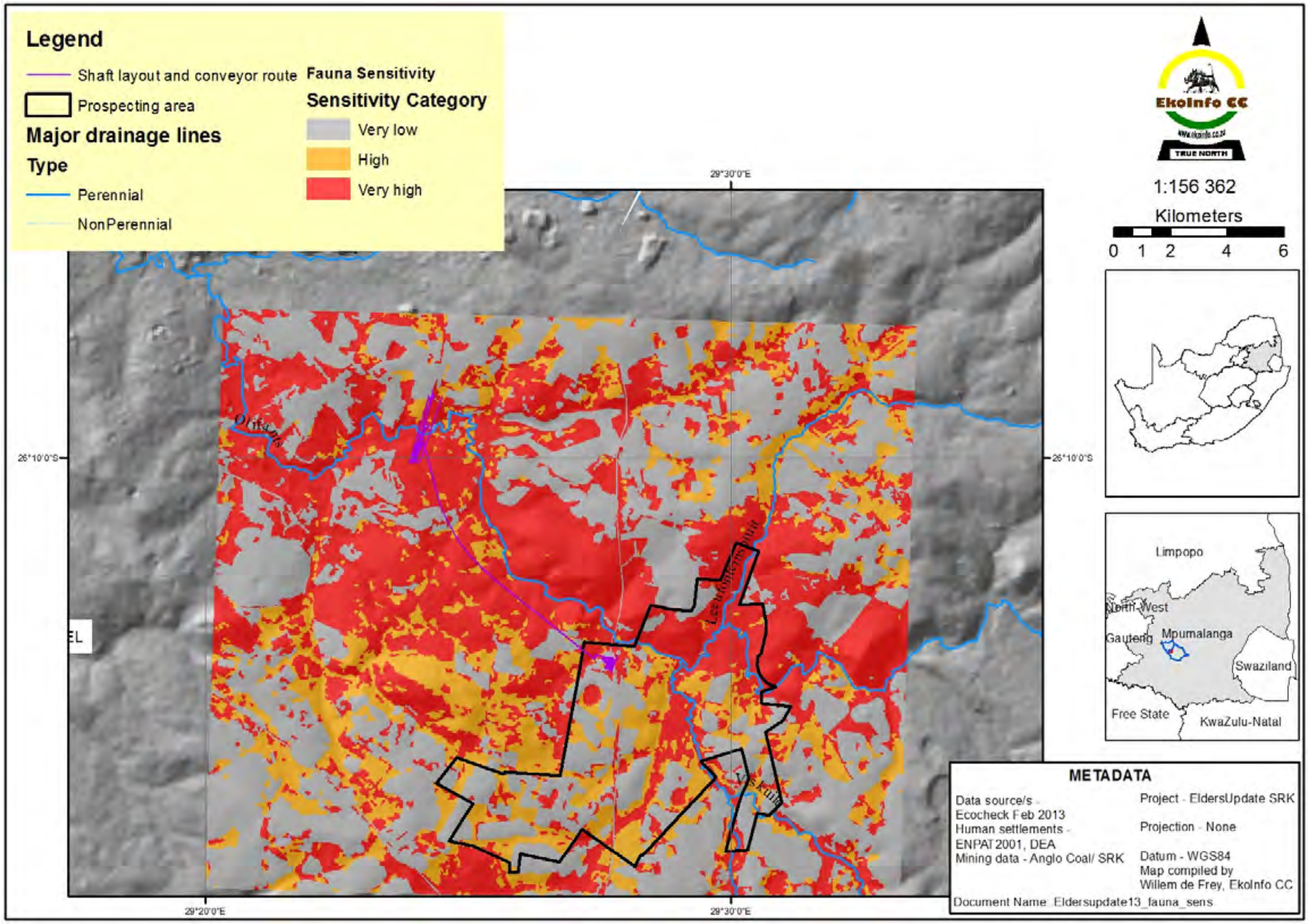


Figure 20: Fauna sensitivity map

Table 33: Overview of the percentage cover per fauna sensitivity category within the prospecting area

Vegetation Community - Land Cover	Fauna sensitivity categories			
	Very low	High	Very high	Grand Total
1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils		1642		1642
2. Themeda triandra - Senecio erubescens Grassland community on fine textured soils			1793	1793
Mining Areas - mainly open cast	63			63
Road	29			29
Transformed Areas - mainly cultivated lands	2003			2003
Wetland			241	241
Grand Total	2095	1642	2035	5772
Percentage cover	36%	28%	35%	100%
Very low – low to high – very high ratio			64%	

Table 34: Overview of the percentage cover per fauna sensitivity category within the conveyor route

Vegetation Community - Land Cover	Fauna sensitivity categories			
	Very low	High	Very high	Grand Total
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils		5		5
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils			37	37
Transformed Areas - mainly cultivated lands	5			5
Wetland			4	4
Grand Total	5	5	41	50
Percentage cover	9%	10%	81%	100%
Very low – low to high – very high ratio			91%	

6.3 Total Ecological Sensitivity

The percentage high to very high sensitivity for the total ecological assessment which was based on the combination of the flora and fauna sensitivities is very similar to the fauna sensitivity. However, the percentage high total ecological sensitivity is slightly higher for the total ecological sensitivity for both the prospecting area (Table 35) and the conveyor route (Table 36); this is attributed to the influence of the flora sensitivity which rated the wetlands lower because the majority of threatened Red Data plants are associated with terrestrial environments. Cultivation contributed the most to the transformation of well-drained natural vegetation, while areas with shallow, rocky soils or waterlogging (wetlands) where avoided. The specialist report concerned with wetlands only should highlight the importance of the wetlands on both a regional and local scale.

From, the total ecological assessment it is evident that the northern section of the prospecting area and most of the area transected by the conveyor (Figure 21) is very high sensitive with regards to the conservation of biodiversity in the area and should therefore present the core of the proposed mine's biodiversity action plan.

6.3.1 September 2015 Update

The only change to the total ecological sensitivity was the lost of habitat to an open cast mine near the western end of the conveyor (Section 4.3.2, Figure 16). There was however a shift in the placement of the proposed infrastructure with the non-linear infrastructure (mining complex) moving to the east and the conveyor slightly to the south, to avoid the new open cast mine (Figure 21).

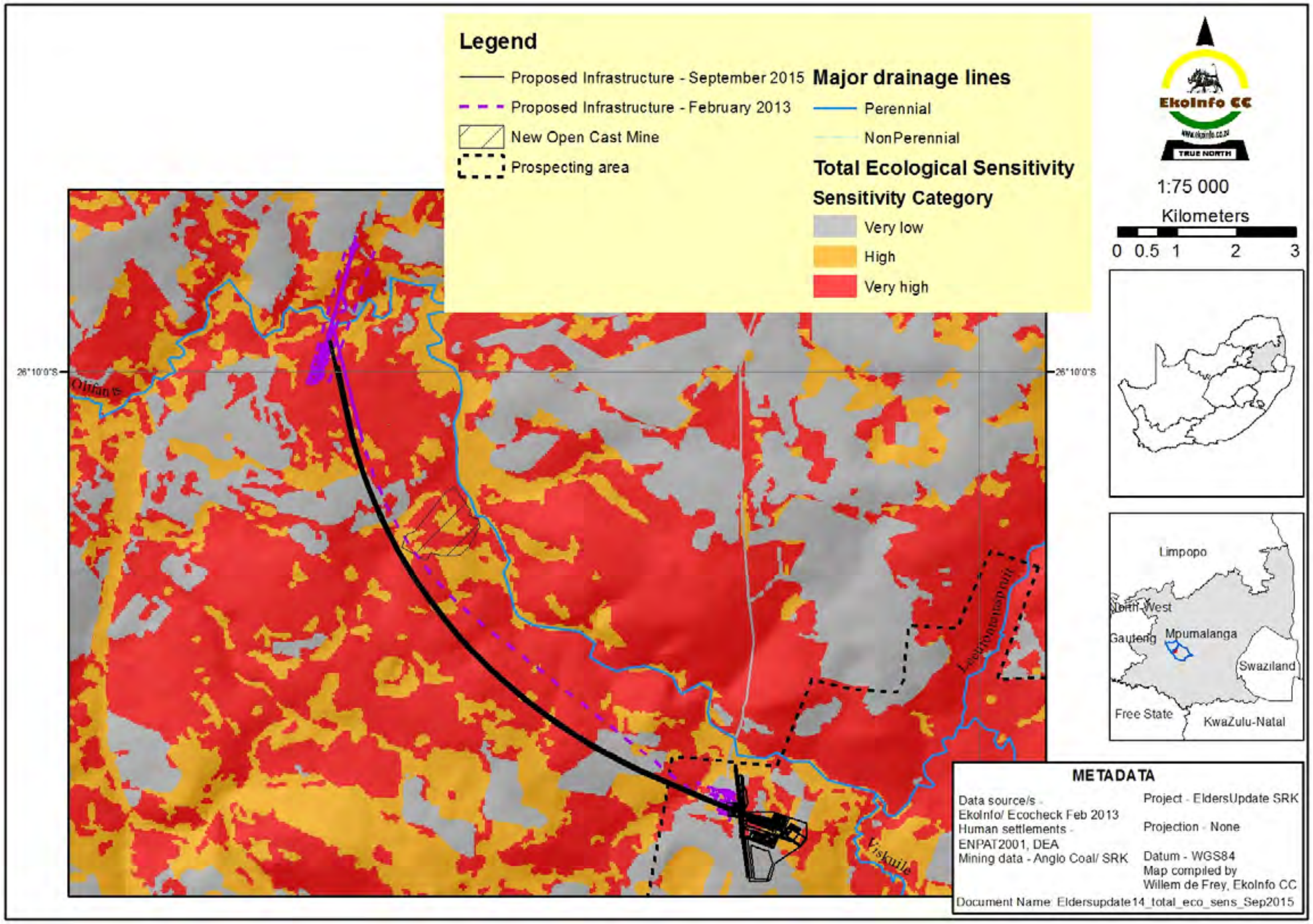


Figure 21: Total ecological sensitivity map

Table 35: Overview of the percentage cover per total ecological sensitivity category within the prospecting area

Vegetation Community - Land Cover	Total ecological sensitivity categories			
	Very low	**High**	**Very high**	**Grand Total**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils		1642		1642
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils			1793	1793
Mining Areas - mainly open cast	63			63
Road	29			29
Transformed Areas - mainly cultivated lands	2003			2003
Wetland		241		241
Grand Total	2095	1883	1793	5772
Percentage cover	36%	33%	31%	100%
Very low – low to high – very high ratio			64%	

Table 36: Overview of the percentage cover per total ecological sensitivity category within the conveyor route

Vegetation Community - Land Cover	Total ecological sensitivity categories			
	Very low	**High**	**Very high**	**Grand Total**
1. Verbena bonariensis - Eragrostis plana Grassland community on coarse textured soils		5		5
2. Themeda triandra - Senecio erubescens Grassland community on fine textured soils			37	37
Transformed Areas - mainly cultivated lands	5			5
Wetland		4		4
Grand Total	5	9	37	50
Percentage cover	9%	17%	73%	100%
Very low – low to high – very high ratio			91%	

7 ENVIRONMENTAL IMPACT ASSESSMENT

7.1 Project Description

7.1.1 Project Description – 2013 survey

SRK provided the following project description (December 2013):

"It is the intention of AAIC to undertake the following main activities as part of the Elders Colliery project:

- Establish the mini-pit and associated surface infrastructure (specific to the open cast workings), from where coal will be transported via 34t on-road trucks on the R35/R542 to Goedehoop Colliery's process plant;
- Establishment of a conveyor route servitude of 36m (including a conveyor belt, service road, pipeline and one 22kV powerline between Elders Colliery and Block 20 Shaft);
- Construction of a decline shaft and associated surface infrastructure for the Elders Colliery; and
- Underground mining activities.

The sections below provide a detailed project description, which will also be featured in the Draft and Final EIA/EMP….

3.2 Existing Infrastructure

Elders Colliery is a new mine, therefore there is no mining-related infrastructure currently in the project area.

3.2.1 Roads

R35

The R35 is a single carriageway with 3,5m lanes in both directions and 1,5m hard shoulders. This road runs north to south and links the towns of Bethal and Middelburg. The R35's design speed is high at 120km/h. The road edge is well maintained and the grass cut short in the road reserve (Aurecon, 2013).

R544

The R544 is a single carriageway with one 3.5m lane in each direction and grassed shoulders. The design speed is at 60km/h and sight distance is good at the intersection of R544 and R35 with no obstruction on the R35. The R544 is stop controlled at the intersection with the R35 being the major road having right of way (Aurecon, 2013).

R542

The R542 is also a single carriageway road with a single 3.5m lane in each direction having grassed shoulders on both sides. Sight distance is excellent however the road surface conditions vary from good to poor with evidence of significant road repairs and potholes together with severe rutting at the road edges. The indicated speed limit is 100km/h and reduces to 60km/h on approach to the intersection with the R35 (Aurecon, 2013).

Sudor Road

The Sudor Road is an existing gravel road which runs from the R35 to existing Sudor Mine, which is adjacent to the proposed Elders Colliery shaft complex. This road will provide access to the Elders Colliery shaft complex from the R35.

3.2.2 Railway lines and conveyors

There are no railway lines or infrastructure in the immediate vicinity of the project site and from the preliminary project description it is not required. A rail line does exist approximately 5km east of the R35 and is aligned approximately in a north – south direction, thereafter heading southeast when travelling further south (Aurecon, 2013).

3.2.3 Existing conveyor belts

A series of conveyor belts run between Block 20 Shaft (currently on care and maintenance) and Goedehoop Colliery's existing Hope Shaft Complex (adjacent to the Goedehoop plant). These conveyors will receive coal from the new Elders overland conveyor (the servitude of which is discussed in section 3 above) and transfer the coal to three new conveyors leading into Goedehoop plant. The three new conveyors will be constructed parallel to the existing conveyor 201, 202 and 203 running between Hope Shaft and Goedehoop plant. This conveyor system will be used during the operational phase of the Elders underground mine.

3.2.4 Dwellings

Vlakkuilen Community(Survey 2013)/ Middelkraal Community (Survey 2015)

The Vlakkuilen is rural community with a total population of 124 people living in 23 households. The community is located within the project footprint area, approximately 3km from the proposed mini-pit and 4.5km from the main Elders Colliery shaft complex.

The Middelkraal Community is a rural community that has previously been relocated to the farm Middelkraal by Glencore. Thirteen of the community's children attend the Wazana Primary School, located in close proximity to the Vlakkuilen Community. The community is located outside the project area, approximately 1 km from the proposed boxcut and associated infrastructure.

Hirsaw Estate

The Hirsaw Estate is located along the R35 national road between Bethal and the Goedehoop Colliery in the Govan Mbeki Municipality. Hirsaw Estate is owned by AATC, however is currently being leased and utilised for agricultural purposes.

3.3 Proposed Infrastructure

The table (next page) overleaf provides information regarding the proposed infrastructure to be constructed at Elders Colliery. … the infrastructure description has been divided into the underground shaft complex, conveyor route servitude and mini pit areas..."

7.1.2 Project Description – 2015 survey

The following project description was extracted from the Terms of Reference document supplied by SRK:

"AOL proposes to develop a new box cut access at the Elders Colliery with 14 years Life of Mine (LOM), and to mine the No. 2 and No. 4 coal seams by means of bord and pillar underground mining methods, making use of continuous miners and shuttle cars. The option analysis conducted during the project evaluation phase indicated that underground mining is deemed financially more feasible as an effective extraction method for the Elders project, although some open cast opportunity exit in the shallower portion of the resource and might be investigated later during the mine life.

The coal deposit is located close to the northern margin of the Highveld Coalfield. It is proposed to mine both the No. 2 and No. 4 seams via a boxcut to be used for personnel, material and coal clearance.

It is proposed to transport coal from the underground operations via a new conveyor route (10 km in length) to Block 20 (a mine out shaft currently on care and maintenance, owned by AOL's Goedehoop Colliery). Coal will be transported from Block 20 to the Goedehoop Colliery on an existing conveyor belt of 8 km for coal processing at the existing Goedehoop Colliery Processing Plant. Refer to Figure 2 for the general layout of Elders Colliery.

The proposed development includes the following activities:

Box cut and associated infrastructure

- Access road;
- Internal roads;
- Service roads;
- Powerlines;
- Pipelines;
- Bulk storage for fuel;
- Surface silo;
- Fencing;
- Topsoil stockpiles;
- Overburden stockpiles;
- Pollution control dams;
- Sewage treatment plant;
- Boxcut;
- Waste and scrap yard;
- Substation;
- Cable yard repair workshop;
- Washbay;
- Stone dust silo;
- Primary crusher in the boxcut;
- Offices; and
- Changehouses.

Conveyor route and servitude (new and update of existing)

- Service road;
- Powerline;
- Pipeline; and
- Fencing."

THE MAIN DIFFERENCE IN THE PROJECT FROM 2013 TO 2015 IS THAT NO OPEN CAST MINING WILL BE TAKING PLACE EXCEPT FOR THE BOXCUT WHICH WILL ALSO FUNCTION AS AN ACCESS DUCT TO THE UNDERGROUND WORKS.

The above infrastructure development has the potential to influence the local and regional biodiversity as follows:

1. Habitat loss
    a. Roads, trenches/ open pits and buildings result in the transformation/ removal of remaining natural vegetation
    b. Roads, trenches/ open pits, buildings and subsidence (underground mining related) influence the soil moisture regime within the landscape which has an influence on vegetation composition and subsequently habitat availability
    c. Fauna avoid natural vegetation inclose proximity of the mining activities due to –
        i. Noise
        ii. Dust
        iii. Prosecution
        iv. Threat from alien invasive or feral species
        v. Change in habitat composition and structure due to exploitation, whether by livestock or humans
2. Habitat fragmentation
    a. Fences, roads, trenches/ open pits and buildings contributes to the fragmentation of large patches of remaining natural vegetation
    b. Fences, roads, trenches/ open pits and buildings destroy small patches of remaining natural vegetation which links larger patches of natural vegetation, which as an influence on connectivity
    c. Fences, roads, trenches/ open pits and buildings deny organisms access to habitat needed for breeding and feeding
    d. Populations and communities of organisms are divided/ separated or disrupted which has an influence on the viability of the communities and populations due to –
        i. Disruption of social structures and subsequent gene flow
        ii. Increased vunerability to stochastic events such as fire, disease, drought, flooding, weather extremes

iii. Increased inter- and intraspecies conflict for resources such as water, food, shelter and breeding opportunity
iv. Increased vulnerability to local extinction due to predation or exploitation

The proposed mining activities will contribute to these impacts on a local scale (construction footprint, operational influence) directly and on regional scale (area of influence, landscape level – quaternary catchment) indirectly. Assessing the direct impact related to the removal or transformation of the remaining natural vegetation locally and regionally is possible using the vegetation map compiled during this study and nationally available landcover data.

To understand or evaluate the indirect/ cumulative impact or ripple effect of the proposed mining activity on a landscape level with regards to habitat loss and habitat fragementation, the following information should be considered:

1. Remaining land with cultivation potential, whether still natural or fallow within the landscape. Old cultivated or fallow lands should rather be optimised or utilised than natural veld being converted to cultivated land.
2. Whether the natural productivity (tons/ ha) of the remaining natural veld or fallow lands is the same, in other words would the same amount (hectares) of land be required to produce the same amount (tons/ha) of food, if the productivity is lower it will imply a larger area would be required to be transformed/ ploughed to deliver the same amount (tons/ha) of food. Therefore the influence of the proposed mining activities will be larger/ higher on a regional scale with regards to habitat loss and fragmentation
3. The current carrying capacity and veld condition of the remaining natural veld. If the current carrying capacity of the natural veld is 10 large stock units per hectare for veld in a good condition (species rich/ diverse veld), which translates to approximately a 1000 heads of cattle per 100 ha of natural veld, then if the remaining natural veld is reduced/ transformed either for open cast mining or cultivation, it will result in an incease in grazing pressure on the remaining natural veld, which will result in a change in floristic species composition and therefore a change in productivity (poorer veld condition – lower species richness/ less diverse veld, lower carrying capacity) as well as a change in the suitability of the remaining natural vegetation as habitat for the biodiversity present in the landscape.

7.2 Direct Impact Assessment

7.2.1 Habitat Loss

7.2.1.1 2013 Project Description

Non-linear infrastructure: Mining Area

The extent/ size of proposed non-linear infrastructure is as follows (Figure 22):

1. Underground mining area - 1 780 ha
2. Shaft Area And Related Infrastructure – 54 ha
    a. Berm Plant Area
    b. Substation
    c. Ventilation Shaft
3. Mini Open Pit And Related Infrastructure – 152 ha
    a. Mini Pit Berm
    b. Overburden Dump
    c. Mini Pit Boxcuts
4. Internal haul road – 5 ha

Based on the surface area of the proposed footprint for surface infrastructure, it is evident that the non-linear infrastructure will not contribute significantly to direct habitat loss and fragmentation on a local scale (Table 37), because it would result in the change of land use related mainly to existing transformed areas, namely cultivated land (more than 50%). The percentage of change in land use, using the mapped extent as a reference is less than 1%, whether natural vegetation or transformed areas (cultivated land). However should the lost cultivated land be replaced by transforming natural vegetation, the cumulative loss of natural vegetation would be 89 ha (natural vegetation) plus 120 ha (cultivated land), therefore a total of 209 ha of natural vegetation could be lost regionally. This also translates to less than 1% of the

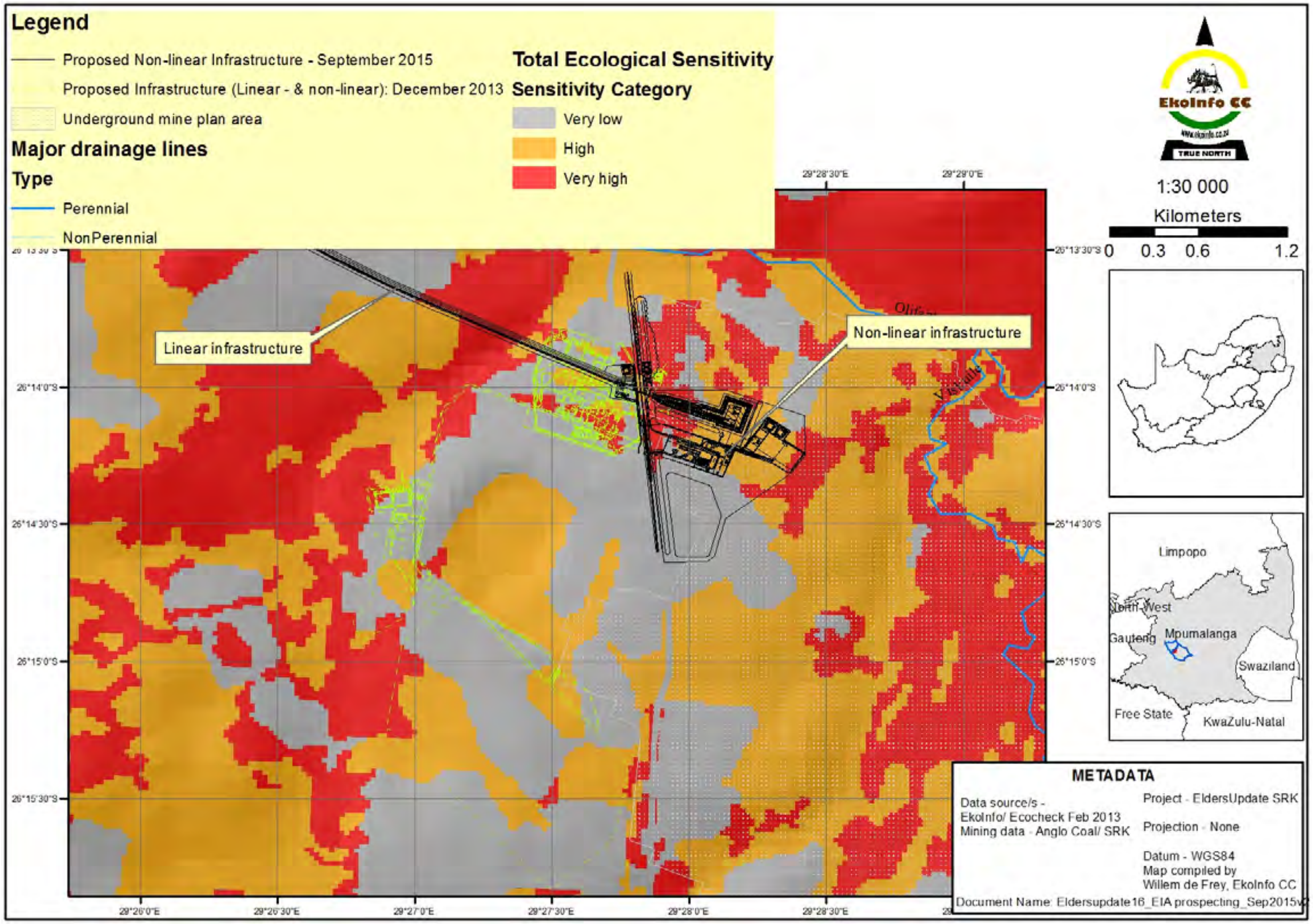


Figure 22: Distribution and extent of both the proposed 2013 and 2015 mining infrastructure overlain on the total ecological sensitivity results

landscape (Quaternary catchments B11A & B11B) (Section 3.4). Therefore it is evident that the non-linear surface infrastructure associated with the mining activity has a limited negative impact on the natural vegetation on a local and regional scale.

The use of underground mining methods to extract the coal as locally a significant positive benefit compared to using a surface approach, because the use of a surface approach (open cast mining) would have resulted in 74% of the mapped remaining natural vegetation being transformed (Table 38), with the additional loss of 454 ha of cultivated land, which if had to be replaced, would have resulted in a cumulative loss of natural vegetation of 1 780 ha. Therefore it would have had contributed locally to a 74% loss of natural vegetation (local high negative impact) and regionally (Quaternary catchments B11A & B11B) to a 2% reduction (regional very low negative impact). It should be noted that although the underground mining has less impact on the natural vegetation and therefore the biodiversity within the area and the region as a whole, the subsidence which could accompany this form of mining does influence the surface soil moisture regime, with a resulting change in floristic composition and therefore habitat conditions which influence the species present.

Linear infrastructure: Conveyor Belt

The proposed conveyor belt between the Elders shaft and Goedehoop Block B (Figure 23) is the most significant linear structure to be constructed for the purpose of the mine. Other linear infrastructure requirements such as the haul road will follow existing roads, while electrical; water and sewage services will be located within the footprint of either the non-linear infrastructure or the servitude of the Elders to Goedehoop conveyor. The footprint of the conveyor belt based on its 36 m servitude is 36 ha (Table 39), of which 92% presents natural vegetation, of which 65% is considered to be of very high conservation significance. However similar to the non-linear infrastructure it represents less than 1% of the mapped extent (local scale) and will be even less on a regional scale (Quaternary catchments B11A & B11B). Therefore the contribution of the conveyor belt to both local and regional transformation/ removal of natural vegetation are considered to be a very low negative impact.

It should however be highlighted that the above calculations only quantify the influence of direct vegetation transformation/ removal as a parameter of habitat loss for both flora and fauna species, but does not quantify the habitat loss related to points 1.b and 1.c (page 65).

7.2.1.2 September 2015 Update

From Figure 22, it is evident that the new non-linear infrastructure had moved to the east on more high and very high total ecological sensitive areas, during the site visit it was confirmed that these remaining areas are mainly associated with wetlands. The presence of the wetland conditions was most probably the main reason why these areas had not been ploughed historically but is rather being used for grazing or pastures. **A critical aspect that should be considered is that the current proposed mining plan excludes the open cast area, which will contribute to the reduction in landscape transformation, as the existing cultivated fields can remain in production.**

From Figure 23, it is evident that the linear structure (conveyor route) has moved slightly south but stayed basically in the same sensitive landscape.

Table 37: Overview of the extent of natural vegetation to be transformed/ removed with regards to the non-linear infrastructure

Shaft area and related infrastructure	**Mapped extent (ha)**	**Qualitative Conservation Status**			**Hectares**	**% Cover**	**Ecological Status**		**% of mapped extent**
Vegetation Communities		**Flora**	**Fauna**	**Total Ecology**			**Natural**	**Transformed**	
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	8346	High	High	High	2	3%	2		0.02%
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	15262	Very high	Very high	Very high	17	30%	17		0.11%
Road	125	Very low	Very low	Very low	3	5%		3	2.27%
Transformed Areas - mainly cultivated lands	16576	Very low	Very low	Very low	27	49%		27	0.16%
Wetland	2721	Low	Very high	High	7	12%	7		0.25%
Totals					54	100%	25	29	
							46%	54%	
Mini pit and related infrastructure									
Vegetation Communities	**Mapped extent (ha)**	**Flora**	**Fauna**	**Total Ecology**	**Hectares**	**% Cover**	**Natural**	**Transformed**	**% of mapped extent**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	8346	High	High	High	55	36%	55		0.66%
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	15262	Very high	Very high	Very high	7	5%	7		0.05%
Transformed Areas - mainly cultivated lands	16576	Very low	Very low	Very low	91	59%		91	0.55%
Wetland	2721	Low	Very high	High	0	0%	0		0.00%
Totals					152	100%	62	91	
							41%	59%	
Haul road									
Vegetation Communities	**Mapped extent (ha)**	**Flora**	**Fauna**	**Total Ecology**	**Hectares**	**% Cover**	**Natural**	**Transformed**	**% of mapped extent**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	8346	4	4	4	0	0%	0		0.00%
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	15262	5	5	5	2	40%	2		0.01%
Transformed Areas - mainly cultivated lands	16576	1	1	1	3	55%		3	0.02%
Wetland	2721	2	5	4	0	5%	0		0.01%
Totals					5	100%	2	3	
							45%	55%	

Cumulative contribution to land use change: Other to mining related									
Vegetation Communities	**Mapped extent (ha)**	**Flora**	**Fauna**	**Total Ecology**	**Hectares**	**% Cover**	**Natural**	**Transformed**	**% of mapped extent**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	8346	High	High	High	56	27%	56		0.68%
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	15262	Very high	Very high	Very high	26	12%	26		0.17%
Road	125	Very low	Very low	Very low	3	1%		3	2.27%
Transformed Areas - mainly cultivated lands	16576	Very low	Very low	Very low	120	57%		120	0.73%
Wetland	2721	Low	Very high	High	7	3%	9		0.26%
Totals					212	100%	89	123	
							42%	58%	

Table 38: Overview of the potential contribution towards habitat loss if the coal was extracted using surface methods rather than underground methods

Vegetation Communities	**Mapped extent (ha)**	**Qualitative Conservation Status**			**Hectares**	**% Cover**	**Ecological Status**		
		Flora	**Fauna**	**Total Ecology**			**Natural**	**Transformed**	**% of mapped extent**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	8346	High	High	High	678	38%	678		8.13%
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	15262	Very high	Very high	Very high	592	33%	592		3.88%
Road	125	Very low	Very low	Very low	7	0%		7	5.57%
Transformed Areas - mainly cultivated lands	16576	Very low	Very low	Very low	447	25%		447	2.70%
Wetland	2721	Low	Very high	High	55	3%	55		2.03%
Totals					1780	100%	1325	454	
							74%	26%	

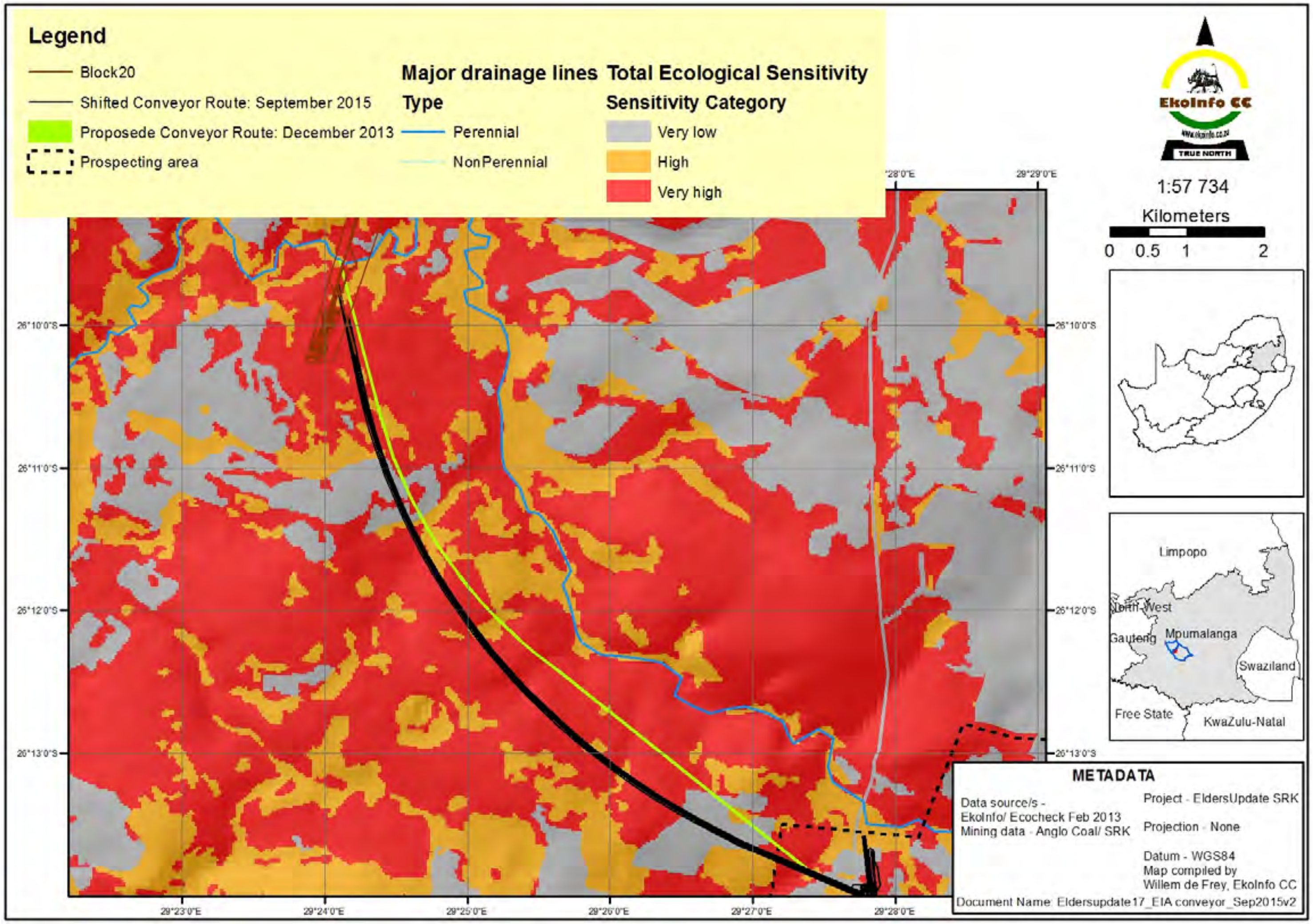


Figure 23: Distribution and extent of the linear infrastructure (2013 and 2015) related to the proposed mining activity overlain on the total ecological sensitivity results

Table 39: Overview of the extent of natural vegetation to be transformed/ removed with regards to the linear infrastructure

Vegetation Communities	Mapped extent (ha)	Qualitative Conservation Status			Hectares	% Cover	Ecological Status		% of mapped extent
		Flora	Fauna	Total Ecology			Natural	Transformed	
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	8346	High	High	High	4	10%	4		0.04%
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	15262	Very high	Very high	Very high	26	74%	26		0.17%
Road	125	Very low	Very low	Very low	0	0%		0	0.00%
Transformed Areas - mainly cultivated lands	16576	Very low	Very low	Very low	3	8%		3	0.02%
Wetland	2721	Low	Very high	High	3	8%	3		0.11%
					36	100%	42	10	
							92%	18%	

7.2.2 Habitat Fragmentation

7.2.2.1 2013 Project Description

Non-linear infrastructure: Mining Area

Visual inspection of Figure 24 indicates that the proposed non-linear mining infrastructure will mostly negatively impact on already isolated patches of natural vegetation, and therefore will basically consolidate an already large patch of transformed area. The fence along the haul road will prevent grounddwelling organsims accessing the pan from the west, while the noise, dust and human presence will also result in certain species not utilising the pan. Therefore the contribution of the non-linear infrastructure to habitat fragmentation locally and regionally is considered to be a very low negative impact.

Linear infrastructure: Conveyor Belt

The conveyor belt between the proposed Elders mine and the existing Goedehoop mine will fragmentate a very large patch/ area of natural vegetation, a visual inspection of Figure 25 supports this statement. Furthermore it will deny free roaming grounddwelling organisms from the southwest access to the perennial water of the Olifants River. Currently the only linear structures which transect this area is low density, low volume gravel secondary and other access roads which have a limited influence on free roaming grounddwelling organsims. The fence along the conveyor belt will result in an impermeable barrier, which will have a higher negative impact on the mobility of free roaming organism than the general cattle fences used on farm boundaries.

7.2.2.2 September 2015 Update

With regards to the non-linear mining infrastructure (Mining area/ complex), the new location will also consolidate mainly already transformed areas (Figure 24), thus it is not contributing to habitat fragmentation.

In terms of the linear structure (conveyour route) the issue remains the same, with the shifted conveyor route still dividing a large area of natural vegetation (Figure 25). **Therefore the *status quo* remains with regards to the impacts and mitigation.**

7.2.3 Loss Of Species Of Concern

Species of concern are those species, whether flora or fauna with either Red Data or protected status (national and provincial). The proposed mining activities can impact negatively on them either directly or indirectly. Directly would be through the destruction of their habitat (transformation of natural vegetation), plants, grounddwelling organisms and organisms with small territories or very specific habitat requirements are the most vulnerable to this type of impact. Mining can have an indirect impact on these organisms through road kills, prosecution due to fear or prejudice, exploitation (bush meat, harvesting, over grazing) and poor management of natural resources (to frequent or to little fire, over – and under utilisation).

7.2.3.1 2013 Project Description

Non-linear infrastructure: Mining Area

More than 50% of the area associated with the non-linear mining infrastructure is already transformed (Table 37) and therefore the potential for impacting negatively on species of concern is lower. Furthermore the use of underground mining rather than open cast mining effectively as already offset the loss of any flora species of concern (mainly provincially protected – Section 4.2.2.2) within the area of the remaining natural vegetation within the footprint of the non-linear infrastructure. The underground mining leaves 1 325 ha (Table 38) intact while the surface infrastructure will transform 81 ha (Table 37) of natural vegetation, thus a ratio of 16: 1 (conservation: transformation). Therefore the impact is considered to be locally very low negative.

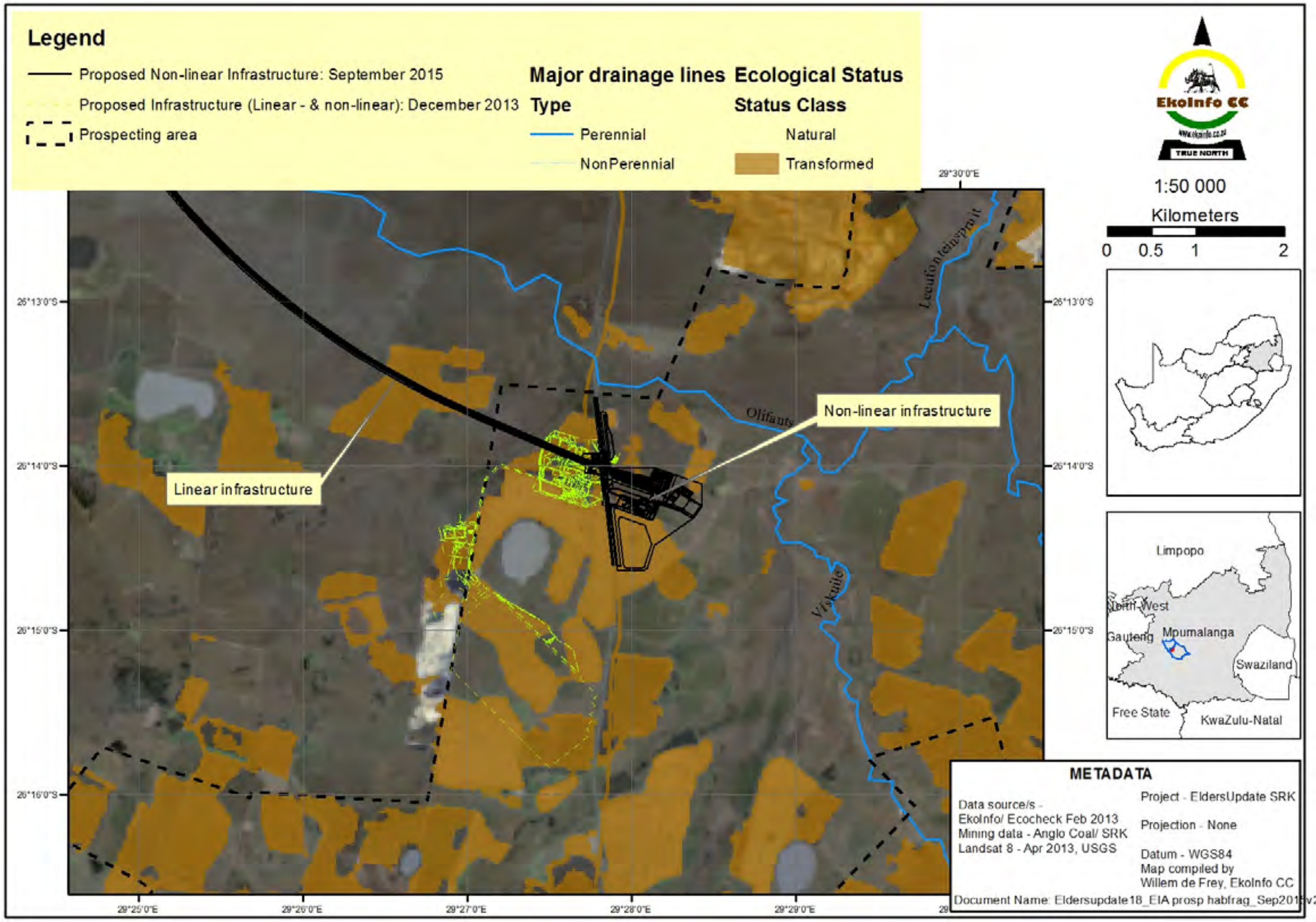


Figure 24: Overview of level of habitat fragmentation (natural and transformed areas) relative to both the non-linear infrastructure from the proposed 2013 and recent 2015 infrastructure

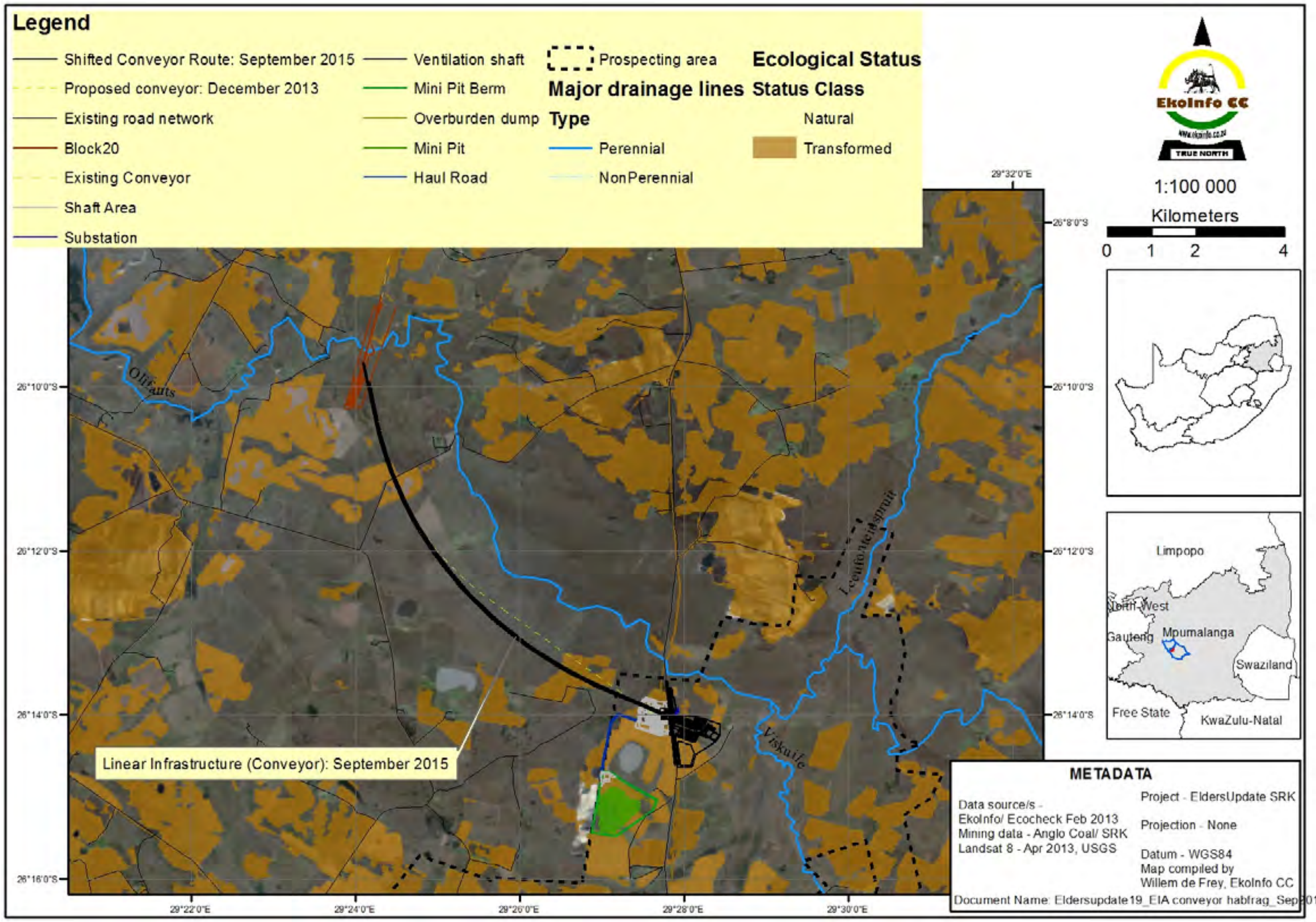


Figure 25: Overview of level of habitat fragmentation (natural and transformed areas) within the vicinity of the linear infrastructure in terms of both the December 2013 and September 2015 project descriptions

Linear infrastructure: Conveyor Belt

More than 80% of the area associated with the linear mining infrastructure (Elders to Goedehoop conveyor belt) represents natural vegetation (Table 39); of which 74% was classified as very high total ecological significance. This area also overlaps with national and provincial conservation important areas (Section 3.5, Figure 5); therefore it is highly likely that it will impact on both Red Data and protected species directly. The only way to reduce this impact is to consider alternative ways (haul road or underground conveyor) of transporting the coal or alternative alignments which transects more existing transformed land than natural land.

7.2.3.2 September 2015 Update

As with the previous mining plan; the probability of the non-linear structures to impact on species of concern, especially flora, is low, as most of the infrastructure is to be located on already transformed or disturbed areas, albeit on wetlands.

In spite of the shift of the conveyor route slightly to the south, the impacts remain the same, and the solutions as well, the only way to minimize the impact to species of concern, especially the flora, is to place the infrastructure along existing transformed areas. With regards to the movement of fauna, especially medium to large sized mammals, the conveyor designs should make provision for large culverts or gaps to allow movement, especially along existing drainage systems.

7.3 Cumulative Or Indirect Impacts

In addition to the direct impacts discussed above, it is expected that the proposed new mining infrastructure will contribute to cumulative and indirect impacts. These indirect and cumulative impacts relate to the following:

1. Transformation of natural habitat elsewhere in the landscape to compensate for the loss of cultivated land;
2. Increased exploitation of the remaining natural veld for grazing by livestock, whether domestic or game due to the limited extent of grazing land in the landscape.
3. Increase in dust during the construction and operation phase due to blasting and movement of mining vehicles and equipment. The dust covers the vegetation reducing their palatability for primary consumers (including cattle and phytophagous invertebrates) and therefore lowers the grazing capacity/ stocking rates of the remaining natural vegetation, resulting in the over utilisation of the remaining vegetation not affected by dust.
4. Certain species are sensitive to noise and the presence of other animals, which results in them leaving the area. This displacement of species will result in a decrease in local biodiversity and an increase in competition for resources somewhere else in the landscape. In addition, rare or sensitive species may be outcompeted by other species more resilient to displacement impacts.

The main objective of mitigating these cumulative impacts should be to reduce the need of transforming additional natural areas elsewhere in the landscape/ region for activities such as:

1. Infrastructure development – residential and industrial areas;
2. Food production – cultivated lands, hydroponics, greenhouses, pastures, feedlots, hatcheries, piggeries, chicken farms; and
3. Wood production – forestry, charcoal, paper pulp

The bottom line is that the post mining environment should be at least as productive as the pre-mining environment and even more so to mitigate the impact of habitat loss and fragmentation to which mining is contributing regionally by causing a ripple effect in the landscape.

If this approach is taken, then the post mining landscape can be as heterogenous and productive as the pre-mining environment while reducing pressure on the remaining natural areas in the landscape and creating sustainable economic opportunities in to the future, even long after the mine has closed. This would further reduce the need to try and extensively rehabilitate large areas, resulting in large areas of low environmental quality and productivity, through the allocation of time and resources for rehabilitating smaller areas will result in areas of high environmental quality and productivity while improving connectivity for wildlife in the area. This includes the establishment of wetlands and outcrops within well identified areas where the rehabilitation and restoration will deliver the most dividents on both a local and regional scale. These high priorty areas should focus on:

1. Reducing edge effects – smoothing the edge of existing natural areas;
2. Increasing habitat diversity – wetland and outcrop areas should be connected;
3. Reflecting the vegetation diversity and dominant trophic classes currently present within the areas, with specific focus on species which are important to pollinators and the improvement of soil conditions such as species from the Asteraceae and Fabacea families; and
4. Removing or reducing access to the remaining natural areas by removing or closing roads

It should be evident that this approach will result in an overall win-win scenario with resources being optimally utilised to the benefit of current and future generations. A concept profile of such a heterogenous post-mining landscape is presented in Figure 26, while Table 40 provides an hypothetical scenario of how the post-mining environment can be designed/ developed to maintain pre-mining productivity with regards to food supply (protein and starch). Note that there is the potential of a no net loss in food production, with substantial potential to increase job creation and expand on infrastructure (housing, roads, services), while providing the following benefits to the environment:

1. No need to transform an additional 142 ha of natural vegetation to facilitate food production activities, whether extensive or intensive which result in the loss or degradation of natural vegetation.
2. Almost half (36 ha) of the original natural veld is rehabilitated to the level where it can function as a wildlife corridor/ refuge and provide ecosystem services and functions such as:
    1. Pollination and honey production – only possible with the re-introduction of forbs.
    2. Flood retention and wildlife habitat – establishment of wetlands and outcrops
    3. Recreation – birding and other outdoor leisure activities.
    4. Education and research

Such an approach to the post-mining landscape will result in the reduction of habitat loss and habitat fragmentation on a regional scale, while improving/ enhancing connectivity between remaining natural areas to the benefit of biodiversity in general. Biodiversity loss due to habitat loss and fragmentation is a global concern and therefore measure which would reduce the need to transform or fragment the remaining natural vegetation in the landscape should be prioritised.

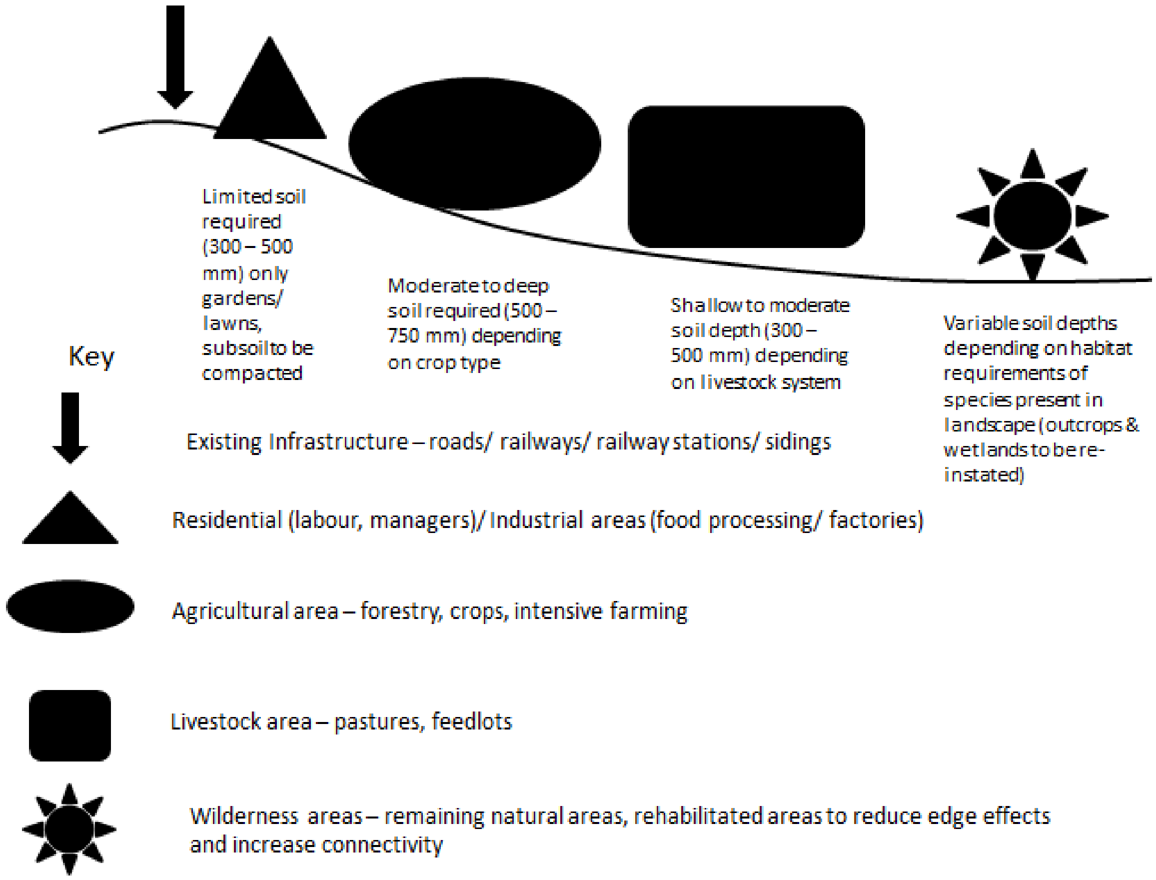


Figure 26: Concept profile of what the heterogenous post-mining landscape could look like, while reducing pressure/ need to transform remaining natural areas in the landscape

Table 40: Hypothetical scenario of how the post mining environment can be developed to maintain pre-mining productivity while benefiting the environment

Pre-mining environment								
Food source	**Method**	**Commodity**	**Extent**	**% Cover**	**Potential**	**Volume**	**Kg food source**	**Labour**
Protein	Extensive - Free roaming livestock	Cattle & sheep	81	45	10 Large stock units/ha	810	202 500	5
Starch	Extensive - Dry land crop	Maize	94	53	9 tons/ ha	846	634 500	10
Human infrastructure			3	2				
Totals			178	100				
Post-mining environment								
Protein	Intensive - concentrated animals	Cattle, Pigs, Chickens	45	25			202 500	50
Starch	Intensive - irrigation/ hydrophonics driven	Maize, Potatoes, Vegetables	80	45			634 500	100
Human infrastructure			18	10				
Rehabilitated land/ wildlife corridor			36	20				
Totals			178	100				

7.4 Table Based Summary Of The Expected Impacts On Biodiversity

7.4.1 Non-linear Infrastructure: Mining Area

7.4.1.1 Habitat loss

Impact description

This involves any activity during which remaining natural vegetation whether in a good or poor state is transformed or removed during the life of mine (pre-construction, construction, operational phases).

Impact Rating

Activity	Transformation or removal of remaining natural vegetation whether with machines or manual labour							
Project phase	Pre-construction through to operational							
Impact summary	Permanent loss of habitat for flora or fauna							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Site or local	Medium	Definite	Medium	-	High
Management Measures	Removal of vegetation should be restricted to the relevant infrastructure footprints only							
	Rocky areas within grasslands are particularly sensitive due to high levels of diversity; these rocky areas should be excluded from all activities related to the proposed project.							
	Topsoil should be stored separately to be used in rehabilitation and landscaping							
	No off-road driving into the natural remaining vegetation should be allowed especially by heavy machinery							
	The development of erosion gullies should be monitored and managed							
	Transformation of natural areas should exclude any areas designated as having high or very high sensitivities							
	Prevent any and all effluent from the mining activities of entering the wetland habitat							
	Prevent contamination of all natural habitat from any source of pollution (air, soil and water)							
	Compile and implement an environmental monitoring programme							
	Prevent all open fires, provide fire-safe zones, facilities and suitable fire control measures							
	Use of branches of trees, shrubs or any vegetation for fire making purposes is strictly prohibited							
	Provide sufficient on-site ablution, sanitation and waste management and hazardous materials management facilities							
	The use of the natural veld for ablution purposes shall not be permitted under any circumstances							
	Dust control on all roads should be prioritised							
	A road management plan should be compiled prior to commencement of construction activities							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long term	Site or local	Medium	Definite	Medium	-	High

Management measures

Habitat loss as a contributor to biodiversity loss is a global concern, and therefore is the transformation/ removal of any remaining vegetation of high significance, because it took centuries to obtain it current state and will take centuries to develop back to its current state. Therefore it is imperative that transformation is kept to the minimal (within the required footprint only), and infrastructure footprints kept to existing transformed areas.

Poor storm water management could result in the development of erosion gullies which will result in the deterioration of the vegetation and subsequent destruction.

The topsoil is an important source of seeds and should be managed as a critical resource to be used wisely in landscaping and rehabilitation.

Compile and implement an environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention f environmental degradation. Biodiversity monitoring should be conducted at least twice per year (Summer, Winter) in order to assess the status of natural habitat and effects of the project on the natural environment.

7.4.1.2 Habitat fragmentation

Impact description

This involves any activity which results in the division of areas of natural vegetation/ habitat, whether by construction activities or fences.

Impact Rating

Activity	The division of areas of natural vegetation/ habitat, whether by construction activities or fences							
Project phase	Pre-construction through to operational							
Impact summary	A barrier is created which has an influence on the movement and dispersal of fauna and flora							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Site or local	Medium	Definite	Medium	-	High
Management Measures	Infrastructure footprint should be kept to the edge of remaining natural areas							
	Infrastructure footprint should be appended to existing transformed areas							
	Preference should be given to all ready transformed areas							
	Maintaining access to water resources for grounddwelling organisms should be considered; the wetlands must be buffered by **at least 100 meters and preferably 500 m** from all activities related to the proposed project.							
	The movement of mammals through the landscape is vital; underpasses/culverts should be mandatory at all linear structures							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Minor	Long term	Site or local	Medium	Definite	Medium	-	High

Management measures

The proposed mining activity is located in an already fragmented (transformed) section of the landscape, and would contribute to the consolidation of existing transformed areas rather than creating new ones. This is especially true of the shaft area. It is for this reason that the habitat fragmentation associated with the non-linear infrastructure is considered to be of medium significance.

However, should the mine expand or additional infrastructure be required, new designs should aim to keep impacts together and prevent unnecessary sprawl.

Demarcate construction areas by semi-permanent means/material, in order to control movement of personnel, vehicles, providing boundaries for construction and operational sites. No painting or marking of rocks or vegetation to identify locality or other information shall be allowed, as it will disfigure the natural setting. Marking shall be done be steel stakes with tags if required.

7.4.1.3 Loss of Species of Concern

Impact description

Species of concern whether flora or fauna; can be lost from the area or even become regionally extinct; due to destruction of their habitat or their exploitation or due to predejuice against them. Species with very specific habitat requirements or social structures are very vulnerable to this impact.

Impact Rating

Activity	Direct or indirect mining related activities can result in the loss of species of concern							
Project phase	Pre-construction through to operational							
Impact summary	A species of concern can permanently disappear from the area or region due to habitat loss, habitat disruption or human activities (exploitation or prejudice/ ignorance)							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Site or local	Medium	Possible	Medium	-	Medium
Management Measures	Remaining areas of natural vegetation, irrespective of their ecological state (poor or good) should be inspected for the presence of species of concern during the optimal time prior to construction by a registered and experienced biodiversity team. This might require a number of visits over a number of months.							
	Employees at the mine should be educated about the environment, the species of concern present and how to deal with them. Ignorance paves the way for prejudice.							
	Employees should not be allowed to harvest, utilise, manage or control any natural resource (water, soil, flora, fauna) unless it is done within the framework of a biodiversity action plan							
	No alien invasive plant or feral animal (domestic or wild) should be introduced into the area or be allowed to establish or spread in the area. Alien invasive or feral species already in the areas should be managed and controlled within the framework of a biodiversity action plan							
	Only regionally, biome specific indigenous species should be used in the landscaping and rehabilitation. The seed and seedlings can be obtained by effectively managing the topsoil prior to construction. A professionally registered biodiversity team consisting of pedologists, botanists and zoologists should assist with the rehabilitation and landscaping plans.							
	No animal may be hunted, trapped, snared or captured for any purpose whatsoever. Fences and boundaries should be patrolled weekly in order to locate and remove snares and traps. Fences should be made visible, especially for flying fauna, specifically avifauna							
	Vehicular traffic should not be allowed after dark in order to limit accidental killing of nocturnal animals.							
	Speed of vehicles should be limted to allow for sufficient safety margins.							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Site or local	Medium	Possible	Medium	-	High

Management measures

Due to the fragmented and homogenous nature (flat, moist soils) of the area in which the non-linear infrastructure is located, it is not expected that species of concern with a threatened Red Data status which is mainly associated with very specific habitat conditions will be present. However, provincially protected species will be present because these species are protected due to the risk of exploitation or prejudice rather than habitat loss. Therefore these species could be locally abundant with the area and every effort should be made to maintain them in the area. There seeds will be present in the topsoil and therefore the topsoil of the remaining natural vegetation should be removed and effectively managed prior to construction to make the seedbed available for landscaping and rehabilitation.

7.4.2 Linear Infrastructure: Conveyor Belt

7.4.2.1 Habitat loss

Impact description

This involves any activity during which remaining natural vegetation whether in a good or poor state is transformed or removed during the life of mine (pre-construction, construction, operational phases).

Impact Rating

<table>
<tr><td>Activity</td><td colspan="8">Transformation or removal of remaining natural vegetation whether with machines or manual labour</td></tr>
<tr><td>Project phase</td><td colspan="8">Pre-construction through to operational</td></tr>
<tr><td>Impact summary</td><td colspan="8">Permanent loss of habitat for flora or fauna</td></tr>
<tr><td rowspan="2">Potential Impact Rating</td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Conseq</td><td>Probab.</td><td>SIGNIFICANCE</td><td>+/-</td><td>Conf. level</td></tr>
<tr><td>Major</td><td>Long term</td><td>Local or site</td><td>High</td><td>Definite</td><td>High</td><td>-</td><td>High</td></tr>
<tr><td rowspan="4">Management Measures</td><td colspan="8">Removal of vegetation should be restricted to the relevant infrastructure footprints only</td></tr>
<tr><td colspan="8">Topsoil should be stored separately to be used in rehabilitation and landscaping</td></tr>
<tr><td colspan="8">No off-road driving into the natural remaining vegetation should be allowed especially by heavy machinery</td></tr>
<tr><td colspan="8">The development of erosion gullies should be monitored and managed</td></tr>
<tr><td rowspan="2">After Management Impact Rating</td><td>Magnitude</td><td>Duration</td><td>Scale</td><td>Conseq</td><td>Probab.</td><td>SIGNIFICANCE</td><td>+/-</td><td>Conf. level</td></tr>
<tr><td>Major</td><td>Long term</td><td>Site or local</td><td>High</td><td>Definite</td><td>High</td><td>-</td><td>High</td></tr>
</table>

Management measures

Habitat loss as a contributor to biodiversity loss is a global concern, and therefore is the transformation/ removal of any remaining vegetation of high significance, because it took centuries to obtain it current state and will take centuries to develop back to its current state. Therefore it is imperative that transformation is kept to the minimal (within the required footprint only), and infrastructure footprints kept to existing transformed areas.

Poor storm water management could result in the development of erosion gullies which will result in the deterioration of the vegetation and subsequent destruction.

The topsoil is an important source of seeds and should be managed as a critical resource to be used wisely in landscaping and rehabilitation.

7.4.2.2 Habitat fragmentation

Impact description

This involves any activity which results in the division of areas of natural vegetation/ habitat, whether by construction activities or fences.

Impact Rating

Activity	The division of areas of natural vegetation/ habitat, whether by construction activities or fences							
Project phase	Pre-construction through to operational							
Impact summary	A barrier is created which has an influence on the movement and dispersal of fauna and flora							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Major	Long term	Regional	High	Definite	High	-	High
Management Measures	Infrastructure footprint should be kept to the edge of remaining natural areas							
	Infrastructure footprint should be appended to existing transformed areas							
	Preference should be given to all ready transformed areas							
	Maintaing access to water resources for grounddwelling organisms should be considered; the wetlands must be buffered by **at least 100 meters, 500 m would be preferable** from all activities related to the proposed project.							
	The free movement of especially grounddwelling organisms needs to be prioritised – underpasses/culverts must be mandatory for all linear structures.							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Major	Long term	Regional	High	Definite	High	-	High

Management measures

The proposed mining activity will transect a very large intact area of natural vegetation and will constrain the movement of free roaming grounddweling organisms. No alternatives were presented and no attempt was made to keep the proposed infrastructure within or along already transformed areas. Threrefore the impact of the current alignment is considered to be high irrespective of the management implemented.

7.4.2.3 Loss of Species of Concern

Impact description

Species of concern whether flora or fauna; can be lost from the area or even become regionally extinct; due to destruction of their habitat or their exploitation or due to predejuice against them. Species with very specific habitat requirements or social structures are very vulnerable to this impact.

Impact Rating

Activity	Direct or indirect mining related activities can result in the loss of species of concern							
Project phase	Pre-construction through to operational							
Impact summary	A species of concern can permanently disappear from the area or region due to habitat loss, habitat disruption or human activities (exploitation or prejudice/ ignorance)							
Potential Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Major	Long term	Regional	High	Possible	High	-	Medium
Management Measures	Large tracts/ patches of natural vegetation should be avoided							
	Remaining areas of natural vegetation, irrespective of their ecological state (poor or good) should be inspected for the presence of species of concern during the optimal time prior to construction by a registered and experienced biodiversity team. This might require a number of visits over a number of months.							
	Employees at the mine should be educated about the environment, the species of concern present and how to deal with them. Ignorance paves the way for prejudice							
	Employees should not be allowed to harvest, utilise, manage or control any natural resource (water, soil, flora, fauna) unless it is done within the framework of a biodiversity action plan							
	No alien invasive plant or feral animal (domestic or wild) should be introduced into the area or be allowed to establish or spread in the area. Alien invasive or feral species already in the areas should be managed and controlled within the framework of a biodiversity action plan							
	Only regionally, biome specific indigenous species should be used in the landscaping and rehabilitation. The seed and seedlings can be obtained by effectively managing the topsoil prior to construction. A professionally registered biodiversity team consisting of pedologists, botanists and zoologists should assist with the rehabilitation and landscaping plans.							
	Fences should be made visible, to avoid collosions by flying fauna, specificically birds							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Conseq**	**Probab.**	**SIGNIFICANCE**	**+/-**	**Conf. level**
	Moderate	Long term	Site or local	Medium	Unlikely	Low	-	High

Management measures

The proposed linear infrastructure transects more than 80% of natural vegetation of which more than 60% is associated with very high total ecological sensitive areas within a large intact area. No attempt was made to avoid this area and no alternatives were presented to evaluate and determine the least environmental option. Therefore the current alignment has a high probability to influence species with a threatened Red Data status as well as increase the risk to provincially protected species through improved access to a fairly remote area.

However should an attempt be made to avoid this area or move the alignment within or adjacent existing transformed areas, it would be able to reduce the impact of this proposed development significantly.

8 CONCLUSION AND WAY FORWARD

In conclusion, it can be stated that the proposed September 2015 project, which excludes open cast mining has mainly a positive influence on a regional scale, in that the ripple effect within the landscape in terms of transformation is reduced. However the conveyor route remains a concern, as the area had already been influenced by mining activities, and the presence of the route will increase access to a remote/ wilderness area. It is the opinion of the terrestrial biodiversity specialists that alternative methods or designs with regard to the conveyor route had not been extensively investigated.

Therefore the way forwards should involve either more intensive assessment of the risks associated with the conveyor route in terms of loss of connectivity for specifically large bodied organisms such as the leopard, brown hyenas, koribustards and korhaan, which utilise large home ranges or alternative methods should be considered to transport the coal such as barges along the Olifants River (Figure 27) or pipelines (Figure 28)

Figure 27: Example of moving coal along a natural barrier such as a river

Figure 28: Example of moving coal via pipelines, which are either buried or extremely permeable with regards to animal movement

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10 APPENDIX A – FLORA COMPONENT

10.1 A.1 - Braun-Blanquet table of the Goedehoop Kriel South vegetation

Note: Relevé's in italics occur within the Elders EMPR area

			1	2	2	2	2	3	3	3	3	*4*	*4*			*1*	3	3	*1*	*1*	2	*2*	*2*	3	3	4	*4*	*4*	5						1	1	1	1	*1*	*1*	2	2	2	3	3	*4*	*4*	*4*	*4*	*4*	*5*
Rel no	1	2	*9*	6	7	8	9	0	1	2	7	*5*	*8*	3	4	*5*	3	8	*4*	*8*	1	*3*	*4*	4	9	1	*3*	*7*	1	5	6	7	8	9	0	1	2	3	*6*	*7*	0	2	5	5	6	*0*	*2*	*4*	*6*	*9*	*0*
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1		1	1	1	1	1	1																						
All TWINSPAN clusters	5	5	7	3	5	7	6	6	6	6	5	4	5	8	8	9	8	8	0	1	0	0	9	0	2	0	1	2	2	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
																					1																														
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8	4	4	0	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community													1																		2																				
Sub community						1.1										1.2							2.1																	2.2											
SPECIES GROUP A																																																			
Eragrostis curvula (Schrad.) Nees				1			3	4		a			1	1		a	1														+	+						+				3									
Verbena bonariensis L.					+			+	1	+				+	1		1	+												+												+							+		
SPECIES GROUP B																																																			
Eragrostis gummiflua Nees	a	1	+	1	a	1	1		1	1	+		+								1																														
Stoebe vulgaris Levyns	a	b			1		1				3	+	1											a			1																		+						
Helichrysum aureonitens Sch.Bip.	+	+		+		1		+				+	+																				+		+		+									+		+			
Haplocarpha scaposa Harv.	+	1	1		+	+							1					+				+			+				1	1	1		1			1	1	+							1						
Conyza podocephala DC.	+			+	+	+	+																					+	+										+												
Helictotrichon turgidulum (Stapf) Schweick.	+					3				1		1	1							+									+																						
Cynodon dactylon (L.) Pers.		b			1			+	1																			1		+	+	a							+			a				1					
Helichrysum coriaceum Harv.				+							1	1	1											+																											
SPECIES GROUP C																																																			
Cirsium vulgare (Savi) Ten.			1						1	+				1	3	b	1	+		+			1							+	1							+		+		+		1		1		1	1		

```
                                                1 2 2 2 2 3 3 3 3 4 4         1 3 3   1 1 2 2 2 3 3 4 4 4 5             1 1 1 1 1 1 2 2 2 3 3 4 4 4 4 4 5 
Rel no                                      | 1 2 9 6 7 8 9 0 1 2 7 5 8 | 3 4 5 3 8 | 4 8 1 3 4 4 9 1 3 7 1 | 5 6 7 8 9 0 1 2 3 6 7 0 2 5 5 6 0 2 4 6 9 0|
                                              1 1 1 1 1 1 1 1 1 1 1 1 1   1 1 1 1 1   1 1 2 1   1 1 1 1 1 1
All TWINSPAN clusters                       | 5 5 7 3 5 7 6 6 6 6 5 4 5 | 8 8 9 8 8 | 0 1 0 0 9 0 2 0 1 2 2 | 3 2 3 7 5 7 7 7 8 4 1 7 2 6 6 7 4 5 6 2 4 4|
Level01                                     | 2 2 2 2 2 2 2 2 2 2 2 2 2 | 2 2 2 2 2 | 1 1 2 1 1 1 1 1 1 1 1 | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1|
Level02                                     | 3 3 3 3 3 3 3 3 3 3 3 3 3 | 3 3 3 3 3 | 2 2 4 2 2 2 2 2 2 2 2 | 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2|
Level03                                     | 4 4 4 4 4 4 4 4 4 4 4 4 4 | 5 5 5 5 5 | 3 3 6 3 3 3 3 3 3 3 3 | 2 2 2 2 2 2 2 2 2 2 1 2 2 2 2 2 2 2 2 2 2 2|
                                                                                        1
Level04                                     | 7 7 7 6 7 7 7 7 7 7 7 7 7 | 8 8 9 8 8 | 4 4 0 4 4 4 5 4 4 5 5 | 2 2 2 3 3 3 3 3 3 2 1 3 2 3 3 3 2 3 3 2 2 2|
Cluster sequence                            | 1 1 1 1 1 1 1 1 1 1 1 1 1 | 2 2 2 2 2 | 3 3 3 3 3 3 3 3 3 3 3 | 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4|

Community                                                           1                                   2
                                                      1.              1.            2.                                      2.
Sub community                               |           1               | 2         |         1             |                     2                      |
                                            |                           |           |                       |                                            |
                                            - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
Pimpinella transvaalensis H.Wolff           |     +     +               |   + +   + |                   + + | 1                 +                 + + + +|
Senecio achilleifolius DC.                  | 1                       + | + + 1     |                       |       +       + +                          |
SPECIES GROUP D
Themeda triandra Forssk.                    |         1           + 1   |         + | 3 a   a 4 1   1   a 1 | + 1 3 4 a 3 a 4 a +   3 1 a a + 1 4 1 1 1 3|
Scabiosa columbaria L.                      |       +           +       |           | 1     + 1 1     + + + | 1       +   +         +     +   + 1 + + a 1|
Ledebouria ovatifolia (Baker) Jessop        |                           |     1     | + +       +   + + + + | 1   + 1 +         +       + 1   1 + 1      |
Berkheya carlinopsis                        |                           |           |         b   1   + 1 + | +   1 + 1 1 1   1 1   1 + + 1 1 1 1 +   + 1|
Elionurus muticus (Spreng.) Kunth           |                   + +     |           | + 1   1           1 + |       a   1 1 a       a     1 +            |
Hypoxis rigidula                            |                           |     +     | 1 1             + +   |       +   1 + +       1 +       +          |
SPECIES GROUP E
Hermannia transvaalensis Schinz             |   +                 +     |           | + +   +   + + 1 + +   |                                            |
Eragrostis capensis (Thunb.) Trin.          |       +               1   |           |   + +   1 1 + +   1   |                                            |
Hermannia depressa N.E.Br.                  |                           |           |       + +   + + + + 1 |       +       +                            |
Kohautia amatymbica Eckl. & Zeyh.           |                           |           | +   +     +   +   + + |                                            |
Berkheya radula (Harv.) De Wild.            |           +       +     + |           |   +         +   + + 1 |                         +     1       1    |
Euphorbia striata                           |   +                     + |     +     | + + +           + +   |                 +                 1        |
Ajuga ophrydis Burch. ex Benth.             |                           |           |       +   + 1       + |                                            |
Becium obovatum                             |                           |           | +     +       1 +     |             +                              |
Berkheya setifera DC.                       |                     +     |           |   1 +             + + |                                            |
Chlorophytum fasciculatum (Baker) Kativu    |                           |       +   |     1   +   +     +   |                                           1|
Crabbea hirsuta Harv.                       |                     +     |           |       + +   +       1 |       1   + + 1 +             +            |
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Rel no	1	2	19	26	27	28	29	30	31	32	37	45	48	3	4	15	33	38	14	18	21	23	24	34	39	41	43	47	51	5	6	7	8	9	10	11	12	13	16	17	20	22	25	35	36	40	42	44	46	49	50
All TWINSPAN clusters	15	15	17	13	15	17	16	16	16	16	15	14	15	18	18	19	18	18	10	11	20	10	9	10	12	10	11	12	12	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8	4	4	10	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community													1																		2																				
Sub community						1.1										1.2							2.1																	2.2											
Gnidia capitata L.f.											+								+	+						1	+										1								1						
Harpochloa falx (L.f.) Kuntze												1							1		+			1					+																						
Helichrysum callicomum Harv.											+								+		+	+		+																											
Helichrysum rugulosum Less.				+															+				+			+			+									+							+						+
Heteropogon contortus (L.) Roem. & Schult.				1															+				1	1				1																	+						
Solanum panduriforme E.Mey.																			+			+	+			+																									
SPECIES GROUP F																																																			
Ranunculus multifidus Forssk.												+						+									+		a	1		+	+			+	+	+		+	+	+		+	+		+	+	1	1
Falckia oblonga Bernh. ex C.Krauss																														1	+								+		+	1	1	+		+					
Hermannia erodioides (Burch. ex DC.) Kuntze																																	1	1				+	1									+		1	1
SPECIES GROUP G - General species																																																			
Hypochaeris radicata L.	1	+	1		+	1	1	a		1	1	+	+	1	+		1	+	+	1	1	1		+		+		1	1				+				+		+						1				+		+
Eragrostis plana Nees	1	a	a		a				1	1	1		1		4			a				+	1	1						b	a	a	+		1	1	+		1		a			1	3	1		1			1
Senecio erubescens		+	+	1	+							+	+							1		+	1	1		1	1			b		+	+	+			+	1			1		1	+	+	+		1		+	+
Oenothera rosea L'H,r. ex Aiton																+		+		+					+			+	+	+	+	+				1		+				+		+		1		+		+	
SPECIES GROUP H - Ferns																																																			
Cheilanthes viridis																													+																						
Pellaea calomelanos																													+																						
SPECIES GROUP I - Forbs which are indicators of disturbance and/or overutilisation																																																			
Oenothera stricta Ledeb. ex Link																								+																											
Plantago lanceolata L.																																								+											

Rel no	1	2	19	26	27	28	29	30	31	32	37	45	48	3	4	15	33	38
All TWINSPAN clusters	15	15	17	13	15	17	16	16	16	16	15	14	15	18	18	19	18	18
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Community													1					
Sub community						1.1										1.2		
Richardia brasiliensis Gomes																		
Tragopogon dubius Scop.																		
Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt					+	+										+		
Trifolium pratense																		
Verbena brasiliensis Vell.													+					
Persicaria lapathifolia (L.) Gray																		
Solanum elaeagnifolium Cav.																		
Sonchus wilmsii R.E.Fr.			+				+	+										
Gomphocarpus fruticosus (L.) Aiton f.								+						1				
Lactuca inermis Forssk.																	+	
Senecio inaequidens DC.																	+	
Sisymbrium thellungii O.E.Schulz																		
Helichrysum oreophilum Klatt																		
Ursinia nana																		
Thesium costatum		+																
Helichrysum caespititium (DC.) Harv.				+														
Felicia muricata				+														
SPECIES GROUP J - Forbs associated with moist conditions																		
Cordylogyne globosa E.Mey.																		
Galium capense																		
Gynandriris simulans (Baker) R.C.Foster																		
Denekia capensis Thunb.																		

Rel no	14	18	21	23	24	34	39	41	43	47	51	5	6	7	8	9	10	11	12	13	16	17	20	22	25	35	36	40	42	44	46	49	50
All TWINSPAN clusters	10	11	20	10	9	10	12	10	11	12	12	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level04	4	4	10	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community													2																				
Sub community					2.1																	2.2											
Richardia brasiliensis Gomes										+											+												
Tragopogon dubius Scop.																				+											+		
Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt					+					+											+												
Trifolium pratense											+																						
Verbena brasiliensis Vell.											+																						
Persicaria lapathifolia (L.) Gray																						+											
Solanum elaeagnifolium Cav.											+																						
Sonchus wilmsii R.E.Fr.										+											+							+			+		+
Gomphocarpus fruticosus (L.) Aiton f.																				+							a						
Lactuca inermis Forssk.	+					+						+	+	+							+												
Senecio inaequidens DC.																																	
Sisymbrium thellungii O.E.Schulz																				+				1									
Helichrysum oreophilum Klatt	+																																
Ursinia nana			+																														
Thesium costatum																																	
Helichrysum caespititium (DC.) Harv.																																	
Felicia muricata			+					+																									
SPECIES GROUP J - Forbs associated with moist conditions																																	
Cordylogyne globosa E.Mey.																																	
Galium capense							1																	+									
Gynandriris simulans (Baker) R.C.Foster																								+									
Denekia capensis Thunb.													+																				

			1	2	2	2	2	3	3	3	3	4	4			1	3	3	1	1	2	2	2	3	3	4	4	4	5						1	1	1	1	1	1	2	2	2	3	3	4	4	4	4	4	5
Rel no	1	2	9	6	7	8	9	0	1	2	7	5	8	3	4	5	3	8	4	8	1	3	4	4	9	1	3	7	1	5	6	7	8	9	0	1	2	3	6	7	0	2	5	5	6	0	2	4	6	9	0
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1		1	1	1	1	1	1																						
All TWINSPAN clusters	5	5	7	3	5	7	6	6	6	6	5	4	5	8	8	9	8	8	0	1	0	0	9	0	2	0	1	2	2	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
																					1																														
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8	4	4	0	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community													1																		2																				
Sub community						1.1										1.2							2.1																	2.2											
Polygala hottentotta C.Presl				+																																															
Monopsis decipiens (Sond.) Thulin				+	+							+																																							
Senecio inornatus DC.							+						+				+										+																+								
Limosella maior Diels						+														+																								+							
Mimulus gracilis R.Br.																																											+								
Plantago longissima Decne.			+									+								+																			+												
Wahlenbergia undulata (L.f.) A.DC.				+																																															
Rhynchosia minima																										+																									
Salvia runcinata L.f.																						+																+													+
Ipomoea aquatica Forssk.																																		a																	
Helichrysum pilosellum (L.f.) Less.																																	+				+										+			
Xyris capensis Thunb.																					+																														
Haplocarpha lyrata Harv.																				+																															
SPECIES GROUP K - Forbs associated with rocky areas (outcrops)																																																			
Aloe greatheadii Sch”nland var. davyana (Sch”nland) Glen & D.S.Hardy																											+																								
Berkheya insignis (Harv.) Thell.																			+																																
Chaetacanthus costatus Nees																																						+	+												
Cycnium racemosum Benth.				+																																															
Dianthus mooiensis																													+																						
Dicoma anomala Sond.																					+																														
Euryops laxus (Harv.) Burtt Davy																										+																									

			1	2	2	2	2	3	3	3	3	4	4			1	3	3	1	1	2	2	2	3	3	4	4	4	5						1	1	1	1	1	1	2	2	2	3	3	4	4	4	4	4	5
Rel no	1	2	9	6	7	8	9	0	1	2	7	5	8	3	4	5	3	8	4	8	1	3	4	4	9	1	3	7	1	5	6	7	8	9	0	1	2	3	6	7	0	2	5	5	6	0	2	4	6	9	0
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1		1	1	1	1	1	1																						
All TWINSPAN clusters	5	5	7	3	5	7	6	6	6	6	5	4	5	8	8	9	8	8	0	1	0	0	9	0	2	0	1	2	2	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
																					1																														
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8	4	4	0	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community											1																				2																				
Sub community						1.1										1.2								2.1																2.2											
Indigofera oxytropis Benth. ex Harv.																			+																																
Leonotis ocymifolia (Burm.f.) Iwarsson var. schinzii (G rke) Iwarsson																					+																														
Polygala uncinata E.Mey. ex Meisn.																													+																						
Psammotropha myriantha Sond.																					+																														
Rhynchosia nitens Benth.																									+																										
Senecio harveianus MacOwan				+																																															
Sphenostylis angustifolia Sond.																																																			+
Vernonia galpinii Klatt																					1																														
Cotula hispida (DC.) Harv.																														1			1	+					1											1	+
Geigeria burkei																											+			+			+	+			+										+				
Hirpicium armerioides (DC.) Roessler																																														+				1	+
Lotononis foliosa Bolus																								+		+																									
Nemesia fruticans (Thunb.) Benth.				+																+									+									+													
Senecio consanguineus DC.																							+										+	+				1					+				+				
Silene burchellii																				+				+																											
SPECIES GROUP L - Widely distributed forbs within the grassland biome																																																			
Acalypha angustata Sond.																+					+	+																													
Acalypha punctata																				+																															
Asclepias eminens (Harv.) Schltr.																																																+			
Aster harveyanus Kuntze																			+																																
Crepis hypochoeridea (DC.) Thell.				1																																		+													

Rel no	1	2	19	26	27	28	29	30	31	32	37	45	48	3	4	15	33	38
All TWINSPAN clusters	15	15	17	13	15	17	16	16	16	16	15	14	15	18	18	19	18	18
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Community													1					
Sub community						1.1										1.2		
Cyanotis speciosa (L.f.) Hassk.																		
Gerbera viridifolia																		
Gnidia caffra (Meisn.) Gilg											1							
Ipomoea bathycolpos																		
Lotononis eriantha Benth.																		
Peucedanum magalismontanum Sond.																		
Polygala amatymbica Eckl. & Zeyh.																		
Rhynchosia totta																		
Thunbergia atriplicifolia E.Mey. ex Nees																		
Vernonia natalensis Sch.Bip. ex Walp.												+						
Zornia milneana Mohlenbr.																		
Anthospermum rigidum				+														
Crotalaria eremicola																		
Elephantorrhiza elephantina (Burch.) Skeels																		
Gazania krebsiana											+							
Helichrysum nudifolium (L.) Less.		1		1							1			+				
Jamesbrittenia aurantiaca (Burch.) Hilliard																		
Justicia anagalloides (Nees) T.Anderson		+																
Osteospermum muricatum																		
Thesium utile A.W.Hill												+						
Turbina oblongata (E.Mey. ex Choisy) A.Meeuse																		
Vernonia hirsuta (DC.) Sch.Bip. ex Walp.																		

Rel no	14	18	21	23	24	34	39	41	43	47	51
All TWINSPAN clusters	10	11	20	10	9	10	12	10	11	12	12
Level01	1	1	2	1	1	1	1	1	1	1	1
Level02	2	2	4	2	2	2	2	2	2	2	2
Level03	3	3	6	3	3	3	3	3	3	3	3
Level04	4	4	10	4	4	4	5	4	4	5	5
Cluster sequence	3	3	3	3	3	3	3	3	3	3	3
Community											
Sub community					2.1						
Cyanotis speciosa (L.f.) Hassk.									+		
Gerbera viridifolia	+										
Gnidia caffra (Meisn.) Gilg			a								
Ipomoea bathycolpos											
Lotononis eriantha Benth.											
Peucedanum magalismontanum Sond.									+		
Polygala amatymbica Eckl. & Zeyh.				+							
Rhynchosia totta		+									
Thunbergia atriplicifolia E.Mey. ex Nees										+	
Vernonia natalensis Sch.Bip. ex Walp.											
Zornia milneana Mohlenbr.						+					
Anthospermum rigidum						+		+			
Crotalaria eremicola											+
Elephantorrhiza elephantina (Burch.) Skeels											
Gazania krebsiana											
Helichrysum nudifolium (L.) Less.									1		+
Jamesbrittenia aurantiaca (Burch.) Hilliard											
Justicia anagalloides (Nees) T.Anderson	+			+						+	
Osteospermum muricatum											
Thesium utile A.W.Hill							+			+	
Turbina oblongata (E.Mey. ex Choisy) A.Meeuse											
Vernonia hirsuta (DC.) Sch.Bip. ex Walp.			1								

Rel no	5	6	7	8	9	10	11	12	13	16	17	20	22	25	35	36	40	42	44	46	49	50
All TWINSPAN clusters	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level04	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community		2																				
Sub community											2.2											
Cyanotis speciosa (L.f.) Hassk.																						
Gerbera viridifolia																						
Gnidia caffra (Meisn.) Gilg																						
Ipomoea bathycolpos																			1			
Lotononis eriantha Benth.			+																			
Peucedanum magalismontanum Sond.																						
Polygala amatymbica Eckl. & Zeyh.																+		+				
Rhynchosia totta					+																	
Thunbergia atriplicifolia E.Mey. ex Nees																						
Vernonia natalensis Sch.Bip. ex Walp.																						
Zornia milneana Mohlenbr.																						
Anthospermum rigidum				+					+			+									+	
Crotalaria eremicola																						
Elephantorrhiza elephantina (Burch.) Skeels				+				+														
Gazania krebsiana					+					1						+	+				1	
Helichrysum nudifolium (L.) Less.																						
Jamesbrittenia aurantiaca (Burch.) Hilliard												+						+	+			
Justicia anagalloides (Nees) T.Anderson																						
Osteospermum muricatum				1						+											+	
Thesium utile A.W.Hill																						
Turbina oblongata (E.Mey. ex Choisy) A.Meeuse			+	+	+																	
Vernonia hirsuta (DC.) Sch.Bip. ex Walp.																						

			1	2	2	2	2	3	3	3	3	4	4			1	3	3
Rel no	1	2	9	6	7	8	9	0	1	2	7	5	8	3	4	5	3	8
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
All TWINSPAN clusters	5	5	7	3	5	7	6	6	6	6	5	4	5	8	8	9	8	8
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Community													1					
Sub community						1. 1										1. 2		
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.				1														
Eriosema salignum E.Mey.																		
Pelargonium pseudofumarioides R.Knuth																		
SPECIES GROUP M - Geophytes found within the study area																		
Hypoxis hemerocallidea Fisch. & C.A.Mey.						+												
Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.																1		
Cyrtanthus tuckii																		
Albuca setosa Jacq.																		
Gladiolus crassifolius Baker																+		
Gladiolus longicollis																		
Hypoxis acuminata Baker												1						
Hypoxis argentea																		
Ledebouria cooperi (Hook.f.) Jessop																		
Moraea thomsonii Baker																		
Trachyandra asperata												+						
Tulbaghia acutiloba Harv.																		
SPECIES GROUP N - Infrequently found grasses																		
Eragrostis racemosa (Thunb.) Steud.																		
Setaria sphacelata																		
Imperata cylindrica (L.) Raeusch.	1							+					a					+
Setaria sphacelata (Schumach.) Moss var. torta (Stapf) Clayton																		

	1	1	2	2	2	3	3	4	4	4	5						1	1	1	1	1	1	2	2	2	3	3	4	4	4	4	4	5
Rel no	4	8	1	3	4	4	9	1	3	7	1	5	6	7	8	9	0	1	2	3	6	7	0	2	5	5	6	0	2	4	6	9	0
	1	1	2	1		1	1	1	1	1	1																						
All TWINSPAN clusters	0	1	0	0	9	0	2	0	1	2	2	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level04	4	4	10	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community													2																				
Sub community					2. 1																	2. 2											
Vernonia oligocephala (DC.) Sch.Bip. ex Walp.									+		+																						
Eriosema salignum E.Mey.																	+	+															
Pelargonium pseudofumarioides R.Knuth																																	
SPECIES GROUP M - Geophytes found within the study area																																	
Hypoxis hemerocallidea Fisch. & C.A.Mey.					1				+						+				+	+													
Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.		1											1									1			a		1	1				1	
Cyrtanthus tuckii																																	
Albuca setosa Jacq.		+																			1											+	
Gladiolus crassifolius Baker							+										+	1								+				+			
Gladiolus longicollis																										r							
Hypoxis acuminata Baker																									+				1	1			
Hypoxis argentea					+																			+									
Ledebouria cooperi (Hook.f.) Jessop																	+	+															
Moraea thomsonii Baker				+				1																									
Trachyandra asperata									+																+					+			
Tulbaghia acutiloba Harv.									+																					+			
SPECIES GROUP N - Infrequently found grasses																																	
Eragrostis racemosa (Thunb.) Steud.	+																																
Setaria sphacelata																																	+
Imperata cylindrica (L.) Raeusch.		+	+			+																		+									
Setaria sphacelata (Schumach.) Moss var. torta (Stapf) Clayton	+									1	+				+										1								

Rel no	1	2	19	26	27	28	29	30	31	32	37	45	48	3	4	15	33	38	14	18	21	23	24	34	39	41	43	47	51	5	6	7	8	9	10	11	12	13	16	17	20	22	25	35	36	40	42	44	46	49	50
All TWINSPAN clusters	15	15	17	13	15	17	16	16	16	16	15	14	15	18	18	19	18	18	10	11	20	10	9	10	12	10	11	12	12	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8	4	4	10	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community													1																		2																				
Sub community						1.1										1.2							2.1																	2.2											
Agrostis eriantha																		+																																	
Eragrostis trichophora Coss. & Durieu																		+																																	
Pennisetum sphacelatum (Nees) T.Durand & Schinz												1	1																																						
Bromus catharticus Vahl																		+		+																													a		
Paspalum dilatatum Poir.			+																																															+	
Paspalum scrobiculatum L.									a			1																																							
Eragrostis micrantha Hack.						a																																													
Setaria nigrirostris (Nees) T.Durand & Schinz																								+																											
Paspalum urvillei Steud.																+																																			
Brachiaria serrata (Thunb.) Stapf																			+										+																						
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy																1													1	+																					
Digitaria brazzae (Franch.) Stapf																			1		1			+																											
Tristachya leucothrix Nees												1							a									1	1																						
Aristida transvaalensis Henrard																													+																						
Eragrostis chloromelas Steud.			1	a		1											1						+		+			1																							+
Hyparrhenia hirta (L.) Stapf	1	a									+												3					1																							
Melinis repens																													+																						
Aristida congesta																																						+													
Aristida junciformis	+									1		1		1																																					
SPECIES GROUP O - Segdes associated with moist conditions																																																			
Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke																								+																											
Cyperus leptocladus Kunth																										+																									

Rel no	1	2	19	26	27	28	29	30	31	32	37	45	48	3	4	15	33	38	14	18	21	23	24	34	39	41	43	47	51	5	6	7	8	9	10	11	12	13	16	17	20	22	25	35	36	40	42	44	46	49	50
All TWINSPAN clusters	15	15	17	13	15	17	16	16	16	16	15	14	15	18	18	19	18	18	10	11	20	10	9	10	12	10	11	12	12	3	2	3	7	5	7	7	7	8	4	1	7	2	6	6	7	4	5	6	2	4	4
Level01	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Level02	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level03	4	4	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	3	3	6	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2
Level04	7	7	7	6	7	7	7	7	7	7	7	7	7	8	8	9	8	8	4	4	10	4	4	4	5	4	4	5	5	2	2	2	3	3	3	3	3	3	2	1	3	2	3	3	3	2	3	3	2	2	2
Cluster sequence	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Community													1																		2																				
Sub community						1. 1										1. 2							2. 1																	2. 2											
Cyperus obtusiflorus																																																			
Cyperus rupestris																					+				+																										
Eleocharis dregeana Steud.																																								b											
Mariscus congestus (Vahl) C.B.Clarke																																								+											
Scirpus burkei C.B.Clarke			1			1												+		1											1																				
SPECIES GROUP P - Woody species found within the study area																																																			
Erythrina zeyheri Harv.																										a												+													
Diospyros austro-afric																													1																						
Diospyros lycioides																					a								4																						
Rhus krebsiana C.Presl ex Engl.																					a																														
Rhus pentheri Zahlbr.																					a								b																						

10.2 A.2 - Species list

Grouped by class and in alphabetical order per family and species

1. Pteridophyta

Adiantaceae

Pellaea calomelanos

Cheilanthes viridis

2. Monocotyledonae

Alliaceae

Tulbaghia acutiloba Harv.

Amaryllidaceae

Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.

Cyrtanthus tuckii

Asphodelaceae

Aloe greatheadii Sch"nland var. davyana (Sch"nland) Glen & D.S.Hardy

Trachyandra asperata

Chlorophytum fasciculatum (Baker) Kativu

Commelinaceae

Cyanotis speciosa (L.f.) Hassk.

Cyperaceae

Cyperus leptocladus Kunth

Cyperus obtusiflorus

Cyperus rupestris

Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke

Eleocharis dregeana Steud.

Mariscus congestus (Vahl) C.B.Clarke

Scirpus burkei C.B.Clarke

Hyacinthaceae

Albuca setosa Jacq.

Ledebouria ovatifolia (Baker) Jessop

Ledebouria cooperi (Hook.f.) Jessop

Hypoxidaceae

Hypoxis hemerocallidea Fisch. & C.A.Mey.

Hypoxis argentea

Hypoxis rigidula

Hypoxis acuminata Baker

Iridaceae

Gladiolus crassifolius Baker

Moraea thomsonii Baker

Gladiolus longicollis Baker var. longicollis

Gynandriris simulans (Baker) R.C.Foster

Poaceae

Eragrostis chloromelas Steud.

Eragrostis capensis (Thunb.) Trin.

Elionurus muticus (Spreng.) Kunth

Paspalum scrobiculatum L.

Digitaria brazzae (Franch.) Stapf

Helictotrichon turgidulum (Stapf) Schweick.

Heteropogon contortus (L.) Roem. & Schult.

Pennisetum sphacelatum (Nees) T.Durand & Schinz

Imperata cylindrica (L.) Raeusch.

Eragrostis racemosa (Thunb.) Steud.

Paspalum urvillei Steud.

Paspalum dilatatum Poir.

Eragrostis gummiflua Nees

Eragrostis micrantha Hack.

Eragrostis plana Nees

Harpochloa falx (L.f.) Kuntze

Hyparrhenia hirta (L.) Stapf

Eragrostis trichophora Coss. & Durieu

Melinis repens

Eragrostis curvula (Schrad.) Nees

Aristida junciformis

Setaria sphacelata

Setaria nigrirostris (Nees) T.Durand & Schinz

Agrostis eriantha

Brachiaria serrata (Thunb.) Stapf

Themeda triandra Forssk.

Setaria sphacelata (Schumach.) Moss var. torta (Stapf) Clayton

Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy

Bromus catharticus Vahl

Aristida transvaalensis Henrard

Cynodon dactylon (L.) Pers.

Tristachya leucothrix Nees

Aristida congesta

Xyridaceae

Xyris capensis Thunb.

3. Dicotyledonae

Acanthaceae

Thunbergia atriplicifolia E.Mey. ex Nees

Chaetacanthus costatus Nees

Justicia anagalloides (Nees) T.Anderson

Crabbea hirsuta Harv.

Aizoaceae
Psammotropha myriantha Sond.

Anacardiaceae
Rhus krebsiana C.Presl ex Engl.

Rhus pentheri Zahlbr.

Apiaceae
Peucedanum magalismontanum Sond.

Pimpinella transvaalensis H.Wolff

Apocynaceae
Cordylogyne globosa E.Mey.

Asclepiadaceae
Asclepias aurea (Schltr.) Schltr.

Asclepias eminens (Harv.) Schltr.

Gomphocarpus fruticosus (L.) Aiton f.

Asteraceae
Helichrysum caespititium (DC.) Harv.

Helichrysum aureonitens Sch.Bip.

Helichrysum nudifolium (L.) Less.

Gazania krebsiana

Helichrysum coriaceum Harv.

Helichrysum callicomum Harv.

Haplocarpha scaposa Harv.

Aster harveyanus Kuntze

Helichrysum oreophilum Klatt

Berkheya setifera DC.

Denekia capensis Thunb.

Helichrysum pilosellum (L.f.) Less.

Crepis hypochoeridea (DC.) Thell.

Cotula hispida (DC.) Harv.

Conyza podocephala DC.
Gerbera viridifolia

Euryops laxus (Harv.) Burtt Davy

Haplocarpha lyrata Harv.

Felicia muricata

Geigeria burkei

Dicoma anomala Sond.

Berkheya radula (Harv.) De Wild.

Berkheya insignis (Harv.) Thell.

Berkheya carlinopsis

Cirsium vulgare (Savi) Ten.

Stoebe vulgaris Levyns

Senecio consanguineus DC.

Senecio erubescens

Senecio harveianus MacOwan

Lactuca inermis Forssk.

Senecio inaequidens DC.

Osteospermum muricatum

Hirpicium armerioides (DC.) Roessler

Senecio achilleifolius DC.

Sonchus wilmsii R.E.Fr.

Senecio inornatus DC.

Tragopogon dubius Scop.

Ursinia nana

Vernonia galpinii Klatt

Hypochaeris radicata L.

Vernonia hirsuta (DC.) Sch.Bip. ex Walp.

Vernonia natalensis Sch.Bip. ex Walp.

Vernonia oligocephala (DC.) Sch.Bip. ex Walp.

Helichrysum rugulosum Less.

Pseudognaphalium luteo-album (L.) Hilliard & B.L.Burtt

Brassicaceae
Sisymbrium thellungii O.E.Schulz

Campanulaceae
Wahlenbergia undulata (L.f.) A.DC.

Caryophyllaceae
Dianthus mooiensis
Silene burchellii

Convolvulaceae
Ipomoea crassipes Hook.

Ipomoea bathycolpos

Ipomoea aquatica Forssk.

Turbina oblongata (E.Mey. ex Choisy) A.Meeuse

Falckia oblonga Bernh. ex C.Krauss

Dipsacaceae
Scabiosa columbaria L.

Ebenaceae
Diospyros austro-africana

Diospyros lycioides

Euphorbiaceae
Acalypha punctata

Euphorbia striata

Acalypha angustata Sond.

Fabaceae
Zornia milneana Mohlenbr.

Sphenostylis angustifolia Sond.

Rhynchosia totta

Rhynchosia nitens Benth.

Erythrina zeyheri Harv.

Rhynchosia minima

Indigofera oxytropis Benth. ex Harv.

Trifolium pratense

Crotalaria eremicola

Lotononis foliosa Bolus

Eriosema salignum E.Mey.

Elephantorrhiza elephantina (Burch.) Skeels

Lotononis eriantha Benth.

Geraniaceae
Pelargonium pseudofumarioides R.Knuth

Lamiaceae
Leonotis ocymifolia (Burm.f.) Iwarsson var. schinzii (G rke) Iwarsson
Ajuga ophrydis Burch. ex Benth.

Salvia runcinata L.f.

Becium obovatum
Lobeliaceae
Monopsis decipiens (Sond.) Thulin

Onagraceae
Oenothera rosea L'H,r. ex Aiton

Oenothera stricta Ledeb. ex Link

Plantaginaceae
Plantago lanceolata L.

Plantago longissima Decne.

Polygalaceae
Polygala amatymbica Eckl. & Zeyh.

Polygala hottentotta C.Presl

Polygala uncinata E.Mey. ex Meisn.

Polygonaceae
Persicaria lapathifolia (L.) Gray

Ranunculaceae
Ranunculus multifidus Forssk.

Rubiaceae
Anthospermum rigidum

Kohautia amatymbica Eckl. & Zeyh.

Richardia brasiliensis Gomes

Galium capense

Santalaceae
Thesium costatum

Thesium utile A.W.Hill

Scrophulariaceae
Mimulus gracilis R.Br.

Cycnium racemosum Benth.

Limosella maior Diels

Nemesia fruticans (Thunb.) Benth.

Jamesbrittenia aurantiaca (Burch.) Hilliard

Solanaceae
Solanum elaeagnifolium Cav.

Solanum panduriforme E.Mey.

Sterculiaceae
Hermannia depressa N.E.Br.

Hermannia transvaalensis Schinz

Hermannia erodioides (Burch. ex DC.) Kuntze

Thymelaeaceae
Gnidia caffra (Meisn.) Gilg

Gnidia capitata L.f.

Verbenaceae
Verbena bonariensis L.

Verbena brasiliensis Vell.

10.3 A.3 - Flora Red Data Categories

Conservation Categories
As used in the southern African Red Data List
Extinct:
Taxa which are no longer known to exist in the wild after repeated searches of their type localities and other known or likely places. This category is also used for a taxon which no longer occurs in the wild but survives in at least some form in cultivation or in a seed bank, but probably so genetically impoverished or altered as to make it impossible to return it to a natural habitat.
Endangered:
Taxa in immediate danger of extinction if the factors causing decline continue operating. Included here are taxa whose numbers of individuals have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.
Vulnerable:
Taxa believed likely to move into the Endangered category in the near future if the factors causing decline continue operating. Included here are taxa of which most or all of the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbance; taxa with populations that have been seriously depleted and whose ultimate security is not yet assured; and taxa with populations that are still abundant but are under threat from serious adverse factors throughout their range.
Rare:
Taxa with small world populations that are not at present Endangered or Vulnerable, but are at risk as some unexpected threat could easily cause a critical decline. These taxa are usually localized within restricted geographical areas or habitats or are thinly scattered over a more extensive range. This category is sometimes termed 'Critically Rare' to distinguish it from the more generally used word 'rare' (Hall & Veldhuis 1985).
Indeterminate:
Taxa known to be Extinct, Endangered, Vulnerable, or Critically Rare but where there is not enough information to say which of the four categories is appropriate.
Insufficiently Known:
Taxa that are suspected but not definitely known to belong to any of the above categories, because of the lack of information. (Note, most of the South African literature has termed this category Uncertain or Unknown).
Not threatened:
This is used for taxa which are no longer in one of the above categories due to an increase in population sizes or to subsequent discoveries of more individuals or populations.
No Information:
Taxa for which no information is available at present to place them under any of the categories listed above.

Some hybrid categories e.g. R/V (Rare/Vulnerable), have also been used where it was not sure which category was most appropriate. This was done rather than using the unsattisfactory'Indeterminate' category

10.4 A.4 - Derived conservation status based on ecological status index

ECOLOGICAL INDICATORS	DESCRIPTION	Base 2002 (100%)	1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils		
Positive	Red data species	4	1	1	25	25		
	Protected species	4	3	3	75	75		
	Species richness	182	106	173	58	95		
	Maximum cover	100	77	76	77	76		
TOTAL					235	271		
Average positive index					59	68		
Negative	Declared weeds	2	1	2	50	100		
	Forbs to grass ratio	3	2	4	67	133		
	Maximum cover of woody layer	100	4	2	4	2		
	Categories of erosion present in area	3	3	2	100	67		
TOTAL					221	302		
Average negative index					55	76		
ECOLOGICAL STATUS	DIFFERENCE				15	-31		
Average ecolgical status					**4**	**-8**		
	Average ecological status (A)	Surface area (ha)	% of study area	Weight (100-% of total) (B)	Applicable environmental legislation (5=100%)	Percentage of applicable legislation (C)	Total (D = A+B+C)	**Derived conservation status (E=D/3)**
1. *Verbena bonariensis - Eragrostis plana* Grassland community on coarse textured soils	4	8455.280	34	66	4	80	150	**50**
2. *Themeda triandra - Senecio erubescens* Grassland community on fine textured soils	-8	3276.174	14	86	4	80	158	**53**

10.5 A.5 - Mpumalanga Parks list parties interested in rescueing plants

MPUMALANGA PARKS BOARD

RESEARCH & DEVELOPMENT, TERRESTRIAL SERVICES
PRIVATE BAG X1088, LYDENBURG, 1120
TEL. 013 235 2395/6/7 FAX. 013 235 2732, E-Mail: kdewet@ cis.co.za

REMOVAL OF VEGETATION FOR RESCUE PUROSES

Herewith, a list of organizations and individuals that may be interested in plant collecting on site. People should be contacted at least a month in advance and a map and species list be provided beforehand.

1.) The National Botanical Institute (Pretoria)
I have spoken to the curator of the herbarium (Marinda Koekemoer) and she is very interested to collect herbarium specimens. Their botanical gardens are run by Nic Klapwijk and he may be interested in live specimens. Both may be contacted on tel: 012 804 3200.

2.) Lowveld Botanical Gardens (Nelspruit)
Mr Johan Hurter is interested in collecting seed and cuttings. He may be contacted at 013 752 5531.

3.) Dr Kevan Balkwill
WITS Botany Department - 011 716 2201 Fax 011 3391145
e-mail: kevinb@gecko.biol.wits.ac.za

4.) Dendrological Society
Tel 012 567 4009 Fax 012 567 0008

5.) Dr Johan Engelbrecht
Tel 013 235 395/6/7 Fax 013 235 2732

6.) The Mpumalanga Plant Specialist Group
Ernst Schmidt 083 2572345

7.) Pieter Winter - University of the North
Tel 015 268 2227
pieterw@unin.unorth.ac.za

8.) Proff Braam van Wyk
Tel 012 420 2545
avanwyk@scientia.up.ac.za

9.) Douglas McMurtry
013 747 2270 / 082 937 134

10.) John and Sandie Burrows – Buffelskloof Nature Reserve: 013 235 3851

10.6 A.6 – Crossover table of the species against the plots recorded during February 2013

		Relevé number:	**9**	**7**	**10**	**8**	**14**	**1**	**2**	**3**	**4**	**6**	**11**	**12**	
		Altitude (m):	**1646**	**1621**	**1654**	**1632**	**1616**	**1602**	**1614**	**1607**	**1593**	**1595**	**1628**	**1629**	
		Soil depth (mm):	**1200**	**1020**	**1200**	**100**	**1200**	**180**	**1200**	**350**	**450**	**1200**	**1200**	**650**	
		Estimate % Clay (A-horizon):	**30**	**15**	**15**	**12**	**11**	**10**	**10**	**10**	**10**	**10**	**8**	**8**	
Botanical Names	**Family**	**Growth form**													**% Constancy**
Achyranthes aspera	Amaranthaceae	Herb												+	8%
Agrostis eriantha	Poaceae	Graminoid			2a		+								17%
Andropogon chinensis	Poaceae	Graminoid										+			8%
Anthericum cooperi	Anthericaceae	Herb				+				+	1				25%
Anthospermum hispidulum	Rubiaceae	Dwarf shrub								+		+			17%
Anthospermum rigidum	Rubiaceae	Dwarf shrub				+					+				17%
Aristida junciformis	Poaceae	Graminoid		+		+						+			25%
Aristida meridionalis	Poaceae	Graminoid				+									8%
Asclepias fruticosa	Apocynaceae						+								8%
Aster harveyanus	Asteraceae	Herb						+							8%
Babiana hypogaea	Iridaceae	GeophyteHerb				r									8%
Becium obovatum	Lamiaceae	Herb				+		+							17%
Bergia decumbens	Elatinaceae	Dwarf shrub									+				8%
Berkheya carlinopsis	Asteraceae	Shrub	2b												8%
Berkheya radula	Asteraceae	Herb	+		+										17%
Berkheya setifera	Asteraceae	Herb		+		1						+			25%
Berkheya speciosa	Asteraceae	Herb			1										8%
Bidens formosa	Asteraceae	Herb							1						8%
Bidens pilosa	Asteraceae	Herb							+						8%
Brachiaria serrata	Poaceae	Graminoid				+				+	+				25%
Bromus catharticus	Poaceae	Graminoid			+		+							+	25%

		Relevé number:	**9**	**7**	**10**	**8**	**14**	**1**	**2**	**3**	**4**	**6**	**11**	**12**	
		Altitude (m):	**1646**	**1621**	**1654**	**1632**	**1616**	**1602**	**1614**	**1607**	**1593**	**1595**	**1628**	**1629**	
		Soil depth (mm):	**1200**	**1020**	**1200**	**100**	**1200**	**180**	**1200**	**350**	**450**	**1200**	**1200**	**650**	
		Estimate % Clay (A-horizon):	**30**	**15**	**15**	**12**	**11**	**10**	**10**	**10**	**10**	**10**	**8**	**8**	
Botanical Names	**Family**	**Growth form**													**% Constancy**
Campuloclinium macrocephalum	Asteraceae	Herb							+						8%
Centella asiatica	Apiaceae	ClimberHerb			1		2a			+			+		33%
Chaetacanthus costatus	Acanthaceae	Dwarf shrubHerb										+			8%
Chamaecrista mimosoides	Fabaceae	Herb						+			+				17%
Cirsium vulgare	Asteraceae	Herb	+		2b		1							+	33%
Commelina africana	Commelinaceae	Herb		+	+	+		+	+	+	+				58%
Conyza bonariensis	Asteraceae	Herb	+												8%
Crabbea acaulis	Acanthaceae	Herb								+					8%
Crassula capitella	Crassulaceae	Herb Succulent				+									8%
Cyanotis speciosa	Commelinaceae	Herb		+				+		+					25%
Cymbopogon excavatus	Poaceae	Graminoid						+							8%
Cynodon dactylon	Poaceae	Graminoid					1								8%
Cyperus rotundus	Cyperaceae	CyperoidHerb Mesophyte							1		+			+	25%
Delosperma 1_870	Mesembryanthemaceae	Herb				+		+				+			25%
Diheteropogon amplectens	Poaceae	Graminoid				+				+		+			25%
Dimorphotheca caulescens	Asteraceae	Herb									+				8%
Diospyros lycioides	Ebenaceae	Shrub									+				8%
Elephantorrhiza elephantina	Fabaceae	Dwarf shrubShrub Suffrutex								+					8%
Elionurus muticus	Poaceae	Graminoid		+		+				+	+				33%
Eragrostis capensis	Poaceae	Graminoid	+	+											17%
Eragrostis chloromelas	Poaceae	Graminoid	+	+				+							25%
Eragrostis curvula	Poaceae	Graminoid					+				1	+	3		33%
Eragrostis gummiflua	Poaceae	Graminoid		+					+	+		+			33%

		Relevé number:	**9**	**7**	**10**	**8**	**14**	**1**	**2**	**3**	**4**	**6**	**11**	**12**	
		Altitude (m):	**1646**	**1621**	**1654**	**1632**	**1616**	**1602**	**1614**	**1607**	**1593**	**1595**	**1628**	**1629**	
		Soil depth (mm):	**1200**	**1020**	**1200**	**100**	**1200**	**180**	**1200**	**350**	**450**	**1200**	**1200**	**650**	
		Estimate % Clay (A-horizon):	**30**	**15**	**15**	**12**	**11**	**10**	**10**	**10**	**10**	**10**	**8**	**8**	
Botanical Names	**Family**	**Growth form**													**% Constancy**
Eragrostis plana	Poaceae	Graminoid	4		3		3		+	+	+		4	2a	67%
Eragrostis racemosa	Poaceae	Graminoid	+	+		+		+	+	+	+	+			67%
Euphorbia striata	Euphorbiaceae	Dwarf shrubHerb						+							8%
Felicia muricata	Asteraceae	Shrub				+									8%
Geigeria burkei	Asteraceae	Herb	+												8%
Gladiolus crassifolius	Iridaceae	GeophyteHerb		+						1					17%
Gnidia capitata	Thymelaeaceae	Dwarf shrubShrub								+	+				17%
Haplocarpha lyrata	Asteraceae	Herb		1	+			+	+	+	1	1			58%
Harpochloa falx	Poaceae	Graminoid		r								+			17%
Helichrysum aureonitens	Asteraceae	Herb	+		+							+			25%
Helichrysum coriaceum	Asteraceae	Herb		+	+	+				+	+				42%
Helichrysum nudifolium	Asteraceae	Herb	+	+	+					+		+			42%
Helichrysum rugulosum	Asteraceae	Herb	1	+		+				+	+				42%
Helictotrichon turgidulum	Poaceae	Graminoid			+										8%
Hermannia transvaalensis	Malvaceae	Herb	+	1		1		1			+	1			50%
Heteropogon contortus	Poaceae	Graminoid		+		1		1		+	+				42%
Hibiscus aethiopicus	Malvaceae	Herb						+		+		+			25%
Hyparrhenia hirta	Poaceae	Graminoid	+							+	+				25%
Hypochaeris radicata	Asteraceae	Herb	+							+	+			+	33%
Hypoxis hemerocallidea	Hypoxidaceae	Geophyte									+	+			17%
Hypoxis obtusa	Hypoxidaceae	Geophyte		+		+		+		+	+				42%
Hypoxis rigidula	Hypoxidaceae	GeophyteHerb		1		1		2b	+	1		+			50%
Imperata cylindrica	Poaceae	Graminoid							+						8%

		Relevé number:	**9**	**7**	**10**	**8**	**14**	**1**	**2**	**3**	**4**	**6**	**11**	**12**	
		Altitude (m):	**1646**	**1621**	**1654**	**1632**	**1616**	**1602**	**1614**	**1607**	**1593**	**1595**	**1628**	**1629**	
		Soil depth (mm):	**1200**	**1020**	**1200**	**100**	**1200**	**180**	**1200**	**350**	**450**	**1200**	**1200**	**650**	
		Estimate % Clay (A-horizon):	**30**	**15**	**15**	**12**	**11**	**10**	**10**	**10**	**10**	**10**	**8**	**8**	
Botanical Names	**Family**	**Growth form**													**% Constancy**
Indigofera oxytropis	Fabaceae	Herb		+				1	r	+	+				42%
Justicia anagalloides	Acanthaceae	Herb	+	+		+				+	r				42%
Kohautia amatymbica	Rubiaceae	Herb		+						+		+			25%
Kyllinga alba	Cyperaceae	CyperoidHerb Mesophyte	+		r		+		+				1		42%
Kyphocarpa angustifolia	Amaranthaceae	Herb				+									8%
Lactuca capensis	Asteraceae	Herb								+					8%
Ledebouria cooperi	Hyacinthaceae	Geophyte				+									8%
Ledebouria ovatifolia	Hyacinthaceae	Geophyte								+					8%
Lobelia flaccida	Lobeliaceae	Herb			+										8%
Miscanthus junceus	Poaceae	Graminoid	+		+				+		+		2a	4	50%
Monocymbium ceresiiforme	Poaceae	Graminoid		+		+						+			25%
Monopsis decipiens	Lobeliaceae	Herb	r		1										17%
Monsonia angustifolia	Geraniaceae	Herb										+			8%
Nesaea sagittifolia	Lythraceae	Dwarf shrub									1				8%
Nidorella anomala	Asteraceae	Herb							1	+					17%
Oxalis corniculata	Oxalidaceae	Herb			+				+						17%
Oxalis obliquifolia	Oxalidaceae	Geophyte								+		+			17%
Panicum natalense	Poaceae	Graminoid				+				1	+	+			33%
Paspalum dilatatum	Poaceae	Graminoid	+		1		2a		2a				1		42%
Pelargonium luridum	Geraniaceae	Geophyte		+					1	r	+				33%
Pentanisia angustifolia	Rubiaceae	Herb		+		+		+		r		+			42%
Peucedanum magalismontanum	Apiaceae	Herb	r												8%
Plantago lanceolata	Plantaginaceae	Herb	+												8%

		Relevé number:	**9**	**7**	**10**	**8**	**14**	**1**	**2**	**3**	**4**	**6**	**11**	**12**	
		Altitude (m):	**1646**	**1621**	**1654**	**1632**	**1616**	**1602**	**1614**	**1607**	**1593**	**1595**	**1628**	**1629**	
		Soil depth (mm):	**1200**	**1020**	**1200**	**100**	**1200**	**180**	**1200**	**350**	**450**	**1200**	**1200**	**650**	
		Estimate % Clay (A-horizon):	**30**	**15**	**15**	**12**	**11**	**10**	**10**	**10**	**10**	**10**	**8**	**8**	
Botanical Names	**Family**	**Growth form**													**% Constancy**
Pollichia campestris	Caryophyllaceae	Herb						+							8%
Pseudognaphalium luteo-album	Asteraceae	Herb			+					+			+		25%
Raphionacme species	Apocynaceae	Herb								+	+				17%
Rhynchosia minima	Fabaceae	ClimberHerb			+										8%
Rhynchosia totta	Fabaceae	ClimberHerb				+				+					17%
Richardia brasiliensis	Rubiaceae	Herb		+					+						17%
Rumex acetosella	Polygonaceae	Herb			+										8%
Scabiosa columbaria	Dipsacaceae	Herb		+		+		r		+		+			42%
Scirpus burkei	Cyperaceae	GraminoidHerb		1	+		1		2a	+				+	50%
Sebaea grandis	Gentianaceae	Herb										+			8%
Senecio achilleifolius	Asteraceae	Herb Shrub	2a		2a				+		+		1		42%
Senecio erubescens	Asteraceae	Herb		+						+		+			25%
Senecio inornatus	Asteraceae	Herb								+	+				17%
Setaria pallide-fusca	Poaceae	Graminoid											+		8%
Setaria sphacelata	Poaceae	Graminoid			+						+				17%
Sida rhombifolia	Malvaceae	Dwarf shrubHerb Shrub						+			+				17%
Solanum elaeagnifolium	Solanaceae	Dwarf shrubShrub					+								8%
Solanum panduriforme	Solanaceae	Dwarf shrubHerb Shrub						+				+			17%
Stoebe vulgaris	Asteraceae	Dwarf shrubShrub		3		1			4	3	3	2a			50%
Striga asiatica	Orobanchaceae	Herb Parasite				+									8%
Sutera neglecta	Scrophulariaceae	Herb										+			8%
Tephrosia capensis	Fabaceae	Dwarf shrubHerb Shrub	+	+		+				+		+			42%
Tephrosia elongata	Fabaceae	Dwarf shrubHerb Shrub				+									8%

		Relevé number:	**9**	**7**	**10**	**8**	**14**	**1**	**2**	**3**	**4**	**6**	**11**	**12**	
		Altitude (m):	**1646**	**1621**	**1654**	**1632**	**1616**	**1602**	**1614**	**1607**	**1593**	**1595**	**1628**	**1629**	
		Soil depth (mm):	**1200**	**1020**	**1200**	**100**	**1200**	**180**	**1200**	**350**	**450**	**1200**	**1200**	**650**	
		Estimate % Clay (A-horizon):	**30**	**15**	**15**	**12**	**11**	**10**	**10**	**10**	**10**	**10**	**8**	**8**	
Botanical Names	**Family**	**Growth form**													**% Constancy**
Themeda triandra	Poaceae	Graminoid	+	3		2b		4	1	2b	2a	4			67%
Thesium utile	Santalaceae	Herb Parasite										+			8%
Thunbergia neglecta	Acanthaceae	Herb Scrambler						+							8%
Trachypogon spicatus	Poaceae	Graminoid		+		4		r		1	+	1			50%
Tristachya leucothrix	Poaceae	Graminoid	r	+	+	+		+				+			50%
Urelytrum agropyroides	Poaceae	Graminoid								r					8%
Verbena bonariensis	Verbenaceae	Herb											+		8%
Verbena brasiliensis	Verbenaceae	Herb			+										8%
Vernonia natalensis	Asteraceae	Herb			+	+									17%
Vernonia oligocephala	Asteraceae	Herb	+							+					17%
Vernonia sutherlandii	Asteraceae	Herb	r												8%
Walafrida densiflora	Scrophulariaceae	Herb								+	+				17%
Ziziphus zeyheriana	Rhamnaceae	Dwarf shrub									1				8%
Zornia milneana	Fabaceae	Herb							+			+			17%

10.7 A.7 – Threatened Red Data Plant Identity Kit

Anacampseros subnuda Poelln. subsp. *lubbersii* (Bleck) Gerbaulet (Vulnerable)

http://www.ispot.org.za/species_dictionary/Anacampseros%20subnuda%20subsp.%20lubbersii?nav=search

Frithia humilis Burgoyne (Endangered)

http://www.ispot.org.za/species_dictionary/Frithia%20humilis?nav=search

Khadia carolinensis (L.Bolus) L.Bolus (Vulnerable)

Personal observation: Carolina area – March 2013

Nerine gracilis R.A.Dyer (Vulnerable)

http://www.ispot.org.za/species_dictionary/Nerine%20gracilis?nav=search

Pachycarpus suaveolens (Schltr.) Nicholas & Goyder (Vulnerable)

http://plants.jstor.org/specimen/k000234928?history=true

10.8 A.8 – Threatened Red Data Plant Comparison 2009 - 2015

Taxon	National Status	RD 2009	RD 2015	Survey Feb 2013	Frequency	Red Data Flora dynamics
Acacia ebutsiniorum	Endangered (EN)	1	1		2	No change
Adenia wilmsii	Endangered (EN)	1	1		2	
Adenium swazicum	Critical Endangered (CR)	1	1		2	
Aloe challisii	Vulnerable (VU)	1	1		2	
Aloe craibii	Critical Endangered (CR)	1	1		2	
Aloe integra	Vulnerable (VU)	1	1		2	
Aloe kniphofioides	Vulnerable (VU)	1	1		2	
Aloe modesta	Vulnerable (VU)	1	1		2	
Aloe simii	Critical Endangered (CR)	1	1		2	
Argyrolobium muddii	Endangered (EN)	1	1		2	
Asclepias dissona	Vulnerable (VU)	1	1		2	
Asclepias velutina	Vulnerable (VU)	1	1		2	
Asparagus fractiflexus	Endangered (EN)	1	1		2	
Asparagus sekukuniensis	Endangered (EN)	1	1		2	
Aspidoglossum xanthosphaerum	Vulnerable (VU)	1	1		2	
Aspidonepsis shebae	Vulnerable (VU)	1	1		2	
Brachystelma dyeri	Vulnerable (VU)	1	1		2	
Brachystelma gerrardii	Endangered (EN)	1	1		2	
Brachystelma longifolium	Vulnerable (VU)	1	1		2	
Brachystelma parvulum	Vulnerable (VU)	1	1		2	
Caesalpinia rostrata	Vulnerable (VU)	1	1		2	
Crocosmia mathewsiana	Vulnerable (VU)	1	1		2	
Crotalaria monophylla	Vulnerable (VU)	1	1		2	
Cyphia bolusii	Vulnerable (VU)	1	1		2	
Cyrtanthus eucallus	Vulnerable (VU)	1	1		2	
Delosperma deilanthoides	Vulnerable (VU)	1	1		2	
Disa alticola	Vulnerable (VU)	1	1		2	
Disa amoena	Vulnerable (VU)	1	1		2	
Disa clavicornis	Endangered (EN)	1	1		2	
Disa vigilans	Endangered (EN)	1	1		2	
Disa zuluensis	Endangered (EN)	1	1		2	
Dyschoriste perrottetii	Vulnerable (VU)	1	1		2	
Encephalartos cupidus	Critical Endangered (CR)	1	1		2	
Encephalartos heenanii	Critical Endangered (CR)	1	1		2	
Encephalartos humilis	Vulnerable (VU)	1	1		2	
Encephalartos laevifolius	Critical Endangered (CR)	1	1		2	
Encephalartos lebomboensis	Endangered (EN)	1	1		2	
Encephalartos middelburgensis	Critical Endangered (CR)	1	1		2	
Encephalartos paucidentatus	Vulnerable (VU)	1	1		2	
Encephalartos senticosus	Vulnerable (VU)	1	1		2	
Erica rivularis	Endangered (EN)	1	1		2	

Taxon	National Status	RD 2009	RD 2015	Survey Feb 2013	Frequency	Red Data Flora dynamics
Erica subverticillaris	Vulnerable (VU)	1	1		2	
Eriosema naviculare	Endangered (EN)	1	1		2	
Eucomis vandermerwei	Vulnerable (VU)	1	1		2	
Gerbera aurantiaca	Endangered (EN)	1	1		2	
Gladiolus cataractarum	Endangered (EN)	1	1		2	
Gladiolus macneilii	Critical Endangered (CR)	1	1		2	
Gladiolus malvinus	Vulnerable (VU)	1	1		2	
Gnidia variabilis	Vulnerable (VU)	1	1		2	
Graderia linearifolia	Vulnerable (VU)	1	1		2	
Helichrysum lesliei	Endangered (EN)	1	1		2	
Helichrysum summo-montanum	Endangered (EN)	1	1		2	
Hesperantha saxicola	Vulnerable (VU)	1	1		2	
Holothrix culveri	Critical Endangered (CR)	1	1		2	
Hypoxis patula	Vulnerable (VU)	1	1		2	
Indigofera hybrida	Vulnerable (VU)	1	1		2	
Khadia carolinensis	Vulnerable (VU)	1	1		2	
Leucospermum saxosum	Endangered (EN)	1	1		2	
Melanospermum italae	Vulnerable (VU)	1	1		2	
Miraglossum davyi	Vulnerable (VU)	1	1		2	
Monopsis kowynensis	Vulnerable (VU)	1	1		2	
Morella microbracteata	Endangered (EN)	1	1		2	
Nerine platypetala	Vulnerable (VU)	1	1		2	
Ocotea bullata	Endangered (EN)	1	1		2	
Ocotea kenyensis	Vulnerable (VU)	1	1		2	
Oxalis davyana	Vulnerable (VU)	1	1		2	
Ozoroa barbertonensis	Vulnerable (VU)	1	1		2	
Pachycarpus suaveolens	Vulnerable (VU)	1	1		2	
Pearsonia hirsuta	Vulnerable (VU)	1	1		2	
Protea curvata	Vulnerable (VU)	1	1		2	
Protea laetans	Vulnerable (VU)	1	1		2	
Protea subvestita	Vulnerable (VU)	1	1		2	
Prunus africana	Vulnerable (VU)	1	1		2	
Rhynchosia rogersii	Vulnerable (VU)	1	1		2	
Schizochilus crenulatus	Vulnerable (VU)	1	1		2	
Sclerochiton triacanthus	Vulnerable (VU)	1	1		2	
Senecio triodontiphyllus	Vulnerable (VU)	1	1		2	
Siphonochilus aethiopicus	Critical Endangered (CR)	1	1		2	
Streptocarpus denticulatus	Vulnerable (VU)	1	1		2	
Streptocarpus fasciatus	Vulnerable (VU)	1	1		2	
Streptocarpus fenestra-dei	Vulnerable (VU)	1	1		2	
Streptocarpus hilburtianus	Vulnerable (VU)	1	1		2	
Streptocarpus occultis	Vulnerable (VU)	1	1		2	
Thesium davidsonae	Vulnerable (VU)	1	1		2	

Taxon	National Status	RD 2009	RD 2015	Survey Feb 2013	Frequency	Red Data Flora dynamics
Thorncroftia thorncroftii	Vulnerable (VU)	1	1		2	
Warburgia salutaris	Endangered (EN)	1	1		2	
Zantedeschia jucunda	Vulnerable (VU)	1	1		2	
Zantedeschia pentlandii	Vulnerable (VU)	1	1		2	
Aloe reitzii var. vernalis	Critical Endangered (CR)	1			1	Species removed from 2015 list
Drimiopsis davidsoniae	Vulnerable (VU)	1			1	
Encephalartos lanatus	Vulnerable (VU)	1			1	
Frithia humilis	Vulnerable (VU)	1			1	
Lotononis difformis	Vulnerable (VU)	1			1	
Tulbaghia coddii	Vulnerable (VU)	1			1	
Alepidea basinuda	Endangered (EN)		1		1	Species added to 2015 list
Alepidea longeciliata	Endangered (EN)		1		1	
Aloe chortolirioides	Vulnerable (VU)		1		1	
Anacampseros subnuda	Vulnerable (VU)		1		1	
Bowiea volubilis	Vulnerable (VU)		1		1	
Brachycorythis conica	Endangered (EN)		1		1	
Brachystelma angustum	Vulnerable (VU)		1		1	
Brachystelma minor	Vulnerable (VU)		1		1	
Ceropegia decidua	Vulnerable (VU)		1		1	
Clivia miniata	Vulnerable (VU)		1		1	
Crassula setulosa	Vulnerable (VU)		1		1	
Disa klugei	Vulnerable (VU)		1		1	
Eulophia chlorantha	Vulnerable (VU)		1		1	
Frithia humilis	Endangered (EN)		1		1	
Haworthia koelmaniorum	Endangered (EN)		1		1	
Haworthia koelmaniorum	Vulnerable (VU)		1		1	
Helichrysum aureum	Vulnerable (VU)		1		1	
Hypodematium crenatum	Vulnerable (VU)		1		1	
Ledebouria galpinii	Endangered (EN)		1		1	
Nerine gracilis	Vulnerable (VU)		1		1	
Pavetta zeyheri	Endangered (EN)		1		1	
Protea roupelliae	Critical Endangered (CR)		1		1	
Searsia pygmaea	Vulnerable (VU)		1		1	
Streptocarpus actinoflorus	Endangered (EN)		1		1	
Streptocarpus cyaneus	Vulnerable (VU)		1		1	
Syncolostemon incanus	Endangered (EN)		1		1	
Thorncroftia lotterii	Vulnerable (VU)		1		1	
Achyranthes aspera				1	1	No species document in February 2013 in threatened Red Data categories
Agrostis eriantha				1	1	
Andropogon chinensis				1	1	
Anthericum cooperi				1	1	
Anthospermum hispidulum				1	1	
Anthospermum rigidum				1	1	

Taxon	National Status	RD 2009	RD 2015	Survey Feb 2013	Frequency	Red Data Flora dynamics
Aristida junciformis				1	1	
Aristida meridionalis				1	1	
Asclepias fruticosa				1	1	
Aster harveyanus				1	1	
Babiana hypogaea				1	1	
Becium obovatum				1	1	
Bergia decumbens				1	1	
Berkheya carlinopsis				1	1	
Berkheya radula				1	1	
Berkheya setifera				1	1	
Berkheya speciosa				1	1	
Bidens formosa				1	1	
Bidens pilosa				1	1	
Brachiaria serrata				1	1	
Bromus catharticus				1	1	
Campuloclinium macrocephalum				1	1	
Centella asiatica				1	1	
Chaetacanthus costatus				1	1	
Chamaecrista mimosoides				1	1	
Cirsium vulgare				1	1	
Commelina africana				1	1	
Conyza bonariensis				1	1	
Crabbea acaulis				1	1	
Crassula capitella				1	1	
Cyanotis speciosa				1	1	
Cymbopogon excavatus				1	1	
Cynodon dactylon				1	1	
Cyperus rotundus				1	1	
Delosperma 1_870				1	1	
Diheteropogon amplectens				1	1	
Dimorphotheca caulescens				1	1	
Diospyros lycioides				1	1	
Elephantorrhiza elephantina				1	1	
Elionurus muticus				1	1	
Eragrostis capensis				1	1	
Eragrostis chloromelas				1	1	
Eragrostis curvula				1	1	
Eragrostis gummiflua				1	1	
Eragrostis plana				1	1	
Eragrostis racemosa				1	1	
Euphorbia striata				1	1	
Felicia muricata				1	1	
Geigeria burkei				1	1	

Taxon	National Status	RD 2009	RD 2015	Survey Feb 2013	Frequency	Red Data Flora dynamics
Gladiolus crassifolius				1	1	
Gnidia capitata				1	1	
Haplocarpha lyrata				1	1	
Harpochloa falx				1	1	
Helichrysum aureonitens				1	1	
Helichrysum coriaceum				1	1	
Helichrysum nudifolium				1	1	
Helichrysum rugulosum				1	1	
Helictotrichon turgidulum				1	1	
Hermannia transvaalensis				1	1	
Heteropogon contortus				1	1	
Hibiscus aethiopicus				1	1	
Hyparrhenia hirta				1	1	
Hypochaeris radicata				1	1	
Hypoxis hemerocallidea				1	1	
Hypoxis obtusa				1	1	
Hypoxis rigidula				1	1	
Imperata cylindrica				1	1	
Indigofera oxytropis				1	1	
Justicia anagalloides				1	1	
Kohautia amatymbica				1	1	
Kyllinga alba				1	1	
Kyphocarpa angustifolia				1	1	
Lactuca capensis				1	1	
Ledebouria cooperi				1	1	
Ledebouria ovatifolia				1	1	
Lobelia flaccida				1	1	
Miscanthus junceus				1	1	
Monocymbium ceresiiforme				1	1	
Monopsis decipiens				1	1	
Monsonia angustifolia				1	1	
Nesaea sagittifolia				1	1	
Nidorella anomala				1	1	
Oxalis corniculata				1	1	
Oxalis obliquifolia				1	1	
Panicum natalense				1	1	
Paspalum dilatatum				1	1	
Pelargonium luridum				1	1	
Pentanisia angustifolia				1	1	
Peucedanum magalismontanum				1	1	
Plantago lanceolata				1	1	
Pollichia campestris				1	1	
Pseudognaphalium luteo-album				1	1	

Taxon	National Status	RD 2009	RD 2015	Survey Feb 2013	Frequency	Red Data Flora dynamics
Raphionacme species				1	1	
Rhynchosia minima				1	1	
Rhynchosia totta				1	1	
Richardia brasiliensis				1	1	
Rumex acetosella				1	1	
Scabiosa columbaria				1	1	
Scirpus burkei				1	1	
Sebaea grandis				1	1	
Senecio achilleifolius				1	1	
Senecio erubescens				1	1	
Senecio inornatus				1	1	
Setaria pallide-fusca				1	1	
Setaria sphacelata				1	1	
Sida rhombifolia				1	1	
Solanum elaeagnifolium				1	1	
Solanum panduriforme				1	1	
Stoebe vulgaris				1	1	
Striga asiatica				1	1	
Sutera neglecta				1	1	
Tephrosia capensis				1	1	
Tephrosia elongata				1	1	
Themeda triandra				1	1	
Thesium utile				1	1	
Thunbergia neglecta				1	1	
Trachypogon spicatus				1	1	
Tristachya leucothrix				1	1	
Urelytrum agropyroides				1	1	
Verbena bonariensis				1	1	
Verbena brasiliensis				1	1	
Vernonia natalensis				1	1	
Vernonia oligocephala				1	1	
Vernonia sutherlandii				1	1	
Walafrida densiflora				1	1	
Ziziphus zeyheriana				1	1	
Zornia milneana				1	1	

11 APPENDIX B – FAUNA COMPONENT

11.1 B.1 Mpumalanga Provincially Protected Animals

Schedule 1
SPECIALLY PROTECTED GAME (SECTION 4 (1) (a))

Common name	Scientific name
Elephant	Loxodonta africanan
all species of rhinoceros	all species of the Family Rhinocerotidae

Schedule 2
PROTECTED GAME (SECTION 4 (1) (b))

AMPHIBIANS, REPTILES AND MAMMALS	
Common name	Scientific name
bullfrog	Pyxicephalus adspersus
all species of reptiles excluding the water leguan, rock leguan and all species of snakes	all species of the Class Reptilia excluding Varanus niloticus, Varanus Exanthematicus and all species of the Sub Order Serpentes
riverine rabbit	Bungolagus monticularis
hedgehog	Atelerix frontalis
samango monkey	Cercophithecus mitis
bushbaby	Otolemur crassicaudatus
lesser bushbaby	Galago moholi
honey-badger	Mellivora capensis
pangolin	Manis temminckii
aardwolf	Proteles cristatus
Cape hunting dog	Lycaon pictus
brown hyaena	Hyaena brunnea
antbear	Orycteropus afer
mountain zebra	Equus zebra zebra
Hartmann's zebra	Equus zebra hartmannae
hippopotamus	Hippopotamus amphibius
giraffe	Giraffa camelopardalis
nyala	Tragelaphus angasi
red duiker	Cephalophus natalensis
blue duiker	Philantomba monticola
reedbuck	Redunca arundinum
mountain reedbuck	Redunca fulvorufula
sable antelope	Hippotragus niger
AMPHIBIANS, REPTILES AND MAMMALS	
roan antelope	Hippotragus equinus
black wildebeest	Connochaetes gnou
tsessebe	Damaliscus lunatus
Lichtenstein's hartebeest	Alcelaphus lichtensteinii
klipspringer	Oreotragus oreotragus
oribi	Ourebia ourebi
steenbok	Raphicerus campestris
Sharpe's grysbok	Raphicerus sharper
suni	Neotragus moschatus
grey rhebuk	Pelea capreolus
eland	Taurotragus oryx
waterbuck	Kobus ellipsiprymnus
cape clawless otter	Aonyx capensis
spotted necked otter	Lutra maculicollis
BIRDS	
Any bird which is a wild animal, excluding a bird referred to in Schedule 3, and the-	
white breasted cormorant	Phalacrocorax lucidus
reed cormorant	Phalacrocorax africanus
red-eyed turtle dove	Streptopelia semitorquata
Cape turtle dove	Streptopelia capicola
laughing dove	Streptopelia senegalensis
all species of mousebirds	all species of the Family Colidae
pied crow	Corvus albus
black crow	Corvus capensis
red-eyed bulbul	Pycnonotus nigricans
black-eyed bulbul	Pycnonotus barbatus
red-winged starling	Onychognathus morio
Cape sparrow	Passer melanurus
spotted-backed weaver	Ploceus cucullatus
Cape weaver	Ploceus capensis
masked weaver	Ploceus velatus
red-billed quelea	Quelea quelea
red bishop	Euplectes orix

11.2 B.2 Photographic records of the animals of the study area

Afrotyphlops bibronii (Smith, 1846)

Crotaphopeltis hotamboeia Laurenti, 1768

Leptotyphlops scutifrons Peters, 1854

Pachydactylus affinins Boulenger, 1896 **(PROTECTED)**

Bubo africanus (Temminck, 1821) **(PROTECTED)**

Canis mesomelas Schreber, 1775

Appendix G4: Noise Specialist Study

REPORT
REVISED NOISE STUDY FOR THE ELDERS COLLIERY

October 2021

Report No 15/4/1

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TABLE OF CONTENTS

GLOSSARY OF ACOUSTIC TERMINOLOGY

Absorption	The process by which a fluid (such as air), material or structure absorbs sound by dissipating the impinging or transmitted sound energy as heat.
Absorption coefficient	The ratio of the absorbed sound energy to the impinging sound energy on a material or structure.
A-weighting	An electronic filter that simulates the human hearing characteristic which is less sensitive to sounds at low frequencies than at high frequencies.
Broad band noise	Noise that contains a wide range of frequencies and cannot be associated with a specific frequency or tone. 'White noise' (like the sound of a radio that is not tuned on a station) is a typical example of broad band noise.
Decibel (dB)	A descriptor that is used to indicate a level determined as 10 times the logarithmic ratio of two quantities of the same physical unit.
dBA	A descriptor that is used to indicate that 10 times the logarithmic ratio of two quantities of the same physical unit has been A-weighted.
Equivalent noise level	A single value noise level that has the same energy content as a time varying noise level measured over a given period of time. Therefore, it is in essence a time-and energy averaged noise level.
Frequency	The characteristic of a time varying signal that describes the number of cycles per second, expressed in Hertz, Hz.
Integrated noise level	A time- and energy averaged measure of a noise signal varying as a function time
L_{A90}	The A-weighted 90% statistical noise level, i.e. the noise level that is exceeded during 90% of the measurement period. It is a very useful descriptor because it provides an indication of what the L_{Aeq} could have been in the absence of noisy single events.
L_{Aeq}	The A-weighted equivalent sound pressure level. This descriptor is internationally used for quantifying and evaluating noise in human-related circumstances. A vast amount of research links this parameter to

human physiological and psychological responses.

L_{Aeq} (T) The A-weighted equivalent sound pressure level, where T indicates the time over which the noise is averaged, i.e. L_{Aeq} (10 min) indicates that the L_{Aeq} was measured over a period of 10 min.

Level The property of any parameter that expresses it's magnitude as 10x the logarithm of the ratio of the value of the parameter to a reference value of the same physical unit. The reference value is 20 μPa (micro- or $20x10^{-6}$ Pascal, or N/m^2) for a sound pressure level and 1 pW (pico or $1x10^{-12}$ Watt) for a sound power level.

Line source A noise source that radiates sound energy as a line in space (e.g. traffic moving on a road). Theoretical reduction in sound pressure level per doubling in distance is 3 dBA.

Noise Unwanted sound

Noise emission The noise energy that is emitted by a noise source into the environment.

Noise immission The noise energy that impinges on a receiver.

Octave frequency band The frequency spectrum is divided into bands with centre frequencies an octave apart from each other, an octave being a doubling in frequency. In practice the standard octave bands most often used are 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz. Used for specifying sound power emission levels of equipment and calculating sound propagation over longer distances.

Point source A noise source that can be described as a point with no dimensions in space. Theoretical reduction in sound pressure level per doubling in distance is 6 dBA. Note that even large noise sources, e.g. an industrial plant or process will reduce to a point source over larger distances.

Sound level meter An instrument used to measure sound/noise

Sound power level The level of the sound energy radiated by a given source per unit time. The magnitude does not depend on physical surroundings, e.g. distance, screening, weather. Cannot be directly measured, but has to be calculated from sound pressure level measurements.

Sound pressure level	The level of the varying sound pressure caused by a sound/noise source. The magnitude depends on the physical parameters of the surroundings.
Third octave frequency band	The frequency spectrum is divided into bands with centre frequencies a third of an octave apart from each other, an octave being a doubling in frequency. Examples of third octave bands are 50 Hz, 63 Hz, 80Hz, 100 Hz, 125 Hz, 160 Hz, 200 Hz, 250 Hz, 315 Hz, 400 Hz, 500 Hz, 630 Hz etc. Often used for analysing an acoustic signal or noises, since it provides a higher resolution than an octave band spectrum.

EXECUTIVE SUMMARY

Introduction

Anglo American Inyosi Coal (AAIC) is proposing to develop the Elders Colliery using underground mining methods (underground board and pillar operation). A previous noise study [1] had a small open pit operation included. However, thereafter it was decided not to continue with the development of the open pit.

The present noise study re-evaluates the potential noise impacts that will be caused by the revised proposal for the Elders Colliery.

Purpose of the noise study

The purpose of this noise study is to:

- *Estimate the current ambient noise levels in the environment of the revised project;*
- *Re-calculate the noise emissions from the revised project during construction and operation; and*
- *Re-assess the potential impacts that these noise emissions will cause on current ambient noise levels in the environment.*

Regulatory framework

The original noise regulations were published in 1990 under the Environment Conservation Act, 1989 [2]. They were at first made non-compulsory with a local authority having to apply to make them compulsory in its area of jurisdiction. Since this lead to an unsatisfactory number of applications, the noise regulations were made compulsory in 1992. However, the arrival of the new Constitution in 1994 voided the legal driving force behind the regulations, since the responsibility for them was devolved from national to provincial level. The Minister of the Environment did circulate sample noise regulations to the provinces in 1997 [3], which they could adopt unchanged or adapt to their own requirements. This has happened in only three provinces, i.e. the Free State, Gauteng and Western Cape.

The original sample noise regulations contain a number of serious flaws and a revision was undertaken by the Department of Environmental Affairs. The resulting new regulations [4] were published on 2 July 2010 under the Air Quality Act, 2005 [5]. They are in essence also a model that can be adapted by municipalities.

In terms of the setting of standards the new regulations make direct and extensive reference to SANS 10103 [6]. This document successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa. It also provides guidelines to typical ambient noise levels that may be expected in different types of districts. Therefore, SANS 10103 [6] was followed for the purpose of this noise impact study.

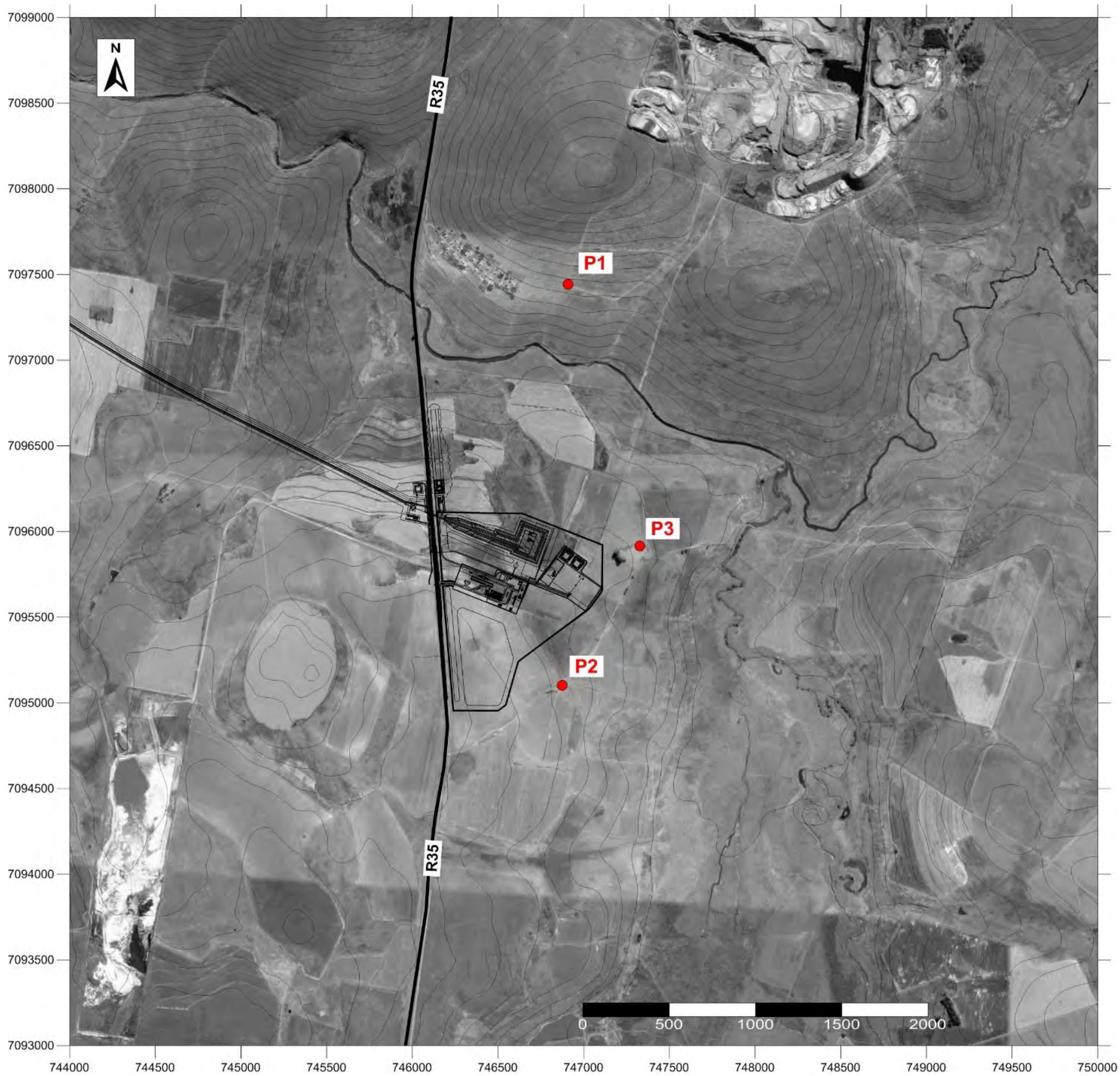
Methodology of the noise study

<u>Site visit</u>

A site visit was conducted on 9 September 2015 for the purpose of orientation, the selection of noise measurement points and the taking of noise measurement samples during the day and night.

<u>Ambient noise level measurements</u>

Three measurement points were selected, as indicated in the figure below.



The measurements were taken in accordance with the procedures specified in SANS 10103 [6]. The following noise parameters were measured at each of the locations:

- *The A-weighted equivalent sound pressure level L_{Aeq} (T) in steps of 1 second duration over a time period T = 20 minutes;*
- *The concurrent A-weighted 90-percentile sound pressure level, L_{A90}; and*
- *The third octave frequency spectra measured in concurrent steps of 1 second duration.*

The noise measurement samples were taken during the day (06:00 to 22:00) and night (22:00 to 06:00).

<u>Modelling of the current ambient noise levels</u>

During the site visit and from the previous noise study [1] it was clear that road traffic on the R35 is the dominant source of noise in the environment of the proposed Elders Colliery. Therefore, the noise immission levels caused by road traffic on the R35 were calculated for typical day- and night-time traffic flow conditions. The calculations were made in accordance with the procedures stipulated in SANS 10210 [7]. For this purpose the traffic flow given in the

SANRAL 2013 Yearbook [8] were used, assuming a 1.5% increase until 2016. The traffic flows used in the calculations are summarised in Appendix B to this report.

The results were projected onto the day- and night-time base reference levels to arrive at estimates of the current ambient noise levels during these periods.

Modelling of noise emissions

A detailed three dimensional model was developed of the proposed Elders Colliery and its environment. The CONCAWE method, as described in SANS 10357 [8], was used to calculate the propagation of noise from the Project. This is an internationally recognised method and takes account of:

- *The noise emission characteristics of sound sources;*
- *The attenuation of sound due to geometric spreading of energy over distance;*
- *The attenuation of sound caused by air absorption and the ground effect;*
- *The effect of meteorological and other atmospheric conditions on the propagation of sound; and*
- *The acoustic screening provided by the topography and walls of the decline shaft.*

The sound power emission levels of equipment and processes, the assumed meteorological and atmospheric conditions used in the calculations are summarised in Appendix B to this report.

Presentation and assessment of the results

The modelling results were presented as contours of the resulting future ambient noise levels and the increases in existing ambient noise levels, superimposed on a scaled satellite image of the Project and its environment.

Assessment of the results

The results were assessed in terms of the guidelines provided by SANS 10103 [6] and the significance rating determined in accordance with the procedure specified by the client, which is reproduced in Appendix C of this report.

Investigated stages of the project

The stages of the project that were investigated are summarised in the following table.

Stage	*Description*	*Main noise sources*
1 Initial above ground construction	• *All activities are at ground level* • *Earthworks for decline shaft* • *Earthworks for shaft infrastructure* • *Construction of overland conveyor* • *No acoustic screening other than natural topography* • *24 hour activities at decline shaft, hauling and stacking of backfill material* • *12 hour activities at infrastructure*	• *Rear dump haul truck 50t* • *Bulldozer D9* • *FEL 988* • *Excavator* • *Drilling rig* • *Road truck 30t* • *Grader 14H* • *Vibrating roller* • *General noise*
2 Continuing construction below ground level	• *Decline shaft construction activities below ground level* • *Shaft walls provide acoustic screening* • *Construction of infrastructure* • *24 hour construction activities at decline shaft, hauling and stacking of backfill material* • *12 hour construction activities at infrastructure*	• *Rear dump haul truck 50t* • *Bulldozer D9* • *FEL 988* • *Excavator* • *Drilling rig* • *General noise*
3 Operational conditions	• *Shaft ventilation system operational (60 m below ground level)* • *Infrastructure fully operational* • *24 hour operation*	• *Block 20 conveyor and drive* • *Silo hopper* • *Ventilation system* • *General noise*
4 Decommissioning and closure	• *Dismantling of infrastructure* • *Breaking and removal of concrete platforms* • *Backfilling of the decline shaft* • *12 hour operations*	• *'Pecker'-equipped excavator* • *Bulldozer D9* • *Articulated Haul-truck 40t* • *General noise*

Conclusions

The following conclusions are drawn on the results of this investigation:

- *The current ambient noise level in the area are dominated by the noise emissions from road traffic on the R35. This is of particular importance for the settlement immediately north of the proposed Elders Colliery and at the nearest farmstead located towards the South-West;*
- *Although there are still many mining operations in the larger environment they are less evident than during the measurements taken in 2012. This is due to the fact that some of them have since closed down, e.g. the large opencast mine some 3 km north of the Elders site;*
- *As a result the current ambient noise levels are very low, at times falling below 20 dBA during night-time. As a consequence the extents of the noise impacts, particularly when expressed as the increase in ambient noise levels, will be substantial. Furthermore, the maximum noise impact will occur during night-time;*

- *During construction the most severe and furthest extent of the noise impact will occur when all activities take place at ground level, especially since the construction of the decline shaft will have to continue at night. However, as soon as the latter are between 15 m and 20 m below ground level the severity and extent of the noise impacts will decrease;*
- *The significance rating during construction is **low**;*
- *Since the ventilation system will be around 60 m below ground level, the noise emissions by the fully operational mine alone will cause a limited extent of the noise impacts;*
- *The most significant noise emissions will be caused by the conveyor system and as a result the noise impact will extend over considerable distances and consequently the cumulative extent of the noise impacts will be large;*
- *Therefore, due to this considerable extent of the noise impacts and their long term nature the significance rating during the operational stage is **medium**;*
- *Due to the much reduced activities during decommissioning and the fact that they in all likelihood will only take place during day-time the significance rating for this stage is **low**;*
- *Due to the noise emissions from road traffic on the R35 dominate current and future ambient noise levels at the settlement and the farmstead the noise impacts at these locations during construction, operations and decommissioning are either negligible or non-existent;*
- *The extent of the noise impacts caused by the conveyor system can be mitigated by either placing it in a trench with a minimum depth of 2 m below ground level or by fitting it with a purpose designed enclosure. The latter option will reduce the significance rating to **low**; and*
- *Although they do not affect the averaged noise levels on which assessments are based the reversing alarms of earthmoving and mining equipment are often singled out as a particularly disturbing characteristic of mining operations. This can be effectively mitigated by fitting the equipment with devices that emit broad band noise instead of pure tone, i.e. 'beeping' sounds.*

Recommendations

Based on the findings of this noise study the following recommendations are made:

- *All earth moving and mining equipment should be fitted with broad band noise emitting devices rather than the standard pure tone reversing alarms; and*
- *If the mitigation of conveyor noise is to be considered, the first choice should be enclosing it as described in this report, with the second choice placing it in a trench with a minimum depth of 2 m below ground level.*

REPORT
REVISED NOISE STUDY FOR THE ELDERS COLLIERY

1. INTRODUCTION

Anglo American Inyosi Coal (AAIC) is proposing to develop the Elders Colliery using underground mining methods (underground board and pillar operation). A previous noise study [1] had a small open pit operation included. However, thereafter it was decided not to continue with the development of the open pit.

The present noise study re-evaluates the potential noise impacts that will be caused by the revised proposal for the Elders Colliery.

2. PURPOSE OF THIS NOISE STUDY

The purpose of this noise study is to:

- Estimate the current ambient noise levels in the environment of the revised project;
- Re-calculate the noise emissions from the revised project during construction and operation; and
- Re-assess the potential impacts that these noise emissions will cause on current ambient noise levels in the environment.

3. REGULATORY FRAMEWORK

The original noise regulations were published in 1990 under the Environment Conservation Act, 1989 [2]. They were at first made non-compulsory with a local authority having to apply to make them compulsory in its area of jurisdiction. Since this lead to an unsatisfactory number of applications, the noise regulations were made compulsory in 1992. However, the arrival of the new Constitution in 1994 voided the legal driving force behind the regulations, since the responsibility for them was devolved from national to provincial level. The Minister of the Environment did circulate sample noise regulations to the provinces in 1997 [3], which they could adopt unchanged or adapt to their own requirements. This has happened in only three provinces, i.e. the Free State, Gauteng and Western Cape.

The original sample noise regulations contain a number of serious flaws and a revision was undertaken by the Department of Environmental Affairs. The resulting new regulations [4] were published on 2 July 2010 under the Air Quality Act, 2005 [5]. They are in essence also a model that can be adapted by municipalities.

In terms of the setting of standards the new regulations make direct and extensive reference to SANS 10103 [6]. This document successfully addresses the manner in which environmental noise measurements are to be taken and assessed in South Africa. It also provides guidelines to typical ambient noise levels that may be expected in different types of districts. Therefore, SANS 10103 [6] was followed for the purpose of this noise impact study.

4. METHODOLOGY OF THE NOISE STUDY

4.1 SITE VISIT

A site visit was conducted on 9 September 2015 for the purpose of orientation, the selection of noise measurement points and the taking of noise measurement samples during the day and night.

4.2 MEASUREMENT POINTS

The three measurement points that were selected are indicated in Figure 4.2.1.

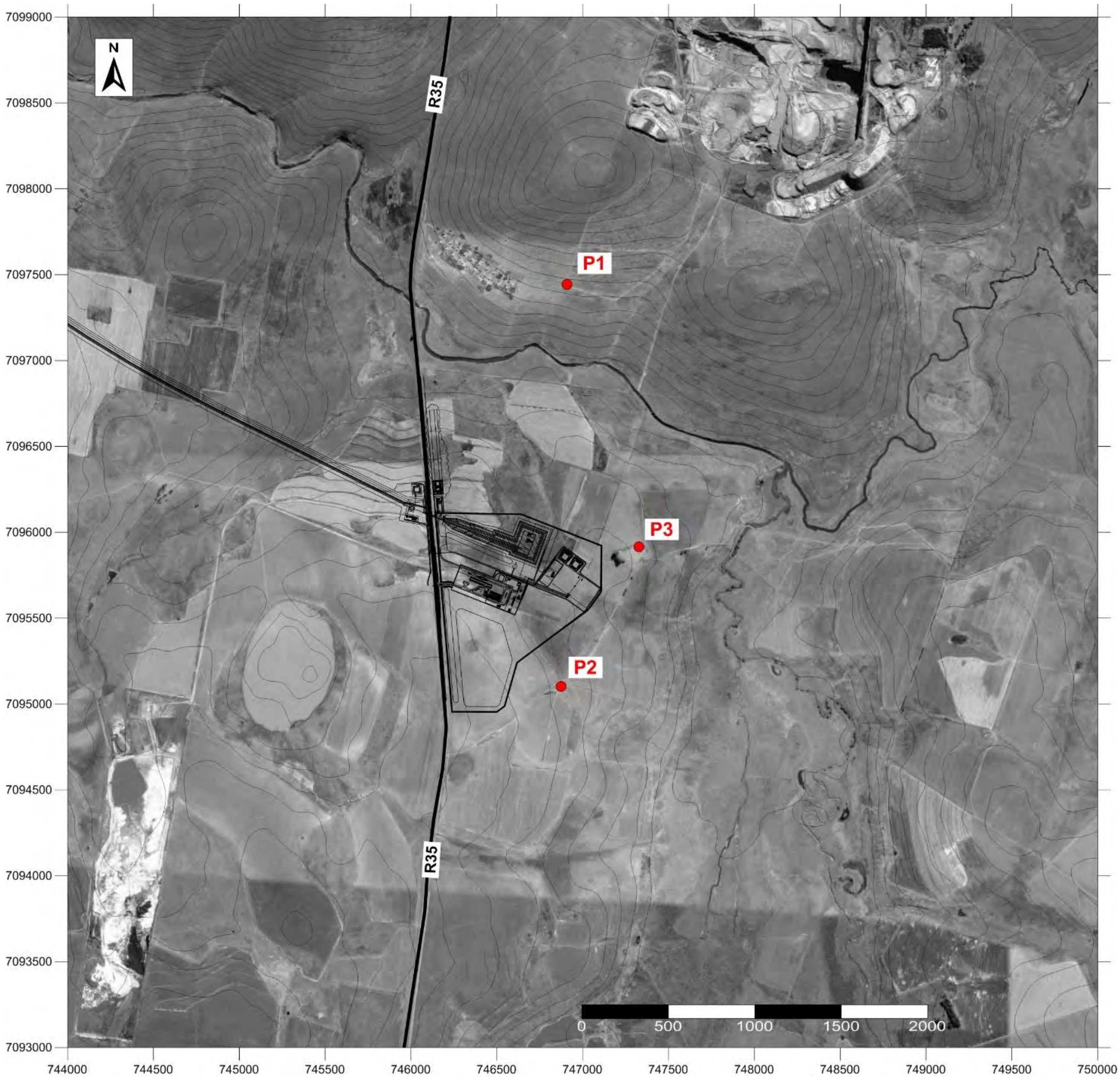


Figure 4.2.1: Image showing the locations of the noise measurement points.

4.3 MEASUREMENT METHODOLOGY

The measurements were taken in accordance with the procedures specified in SANS 10103 [6]. The following noise parameters were measured at each of the locations:

- The A-weighted equivalent sound pressure level L_{Aeq} (T) in steps of 1 second duration over a time period T = 20 minutes;
- The concurrent A-weighted 90-percentile sound pressure level, L_{A90}; and
- The third octave frequency spectra measured in concurrent steps of 1 second duration.

The noise measurement samples were taken during the day (06:00 to 22:00) and night (22:00 to 06:00). A list of the measurement equipment is given in Appendix A to this report.

4.4 PROCESSING OF THE RESULTS

In order to determine the base reference levels onto which calculated noise emissions could be projected the measurement results had to be processed. This involved removing the noise energy caused by extraneous single events, e.g. vehicles passing on the R35.

4.5 MODELLING OF THE CURRENT AMBIENT NOISE LEVELS

During the site visit and from the previous noise study [1] it was clear that road traffic on the R35 is the dominant source of noise in the environment of the proposed Elders Colliery. Therefore, the noise immission levels caused by road traffic on the R35 were calculated for typical day- and night-time traffic flow conditions. The calculations were made in accordance with the procedures stipulated in SANS 10210 [7]. For this purpose the traffic flow given in the SANRAL 2013 Yearbook [8] were used, assuming a 1.5% increase until 2016. The traffic flows used in the calculations are summarised in Appendix B to this report.

The results were projected onto the day- and night-time base reference levels described in section 4.4 to arrive at estimates of the current ambient noise levels during these periods.

4.6 MODELLING OF NOISE EMISSIONS

A detailed three dimensional model was developed of the proposed Elders Colliery and its environment. The CONCAWE method, as described in SANS 10357 [8], was used to calculate the propagation of noise from the Project. This is an internationally recognised method and takes account of:

- The noise emission characteristics of sound sources;
- The attenuation of sound due to geometric spreading of energy over distance;
- The attenuation of sound caused by air absorption and the ground effect;
- The effect of meteorological and other atmospheric conditions on the propagation of sound; and
- The acoustic screening provided by the topography and walls of the decline shaft.

The sound power emission levels of equipment and processes, the assumed meteorological and atmospheric conditions used in the calculations are summarised in Appendix B to this report.

4.7 PRESENTATION OF THE RESULTS

The modelling results were presented as contours of the resulting future ambient noise levels and the increases in existing ambient noise levels, superimposed on a scaled satellite image of the Project and its environment.

The contours calculated for resulting future ambient noise levels were:

- 35 dBA;
- 40 dBA;
- 45 dBA;
- 50 dBA;
- 55 dBA; and
- 60 dBA.

Table 5 of SANS 10103 [6] provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in noise level, the following criteria are of relevance:

- Δ ≤ 0 dBA: An increase of 0 dBA or less will not cause any response from a community. Any increase of less than 1 dBA is negligible. For a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level will not be noticeable. Therefore, 3 dBA is a useful ‘significance indicator’ that will be used in this study to assess whether a noise impact is significant or not;
- 0 dBA < Δ ≤ 10 dBA: An increase of between 0 dBA and 10 dBA will elicit ‘little’ community response with ‘sporadic complaints’. However, between 5 dBA and 15 dBA the strength of the response will gradually change to ‘medium’ with ‘widespread complaints’;
- 5 dBA < Δ ≤ 15 dBA: An increase of between 5 dBA and 15 dBA will elicit a ‘medium’ community response with ‘widespread complaints’. It is also worth noting that an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be ‘strong’ with ‘threats of community action’;
- 15 dBA < Δ: For an increase in excess of 15 dBA the community response will gradually increase in strength to ‘very strong’ with ‘vigorous community action’; and
- 10 dBA < Δ ≤ 20 dBA: For an increase of between 10 dBA and 20 dBA the community response will gradually increase in strength to ‘strong’ with ‘threats of community action’;

The overlapping ranges of community responses reflect the fact that there is no clear-cut transition from one community response to another. Instead the transition is more gradual and may differ substantially from one scenario to another, depending on a large number of variables.

The increase in the ambient noise level was expressed as contours of:

- Δ = 0 dBA
- Δ = 1 dBA
- Δ = 3 dBA (significance indicator)
- Δ = 5 dBA
- Δ = 10 dBA
- Δ = 15 dBA

4.8 ASSESSMENT OF THE RESULTS

The results were assessed in terms of the guidelines provided by SANS 10103 [6] and the significance rating determined in accordance with the procedure specified by the client, which is reproduced in Appendix C of this report.

4.9 INVESTIGATED STAGES OF THE PROJECT

The stages of the project that were investigated are summarised in Table 4.9.1.

TABLE 4.9.1
Summary of the calculated and assessed stages

Stage	Description	Main noise sources
1 Initial above ground construction	• All activities are at ground level • Earthworks for decline shaft • Earthworks for shaft infrastructure • Construction of overland conveyor • No acoustic screening other than natural topography • 24 hour activities at decline shaft, hauling and stacking of backfill material • 12 hour activities at infrastructure	• Rear dump haul truck 50t • Bulldozer D9 • FEL 988 • Excavator • Drilling rig • Road truck 30t • Grader 14H • Vibrating roller • General noise
2 Continuing construction below ground level	• Decline shaft construction activities below ground level • Shaft walls provide acoustic screening • Construction of infrastructure • 24 hour construction activities at decline shaft, hauling and stacking of backfill material • 12 hour construction activities at infrastructure	• Rear dump haul truck 50t • Bulldozer D9 • FEL 988 • Excavator • Drilling rig • General noise
3 Operational conditions	• Shaft ventilation system operational (60 m below ground level) • Infrastructure fully operational • 24 hour operation	• Block 20 conveyor and drive • Silo hopper • Ventilation system • General noise
4 Decommissioning and closure	• Dismantling of infrastructure • Breaking and removal of concrete platforms • Backfilling of the decline shaft • 12 hour operations	• 'Pecker'-equipped excavator • Bulldozer D9 • Articulated Haul-truck 40t • General noise

5. RESULTS

5.1 BASELINE NOISE MEASUREMENTS

The results of the baseline noise measurements are summarised in Tables 5.1.1 and 5.1.2. The detailed measurement results are given in Appendix D to this report.

TABLE 5.1.1
Summary of the baseline noise measurement results: Day-time

Point	Start Time	L_{Aeq} (20 min) dBA	L_{A90} dBA	$L_{Aeq} – L_{A90}$ dB	Comments
P1	06/09/2015 11:44	34.4	27.4	7.0	Overcast. Birdsong in the fields. Children laughing in the settlement. Traffic on R35 audible.
P2	06/09/2015 13:05	36.2	30.0	6.2	Overcast. R35 audible in distance as a constant hum. Line of sight onto road. Occasional birdcalls.
P3	06/09/2015 12:30	30.6	24.2	6.4	Overcast. R35 audible in distance as a constant hum. Bird song in the nearby trees.
Averages		33.7	27.2	6.5	-

TABLE 5.1.2
Summary of the baseline noise measurement results: Night-time

Point	Start Time	L_{Aeq} (20 min) dBA	L_{A90} dBA	$L_{Aeq} – L_{A90}$ dB	Comments
P1	06/09/2015 23:28	36.7	20.5	16.2	Clear skies with dense fog in lower lying areas and riverbeds. Occasional birdcalls. R35 audible in the distance. Very quiet when there is no traffic. Occasionally dogs barking in the settlement.
P2	07/09/2015 00:04	34.2	17.0	17.2	Dogs howling, donkey braying afar. R35 audible, constant hum. Assortment of night birds calling. Clear skies but dense fog in lower lying areas and riverbeds. Cattle bellowing in the distance.
P3	07/09/2015 00:34	30.2	18.3	11.9	Clear skies with dense fog. R35 audible in the distance. Occasional bird calls. Donkey braying in the distance.
Averages		33.7	18.6	15.1	-

The following remarks apply to the results given in Tables 5.1.1 and 5.1.2:

- The comments confirm that road traffic on the R35 provide a major source of noise in the area, although the detailed results (see Appendix D) show that during night-time it manifests more in terms of separated single events;
- The measured L_{Aeq} (20 min) taken during day- and night-time are very much comparable;
- However, the concurrently measured night-time L_{A90} are significantly lower than during day-time, the average difference being 15.1 dB compared to 6.5 dB during day-time. This indicates that noise single events, such as described in the comments and reflected in the detailed results (see Appendix D), had a marked effect on the measured L_{Aeq};
- If it is assumed that in the absence of marked single noise events the typical difference between a measured L_{Aeq} and concurrent L_{A90} is 7 dB then the reference

baseline ambient L_{Aeq} (see section 4.4) become 34.2 dBA and 25.6 dBA for day- and night-times, respectively; and

- Therefore, it is recommended that the reference noise levels onto which the noise emissions from the proposed Elders Colliery are projected be 34 dBA and 26 dBA for day- and night-times, respectively.

5.2 CALCULATED CURRENT AMBIENT NOISE LEVELS

The calculated current ambient noise levels are presented in Figures 5.2.1 and 5.2.2.

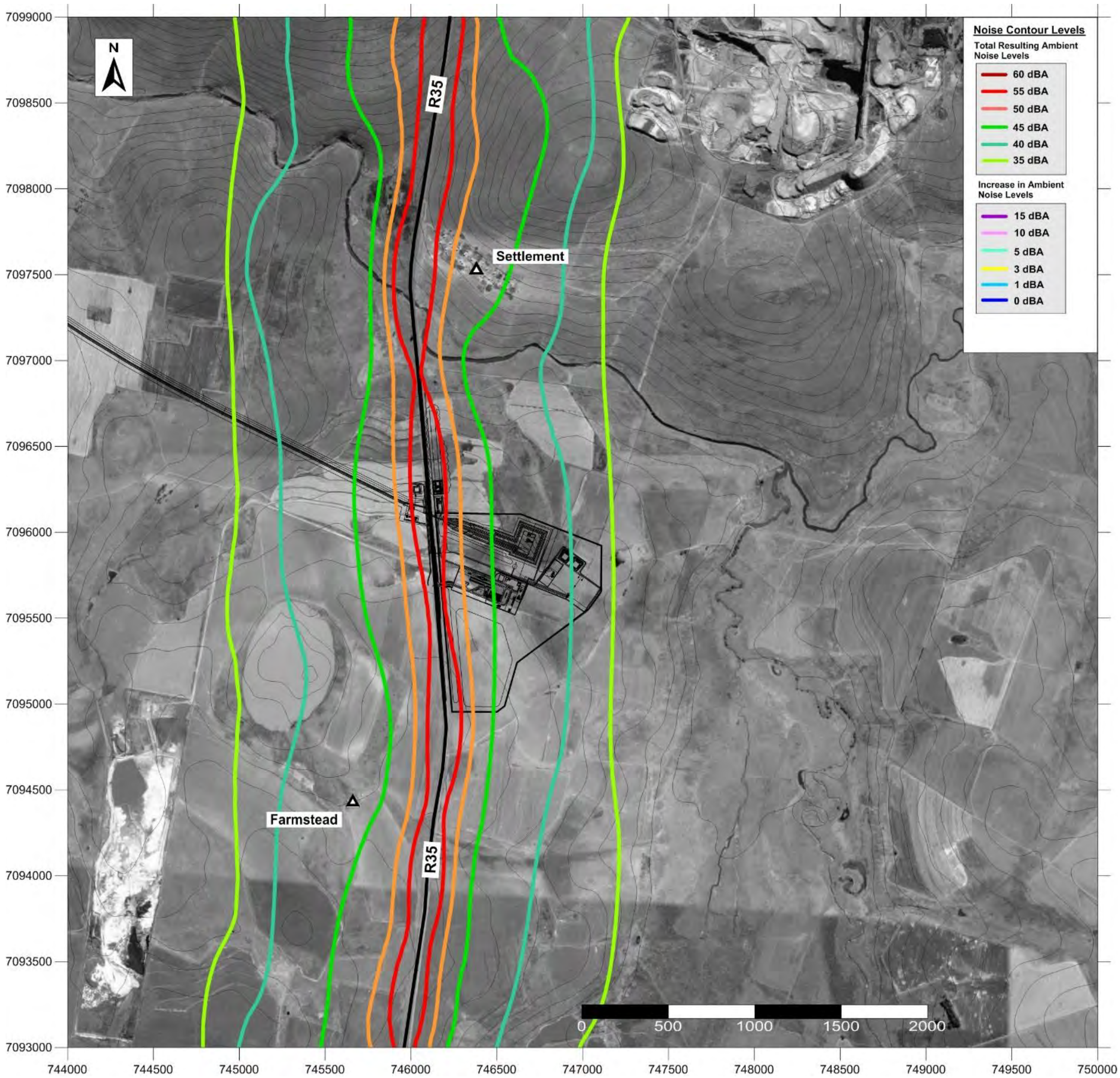


Figure 5.2.1: Contours of the calculated day-time ambient noise levels.

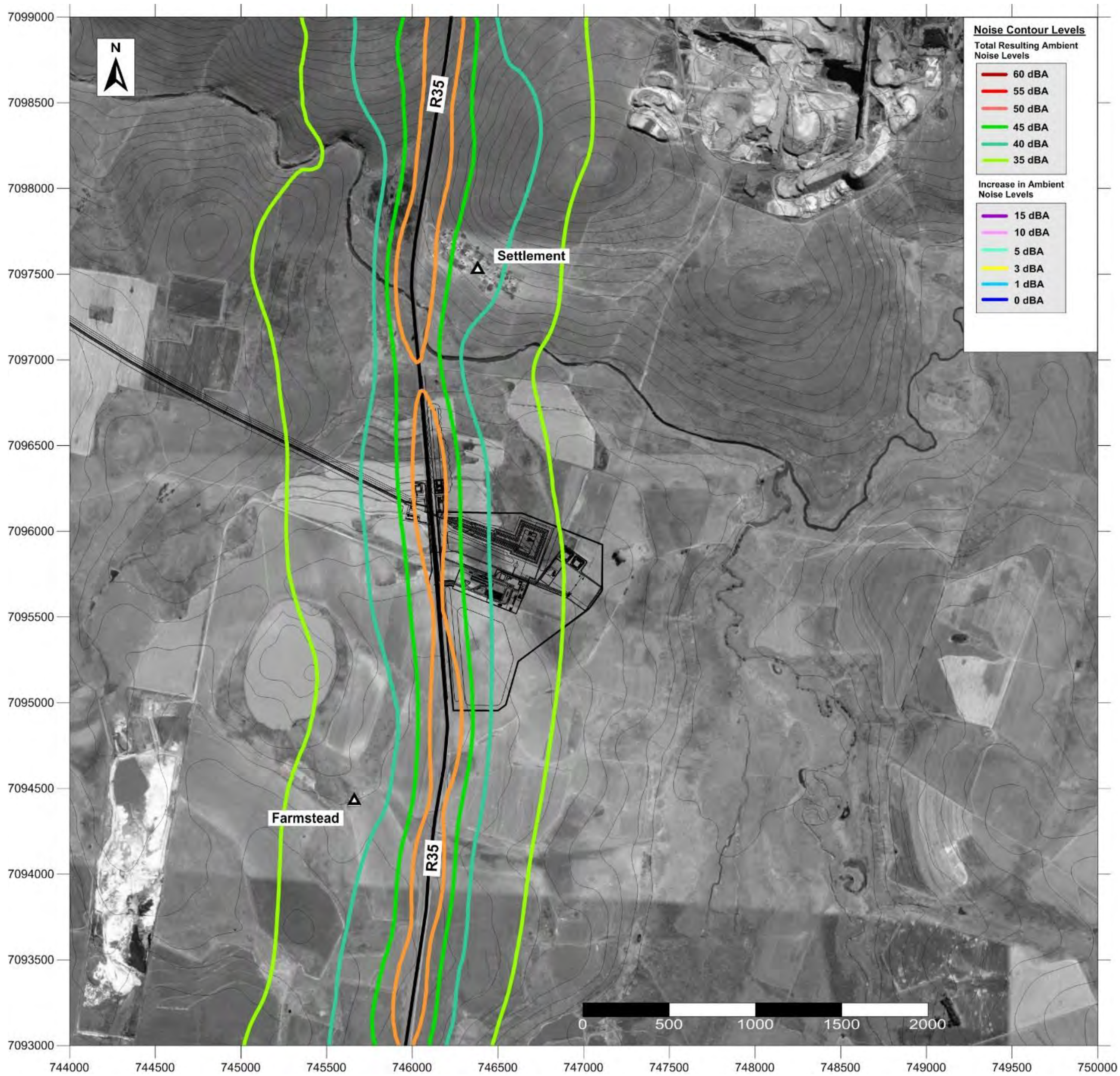


Figure 5.2.2: Contours of the calculated night-time ambient noise levels.

The following remarks apply to the results illustrated in Figures 5.2.1 and 5.2.2:

- At the settlement the current ambient noise levels range from approximately 45 dBA to 55 dBA and from approximately 40 dBA to 50 dBA during day- and night- time, respectively;
- The day-time noise levels fall within the 55 dBA listed by SANS 10103 [6] for 'urban districts' and the recommendation by the World Health Organisation (WHO) [9] for residential areas;
- For night-time the corresponding SANS 10103 [6] and WHO [9] noise level is 45 dBA. Therefore, there is an excess of approximately 5 dB for the settlement properties in close proximity to the R35. It must be stressed that this excess is solely due to the noise emissions from road traffic on the R35;

- At the farmstead the current ambient noise level is below 45 dBA and between 35 dBA and 40 dBA during day- and night- time, respectively; and
- This falls well within the recommended limits of 55 dBA and 45 dBA of the WHO [9] for the day- and night-time, respectively. In terms of SANS 10103 [6] this compares well with the 45 dBA and 35 dBA listed as typical for 'rural districts' for these time periods. Again it must be stressed that the excess over 35 dBA is caused by the noise emissions from road traffic on the R35 alone.

5.3 STAGE 1: INITIAL CONSTRUCTION

The noise impacts for Stage 1 (all construction activities are at ground level, see Table 4.9.1 in section 4.9) are presented in Figures 5.3.1 to 5.3.4.

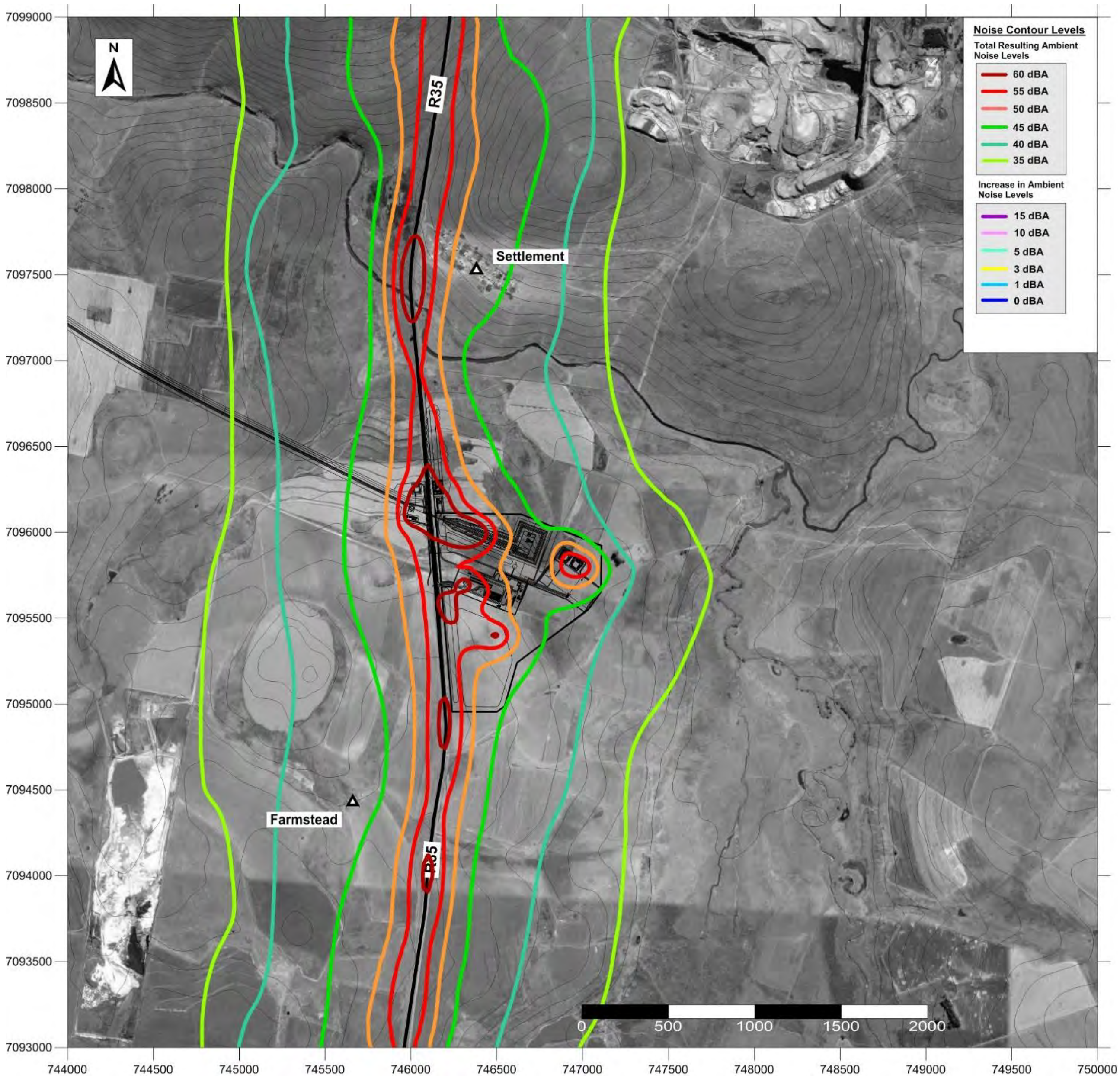


Figure 5.3.1: Stage 1: Noise impacts during day-time expressed as the total resulting ambient noise levels.

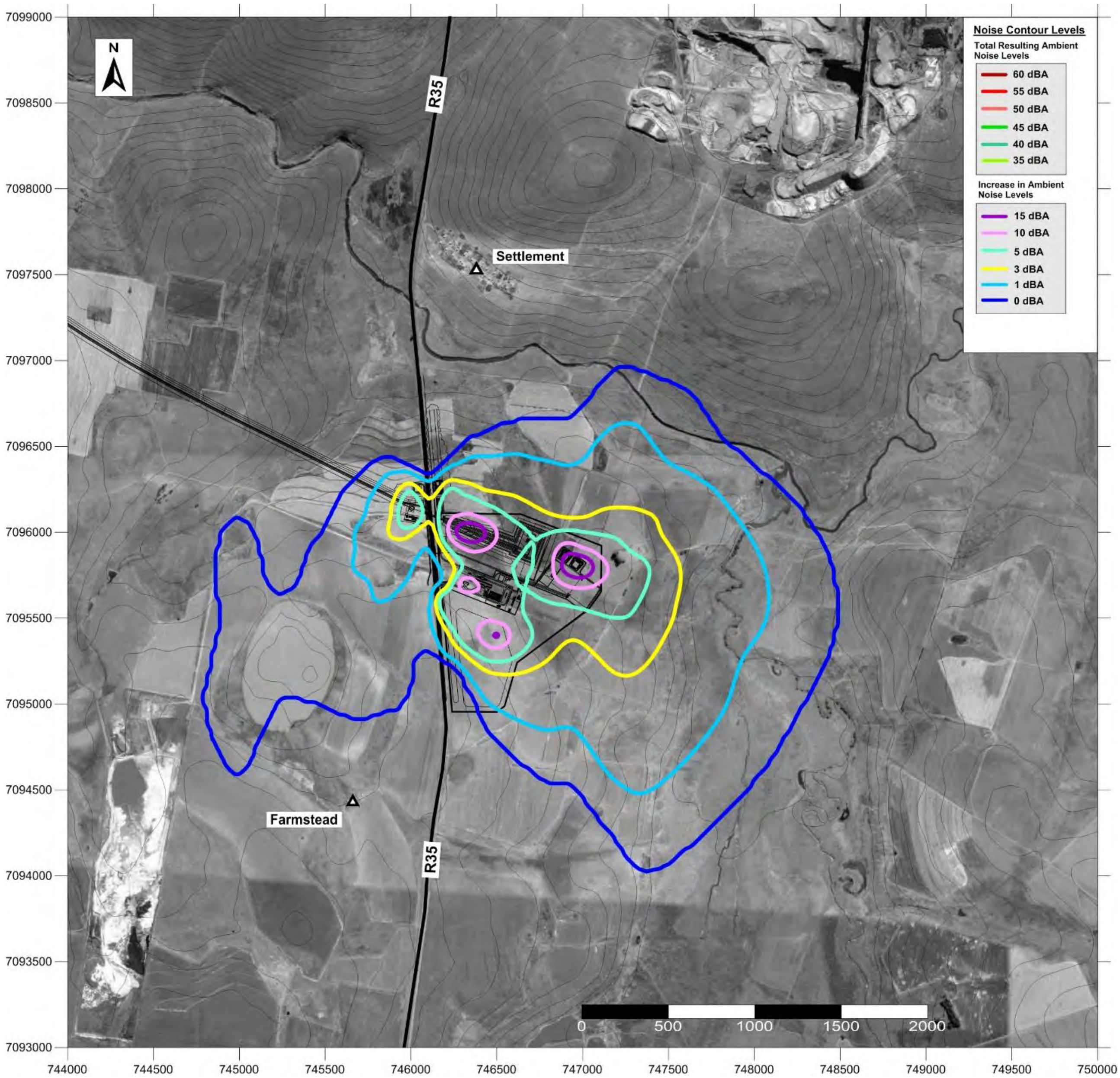


Figure 5.3.2: Stage 1: Noise impacts during day-time expressed as the increase in ambient noise levels.

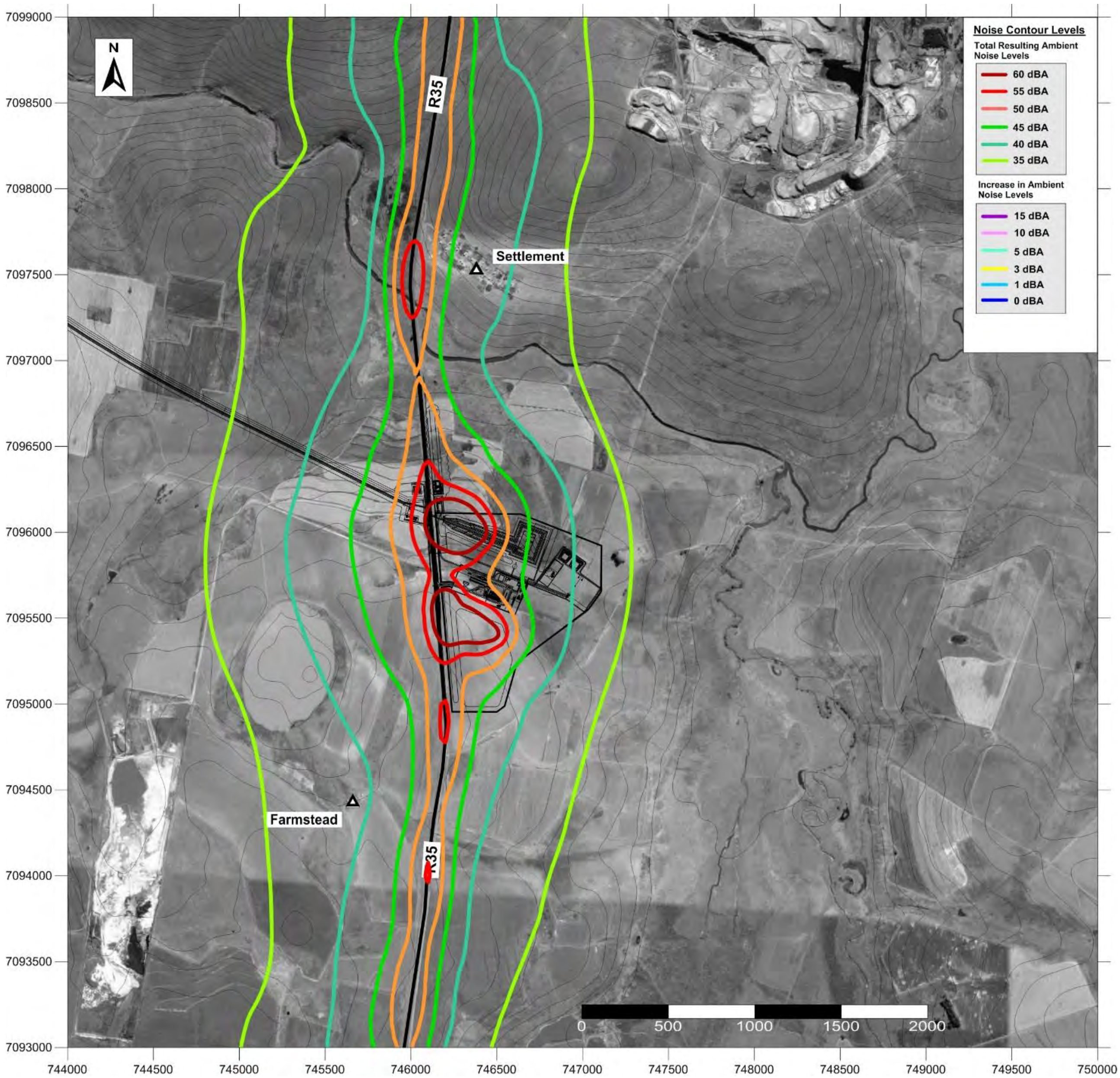


Figure 5.3.3: Stage 1: Noise impacts during night-time expressed as the total resulting ambient noise levels.

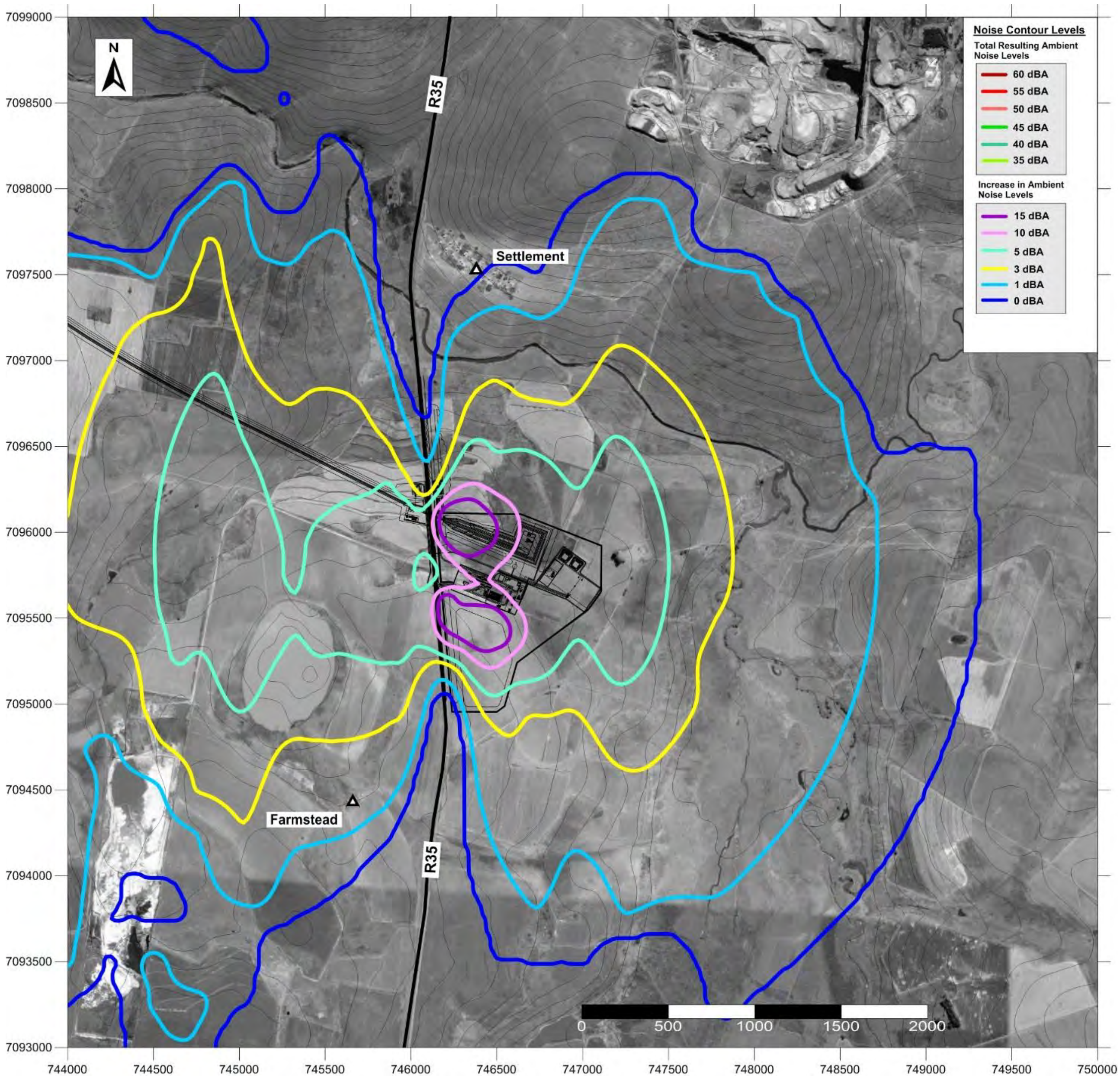


Figure 5.3.4: Stage 1: Noise impacts during night-time expressed as the increase in ambient noise levels.

The results illustrated in Figures 5.3.1 to 5.3.4 show that:

- The total resulting ambient noise levels are in essence determined by the noise emissions from road traffic on the R35, both during day- and night-time. The contours of high noise levels are concentrated around the specific construction activities;
- During day-time the contours indicating a significant increase in ambient noise levels (yellow) are essentially limited to the construction site. The settlement and farmstead are unaffected; and
- During night-time the contours cover a much larger area, due to the very low baseline ambient noise levels. However, the settlement will remain unaffected and at the farmstead the increase will be insignificant.

The results illustrated in Figures 5.3.1 to 5.3.4 are assessed in terms of SANS 10103 [6] and the SRK methodology (see Appendix C) in Tables 5.3.1 and 5.3.2, respectively.

TABLE 5.3.1
Assessment in terms of the SANS 10103 guidelines: Stage 1 Construction

Noise sensitive receptor	Period	Criterion	Compliance	Increase Δ	Community reaction
Settlement	Day (06:00 – 22:00)	≤ 55 dBA	Yes	Δ = 0 dB	'No community reaction'
Farmstead		≤ 45 dBA	Yes	Δ = 0 dB	'No community reaction'
Settlement	Night (22:00 – 06:00)	≤ 45 dBA	No Due to road traffic	Δ = 0 dB	'No community reaction'
Farmstead		≤ 35 dBA	No Due to road traffic	Δ ≤ 3 dB Insignificant	'Little with sporadic complaints'

TABLE 5.3.2
Assessment in terms of the SRK methodology: Stage 1 Construction

<table>
<tr><th>Activity</th><td colspan="8">Construction of decline shaft and infrastructure</td></tr>
<tr><th>Project phase</th><td colspan="8">Construction</td></tr>
<tr><th>Impact summery</th><td colspan="8">General rise in ambient noise levels may affect community well-being and other physiological side effects due to sleep disturbance</td></tr>
<tr><th rowspan="2">Potential Impact rating</th><th>Magnitude</th><th>Duration</th><th>Scale</th><th>Consequence</th><th>Probability</th><th>SIGNIFICANCE</th><th>+/-</th><th>Conf.</th></tr>
<tr><td>Minor</td><td>Short term</td><td>Local</td><td>Low</td><td>Possible</td><td>Low</td><td>-</td><td>High</td></tr>
<tr><th>Management measures</th><td colspan="8">• Ensure high level of equipment maintenance, especially intake and exhaust mufflers
• Withdraw equipment for maintenance if change in noise emission characteristics is noticeable
• Replace pure tone (beeping) with broadband (hissing) reversing alarms
• Maintain noise complaint register and act promptly to complaints</td></tr>
<tr><th rowspan="2">After Management Impact Rating</th><th>Magnitude</th><th>Duration</th><th>Scale</th><th>Consequence</th><th>Probability</th><th>SIGNIFICANCE</th><th>+/-</th><th>Conf.</th></tr>
<tr><td>Minor</td><td>Short term</td><td>Site</td><td>Low</td><td>Possible</td><td>Low</td><td>-</td><td>High</td></tr>
</table>

5.4 STAGE 2: CONTINUING CONSTRUCTION

The noise impacts for Stage 2 (decline shaft construction is below ground level, other activities continue at ground level, see Table 4.9.1 in section 4.9) are presented in Figures 5.4.1 to 5.4.4.

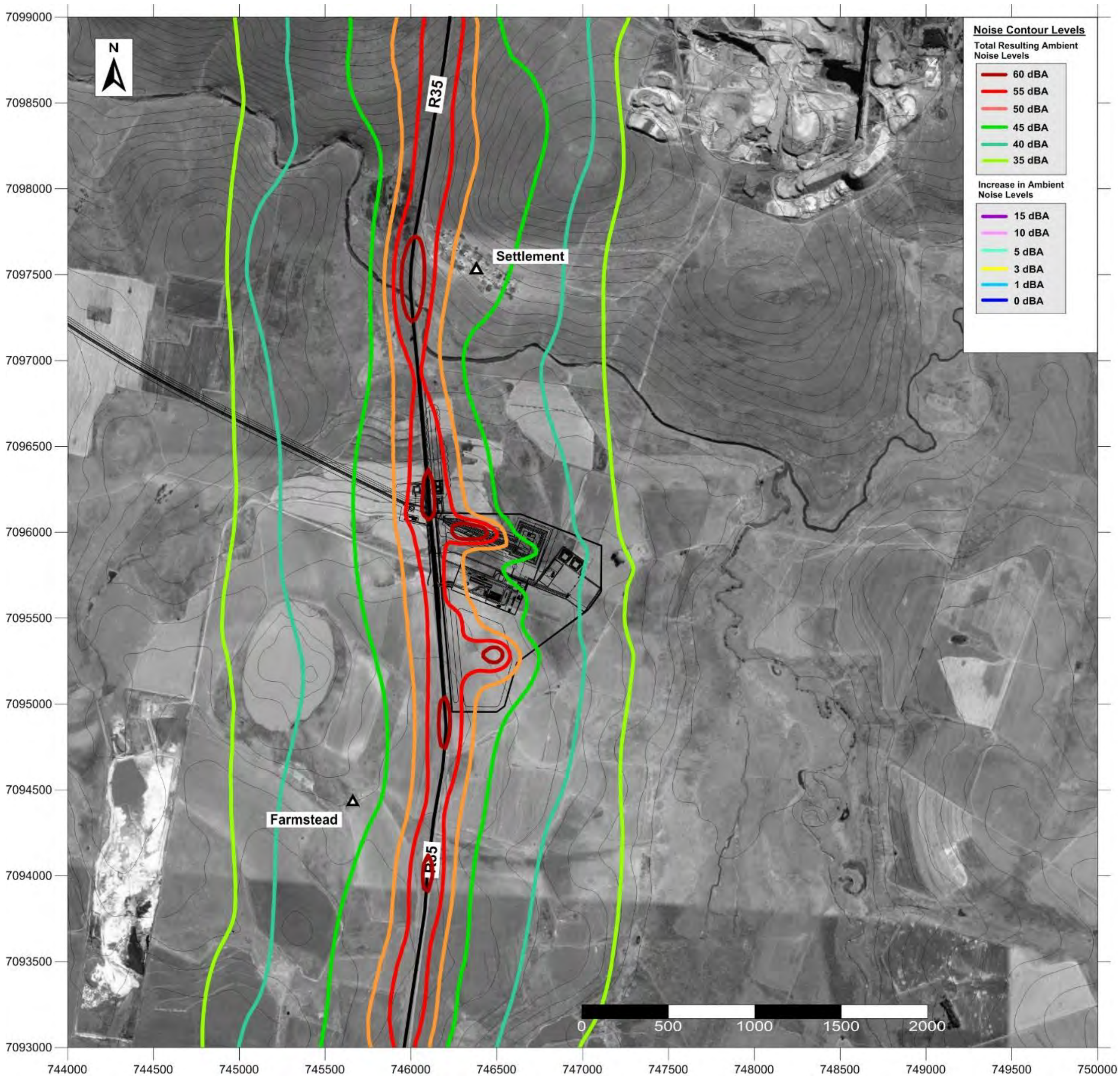


Figure 5.4.1: Stage 2: Noise impacts during day-time expressed as the resulting total ambient noise levels.

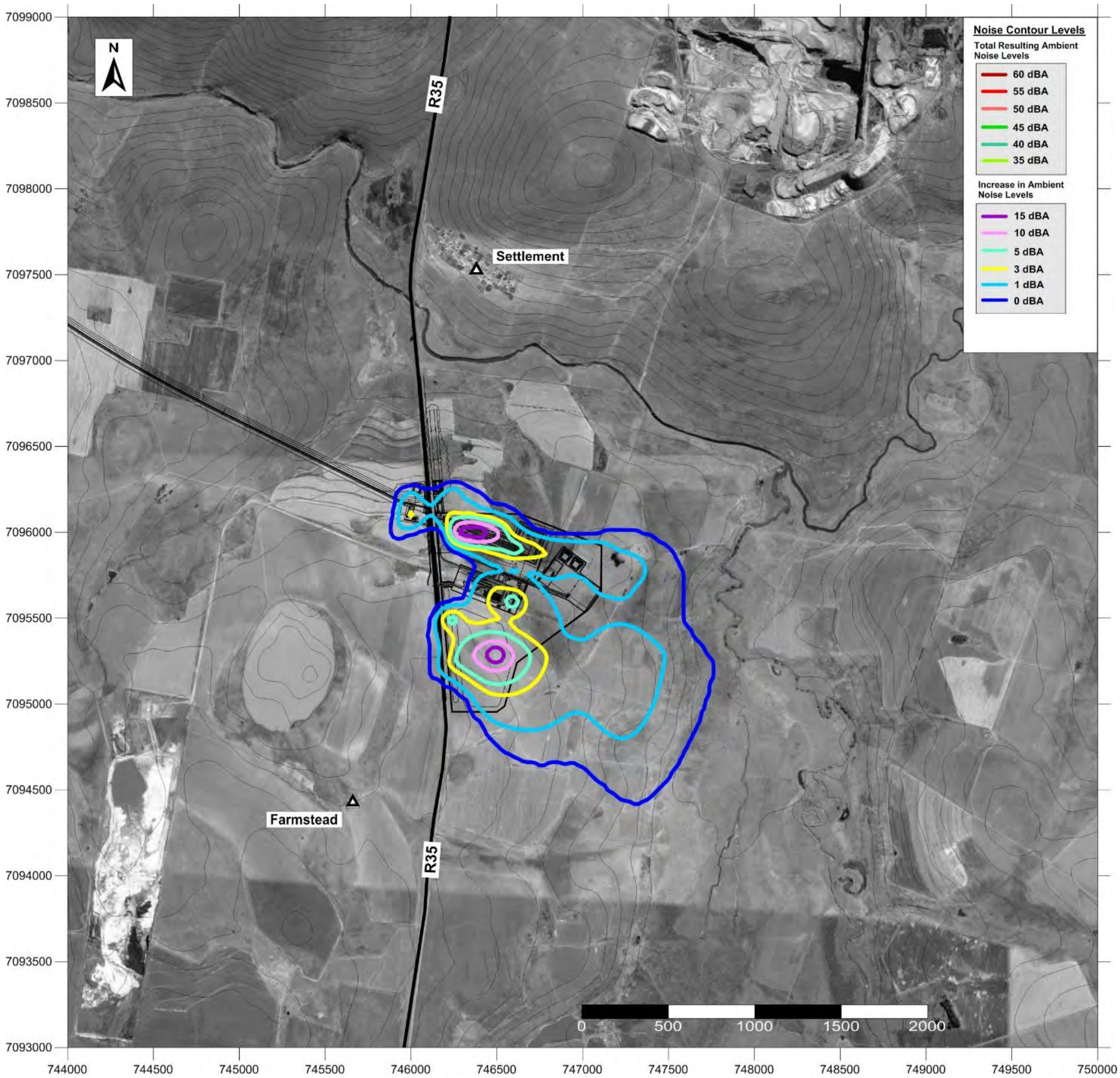


Figure 5.4.2: Stage 2: Noise impacts during day-time expressed as the increase in ambient noise levels.

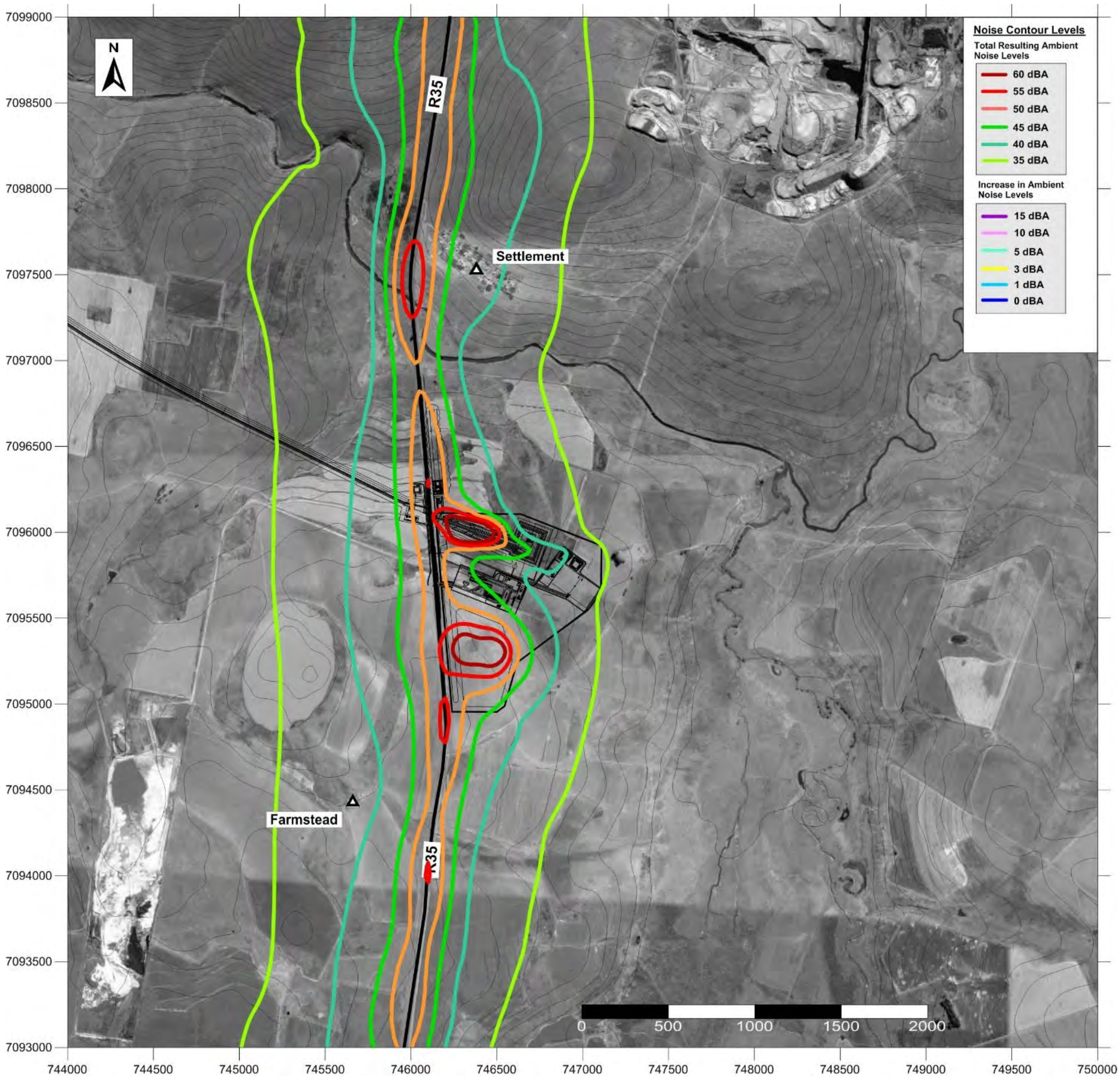


Figure 5.4.3: Stage 2: Noise impacts during night-time expressed as the resulting total ambient noise levels.

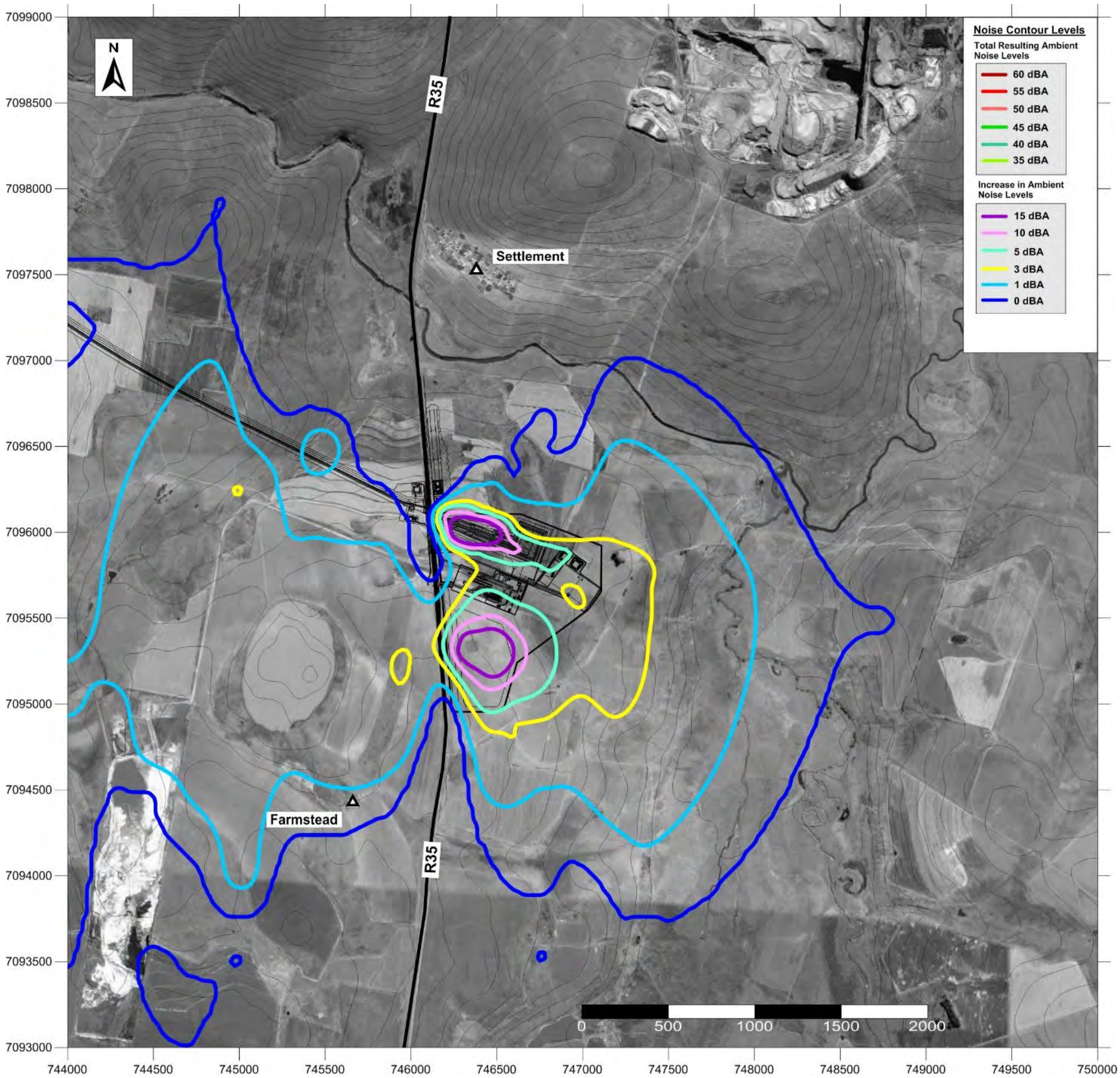


Figure 5.4.4: Stage 2: Noise impacts during night-time expressed as the increase in ambient noise levels.

The results given in Figures 5.4.1 to 5.4.4 show that:

- Due to the construction of the decline shaft moving below ground level the extents of the noise impacts are substantially reduced, both during day- and night-time; and
- At both the settlement and the farmstead the noise impacts remain very much comparable to those determined for Stage 1. This is due to the dominant noise contribution of road traffic on the R35.

The results illustrated in Figures 5.4.1 to 5.4.4 are assessed in terms of SANS 10103 [6] and the SRK methodology (see Appendix C) in Tables 5.4.1 and 5.4.2, respectively.

TABLE 5.4.1
Assessment in terms of the SANS 10103 guidelines: Stage 2 Construction

Noise sensitive receptor	Period	Criterion	Compliance	Increase ∆	Community reaction
Settlement	Day (06:00 – 22:00)	≤ 55 dBA	Yes	∆ = 0 dB	'No community reaction'
Farmstead		≤ 45 dBA	Yes	∆ = 0 dB	'No community reaction'
Settlement	Night (22:00 – 06:00)	≤ 45 dBA	No Due to road traffic	∆ = 0 dB	'No community reaction'
Farmstead		≤ 35 dBA	No Due to road traffic	∆ < 1 dB Negligible	'No community reaction'

TABLE 5.4.2
Assessment in terms of the SRK methodology: Stage 2 Construction

Activity	Construction of decline shaft and infrastructure							
Project phase	Construction							
Impact summery	General rise in ambient noise levels may affect community well-being and other physiological side effects due to sleep disturbance							
Potential Impact rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Short term	Site	**Low**	Possible	**Low**	-	High
Management measures	• Ensure high level of equipment maintenance, especially intake and exhaust mufflers • Withdraw equipment for maintenance if change in noise emission characteristics is noticeable • Replace pure tone (beeping) with broadband (hissing) reversing alarms • Maintain noise complaint register and act promptly to complaints							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Short term	Site	**Low**	Possible	**Low**	-	High

5.5 STAGE 3: OPERATIONAL CONDITIONS

The noise impacts for Stage 3 (fully operational conditions, see Table 4.9.1 in section 4.9) are presented in Figures 5.5.1 to 5.5.4.

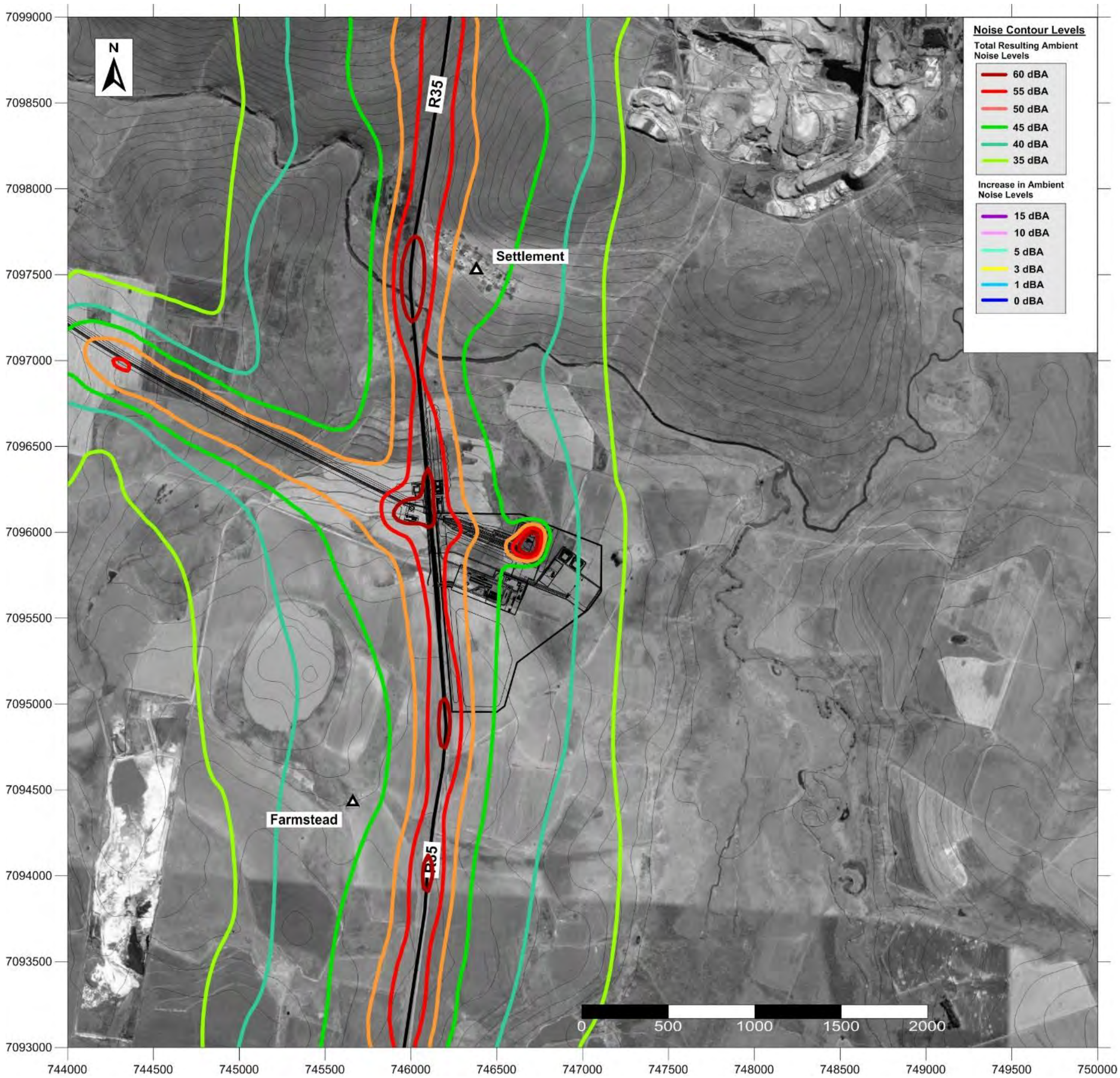


Figure 5.5.1: Stage 3: Noise impacts during day-time expressed as the resulting total ambient noise levels.

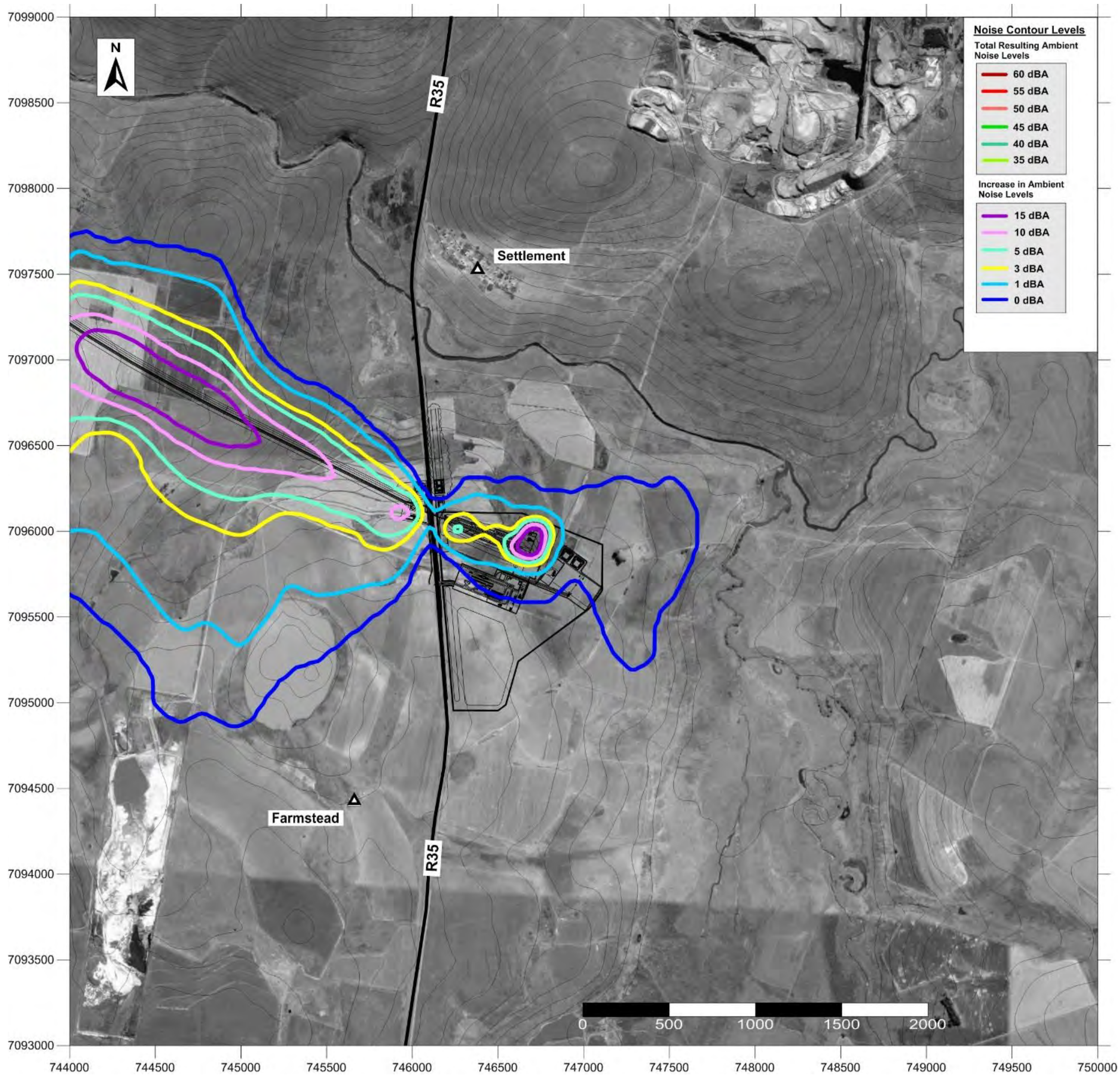


Figure 5.5.2: Stage 3: Noise impacts during day-time expressed as the increase in ambient noise levels.

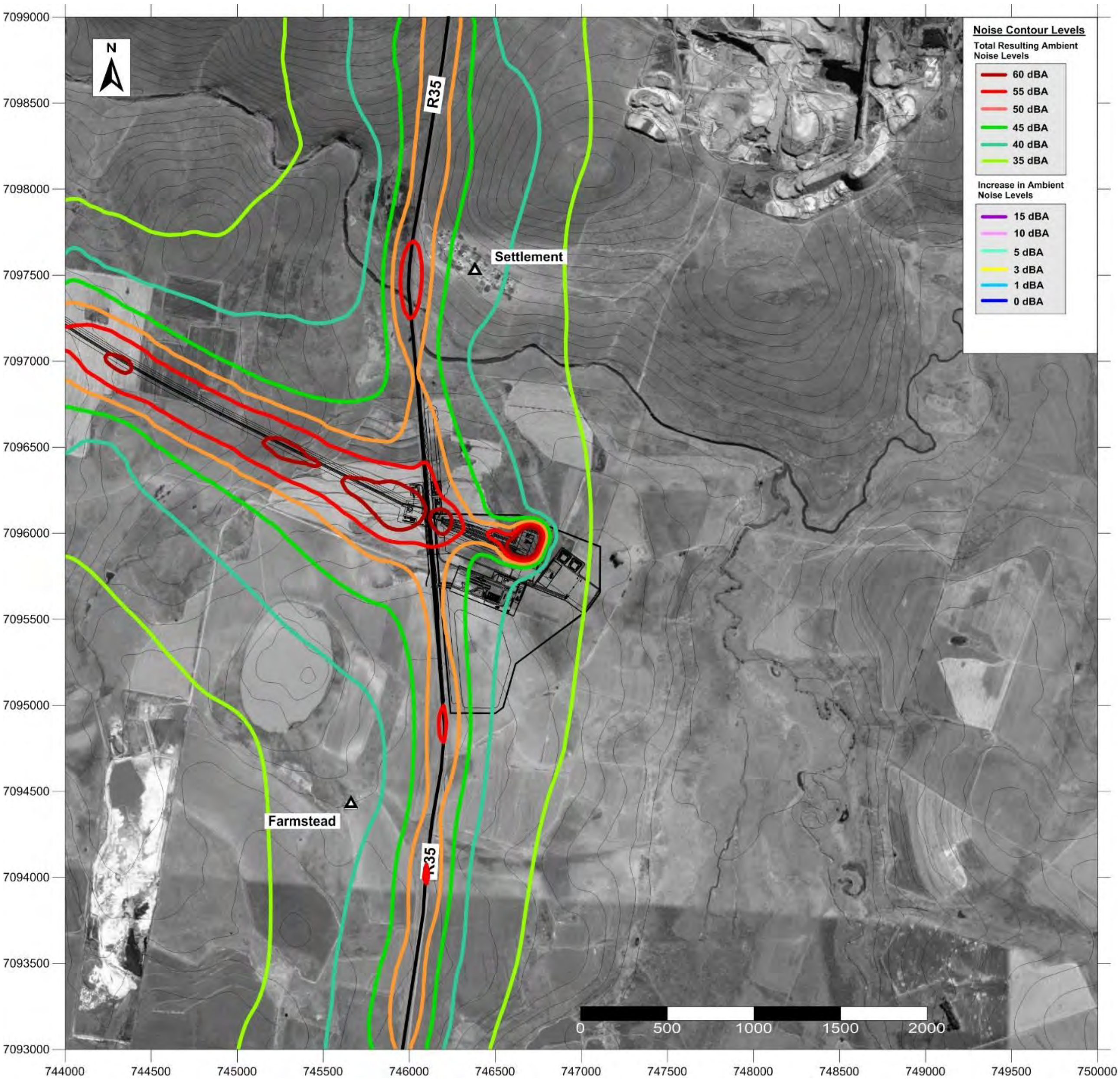


Figure 5.5.3: Stage 3: Noise impacts during night-time expressed as the resulting total ambient noise levels.

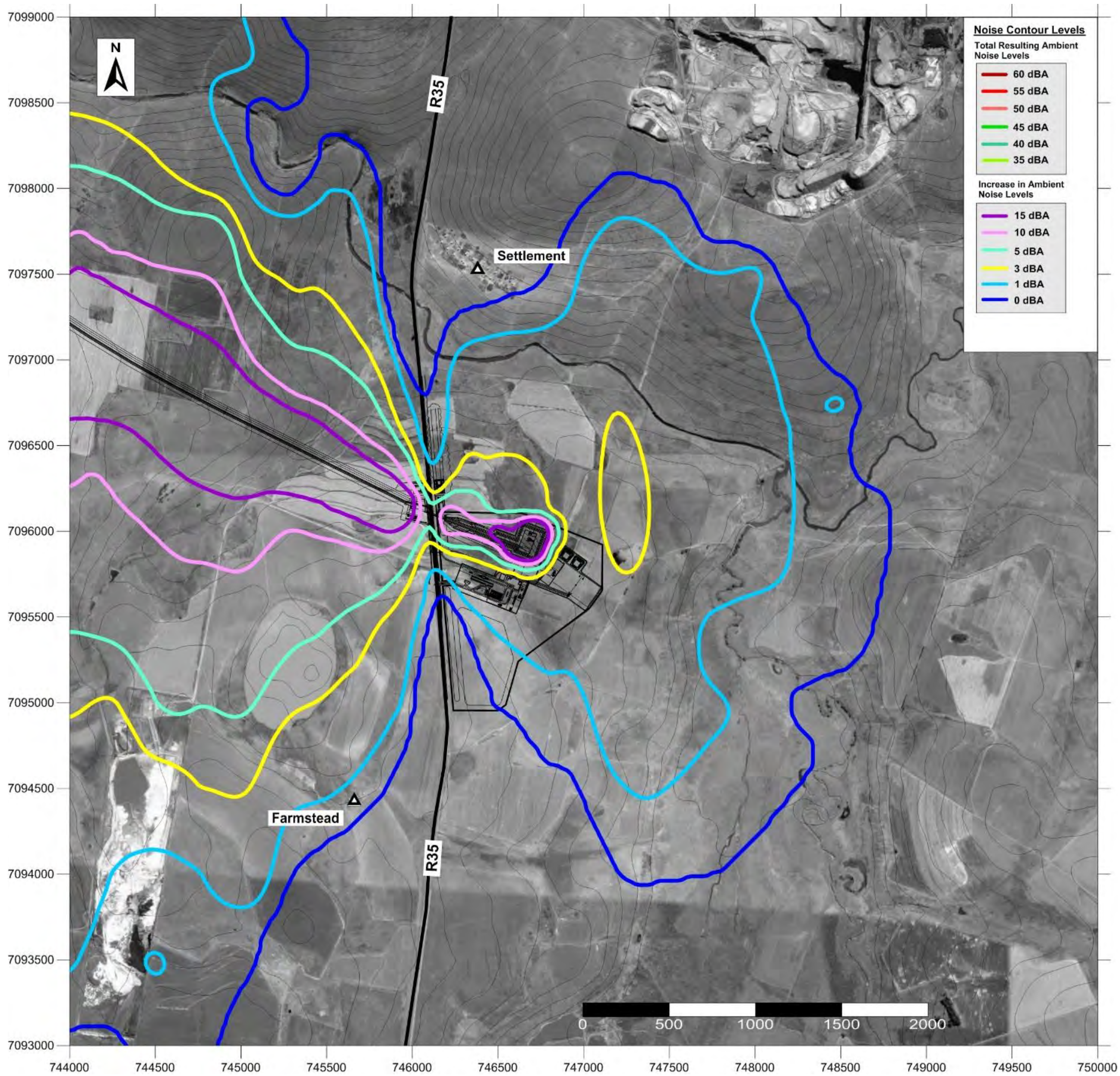


Figure 5.5.4: Stage 3: Noise impacts during night-time expressed as the increase in ambient noise levels.

The results given in Figures 5.5.1 to 5.5.4 show that:

- Both during day- and night-time the noise emissions from the overland conveyor have a very significant impact on ambient noise levels west of the R35. This is due to the fact that the conveyor is a line source of noise. All else being equal the attenuation due to the geometric spreading of noise energy per doubling of distance is 3 dB for a line source. This is in contrast to a point source, e.g. the crusher, for which the attenuation per doubling in distance is 6 dB; and
- However, at both the settlement and the farmstead the noise impacts remain very much comparable to those determined for Stages 1 and 2. This is due to the dominant noise contribution of road traffic on the R35.

For the mitigation of the conveyor noise contribution two possible approaches were evaluated:

- Placing the conveyor in a trench with a minimum depth of 2 m below ground level; and
- Enclosing the conveyor in a structure similar to that indicated in Figure 5.5.5.

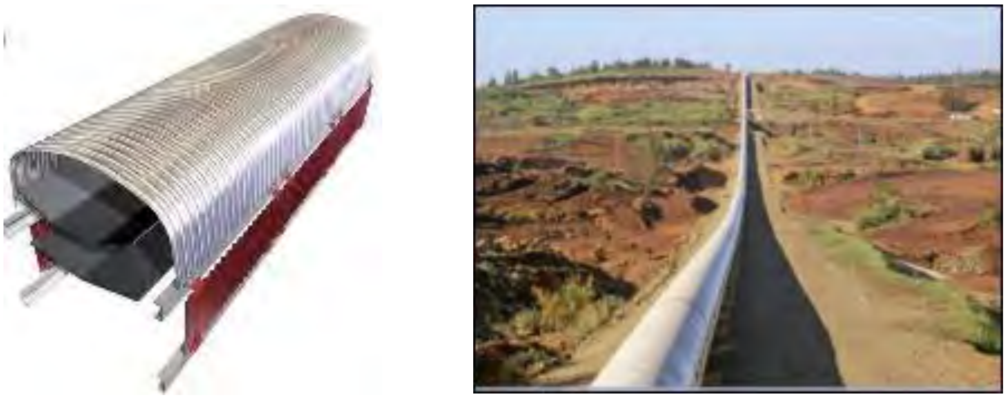


Figure 5.5.5: Images illustrating the enclosure of a conveyor (source www.capotex.com).

The noise impacts including these mitigation measures were calculated for night-time only, since this is when the maximum extent of the contours occur. The results are given in Figures 5.5.6 to 5.5.9.

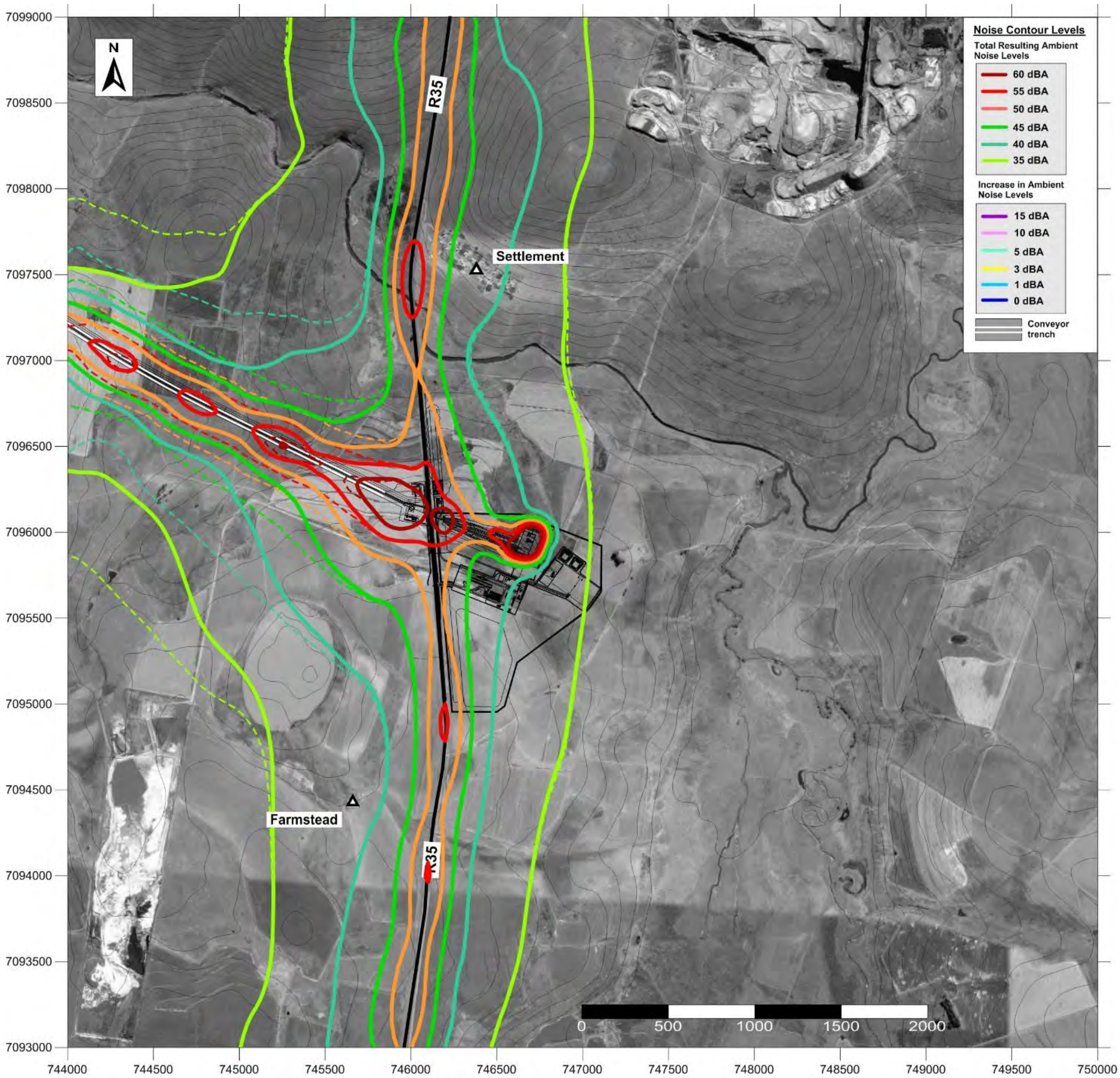


Figure 5.5.6: Stage 3: Noise impacts during night-time mitigated by placing the conveyor in a trench expressed as the resulting total ambient noise levels. The dashed lines represent the unmitigated condition.

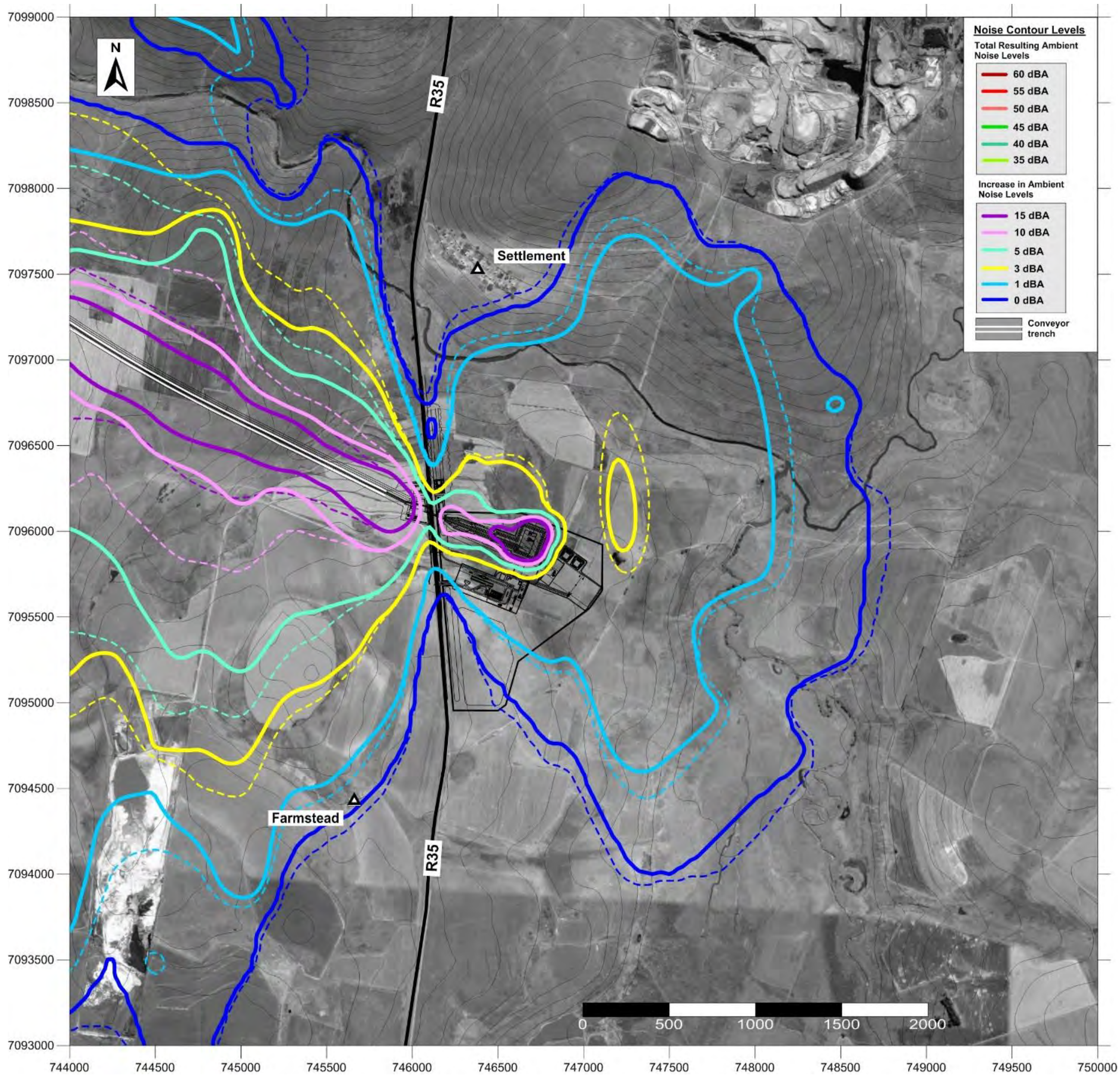


Figure 5.5.7: Stage 3: Noise impacts during night-time mitigated by placing the conveyor in a trench expressed as the increase in ambient noise levels. The dashed lines represent the unmitigated condition.

The results in Figures 5.5.6 and 5.5.7 show that the extents of the noise impacts contours have been substantially reduced. However, there remains a large area where the increase in ambient noise levels will be above 15 dB.

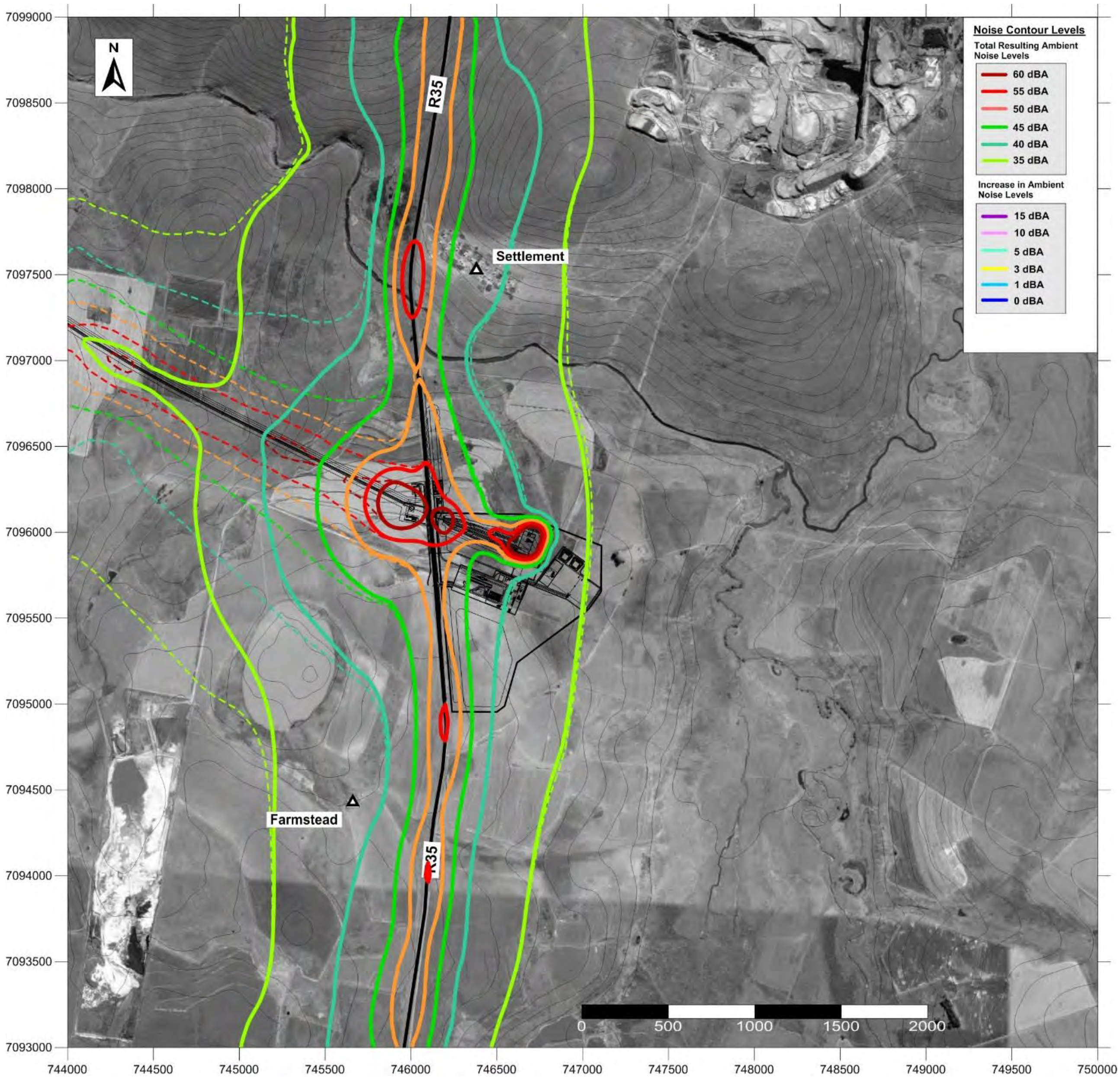


Figure 5.5.8: Stage 3: Noise impacts during night-time mitigated by enclosing the conveyor expressed as the resulting total ambient noise levels. The dashed lines represent the unmitigated condition.

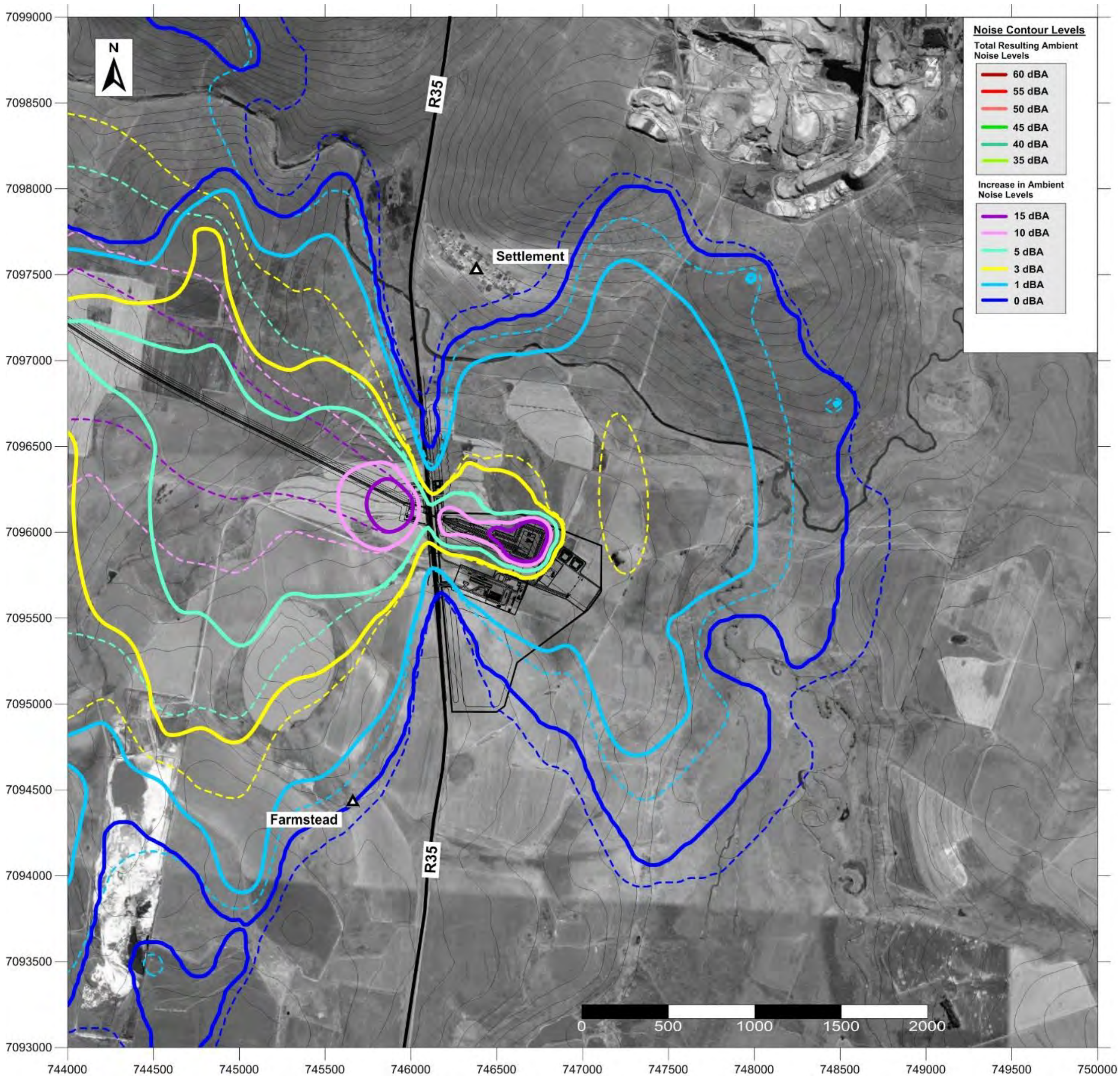


Figure 5.5.9: Stage 3: Noise impacts during night-time mitigated by enclosing the conveyor expressed as the increase in ambient noise levels. The dashed lines represent the unmitigated condition.

The results in Figures 5.5.8 and 5.8.9 show that by enclosing the conveyor in a structure similar to that shown in Figure 5.5.5 the noise impacts are very significantly reduced.

The results illustrated in Figures 5.5.1 to 5.5.4 and 5.5.6 to5.5.9 are assessed in terms of SANS 10103 [6] in Tables 5.5.1 and the SRK methodology (see Appendix C) in Tables 5.5.3 and 5.5.4.

TABLE 5.5.1
Assessment in terms of the SANS 10103 guidelines: Stage 3 Operations

Noise sensitive receptor	Period	Criterion	Compliance	Increase Δ	Community reaction
Settlement	Day (06:00 – 22:00)	≤ 55 dBA	Yes	Δ = 0 dB	'No community reaction'
Farmstead		≤ 45 dBA	Yes	Δ = 0 dB	'No community reaction'
Settlement	Night (22:00 – 06:00)	≤ 45 dBA	No Due to road traffic	Δ = 0 dB	'No community reaction'
Farmstead		≤ 35 dBA	No Due to road traffic	Δ < 1 dB Negligible	'No community reaction'

TABLE 5.5.2
Assessment in terms of the SRK methodology: Stage 3 Operations – conveyor in trench

Activity	Construction of decline shaft and infrastructure							
Project phase	Construction							
Impact summery	General rise in ambient noise levels may affect community well-being and other physiological side effects due to sleep disturbance							
Potential Impact rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Long term	Local	**Medium**	Possible	**Medium**	-	High
Management measures	• Place conveyor in a trench with a depth of at least 2m • Ensure high level of equipment maintenance, especially intake and exhaust mufflers • Withdraw equipment for maintenance if change in noise emission characteristics is noticeable • Replace pure tone (beeping) with broadband (hissing) reversing alarms • Maintain noise complaint register and act promptly to complaints							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Long term	Local	**Medium**	Possible	**Medium**	-	High

TABLE 5.5.2
Assessment in terms of the SRK methodology: Stage 3 Operations – conveyor enclosed

Activity	Construction of decline shaft and infrastructure							
Project phase	Construction							
Impact summery	General rise in ambient noise levels may affect community well-being and other physiological side effects due to sleep disturbance							
Potential Impact rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Long term	Local	**Medium**	Possible	**Medium**	-	High
Management measures	• Enclose the conveyor as indicated in Figure 5.5.5 • Ensure high level of equipment maintenance, especially intake and exhaust mufflers • Withdraw equipment for maintenance if change in noise emission characteristics is noticeable • Replace pure tone (beeping) with broadband (hissing) reversing alarms • Maintain noise complaint register and act promptly to complaints							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Long term	Local	**Medium**	Unlikely	**Medium**	-	High

5.6 STAGE 4: DECOMMISSIONING

The noise impacts for Stage 4 (decommissioning, see Table 4.9.1 in section 4.9) are presented in Figures 5.6.1 and 5.6.2.

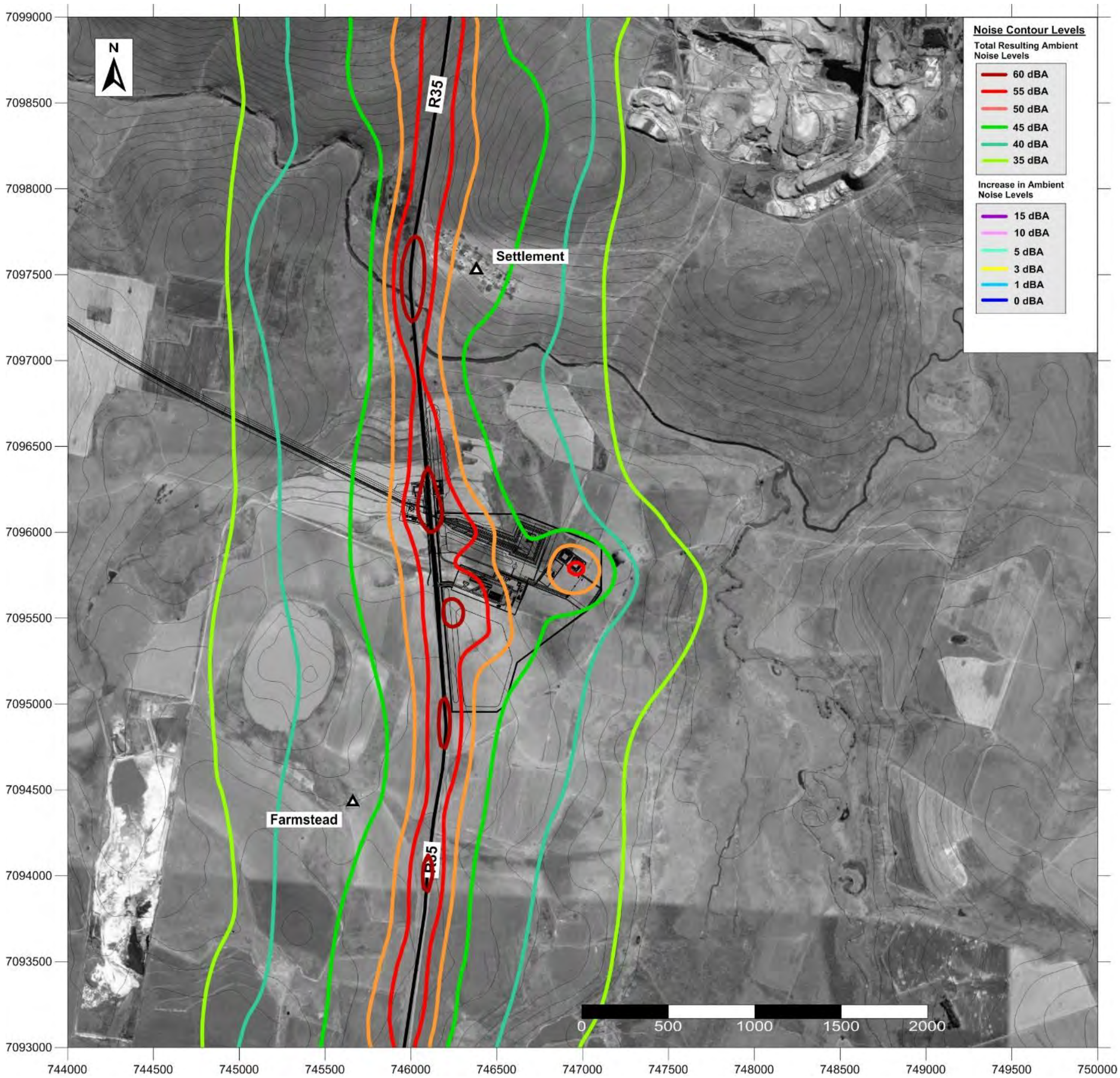


Figure 5.6.1: Stage 4: Noise impacts during day-time expressed as the resulting total ambient noise levels.

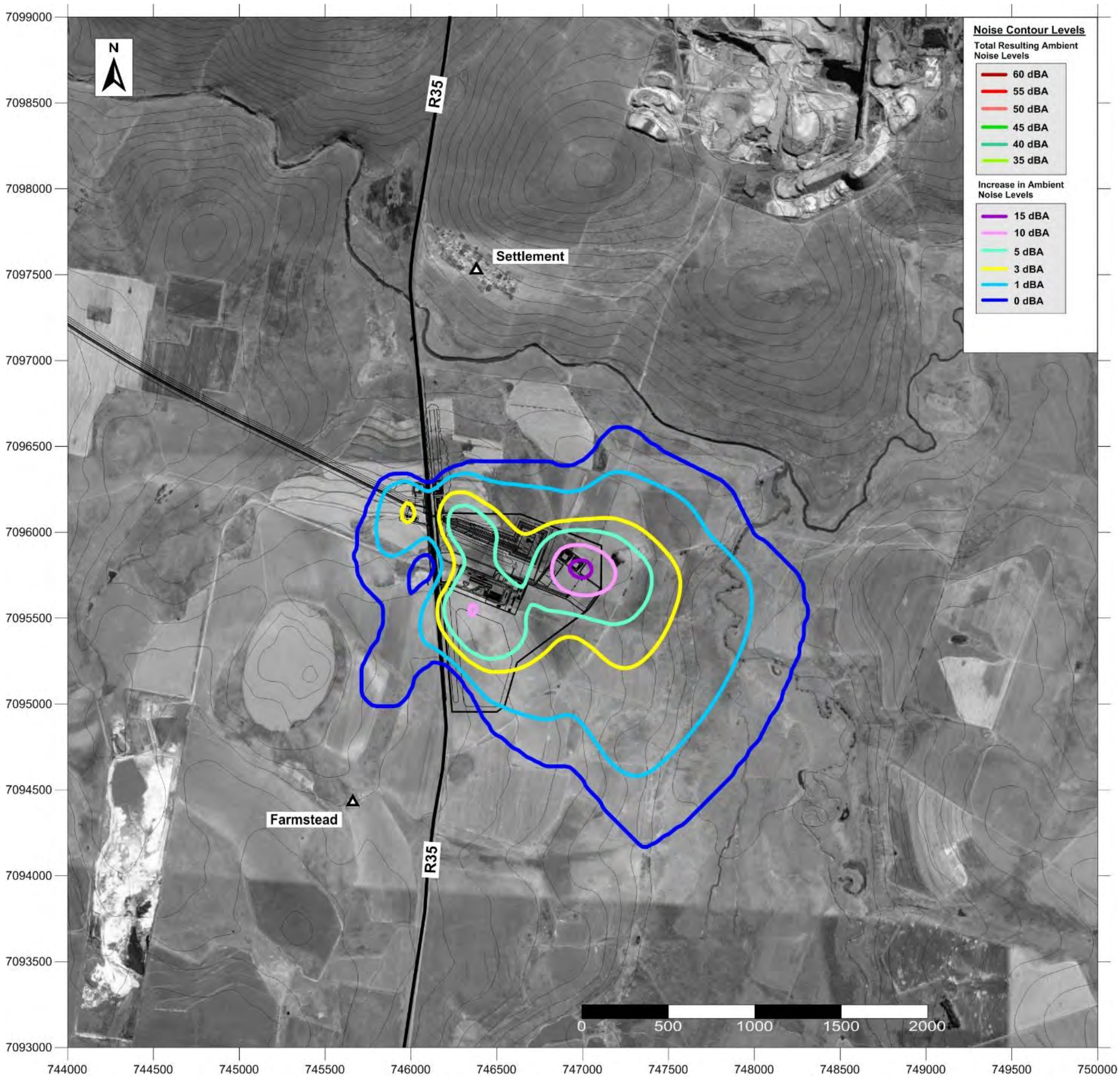


Figure 5.6.2: Stage 4: Noise impacts during day-time expressed as the increase in ambient noise levels.

The results given in Figures 5.6.1 to 5.6.4 show that the noise impact contours are limited to the site and that none of the noise sensitive receptors will be affected.

The results illustrated in Figures 5.6.1 and 5.6.2 are assessed in terms of SANS 10103 [6] and the SRK methodology (see Appendix C) in Tables 5.6.1 and 5.6.2, respectively.

TABLE 5.6.1
Assessment in terms of the SANS 10103 guidelines: Stage 4 Decommissioning

Noise sensitive receptor	Period	Criterion	Compliance	Increase ∆	Community reaction
Settlement	Day (06:00 – 22:00)	≤ 55 dBA	Yes	∆ = 0 dB	‘No community reaction’
Farmstead		≤ 45 dBA	Yes	∆ = 0 dB	‘No community reaction’
Settlement	Night (22:00 – 06:00)	≤ 45 dBA	No Due to road traffic	∆ = 0 dB	‘No community reaction’
Farmstead		≤ 35 dBA	No Due to road traffic	∆ = 0 dB	‘No community reaction’

TABLE 5.6.2
Assessment in terms of the SRK methodology: Stage 4 Decommissioning

Activity	Construction of decline shaft and infrastructure							
Project phase	Construction							
Impact summery	General rise in ambient noise levels may affect community well-being and other physiological side effects due to sleep disturbance							
Potential Impact rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Short term	Site	**Low**	Unlikely	**Low**	-	High
Management measures	• Ensure high level of equipment maintenance, especially intake and exhaust mufflers • Withdraw equipment for maintenance if change in noise emission characteristics is noticeable • Replace pure tone (beeping) with broadband (hissing) reversing alarms • Maintain noise complaint register and act promptly to complaints							
After Management Impact Rating	**Magnitude**	**Duration**	**Scale**	**Consequence**	**Probability**	**SIGNIFICANCE**	**+/-**	**Conf.**
	Minor	Short term	Site	Low	Unlikely	Low	-	High

6. CONCLUSIONS

The following conclusions are drawn on the results of this investigation:

- The current ambient noise level in the area are dominated by the noise emissions from road traffic on the R35. This is of particular importance for the settlement immediately north of the proposed Elders Colliery and at the nearest farmstead located towards the South-West;
- Although there are still many mining operations in the larger environment they are less evident than during the measurements taken in 2012. This is due to the fact that some of them have since closed down, e.g. the large opencast mine some 3 km north of the Elders site;
- As a result the current ambient noise levels are very low, at times falling below 20 dBA during night-time. As a consequence the extents of the noise impacts, particularly when expressed as the increase in ambient noise levels, will be substantial. Furthermore, the maximum noise impact will occur during night-time;
- During construction the most severe and furthest extent of the noise impact will occur when all activities take place at ground level, especially since the construction of the decline shaft will have to continue at night. However, as soon as the latter are between 15 m and 20 m below ground level the severity and extent of the noise impacts will decrease;
- The significance rating during construction is **low**;
- Since the ventilation system will be around 60 m below ground level, the noise emissions by the fully operational mine alone will cause a limited extent of the noise impacts;
- The most significant noise emissions will be caused by the conveyor system and as a result the noise impact will extend over considerable distances and consequently the cumulative extent of the noise impacts will be large;
- Therefore, due to this considerable extent of the noise impacts and their long term nature the significance rating during the operational stage is **medium**;
- Due to the much reduced activities during decommissioning and the fact that they in all likelihood will only take place during day-time the significance rating for this stage is **low**;
- Due to the noise emissions from road traffic on the R35 dominate current and future ambient noise levels at the settlement and the farmstead the noise impacts at these locations during construction, operations and decommissioning are either negligible or non-existent;
- The extent of the noise impacts caused by the conveyor system can be mitigated by either placing it in a trench with a minimum depth of 2 m below ground level or by fitting it with a purpose designed enclosure. The latter option will reduce the significance rating to **low**; and
- Although they do not affect the averaged noise levels on which assessments are based the reversing alarms of earthmoving and mining equipment are often singled out as a particularly disturbing characteristic of mining operations. This can be

effectively mitigated by fitting the equipment with devices that emit broad band noise instead of pure tone, i.e. 'beeping' sounds.

7. RECOMMENDATIONS

Based on the findings of this noise study the following recommendations are made:

- All earth moving and mining equipment should be fitted with broad band noise emitting devices rather than the standard pure tone reversing alarms; and
- If the mitigation of conveyor noise is to be considered, the first choice should be enclosing it as described in this report, with the second choice placing it in a trench with a minimum depth of 2 m below ground level.

8. REFRENCES

In this report reference was made to the following documentation:

(1) F le R Malherbe, FMAC Report No. 12/2/4/2, Noise Study for the Elders Colliery Project, February 2014.

(2) Noise Regulations, 1990, published under the Environment Conservation Act, 1989 (Act No. 73 of 1989), Government Gazette No. 12435, 27 April 1990.

(3) Model noise regulations published under the Environment Conservation Act, Act 73 of 1989, by the Minister of the Environment in 1997.

(4) Model air quality management by-law for easy adoption and adaptation by municipalities, 2010.

(5) National Environment Management Air Quality Act, Act 39 of 2004, Government Gazette No. 33342, 2 July 2010.

(6) SANS 10103:2008 'The measurement and rating of environmental noise with respect to annoyance and to speech communication', Edition 6.

(7) SANS 10210:2004 'Calculating and predicting road traffic noise'

(8) SANS 10357:2004 'The calculation of sound propagation by the Concawe method'

(9) Guidelines for Community Noise, World Health Organisation, Geneva, 1999.

F le R Malherbe Pr Eng

APPENDIX A

Measurement instrumentation

9. APPENDIX A: MEASUREMENT INSTRUMENTATION

The measurement instrumentation that was used in this noise study is summarised in Table A-1. The measurement instrumentation complies with the accuracy requirements specified for a Type 1 instrument in:

- SANS 61672-1/IEC 61672-1, *Electro acoustics – Sound level meters – Part 1: Specifications.* **Amendment 1**
- SANS 60942/IEC 60942 (SABS IEC 60942), *Electro acoustics – Sound calibrators*.

TABLE A-1
Measurement instrumentation

Instrument	Type	Serial Number	Date calibrated	Calibration Certificate
Sound level meter	B&K 2250	3004727	2014/01/28	AV\AS-4390
Microphone	B&K 4189	2888663	2014/01/28	AV\AS-4390
Sound level calibrator	B&K 4230	1511916	2014/03/04	AV\AS-4400

The calibration status of the instrumentation was checked before and after each set of measurements against a calibrated signal with a level of 94.0 dB at 1 kHz. In each case the instrument displayed a reading of within 1 dB of the calibrated value. A windshield supplied by the manufacturer of the instrument was used during all the measurements.

APPENDIX B

Noise emission levels for equipment and processes, meteorological and traffic flow data

10. APPENDIX B: NOISE EMISSION LEVELS FOR EQUIPMENT AND PROCESSES

10.1 NOISE EMISSION LEVELS FOR MINING EQUIPMENT

The sound power levels of the mining equipment used in the calculations are summarised in Table 10.1.1.

TABLE 10.1.1
Sound power emission levels for mining equipment

Equipment	Sound power emission level, dB re 1 pW, in octave band, Hz						
	63	125	250	500	1000	2000	4000
Silo	98.0	94.0	91.0	92.0	92.0	94.0	89.0
Conveyor drive	97.1	93.8	95.0	98.2	98.1	96.0	93.7
Crusher	104.1	107.6	110.5	109.3	105.1	100.1	92.3
Transfer tower	101.6	104.8	105.8	104.7	101.4	98.1	93.2
Ventilation system	110.9	110.4	109.9	114.2	110.7	106.2	98.4
Articulated haul truck 40t	100.0	118.0	111.0	109.0	107.0	103.0	97.0
D9 bulldozer	107.9	113.2	116.9	114.4	110.6	106.8	100.2
FEL 988	100.4	111.9	107.8	106.0	103.2	98.6	92.0
Grader Cat 14h	112.0	105.0	109.0	101.0	96.0	93.0	89.0
Vibrating roller	99.4	116.4	111.4	112.7	113.1	109.6	104.9
Drill dm30	90.0	101.0	102.0	105.0	105.0	104.0	99.0
Road truck 30 t	113.0	106.0	105.0	105.0	101.0	99.0	96.0
Excavator	95.0	100.0	103.0	105.0	105.0	100.0	100.0
General noise	112.6	115.5	110.3	113.3	115.8	113.9	112.7
'Pecker'-excavator	98.9	102.6	105.9	105.7	103.2	99.9	93.2
Conveyor open	67.6	71.2	71.4	75.4	75.4	74.2	70.2
Conveyor enclosed	35.9	42.1	42.0	43.2	50.7	46.6	29.8

10.2 TRAFFIC FLOW ON THE MAIN ROAD

The traffic flow that was assumed for the R35 and R544 is summarised in Table 10.2.1.

Table 10.2.1
Summary of the assumed traffic flow

Period	Q	%H	v	gr	st
Day	237	100	34	0	smooth
Night	71	96	34	0	smooth

Where: Q = Total number of vehicles per hour in both directions

%H = Percentage heavy vehicles

v = Average speed of the traffic, km/h

gr = The gradient of the road

st = Road surface texture

10.3 METEOROLOGICAL CONDITIONS ASSUMED FOR CALCULATIONS

The meteorological conditions that were assumed for the calculations are summarised in Table 10.3.1.

TABLE 10.3.1
Assumed meteorological conditions

Parameter	Assumed value
Temperature	25 °C Day
	11 °C Night
Wind	2 m/s N
Humidity	50 % RHD Day
	50 % RHD Night
Static air pressure	86.1 kPa
Solar irradiation	700 W/m^2
Cloud cover	2/8
Acoustically soft ground conditions	70%

APPENDIX C

SRK assessment methodology

11. APPENDIX C: SRK IMPACT ASSESSMENT METHODOLOGY

PART A: DEFINING CONSEQUENCE IN TERMS OF MAGNITUDE, DURATION AND SPATIAL SCALE *Use these definitions to define the consequence in Part B*		
Impact characteristics	**Definition**	**Criteria**
MAGNITUDE	Major	Substantial deterioration or harm to receptors; receiving environment has an inherent value to stakeholders; receptors of impact are of conservation importance; or identified threshold often exceeded
	Moderate	Moderate/measurable deterioration or harm to receptors; receiving environment moderately sensitive; or identified threshold occasionally exceeded
	Minor	Minor deterioration (nuisance or minor deterioration) or harm to receptors; change to receiving environment not measurable; or identified threshold never exceeded
	Minor+	Minor improvement; change not measurable; or threshold never exceeded
	Moderate+	Moderate improvement; within or better than the threshold; or no observed reaction
	Major+	Substantial improvement; within or better than the threshold; or favourable publicity
DURATION	Short term	Up to 18 months.
	Medium term	18 months to 5 years
	Long term	Longer than 5 years
SPATIAL SCALE OR POPULATION	Site or local	Site specific or confined to the immediate project area
	Regional	May be defined in various ways, e.g. cadastral, catchment, topographic
	National/ International	Nationally or beyond

PART B: DETERMINING CONSEQUENCE RATING *Rate consequence based on definition of magnitude, spatial extent and duration*					
			SPATIAL SCALE/ POPULATION		
			Site or Local	**Regional**	**National/ international**
MAGNITUDE					
Minor	**DURATION**	**Long term**	Medium	Medium	High
		Medium term	Low	Low	Medium
		Short term	Low	Low	Medium
Moderate	**DURATION**	**Long term**	Medium	High	High
		Medium term	Medium	Medium	High
		Short term	Low	Medium	Medium
Major	**DURATION**	**Long term**	High	High	High
		Medium term	Medium	Medium	High
		Short term	Medium	Medium	High

PART C: DETERMINING SIGNIFICANCE RATING *Rate significance based on consequence and probability*				
		CONSEQUENCE		
		Low	**Medium**	**High**
PROBABILITY (of exposure to impacts)	**Definite**	Medium	Medium	High
	Possible	Low	Medium	High
	Unlikely	Low	Low	Medium

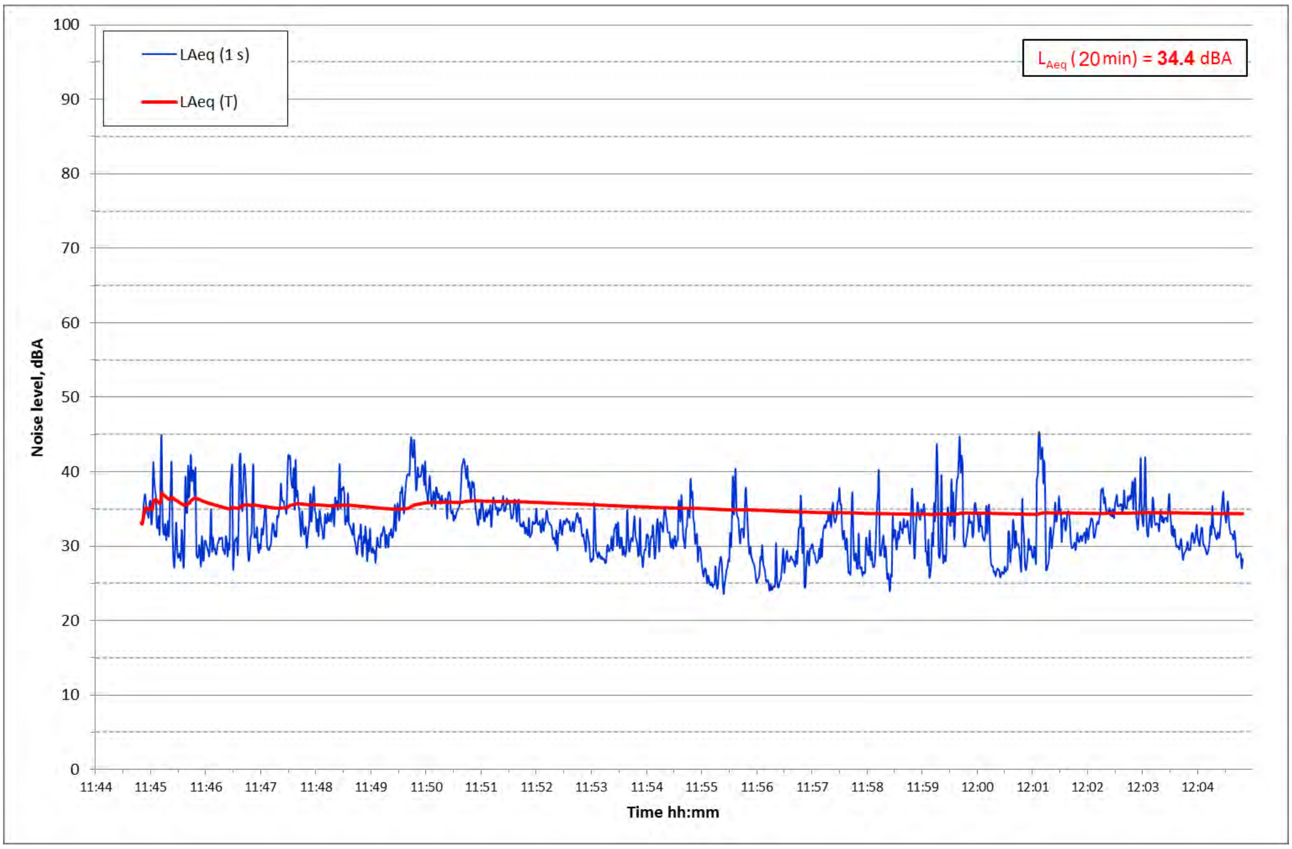
PART D: CONFIDENCE LEVEL		
High	Medium	Low

APPENDIX D

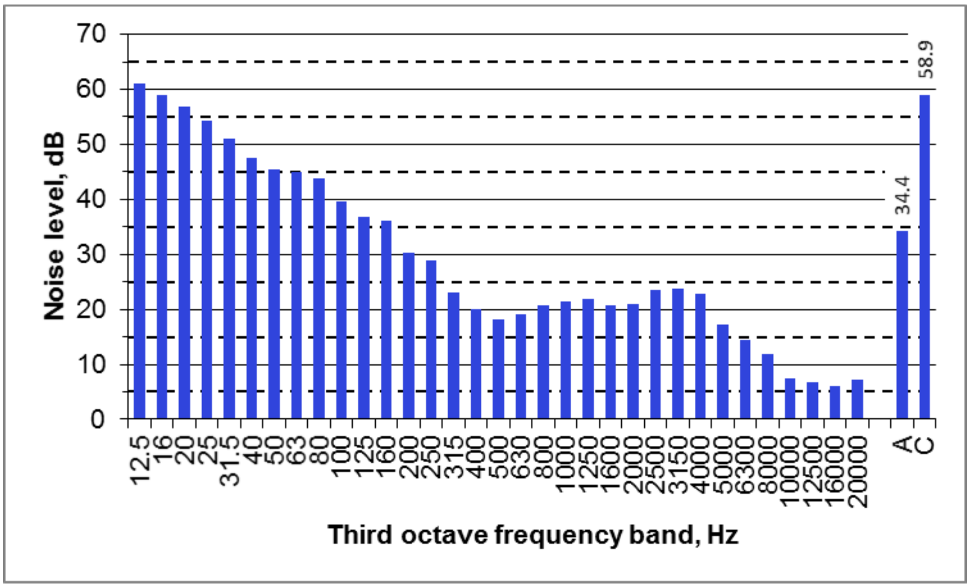
Detailed measurement results

12. APPENDIX D: DETAILED MEASUREMENT RESULTS

The detailed measurement results are given in Figures D-1 to D-4.

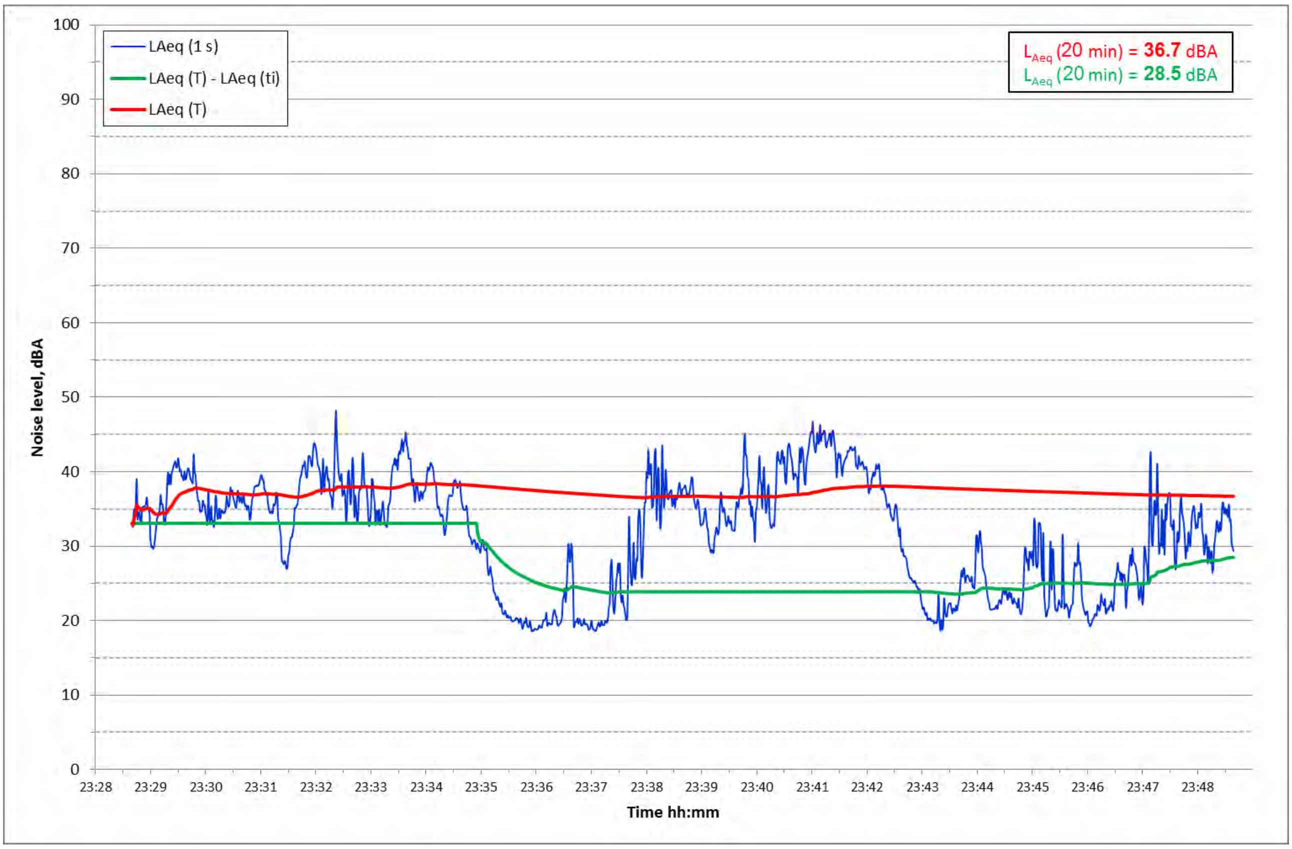


a)

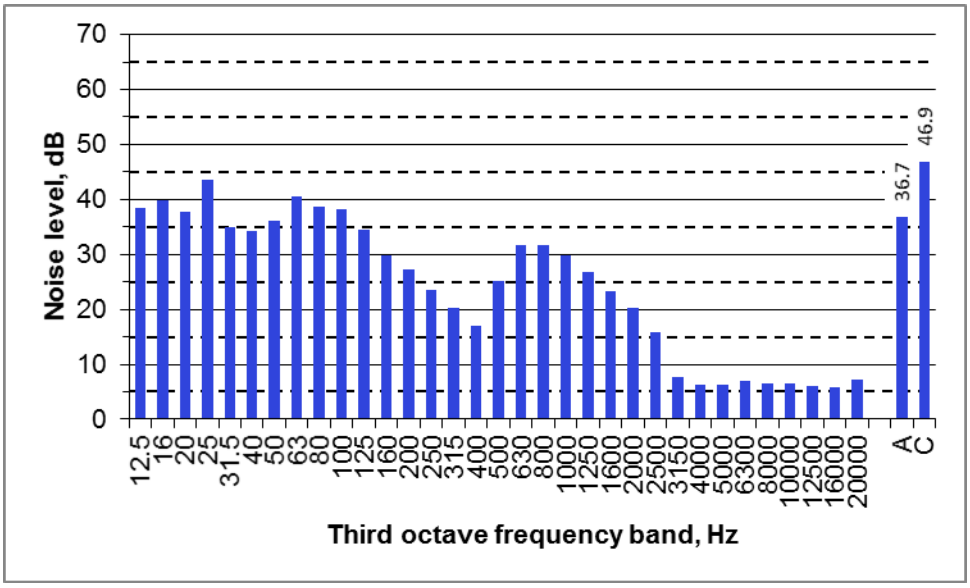


b)

Figure D-1: Ambient noise level measured at P1 during the day: a) profile of the measurement and b) third octave band frequency spectrum measured in between passing road traffic.

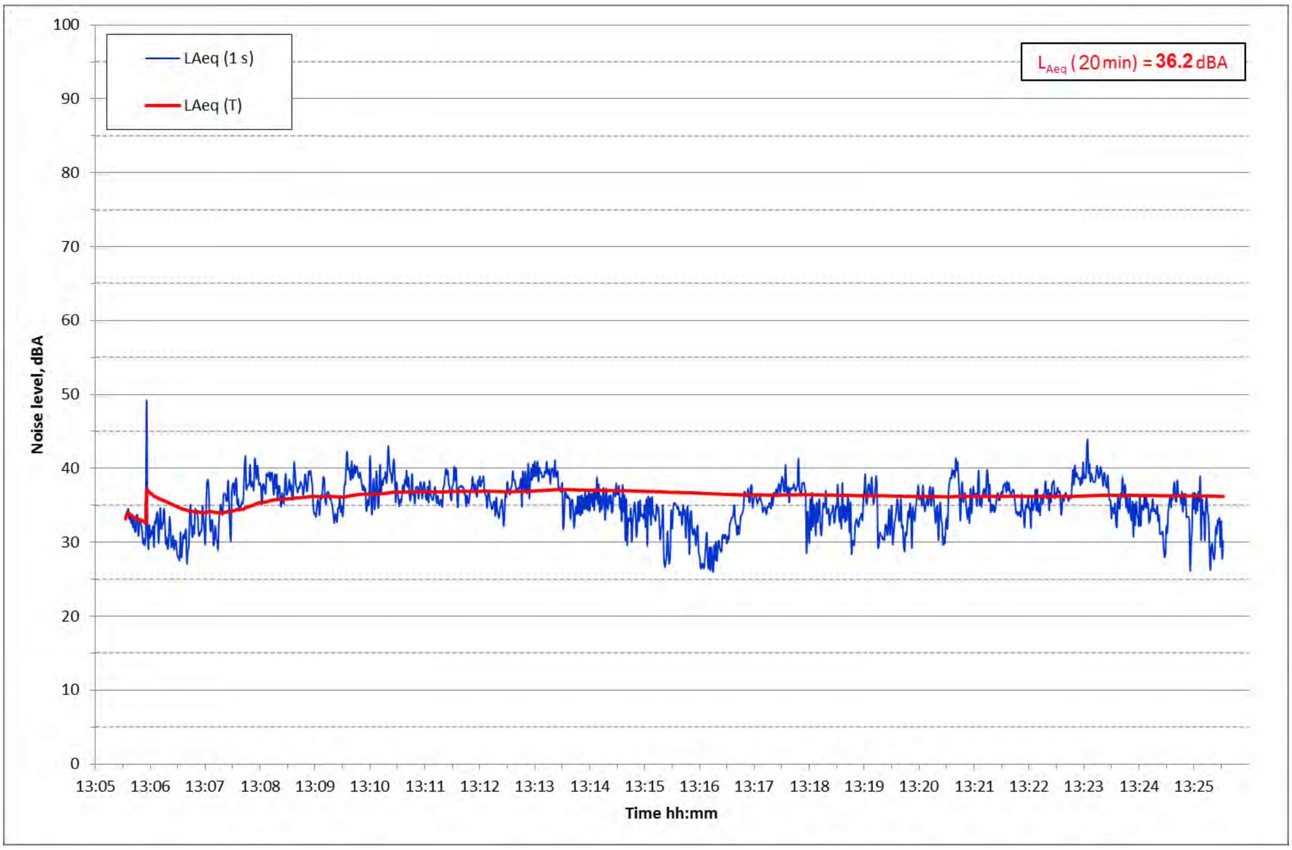


a)



b)

Figure D-2: Ambient noise level measured at P1 during the night: a) profile of the measurement and b) third octave band frequency spectrum measured in between passing road traffic. For the results given in green the noise energy of the single events have been removed.



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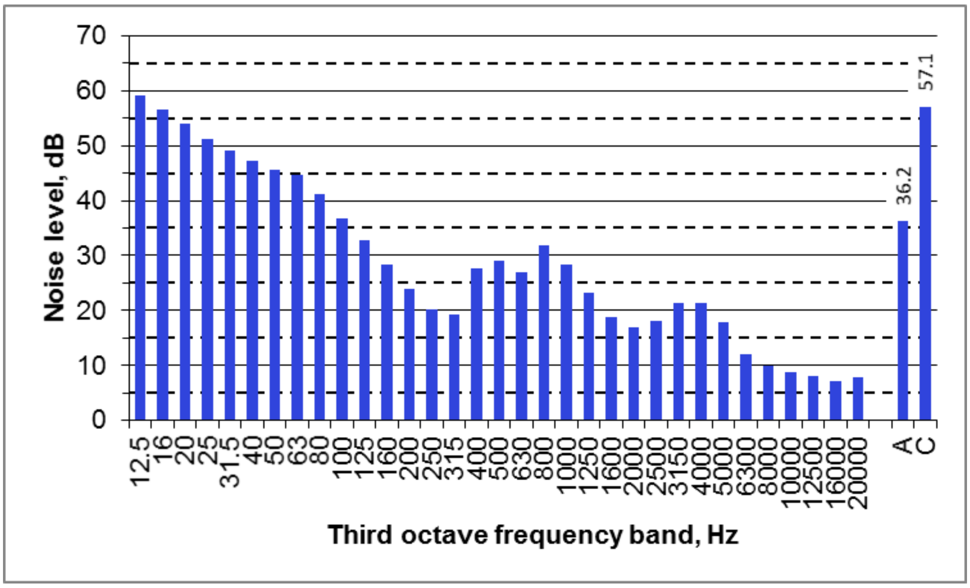
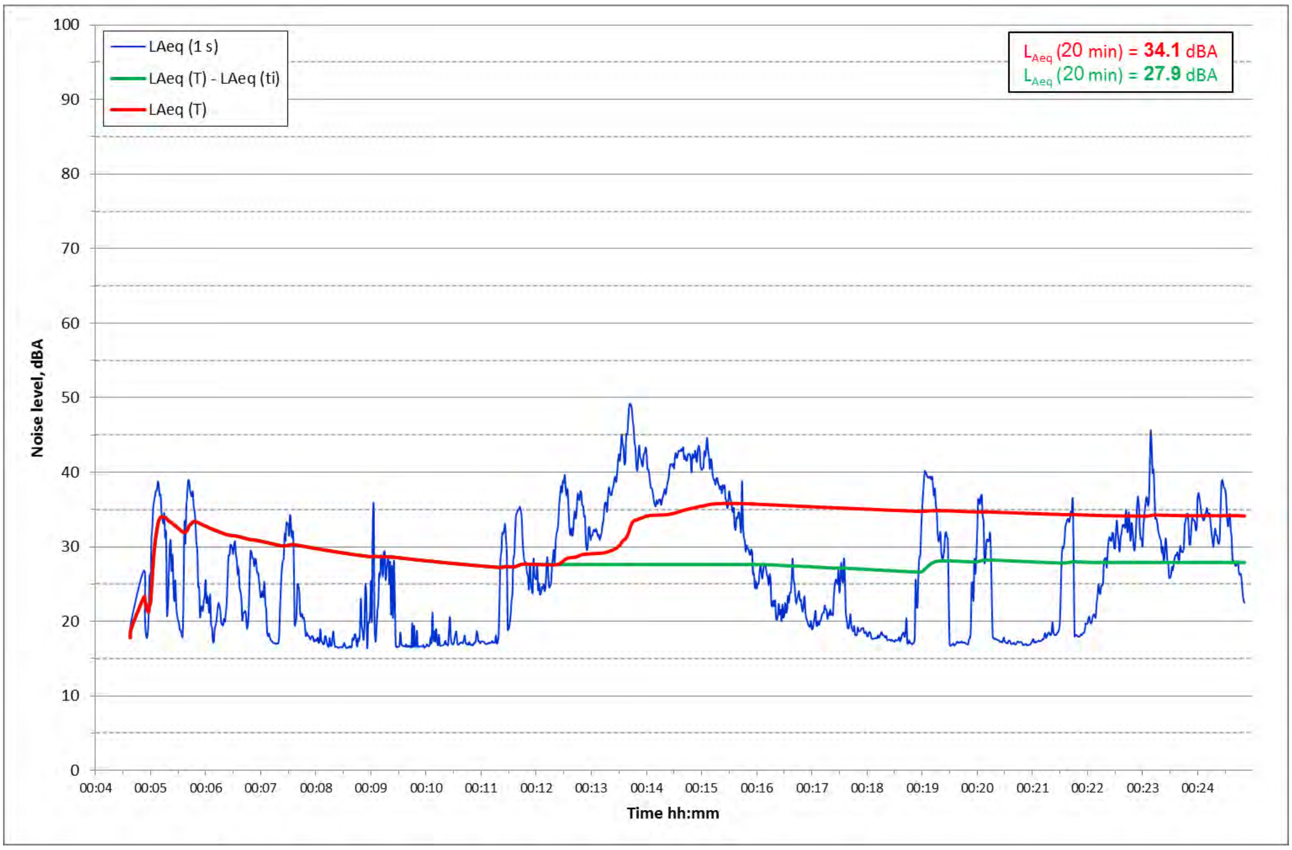


b)

Figure D-3: Ambient noise level measured at P2 during the day: a) profile of the measurement and b) third octave band frequency spectrum measured in between passing road traffic.



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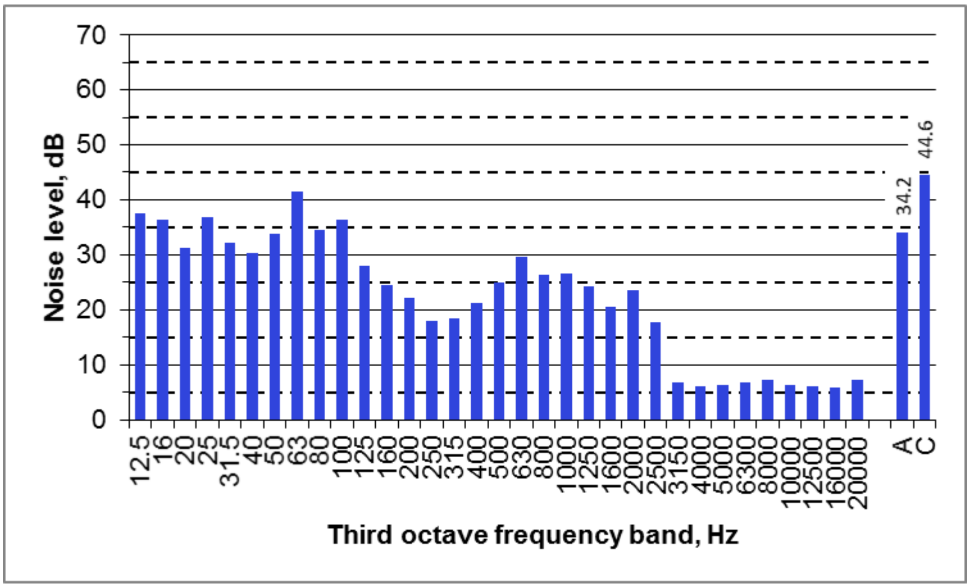
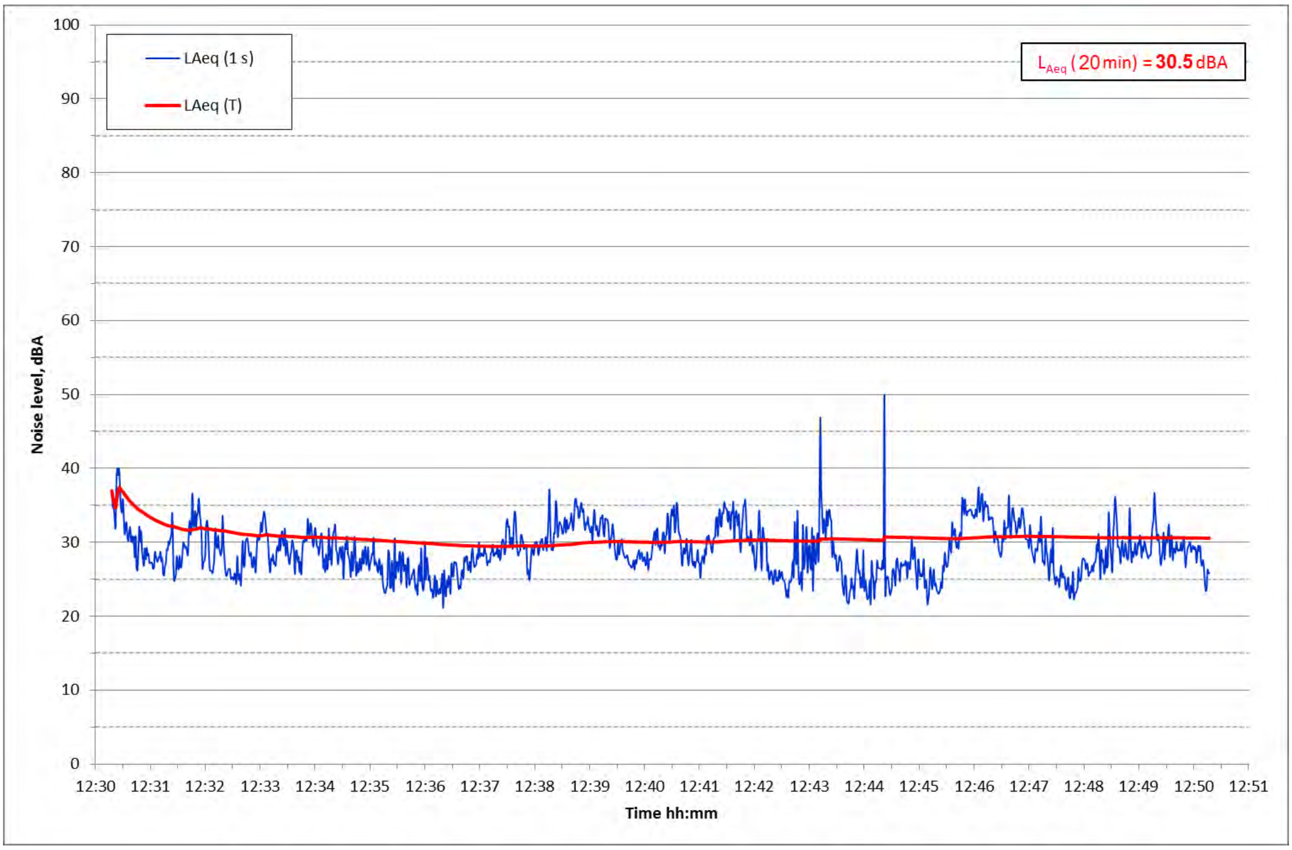


b)

Figure D-4: Ambient noise level measured at P2 during the night: a) profile of the measurement and b) third octave band frequency spectrum in between passing road traffic. For the results given in green the noise energy of the single events have been removed.



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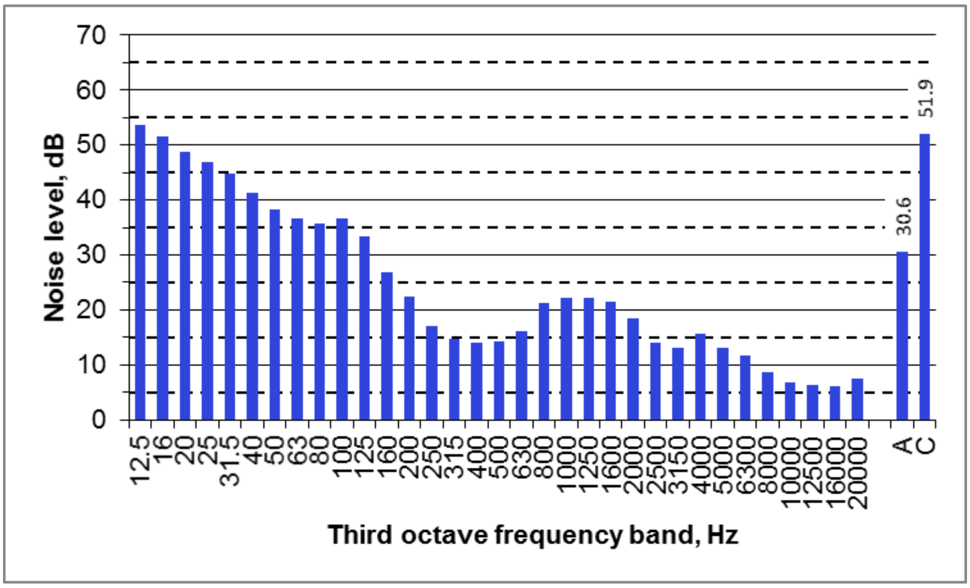
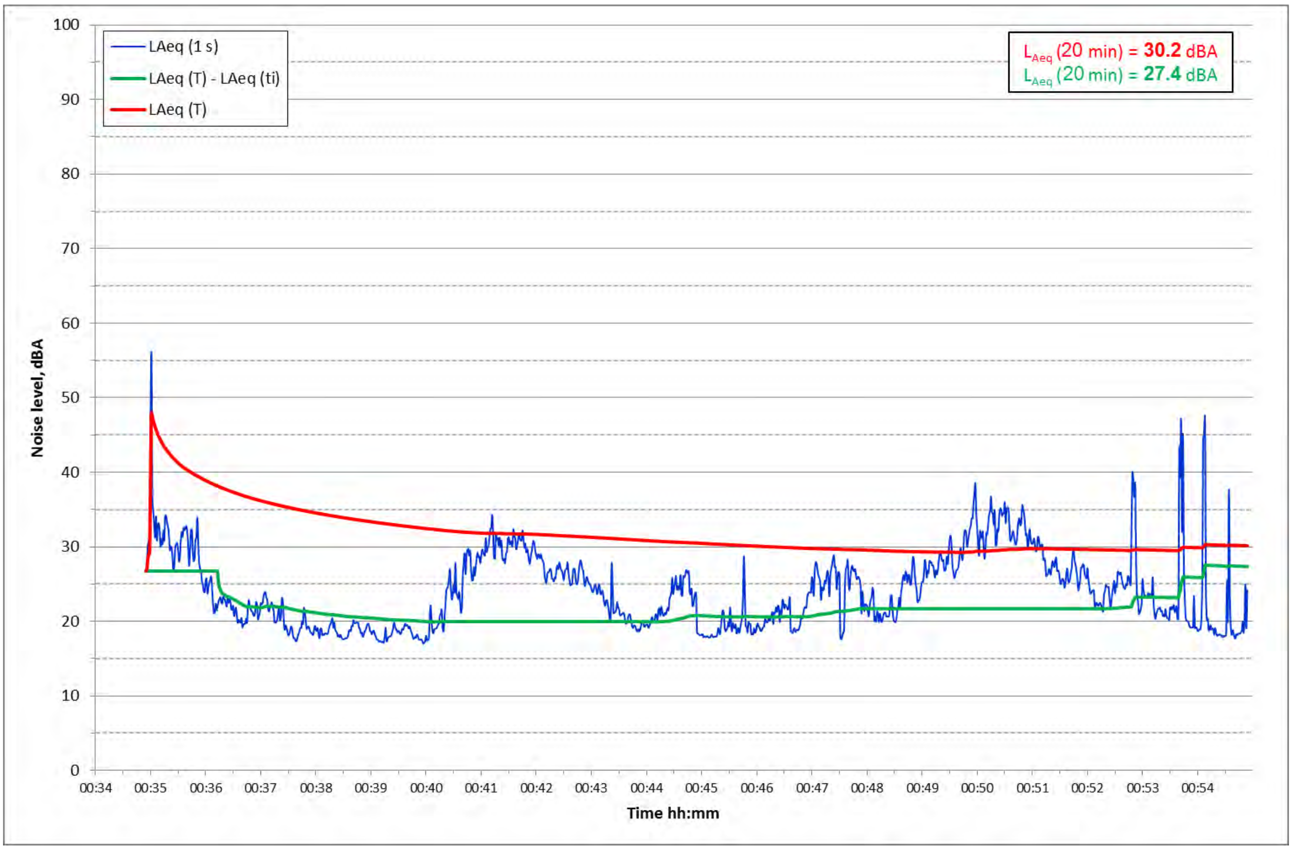
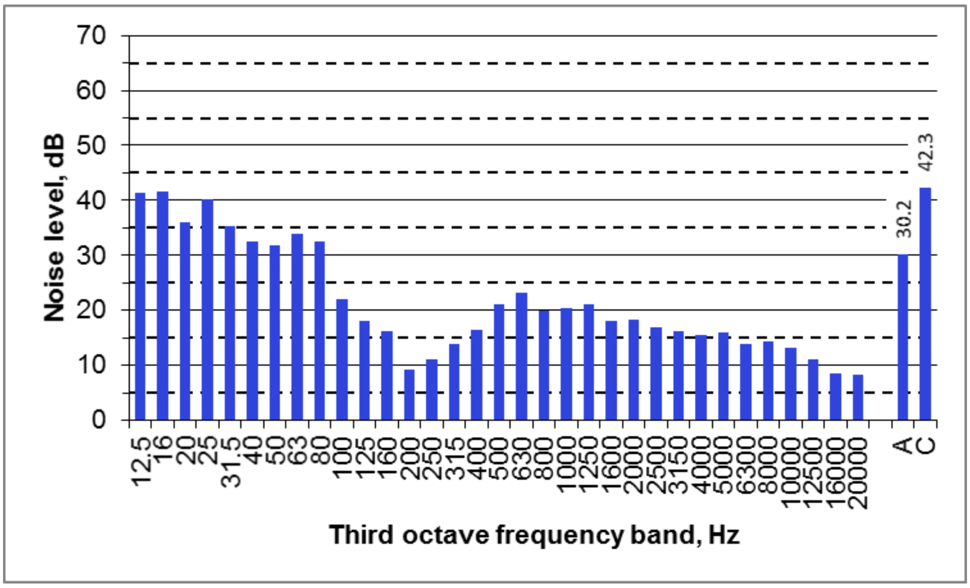


b)

Figure D-5: Ambient noise level measured at MP3 during the day: a) profile of the measurement and b) third octave band frequency spectrum.



a)



b)

Figure D-6: Ambient noise level measured at MP3 during the night: a) profile of the measurement and b) third octave band frequency spectrum during a quiet period. For the results given in green the noise energy of the single events have been removed.

Appendix G5: Blasting Specialist Study

Blast Management & Consulting

Report: Blast Impact Assessment

Environmental Impact Assessment for a proposed
Underground Coal Mine, Mpumalanga
Elders Colliery Project

Prepared for:
SRK Consulting (South Africa) (Pty) Ltd
On behalf of
Anglo Operations (Pty) Ltd
September 2015

BM&C Ref No:	SRK~Elders Colliery Project~EIAReport150916V00.docx
Client Project Ref No:	484436

Quality Service on Time

Date: 2015/09/16

Signed:
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ii. Study Team Qualifications And Background

The study team comprises of JD Zeeman as member of Blast Management & Consulting and Blast Management & Consulting employees. Blast Management & Consulting's main areas of concern are Pre-blast consultation and monitoring, Insitu monitoring, Post blast monitoring and consulting as well as specialised projects. Blast Management & Consulting has been active in the mining industry since 1997 and work has been done on various levels for mining companies in South Africa, Botswana, Namibia, Mozambique, Democratic Republic of Congo, Sierra Leone and Côte d'Ivoire.

I have obtained the following Qualifications:

1985 - 1987	Diploma: Explosives Technology, Technikon Pretoria
1990 - 1992	BA Degree, University Of Pretoria
1994	National Higher Diploma: Explosives Technology, Technikon Pretoria
1997	Project Management Certificate: Damelin College
2000	Advanced Certificate in Blasting, Technikon SA

Member: International Society of Explosives Engineers

iii. Independence Declaration

Blast Management & Consulting is an independent company. The work done for the report was performed in an objective manner and according to national and international standards, even if the results and findings are not favourable to the client. Blast Management & Consulting has the expertise in conducting the specialist report relevant to the study. Blast Management will not engage in any conflicting interests in the undertaking of this study.

Document Control:

Name	Responsibility	Signature	Date
C Zeeman **Blast Management & Consulting**	**Document Preparation**	Zeeman	**16/09/2015**
JD Zeeman **Blast Management & Consulting**	**Consultant**		**16/09/2015**

Table of Contents

List of Acronyms used in this Report

Air Pressure Pulse	APP
Ammonium nitrate/fuel oil	ANFO
Blast Management & Consulting	BM&C
Burden (m)	B
Coordinates (South African)	WGS 84
Distance (m)	D
Duration	Dur
East	E
East	E
Environmental Impact Assessment	EIA
Explosive Mass (kg)	E
Explosives (Trinitrotoluene)	TNT
Frequency	Freq.
Gas Release Pulse	GRP
Interested and Affected Parties	I&AP
Magnitude/Severity	M/S
Maximum Throw (m)	L
Nitrogen Dioxide	NO_2
Nitrogen Monoxide	NO
Nitrogen Oxide	NOx
North	N
North East	NE
North West	NW
Noxious Fumes	NOx's
Peak Particle Velocity	PPV
Points of Interest	POI
Probability	P
Rock Pressure Pulse	RPP
Scale	Sc
Scaled Burden ($m^{3/2}kg^{-1/2}$)	Bs
Site Constant	a and b
South	S
South East	SE
South West	SW
Stemming height (m)	SH
United States Bureau of Mine	USBM
West	W
With Mitigation Measures	WM
Without Mitigation Measures	WOM

List of Units used in this Report

Air Blast	dB
Air Blast Limit	dBL
Blasted Tonnage	T
Centimetre	cm
Charge Energy	MJ
Charge Height	m
Charge mass / m (kg/m)	Mc
Cup Density	Gr/cm^3
Drill hole angle	θ
Energy Factor	MJ/m^3 or MJ/t
Factor value	k
Frequency	Hz
Gravitational constant	g
Ground Vibration	mm/s
Kilometre	km
kPa	kilopascal
Latitude/Longitude Hours/degrees/minutes/seconds	Lat/Lon hddd°mm'ss.s"
Mass	kg
Meter	m
Milliseconds	ms
Parts per million	ppm
Pascal	Pa
Peak Acceleration	mm/s^2
Peak Displacement	mm
Peak Particle Velocity	mm/s
Percentage	%
Pounds per square inch	psi
Powder Factor	kg/m^3
Powder factor	kg/m^3 or kg/t
Vector Sum Peak Particle Velocity	mm/s
Volume	m^3

List of Figures

List of Tables

Executive Summary

Blast Management & Consulting (BM&C) was contracted as part of Environmental Impact Assessment (EIA) to perform an initial review of possible impacts with regards to blasting operations in the proposed new opencast mining operation. Ground vibration, air blast, fly rock and fumes are some of the aspects as a result from blasting operations. The report concentrates on the ground vibration and air blast intends to provide information, calculations, predictions, possible influences and mitigations of blasting operations for this project.

The proposed new box-cut for the Elders project was evaluated for the effects yielded by blasting operations over an area as wide as 1500 m. The range of structures observed in this area is mainly the R35 tarred roads, the Middelkraal community, the Olifants River, the Viskuile River, other small informal settlement, farm steads and water boreholes. The project evaluated consists mainly of one box-cut that will provide access to underground mining operations. There are currently no blasting operations conducted on site.

The project area has possibility of presence of people and possibly farm animals at close distances to the operations when blasting of the box-cut is done. The location of structures around the box-cut area is such that the charge evaluated showed possible influences due to ground vibration. This is mainly for the R35 Road and new infrastructure for the project. Ground vibration mitigation will be required for these structures. Ground vibrations predicted ranged between very low levels and very high at 519 mm/s for points of interest identified. Ground vibration at structures and installations other than the identified problematic structures is well below any specific concern for inducing damage. There is a possibility that ground vibration may be perceptible at the Middelkraal settlement.

Air blast levels indicate fewer concerns than ground vibration. Air blast predicted for the maximum charge ranges between 113 and 117 dB where structures are of concern. The predictions indicate that air blast levels at nearest house structures are low and not expected to have any significant influence or reason for damage concern. Complaints from air blast are normally based on the actual effects that are experienced due to rattling of roof, windows, doors etc. These effects could startle people and raise concern of possible damage.

An exclusion zone for safe blasting was also calculated. The exclusion zone was established to be at least 207 m. Normal practice observed in mines is a 500 m exclusion zone. The use of 500 m exclusion zone is rather recommended.

There are various water boreholes that are located relatively far from the box-cut area. The locations are such that no possible permanent damage is likely.

Recommendations were made that should be considered. Specifically for monitoring of ground vibration and air blast, save blasting zones, blast design, road closures, safe ground vibration and air blast limits, stemming lengths, blasting times and monitoring of blasting operations.

This concludes this investigation for the Elders Colliery Underground Mine Project. It will be possible to develop the box-cut in a safe and effective manner provided attention is given to the areas of concern and recommendations as indicated.

1 Introduction

The proposed Elders Colliery is located approximately 25 km north of Bethal on the R35 provincial road towards Middelburg in the Mpumalanga Province. The project falls mainly within the Gert Sibande District Municipality and Govan Mbeki Local Municipality as well as in the Nkangala District Municipality and Steve Tshwete Local Municipality at coordinates (Lat/Lon WGS84) 26°14'6.37"S 29°28'8.84"E.

Anglo Operations (PTY) Ltd (AOL) proposes to develop a new box cut access at the Elders Colliery with 14 years Life of Mine (LOM), and to mine the No. 2 and No. 4 coal seams by means of board and pillar underground mining methods, making use of continuous miners and shuttle cars. The option analysis conducted during the project evaluation phase indicated that underground mining is deemed financially more feasible as an effective extraction method for the Elders project, although some open cast opportunity exit in the shallower portion of the resource and might be investigated later during the mine life.

The coal deposit is located close to the northern margin of the Highveld Coalfield. It is proposed to mine both the No. 2 and No. 4 seams via a box-cut to be used for personnel, material and coal clearance.

Blast Management & Consulting (BM&C) was contracted as part of Environmental Impact Assessment (EIA) to perform an initial review of possible impacts with regards to blasting operations in the proposed new box-cut. Ground vibration, air blast and fly rock are some of the aspects that result from blasting operations. This study will review possible influences that blasting may have on the surrounding area in respect of these aspects. The report concentrates on the ground vibration and air blast and intends to provide information, calculations, predictions, possible influences and mitigations of blasting operations for this project.

2 Objectives

The objective of this document is outlining the expected environmental effects that the box-cut blasting operations could have on the surrounding environment and proposal of specific mitigation measures that will be required. This study investigates the related influences of expected ground vibration, air blast and fly rock. These effects are investigated in relation to the surroundings of the blast site and possible influence on the neighbouring houses and owners or occupants.

The objectives are investigated taking specific protocols into consideration. The protocols applied in this document are based on the author's experience, guidelines from literature research, client requirements and general indicators from the various acts of South Africa. There is no direct reference in the following acts with regards to requirements and limits on the effect of ground vibration and air blast specifically and some of the aspects addressed in this report. The acts consulted are:

- National Environmental Management Act No. 107 of 1998,

- Mine Health and Safety Act No. 29 of 1996,
- Mineral and Petroleum Resources Development Act No. 28 of 2002 and
- Explosives Act No. 26 of 1956 and amended No. 15 of 2003.

The guidelines and safe blasting criteria are according international accepted standards and specific applied in this document is the United States Bureau of Mines (USBM) criteria for safe blasting for ground vibration and recommendations on air blast. There are no specific South African standard and the USBM is well accepted as standard for South Africa.

However it is sure that the protocols and objectives will fall within the broader spectrum as required by the various acts.

3 Scope of Blast Impact Study

The scope of the study is determined by the terms of reference to achieve the objectives. The terms of reference can be summarized according to the following steps taken as part of the EIA study with regards specifically to ground vibration and air blast due to blasting operations.

Background information of the proposed site
Structure Profile
Mining operations and Blasting Operation Requirements
Effects of blasting operations:
Ground vibration
Air blast
Fly rock
Site specific evaluation blasting effects for each area in relation to the points of interest identified
Risk Assessment
Mitigations
Recommendations
Conclusion

4 Study Area

The proposed Elders Colliery is located approximately 25 km north of Bethal on the R35 provincial road towards Middelburg in the Mpumalanga Province. The project falls mainly within the Gert Sibande District Municipality and Govan Mbeki Local Municipality as well as in the Nkangala District Municipality and Steve Tshwete Local Municipality at coordinates (Lat/Lon WGS84) 26°14'6.37"S 29°28'8.84"E.
Figure 1 shows a geographical locality plan of the proposed project area. Figure 2 shows view of the proposed mining area with layout of the underground mine location.

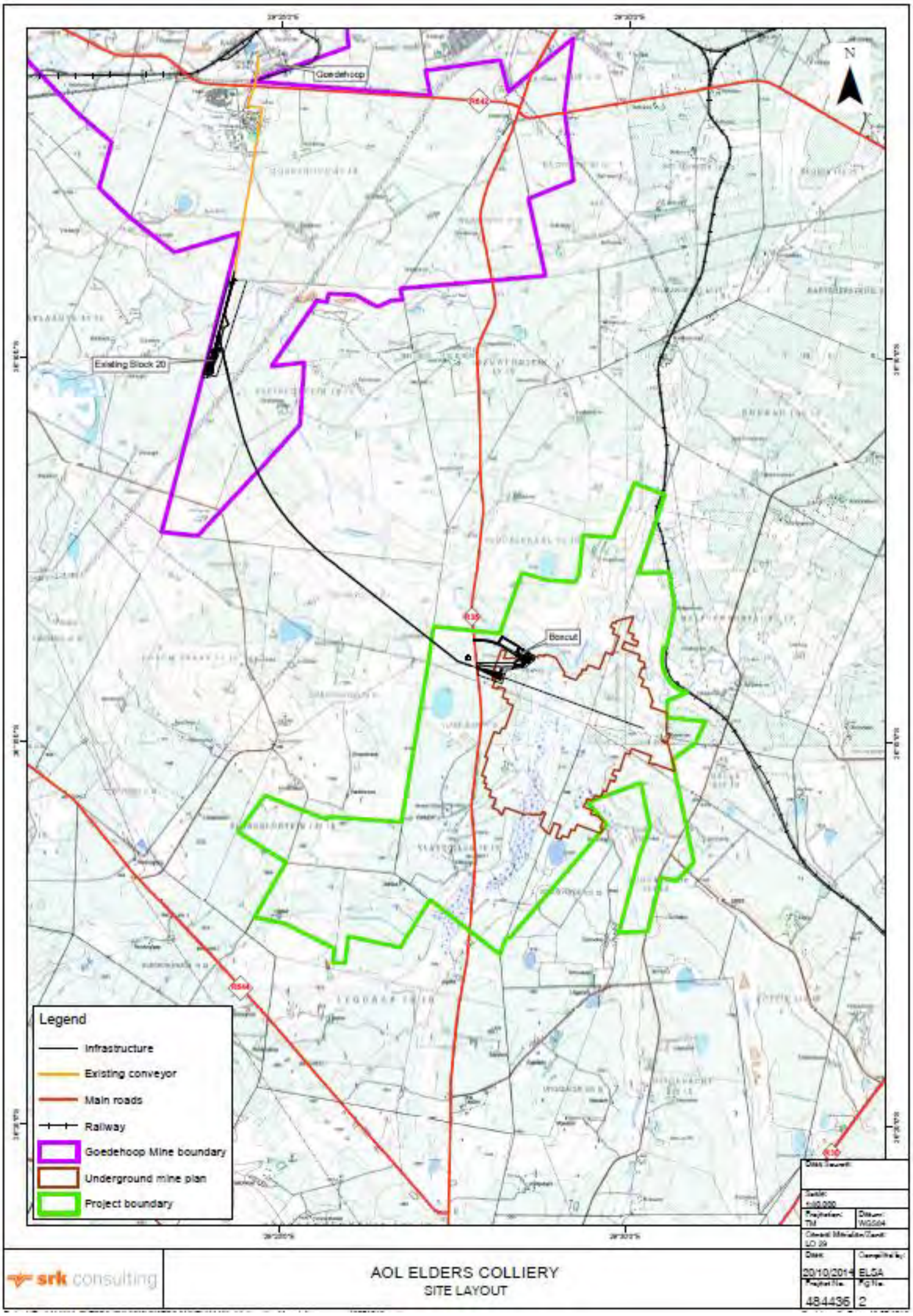

Figure 1: Locality map indicating the position of the proposed Mine area

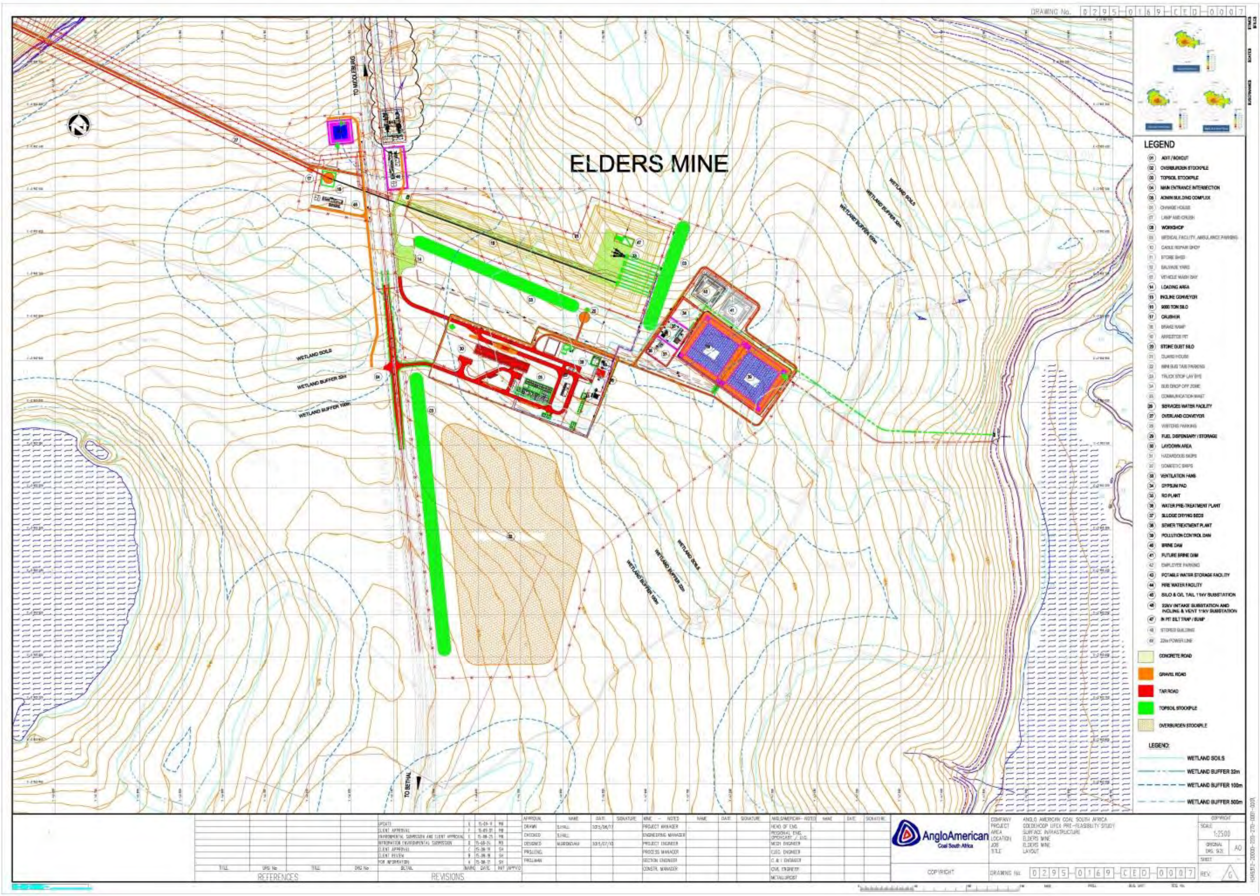

Figure 2: Proposed mining area layout

5 Methodology

The detailed plan of study consists of the following sections.

- Site visit: Intention to understand location of the site and its surroundings,
- Site Structure Profile: Identifying all surface structures / installations that are found with the 1500m possible influence area. A list of POI's are created that will be used for evaluation.
- Base line influence or Blast Monitoring: The project evaluated is a new operation with no blasting activities currently being done. No monitoring is thus specifically required as baseline is considered zero with no influence.
- Site evaluation: This consists of evaluation of the mining operations and the possible influences from blasting operations. The methodology consists of modelling the expected impact based on expected drilling and blasting information for the project. Various accepted mathematical equations are applied to determine the attenuation of ground vibration, air blast and fly rock. These values are then calculated over distance investigated from site and shown as amplitude level contours. Overlay of these contours with the location of the various receptors then give indication of the possible impact and expected result of potential impact. Evaluation of each receptor according to the predicted levels will then give indication of possible mitigation

measures to be done or not. The possible environmental or social impacts are then addressed in the detailed EIA phase investigation.

- Reporting: All data is prepared in a single report and provided for review.
- Presentation: Outcome of investigation can then be presented firstly to client and secondly to the public (I&AP) where necessary.

6 Assumptions and Limitations

The project is at a stage where certain assumptions and limitations are applicable. There is at this stage no planned blast design for the new box-cut. A design for similar type operations had to be used to determine impacts and to evaluate these impacts. Box-cut operations have possibility of influence specific in relation to aspects such as ground vibration, air blast and fly rock.

6.1 Mining and Blasting Operations

Conventional box-cut establishing will consist of drilling, blasting, loading and hauling operations.
A blast design for a box-cut of similar design as presented here was used as basis for expected drilling, charging and blasting operations.
The following information is data taken from a blast design done on specific blast design software. Information retrieved for this planned blast is the blast technical specifications and simulations that provide information of detonation sequence and maximum charge mass detonating. The information provided shows only one design of 6 blasts that was required for this box-cut. The Elders box-cut is expected to very similar in design and layout of the blasts.
Table 1 below summarises the blast design information for the design used. A blast design is required in order to determine expected outcomes from blast operations. Figure 3 shows the design layout and simulation for the blast used as an example.

Table 1: Information on blast designs used

DESIGN FACTORS FOR:			
Blast Name:	Blast03		
Scenario:	10	Scenario 10	
Area Option:	Blast03	23.00	
Hole Option:	Blast03	24	
Deck Option:	Blast03	25	
Downhole Delay Option:	Blast03	26	
Surface Delay Option:	Blast03	27	
Using Marked Holes and blast Parameters:			
	Av. Burden	4	m
	Av. Spacing	4	m
	All Hole Lengths	4 704.900	m
	Volume	75 278.400	m^3
	Rock SG	2.64	
	Tonnage	198 734.976	tonnes

	Marked Holes	371	
	Charge Mass	50 702.803	kg
	Charge Energy	134 615.941	MJ
	POWDER FACTOR	0.674	kg/m³
	POWDER FACTOR	0.255	kg/t
	ENERGY FACTOR	1.788	MJ/m³
	ENERGY FACTOR	0.677	MJ/t

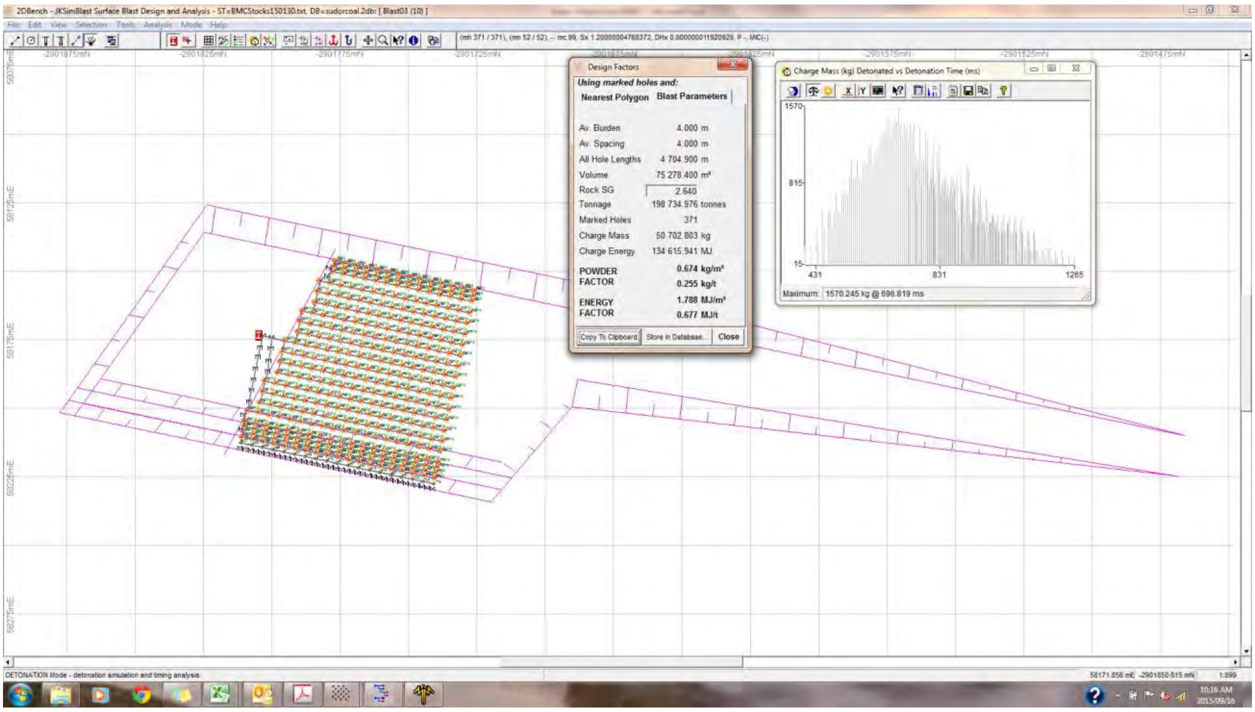

Figure 3: Box-cut layout with blast simulation

6.2 The process of a blasting operation

Blasting operations are done to achieve a specific result, breaking rock and moving the material to facilitate effective loading of the broken material. A block identified for blasting is identified and marked. A pattern of blast hole positions are marked and the required depths is drilled. After drilling the blast holes are loaded with an initiation system and explosives. The initiation system will initiated the main explosives column. The explosives energy performs work on the blast hole side wall – cracking the material and eventually moves the material into a desired direction leaving material in one heap. The blast holes are not loaded to the top of the blast hole. Space is left for stemming material that is loaded on top of the explosives to the rim of the blast hole. The stemming material acts to contain the energy of the explosives to ensure the energy is working where it is required – breaking rock. When charging of blast holes is done a surface initiation system is laid out. This surface initiation is designed to ensure initiation of the blast holes in a particular sequence. This sequence provides mechanism for proper fragmentation and movement of the material blasted. Energy of different explosives varies. How the energy work is also dependant on factors such as rock type, burdens, spacing, quantity etc.

Rock is affected by detonating explosives in three principal stages. Firstly crush of blast hole walls. Secondly compressive stress waves in all directions. Thirdly released gas volume is forced into the cracks and the material is moved. In this blast process there are specific effects occurring. Some of the energy not completely used is transmitted outwards from the blast hole, much like a stone thrown in a pool of water and the ripples that moves outwards. This leaves to fact that blast operations do have effects on its immediate surrounding area. These effects manifesting in various forms of which the level or intensity is reason for prediction, evaluation and risk analysis in this report. These effects can manifest in the form of ground vibration and air blast. Additionally to this we need to considered effects such as fumes and fly rock as which are normally specific negative effects that can occur. The application of explosives breaking rock will always have a positive and negative manifestation of different energies. It is the effects that have negative outcome that we concentrate on and that will need to be managed. The following sections address the reason, prediction, modelling and control on aspects like ground vibration, air blast, fly rock and fumes.

7 Legal Requirements

The protocols applied in this document are based on the author's experience, guidelines from literature research, client requirements and general indicators from the various acts of South Africa. There is no direct reference in the following acts with regards to requirements and limits on the effect of ground vibration and air blast specifically and some of the aspects addressed in this report. The acts consulted are: National Environmental Management Act No. 107 of 1998, Mine Health and Safety Act No. 29 of 1996, Mineral and Petroleum Resources Development Act No. 28 of 2002 and the Explosives Act Explosives Act No. 26 of 1956 and amended No. 15 of 2003.

The guidelines and safe blasting criteria are according international accepted standards and specific applied in this document is the United States Bureau of Mines (USBM) criteria for safe blasting for ground vibration and recommendations on air blast. There are no specific South African standard and the USBM is well accepted as standard for South Africa. Additional criteria as required by various institutions in South Africa i.e. Eskom, Telkom, Transnet, Rand Water Board etc. is also taken into consideration.
The protocols and objectives will fall within the broader spectrum as required by the various acts.

8 Sensitivity of Project

Review of the project area and areas surrounding before any specific analysis a sensitivity mapping is done based on typical areas and distances from the proposed box-cut area. This sensitivity map uses mainly distances normally associated where possible influences may occur or is not expected to occur. Two different areas where identified for this. Firstly a high sensitive area of 500 m area around the mining area is identified. Normally the 500 m is considered an area that should be cleared from all people and animals prior to blasting. Levels of ground vibration and air blast are also expected to be higher closer to the pit area. Secondly an area of 500 m to 1500 m around the pit area that can be considered as medium sensitive is identified. In this area the possibility of influence is still expected but definitely lower impact. The expected level of influence to be low but there may still be reason for concern as levels could be less than to cause structure damage but may still upset people. Figure 3 shows the sensitivity mapping with identified POI's and surrounding areas. The specific influences will be determined through the worked done for this project in this report.

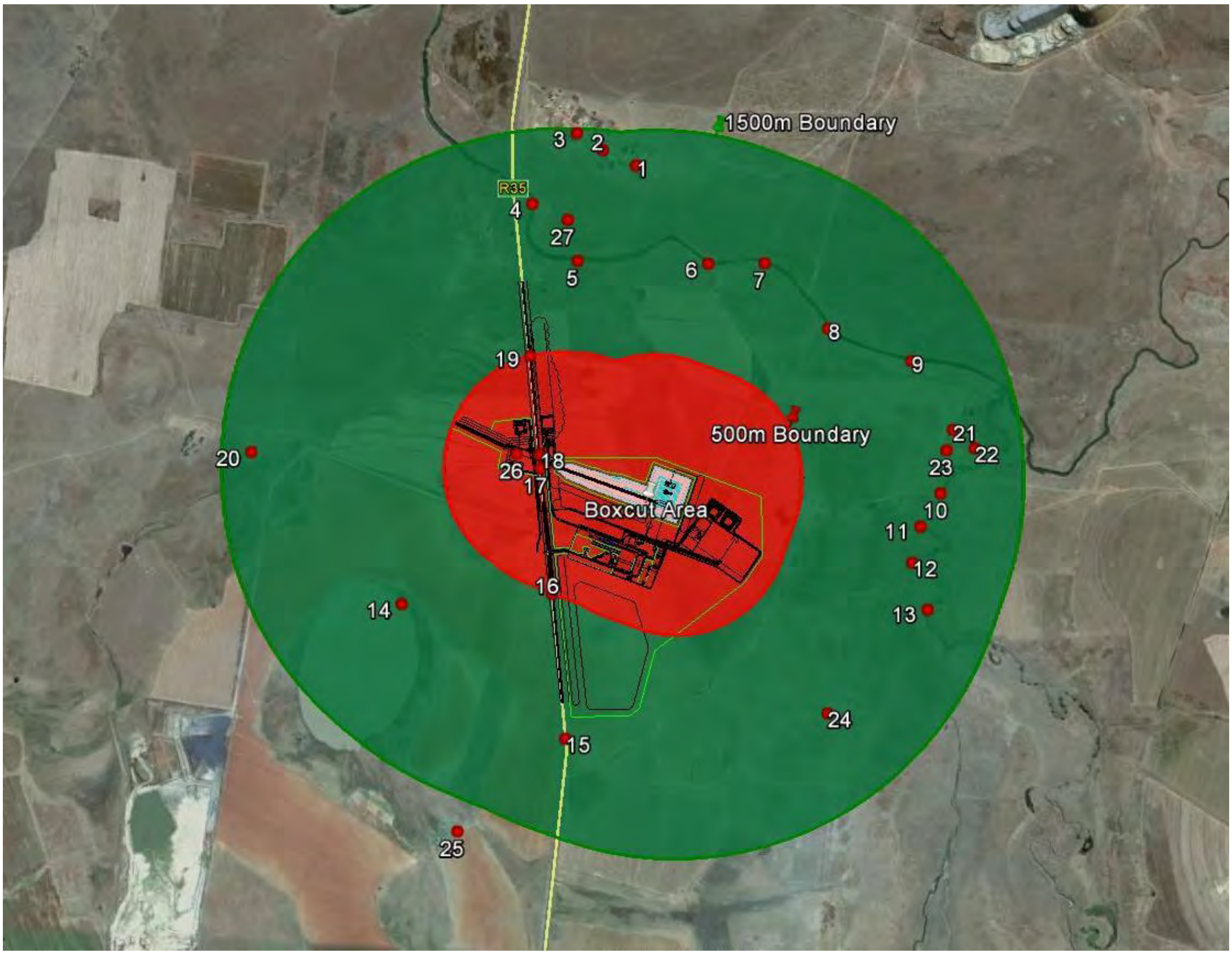

Figure 4: Identified sensitive areas

9 Consultation process

No specific consultation with external parties was utilised. The work done is based on the author's knowledge and information provided by the client.

10 The expected effects from blasting operations

Blasting operations have effect to its surroundings. These effects can manifest in the form of ground vibration, air blast, fumes, fly rock etc. The application of explosives breaking rock will always have a positive and negative manifestation of different energies. It is the effects that have negative outcome that we concentrate on and that will need to be managed. The following sections address the reason, prediction, modelling and control on aspects like ground vibration, air blast, fly rock and fumes.

10.1 Ground vibration

Explosives are used to break rock through the shock waves and gasses yielded from the explosion. Ground vibration is a natural result from blasting activities. The far field vibrations are inevitable, but un-desirable by products of blasting operations. The shock wave energy that travels beyond the zone of rock breakage is wasted and could cause damage and annoyance. The level or intensity of these far field vibration is however dependant on various factors. Some of these factors can be controlled to yield desired levels of ground vibration and still produce enough rock breakage energy.

Factors influencing ground vibration are the charge mass per delay, distance from the blast, the delay period and the geometry of the blast. These factors are controlled by planned design and proper blast preparation.

The larger the charge mass per delay - not the total mass of the blast, the greater the vibration energy yielded. Blasts are timed to produce effective relief and rock movement for successful breakage of the rock. A certain quantity of holes will detonate within the same time frame or delay and it is the maximum total explosive mass per such delay that will have the greatest influence. All calculations are based on the maximum charge detonating on a specific delay.

Secondly is the distance between the blast and the point of interest / concern. Ground vibrations attenuate over distance at a rate determined by the mass per delay, timing and geology. Each geological interface a shock wave encounters will reduce the vibration energy due to reflections of the shock wave. Closer to the blast will yield high levels and further from the blast will yield lower levels.

Thirdly the geology of the blast medium and surroundings has influences as well. High density materials have high shock wave transferability where low density materials have low transferability of the shock waves. Solid rock i.e. norite will yield higher levels of ground vibration than sand for the same distance and charge mass. The precise geology in the path of a shock wave cannot be observed easily, but can be tested for if necessary in typical signature trace studies - which are discussed shortly below.

10.1.1 Ground Vibration Prediction

When predicting ground vibration and possible decay, a standard accepted mathematical process of scaled distance is used. The equation applied (Equation 1) uses the charge mass and distance with two site constants. The site constants are specific to a site where blasting is to be done. In the absence of actual mining operations being conducted and measurements done from blasting a

general set of site constants is used until such time that the site constant can be tested. The specific site constants used are factors that have significant safety factor build in to cater for unknown geology. In new opencast operations a process of testing for the constants can be done using a signature trace study in order to predict ground vibrations more accurately. The analysis of the data in such a study will also give an indication of frequency decay over distance. The utilization of the scaled distance prediction formula is standard practice.
Equation 1:

$$\mathrm{PPV} = \mathrm{a}\left(\frac{\mathrm{D}}{\sqrt{\mathrm{E}}}\right)^{-\mathrm{b}}$$

Where:
PPV = Predicted ground vibration (mm/s)
a = Site constant
b = Site constant
D = Distance (m)
E = Explosive Mass (kg)

Applicable and accepted factors a&b for new operations is as follows:
Factors:
a = 1143
b = -1.65

Utilizing the abovementioned equation and the given factors, allowable levels for specific limits and expected ground vibration levels can then be calculated for various distances.

Review of the type of structures that are found within the possible influence zone of the proposed mining area and the limitations that may be applicable, different limiting levels of ground vibration will be required. This is due to the typical structures and installations observed surrounding the site and location of the project area. Structures types and qualities vary greatly and this calls for limits to be considered as follows: 6 mm/s, 12.5 mm/s levels and 25 mm/s at least.

The blast design indicates that a maximum charge loaded in a single blast hole is 195 kg and detonation simulation shows that 1570 kg charge mass could be detonating simultaneously. This range of charge mass will span the expected charging to be done in this area. These charge masses were used for modelling aspects in this report. Applying the above charge masses, various ground vibration calculations were done and considered in this report.

Based on the designs presented on expected drilling and charging design, the following Table 2 shows expected ground vibration levels (PPV) for various distances calculated at the two different charge masses. A low charge mass and a maximum charge mass as worst case scenario. The charge masses are 195 kg and 1570 kg.

Table 2: Expected Ground Vibration at Various Distances from Charges Applied in this Study

No.	Distance (m)	Expected PPV (mm/s) for 195 kg Charge	Expected PPV (mm/s) for 1570 kg Charge
1	50.0	139.3	778.7
2	100.0	71.4	398.9
3	150.0	22.7	127.1
4	200.0	14.1	79.1
5	250.0	9.8	54.7
6	300.0	7.2	40.5
7	400.0	4.5	25.2
8	500.0	3.1	17.4
9	600.0	2.3	12.9
10	700.0	1.8	10.0
11	800.0	1.4	8.0
12	900.0	1.2	6.6
13	1000.0	1.0	5.6
14	1250.0	0.7	3.8
15	1500.0	0.5	2.8
16	1750.0	0.4	2.2
17	2000.0	0.3	1.8
18	2500.0	0.2	1.2
19	3000.0	0.2	0.9
20	3500.0	0.1	0.7

Figure 5 below shows the relationship of ground vibration over distance for the three charges considered as given in Table 2 above. The attenuation of ground vibration over distance is clearly observed. Ground vibration attenuation follows a logarithmic trend and the graph indicates this trend. Indicated on the graph as well are the limits that should be applicable due to the various structures and types of installations in this area as given above. The graph can be used to scale expected ground vibration at specific distances for the same maximum charges as used in this report. The expected vibration level at specific distance can be read from the graph, provided the same maximum charges are applicable, or by rough estimate if the charge per delay should be between the charge masses applied for this case.

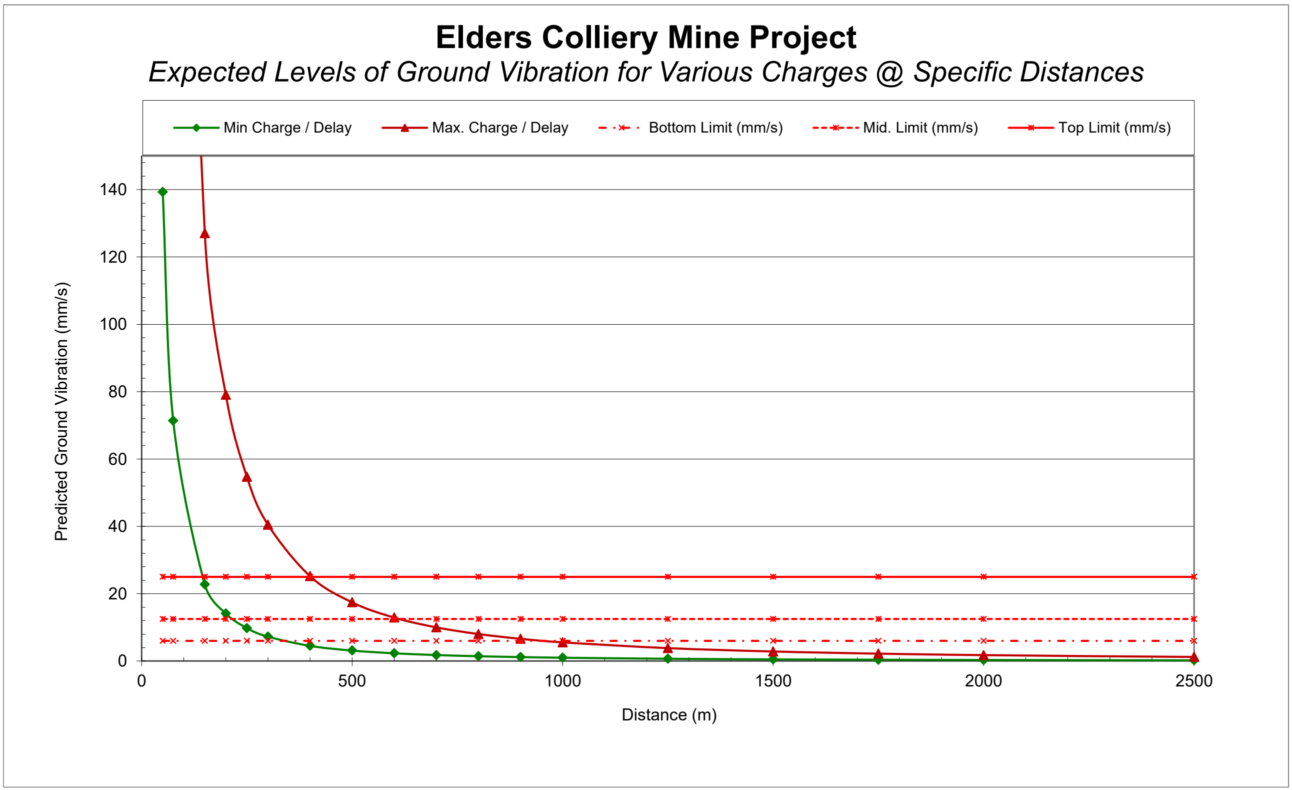

Figure 5: Ground vibration over distance for the two charge masses used in modelling

10.1.2 Ground vibration limitations on structures

Limitations on ground vibration are in the form of maximum allowable levels or intensity for different installations and / or structures. There are no specific South African standards or criteria for safe ground vibration levels. Ground vibration limits are dependent on the intensity and frequency of the ground vibration.

Currently the United States Bureau of Mines (USBM) criterion for safe blasting is applied as an industry standard where private structures are of concern. This is a process of evaluating the vibration amplitudes and frequency of the vibrations according to set rules for preventing damage. The vibration amplitudes and frequency is then plotted on a graph. Low frequency of ground vibration will allow for low levels of ground vibration and high levels of ground vibration will allow for high levels of ground vibration. Figure 6 below shows a graph of the USBM analysis for safe ground vibration levels. Data is inserted to demonstrate typical results. The graph indicates two main areas:

- Safe ground vibration levels: Analysed data is displayed in the bottom half of the graph.
- Unsafe ground vibration levels: Analysed data is displayed in the top half of the graph.

Figure 6: USBM Analysis Graph

Additional limitations that should be considered are as follows, these were determined through research and various institutions:

- National Roads/Tar Roads: 150 mm/s
- Steel pipelines: 50 mm/s
- Electrical Lines: 75 mm/s
- Railway: 150 mm/s
- Concrete aged less than 3 days: 5 mm/s
- Concrete after 10 days: 200 mm/s
- Sensitive Plant equipment: 12 mm/s or 25 mm/s depending on type – some switches could trip at levels less than 25 mm/s.

Considering the above limitations, BM&C work is based on the following:

- USBM criteria for safe blasting
- The additional limitations provided
- Consideration of private structures
- Should these structures be in poor condition is the basic limit of 25 mm/s reduced to 12.5 mm/s or even when structures are in very poor condition limits will be restricted to 6 mm/s
- We also consider the input from other consultants in the field locally and internationally.

10.1.3 Ground vibration limitations with regards to human perceptions

A further aspect of ground vibration and frequency of vibration is the human perception. It should be realized that the legal limit for structures is significantly greater than the comfort zones for people. Humans and animals are sensitive to ground vibration and vibration of the structures. Research has shown that humans will respond to different levels of ground vibration and at different frequencies.

Ground vibration is experienced as “Perceptible”, “Unpleasant” and “Intolerable” (only to name three of the five levels tested) at different vibration levels for different frequencies. This is indicative of the human’s perceptions on ground vibration and clearly indicates that humans are sensitive to ground vibration. This “tool” is only a guideline and helps with managing ground vibration and the respective complaints that people could have due to blast induced ground vibrations. Humans already perceive ground vibration levels of 4.5 mm/s as unpleasant. (See Figure 7).
Generally people also assume that any vibrations of the structure - windows or roofs rattling - will cause damage to the structure. Air blast also induces vibration of the structure and is the cause of nine out of ten complaints.

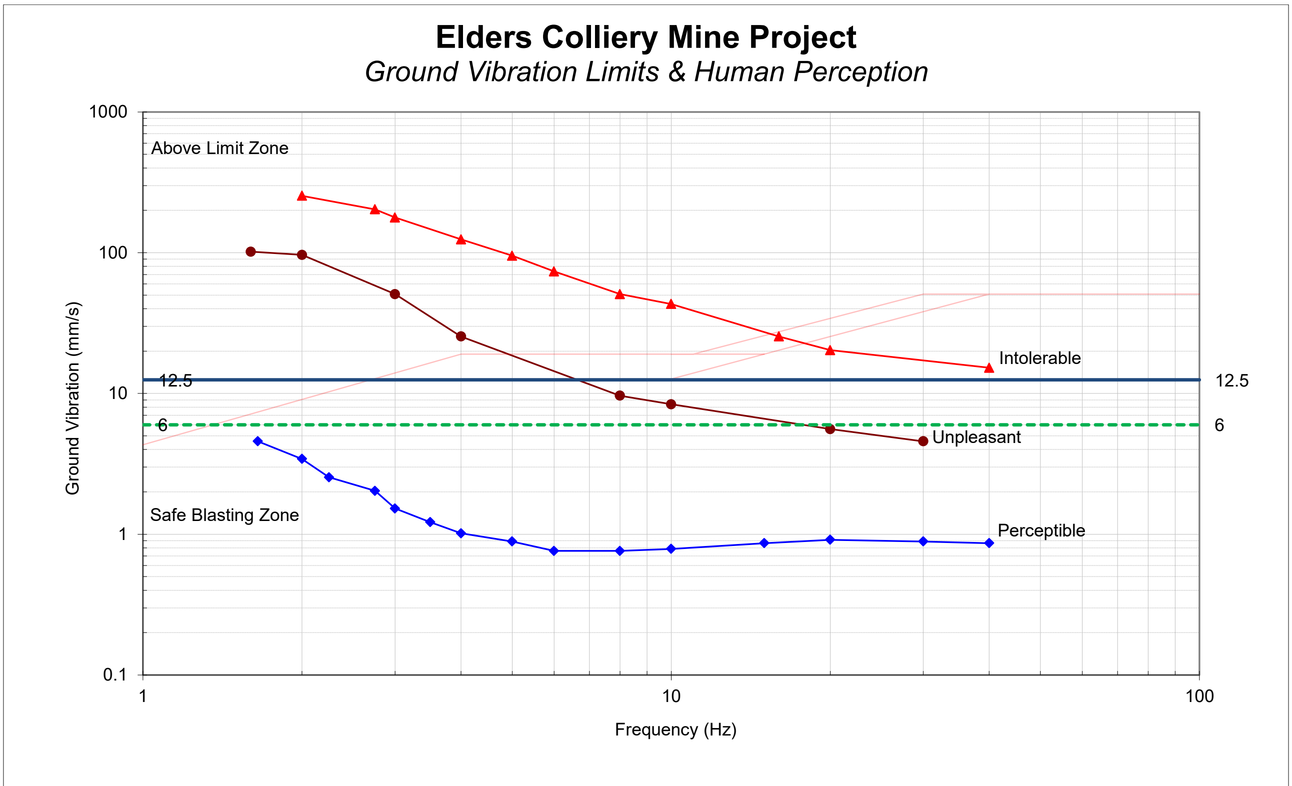

Figure 7: USBM Analysis with Human Perception

10.2 Air blast

Air blast or air-overpressure is pressure acting and should not be confused with sound that is within audible range (detected by the human ear). Sound is also a build up from pressure but is at a completely different frequency to air blast. Air blast is normally associated with frequency levels less than 20 Hz, which is the threshold for hearing. Air blast is the direct result from the blast process although influenced by meteorological conditions the final blast layout, timing, stemming, accessories used, covered or not covered etc. all has an influence on the outcome of the result.

The three main causes of air blasts can be observed as:

Direct rock displacement at the blast; the air pressure pulse (APP)
Vibrating ground some distance away from the blast; rock pressure pulse (RPP)
Venting of blast holes or blowouts; the gas release pulse (GRP)

10.2.1 Air blast limitations on structures

The recommended limit for air blast currently applied in South Africa is 134dB. This is specifically pertaining to air blast or otherwise known as air-overpressure. This takes into consideration where public is of concern. Air-overpressure is pressure acting and should not be confused with sound that is within audible range (detected by the human ear). However, all attempts should be made to keep air blast levels generated from blasting operations below 120dB or greater magnitude toward critical areas where public is of concern. This will ensure that the minimum amount of disturbance is generated towards the critical areas surrounding the mining area.

Based on work carried out by Siskind *et.al.* (1980), monitored air blast amplitudes up to 135dB are safe for structures, provided the monitoring instrument is sensitive to low frequencies (down to 1Hz). Persson *et.al.* (1994) have published the following estimates of damage thresholds based on empirical data (Table 3). Levels given in Table 3 are at the point of measurement. The weakest point on a structure is the windows and ceilings.

Table 3: Damage Limits for Air Blast

Level	**Description**
>130 dB	Resonant response of large surfaces (roofs, ceilings). Complaints start.
150 dB	Some windows break
170 dB	Most windows break
180 dB	Structural Damage

All attempts should be made to keep air blast levels generated from blasting operations well below 120dB where public is of concern. This will ensure that the minimum amount of disturbance is generated towards the critical areas surrounding the mining area and limit the possibility of complaints due to the secondary effects from air blast.

10.2.2 Air blast limitations with regards to human perceptions

Considering the human perception and misunderstanding that could occur between ground vibration and air blast, BM&C generally recommends that blasting be done in such a way that air blast levels is kept below 120dB. In this way it is certain that fewer complaints will be received for blasting operations. The effects on structures that startled people are significantly less – thus no reason for complaining. It is the actual influence on structures like rattling of windows or doors or large roof surface's that startle people. These effects are sometimes misjudged as ground vibration and considered as damaging to the structure.

Initial limits for evaluating conditions have been set at 120dB, 120 dB to 134dB and greater than 134dB. USBM limits are 134dB for nuisance, at this level 5% of residents would be expected to complain, because they are startled and frightened; even 120dB could sometimes lead to rattling windows, feelings of annoyance and fright.

10.2.3 Air blast prediction

An aspect that is not normally considered as pre-operation definable is the effect of air blast. This is mainly due to the fact that air blast is an aspect that can be controlled to a great degree by applying basic rules. Air blast is the direct result from the blast process, although influenced by meteorological conditions, the final blast layout, timing, stemming, accessories used, covered or not covered etc. all has an influence on the outcome of the result.

Standards do exist and predictions can be made, but it must be taken in to account that predictions of air blast is most effective only when measured and calibrated according to the circumstances where blasting is taking place. Measured data showed significant variations due to changing meteorological conditions. It was decided to rather apply the basic standard prediction method for air blast prediction and not using the recorded data.

The following equation is associated with predictions of air blast, but is considered by the author as subjective. In this report a standard equation to calculate possible air blast values was used. This equation does not take temperature or any weather conditions into account. Values were calculated using a cube root scaled distance relationship from expected charge masses and distance. Equation 2 is normally used where no actual data exists.

Equation 2:

$$dB = 165 - 24 \log 10 \frac{D}{E^{1/3}}$$

Where:
dB = Air blast level (dB)
D = Distance from source (m)
E = Maximum charge mass per delay (kg)

Although the above equation was applied for prediction of air blast levels, additional measures are also recommended in order to ensure that air blast and associated fly-rock possibilities are minimized as best possible. As discussed earlier the prediction of air blast is very subjective. Following in Table 4 below is a summary of values predicted according to Equation 2. Figure 8 shows the graphical relationship for air blast as set out in Table 4.

Table 4: Air Blast Predicted Values

No.	Distance (m)	Air blast (dB) for 195 kg Charge	Air blast (dB) for 1570 kg Charge
1	50.0	143	150
2	100.0	138	146
3	150.0	131	138
4	200.0	128	135
5	250.0	126	133
6	300.0	124	131
7	400.0	121	128
8	500.0	119	126
9	600.0	117	124
10	700.0	115	122
11	800.0	114	121
12	900.0	112	120
13	1000.0	111	119
14	1250.0	109	116
15	1500.0	107	114
16	1750.0	105	113
17	2000.0	104	111
18	2500.0	102	109
19	3000.0	100	107
20	3500.0	98	106

Figure 8: Predicted air blast levels

10.3 Fly rock

Blasting practices require some movement of rock to facilitate the excavation process. The extent of movement is dependent on the scale and type of operation. For example, blasting activities within large coal mines are designed to cast the blasted material much greater distances than practices in a quarrying or hard rock operations. This movement should be in the direction of the free face, and therefore the orientation of the blasting is important. Material or elements travelling outside of this expected range may be considered to be fly rock.

Fly rock can be explained and defined in the following three categories:

- Throw - the planned forward movement of rock fragments that form the muck pile within the blast zone.
- Fly rock - the undesired propulsion of rock fragments through the air or along the ground beyond the blast zone by the force of the explosion that is contained within the blast clearance (exclusion) zone. Fly rock using this definition, while undesirable, is only a safety hazard if a breach of the blast clearance (exclusion) zone occurs.
- Wild fly rock - the unexpected propulsion of rock fragments, when there is some abnormality in a blast or a rock mass, which travels beyond the blast clearance (exclusion) zone.

Figure 9 below shows the schematic fly rock terminology.

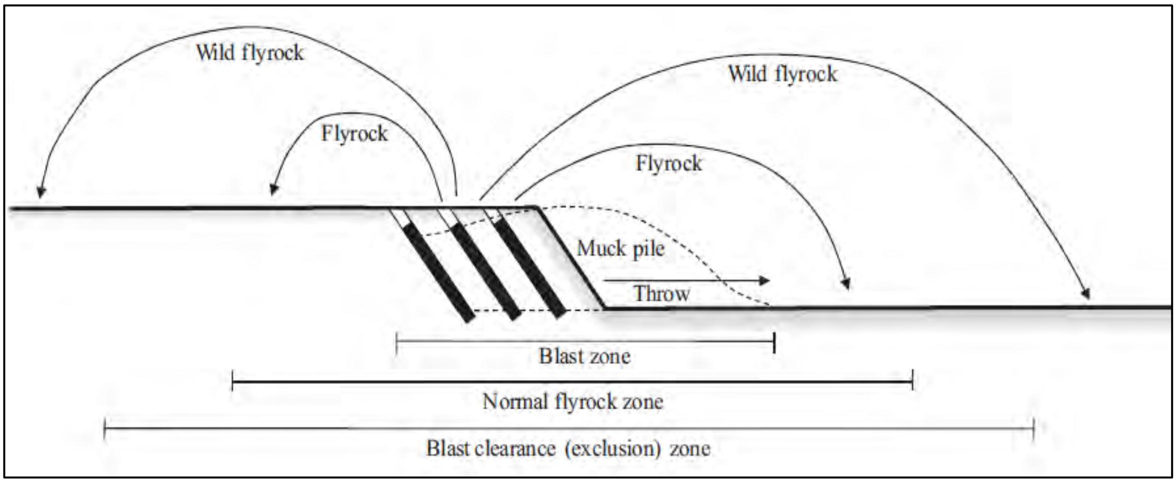

Figure 9: Schematic of fly rock terminology

10.3.1 Fly rock causes

Fly rock from blasting can result from the following conditions:

- When burdens are too small rock elements can be propelled out of the free face area of the blast.
- Rock elements can be forced upwards creating a crater forming fly rock when burdens are too large and movement of blast material is restricted and stemming length is not correct.
- If the stemming material is of improper quality or too little the stemming is ejected out of the blast hole and fly rock is created.

Stemming of correct type and length is required to ensure that explosive energy is efficiently used to its maximum and to control fly rock.

10.3.2 Fly rock predictions

The occurrence of fly rock in any form will have a negative impact if found to travel outside the safe boundary. A general unsafe boundary is normally considered to be within a radius of 500 m. If a road, structure, people or animals are within the 500 m unsafe boundary of the blast, irrespective of the possibility of fly rock or not, precautions must always be taken to stop the traffic, remove people and / or animals for the duration of the blast.

Calculations are also used to help and assist determining safe distances. Method currently applied by BM&C is according to the International Society of Explosives Engineers (ISEE) Blasters Handbook. Using these calculations the minimum safe distances can be determined that should be cleared of people, animals and equipment. Figure 10 shows the results from the ISEE calculations for the two types of operations and drill diameter sizes that are applied in the design for this project.

The stemming length calculation in the design is based on a midrange of 25 times the blast hole diameter. The absolute minimum exclusion zone calculated is 207 m. This calculation is a guideline and any distance cleared should not be less. The occurrence of fly rock can however never be excluded 100%. Best practices can be and are implemented. The occurrence of fly rock can be mitigated but the possibility of the occurrence there off, can never be eliminated.

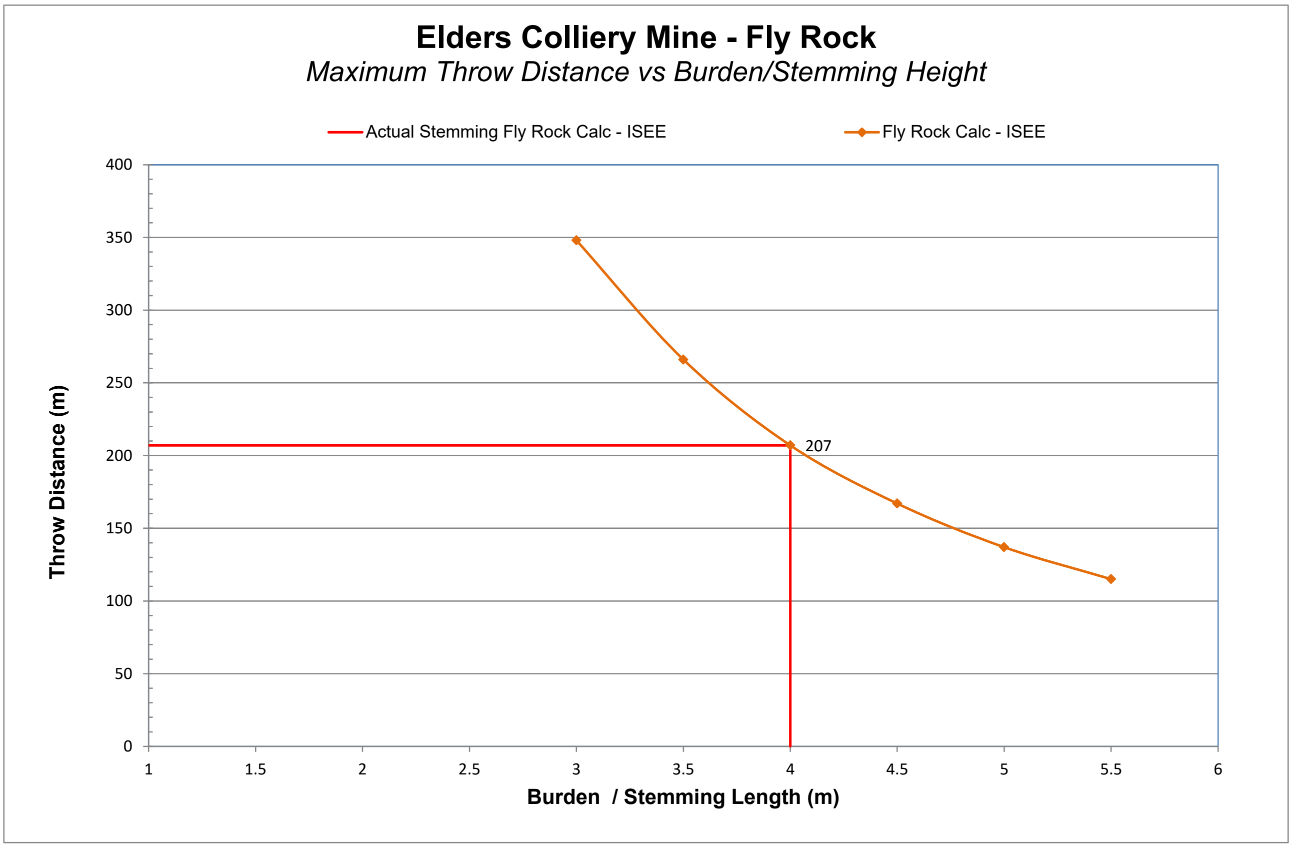

Figure 10: Predicted Fly rock

10.3.3 Impact of fly rock

The occurrence of fly rock in any form will have impact if found to travel outside the safe boundary. This safe boundary may be anything between 10m or 500m. If a road or structure or people or animals are closer than the safe boundary from a blast irrespective of the possibility of fly rock or not precautions should be taken to stop the traffic, remove people or animals for the period of the blast. Fact is fly rock will cause damage to the road, vehicles or even death to people or animals. This safe boundary is determined by the appointed blaster. BM&C normally recommends no shorter distance than 500m.

10.4 Vibration impact on provincial and national roads

The influence of ground vibration on tarred roads are expected when levels is in the order of 150mm/s and greater. Or when there is actual movement of ground when blasting is done to close to

the road or subsidence is caused due to blasting operations. Normally 100 blast hole diameters are a minimum distance between structure and blast hole to prevent any cracks being formed into the surrounds of a blast hole. Crack forming is not restricted to this distance. Improper timing arrangements may also cause excessive back break and cracks further than expected. Fact remain that blasting must be controlled in the vicinity of roads. There is no record of influence on gravel roads due to ground vibration. The only time damage can be induced is when blasting is done next to the road and there is movement of ground. Fly rock will have greater influence on the road as damage from falling debris may impact on the road surface if no control on fly rock is considered.
Air blast does not have influence on roads due to the type of structure. The structure is flat on the ground and cannot be influenced by air blast.

10.5 Vibration will upset adjacent communities

The effects of ground vibration and air blast will have influence on people. These effects tend to create noises on structures in various forms and people react to these occurrences even at low levels. As with human perception given above – people will experience ground vibration at very low levels. These levels are well below damage capability for most structures.
Much work has also been done in the field of public relations in the mining industry. Most probably one aspect that stands out is “Promote good neighbour ship”. This is achieved through communication and more communication with the neighbours. Consider their concerns and address in a proper manner.

The first level of good practice is to avoid unnecessary problems. One problem that can be reduced is the public's reaction to blasting. Concern for a person's home, particularly where they own it, could be reduced by a scheme of precautionary, compensatory and other measures which offer guaranteed remedies without undue argument or excuse.

In general it is also in an operator's financial interests not to blast where there is a viable alternative. Where there is a possibility of avoiding blasting, perhaps through new technology, this should be carefully considered in the light of environmental pressures. Historical precedent may not be a helpful guide to an appropriate decision.

Independent structural surveys are one way of ensuring good neighbour ship. There is a part of inherent difficulty in using surveys as the interpretation of changes in crack patterns that occur may be misunderstood. Cracks open and close with the seasonal changes of temperature, humidity and drainage, and numbers increase as buildings age. Additional actions need to be done in order to supplement the surveys as well.

The means of controlling ground vibration, overpressure and fly rock have many features in common and are used by the better operators. It is said that many of the practices also aid cost-effective production. Together these introduce a tighter regime which should reduce the incidence of fly rock and unusually high levels of ground vibration and overpressure. The measures include the need for the following:

- Correct blast design is essential and should include a survey of the face profile prior to design, ensuring appropriate burden to avoid over-confinement of charges which may increase vibration by a factor of two.
- The setting-out and drilling of blasts should be as accurate as possible and the drilled holes should be surveyed for deviation along their lengths and, if necessary, the blast design adjusted.
- Correct charging is obviously vital, and if free poured bulk explosive is used, its rise during loading should be checked. This is especially important in fragmented ground to avoid accidental overcharging.
- Correct stemming will help control air blast and fly rock and will also aid the control of ground vibration. Controlling the length of the stemming column is important; too short and premature ejection occurs, too long and there can be excessive confinement and poor fragmentation. The length of the stemming column will depend on the diameter of the hole and the type of material being used.
- Monitoring of blasting and re-optimising the blasting design in the light of results, changing conditions and experience should be carried out as standard.

10.6 Cracking of houses and consequent devaluation

Houses in general have cracks. It is reported that a house could develop up to 15 cracks a year. Ground vibration will be mostly responsible for cracks in structures if high enough and at continued high levels. The influences of environmental forces such as temperature, water, wind etc. are more reason for cracks that have developed. Visual results of actual damage due to blasting operations are limited. There are cases where it did occur and a result is shown in Figure 11 below. A typical X crack formations is observed.

Figure 11: Example of blast induced damage.

Observing cracks of this form on a structure will certainly influence the value as structural damage has occurred. The presence of general vertical cracks or horizontal cracks that are found in all structures does not need to indicate devaluation due to blasting operations but rather devaluation due to construction, building material, age, standards of building applied. Proper building standards are not always applied or else stated was not always applied in the country side when houses were built. Thus damage in the form of cracks will be present. Exact costing of devaluation for normal cracks observed is difficult to estimate. A property valuator will be best to determine property value. The value of the property will however be determined on the total property and not only on the condition of the house. Mining operations may not have influence to change the status quo of any property.

10.7 Water well Influence from Blasting Activities

Water boreholes are present around the proposed site. The author has not had much experience on the effect of blasting on water wells but specific research was done and results from this research work are presented.

Case 1 looked at 36 case histories. Vibration levels up 50 mm/s were measured. The well yield and aquifer storage improved as the mining neared the wells, because of the opening of the fractures from loss of lateral confinement, not blasting. This is similar to how stress-relief fractures form. At one site the process was reversed after the mine was backfilled. It was more likely the fractures were recompressed. It was stated that blasting may cause some temporary (transient) turbidity similar to those events that cause turbidity without blasting. Such as:

1. Natural sloughing off inside of the well bore due to inherent rock instability. This can be accelerated by frequent over pumping. This is common to wells completed through considerable thickness of poorly consolidated and/or highly fractured clay stones and shale’s.

2. Significant rainfall events. The apertures of the shallow fractures that are intersected by a domestic well are commonly highly transmissive, thus will transmit substantial amounts of shallow flowing and rapidly recharging water. This water will commonly be turbid and can enter the well in high volumes. The lack of grouting of the near surface casing commonly allows this to happen. Also, if the top of the well is not grouted properly surface water can enter along the side of the casing and flow down the annulus.

The Berger Study observed ground-water impacts from manmade stress-release caused the rock mass removal during mining, but nothing from the blasting. The water quality and water levels were unaffected by the blasting. The "opening up" of the fractures lowered the ground-water levels by increasing the storage or porosity.

A study tested wells 50 m from a blast. Wells exhibited no quality or quantity impacts. Blast pressure surges ranged from 3 cm to 10 cm. Blasting caused no noticeable water table fluctuations and the hydraulic conductivity was unchanged. The pumping of the pit and encroachment of the high wall toward the wells dewatered the water table aquifer.

It may then be concluded from the studies researched as follows: Depending on the well construction, litho logic units encountered, and proximity to the blasting, it is believed that large shots could act as a catalyst for some well sloughing or collapse. However, the well would have to be inherently weak to begin with. The small to moderate shots will not show to impact wells. The minor water fluctuations attributed to blasting may cause a short term turbidity problem, but do not pose any long term problems. This fluctuation would not cause well collapse, as fluctuations from recharge and pumping occurs frequently. Long term changes to the well yield are more likely due to the opening of fractures from loss of lateral confinement. Short term dewatering of wells is caused by the opening of the fractures creating additional storage. A longer term dewatering is caused by encroachment of the high wall and pumping of the pit water. The pit acts like a large pumping well. It is not believed that long term water quality problems will be caused by blasting alone. The possible exception is the introduction of residual nitrates, from the blasting materials, into the ground water system. This is only possible through wells that are hydro logically connected to a blasting site. Most of the long term impacts on water quality are due to the mining (the breakup of the rocks). The influence will also be dependant if wells are beneath the excavation. Stress relief effects occur at shorter distances in this instance.

The results observed and levels recorded during research done showed that levels up to 50 mm/s or even higher in certain cases did not have any noticeable effect. It seems that safe conditions will be in the order of the 50 mm/s. In addition to this there are certain aspects that will need to be addressed prior to blasting operations.

11 Baseline Results

11.1 General ground vibration and air blast information

The base line information for the project is based on zero influence with regards to blast impacts. The project is currently not active with any blasting operations being done. As part of the baseline all possible structures in a possible influence area is identified.

11.2 Structure Profile

As part of the baseline all possible structures in a possible influence area is identified. The site was reviewed and presented hereafter. The site was reviewed / scanned using Google Earth imagery. Information sought from review was typically the kind of surface structures that are present in a 1500 m radius from the proposed box-cut that will require consideration during modelling of blasting operations. This could consists of houses, general structures, power lines, pipe lines, reservoirs, mining activities, roads, shops, schools, gathering places, possible historical sites etc. A list was prepared as best possible for each structure in the vicinity of the pit areas. The list prepared covers structures and points of interest (POI) in the 1500 m boundary. A list of structure locations was required for determining the allowable ground vibration limits and air blast limits possible. Figure 12 shows an aerial view of the box-cut area, the planned underground and surroundings with points of interest. The list compiled is provided in Table 5 below.

Box-cut Area:

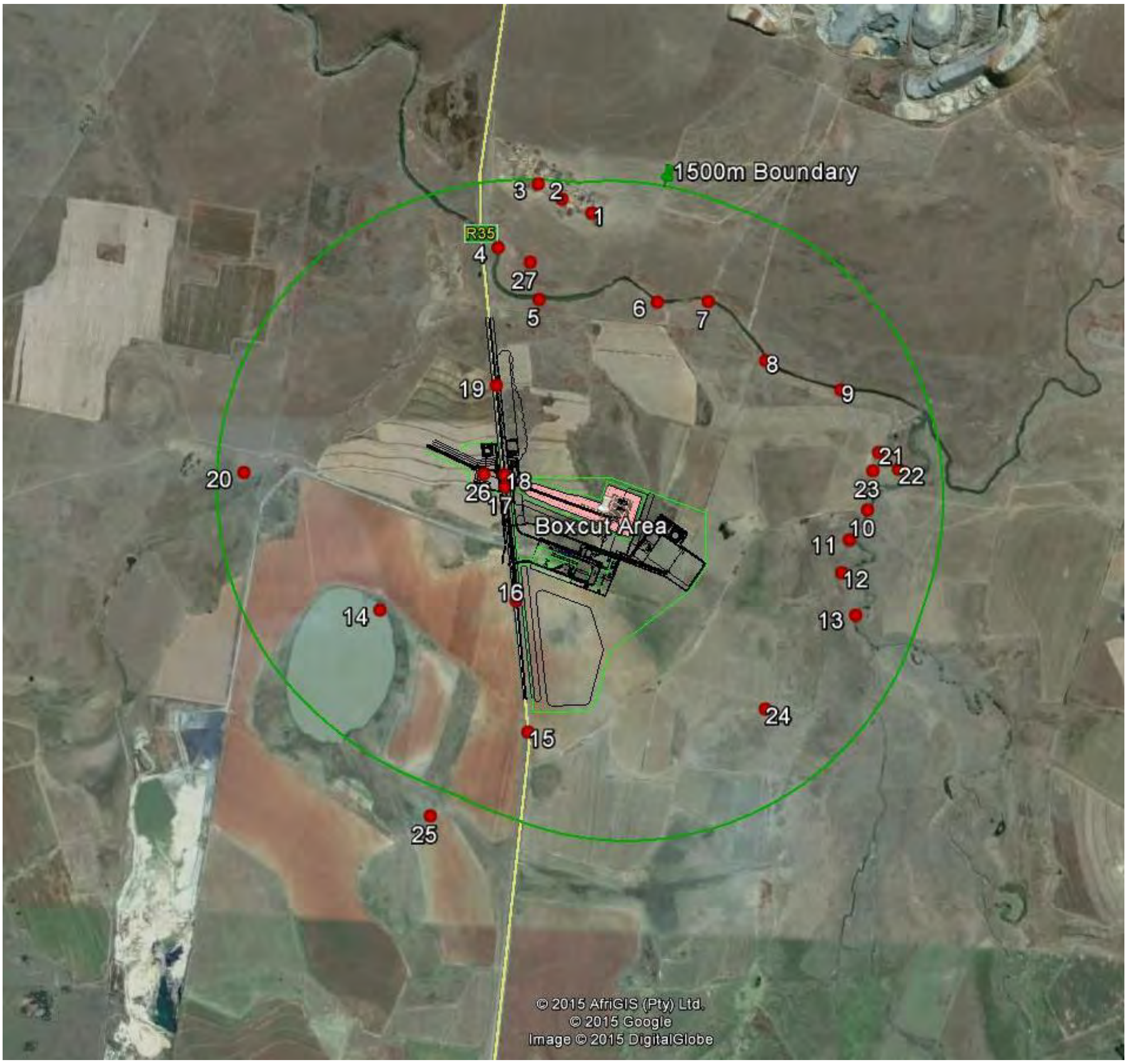

Figure 12: Aerial view and surface plan of the proposed mining area with points of interest identified.

Note: Red Place marks = POI indicators

Table 5: List of points of interest used (WGS84 – LO 29°)

Tag	Description	Classification	Y	X
1	Informal Housing	1	-46771.63	2901484.76
2	Informal Housing	1	-46622.64	2901415.50
3	Informal Housing	1	-46505.87	2901338.88
4	Olifants River	6	-46303.24	2901650.14
5	Olifants River	6	-46506.56	2901907.09

6	Olifants River	6	-47094.90	2901923.21
7	Olifants River	6	-47348.11	2901921.69
8	Olifants River	6	-47633.30	2902214.38
9	Olifants River	6	-48007.35	2902361.75
10	Viskuile River	6	-48137.26	2902954.55
11	Viskuile River	6	-48045.73	2903103.24
12	Viskuile River	6	-48007.59	2903265.12
13	Viskuile River	6	-48076.17	2903475.95
14	Pan	6	-45713.07	2903440.18
15	R35 Road	5	-46445.49	2904042.68
16	R35 Road	5	-46388.71	2903396.37
17	R35 Road	5	-46337.78	2902836.67
18	R35 Road	5	-46333.67	2902775.92
19	R35 Road	5	-46293.01	2902332.32
20	Cement Dam	5	-45038.15	2902759.35
21	Structure	2	-48193.45	2902670.64
22	Structure	2	-48292.01	2902753.62
23	Building/Structure	2	-48164.76	2902761.43
24	Cement Dam	5	-47623.86	2903937.33
25	Informal Settlement	1	-45961.16	2904453.75
26	Silo	5	-46230.65	2902771.15
27	Windmill	8	-46463.23	2901723.20

Notes: The type of POI's identified is grouped into different classes. These classes are indicated as "Classification" in table above. The classification is a Blast Management & Consulting classification to assist with sorting the different types of installations. Table 6 below shows the descriptions for the classifications used.

Table 6: POI Classification used

Class	**Description**
1	Rural Building and structures of poor construction
2	Private Houses and people sensitive areas
3	Office and High rise buildings
4	Animal related installations and animal sensitive areas
5	Industrial buildings and installations
6	Earth like structures – no surface structure
7	Graves & Heritage
8	Water Borehole

Site visit was conducted and structures observed. Structures range from well build structures to informal building styles. Table 7 shows photos of structures found in the area.

Table 7: Structure Profile

Structure Photo	Description
	Bridge over Olifants River
	Windmill across river from site

	Middelkraal Village
	Middelkraal Village

	View of Middelkraal Village from site
	Middelkraal Village - Zoomed

	Small settlement on southwestern side

12 Construction Phase: Impact Assessment and Mitigation Measures

The establishment of access to the underground operation in the form of a box-cut could be considered either as construction or as a part of the operational phase. There will certainly be construction operations for establishing offices, dams, conveyors etc. which would not really require blasting operations. For this project the box-cut is considered part of the operational phase. Should the authorities considered the box-cut part of the construction phase the same analyses and evaluation will be applicable.

13 Operational Phase: Impact Assessment and Mitigation Measures

The area surrounding the proposed box-cut area was reviewed for structures, traffic, roads, human interface, animals interface etc. Various installations and structures were observed. These are listed in Table 6. This section concentrates on the outcome of modelling the possible effects of ground vibration, air blast and fly rock specifically to these points of interest or possible interfaces. In evaluation the two different charge mass scenarios is considered with regards to ground vibration and air blast. Review of the blast design and the possible timing of a blast the two different charge masses of 195 and 1570 kg were selected to ensure proper source coverage.

Ground vibration and air blast was calculated from the edge of the pit outline and modelled accordingly. Blasting further away from the pit edge will certainly have lesser influence on the surroundings. A worst case is then applicable with calculation from pit edge. As explained previously reference is only made to some structures and these references covers the extent of all structures surrounding the mine.

The following aspects with comments are addressed for each of the evaluations done:

- Ground Vibration Modelling Results
- Ground Vibration and human perception
- Vibration impact on national and provincial road
- Vibration will upset adjacent communities
- Cracking of houses and consequent devaluation
- Air blast Modelling Results
- Impact of fly rock

Please note that this analysis does not take geology, topography or actual final drill and blast pattern into account. The data is based on good practise applied internationally and considered very good estimates based on the information provided and supplied in this document.

13.1 Review of expected ground vibration

Presented herewith are the expected ground vibration level contours. Discussion of level of ground vibration and relevant influences is also given. Expected ground vibration levels were calculated for each of the structure locations or POI's considered surrounding the mining area. Evaluation is given for each POI with regards to human perception and structure concern. Evaluation is done in form of the criteria what humans experience and where by structures could be damaged. This is according to accepted criteria for prevention of damage to structures and when levels are low enough to have no significant influence. Tables are provided for each of the different charge modelling done with regards to Tag, Description, Specific Limit, Distance (m), Predicted PPV (mm/s), and Possible Concern for Human perception and Structure. The "Tag" No. is number corresponding to the location indicated on POI figures. "Description" indicates the type of the structure. The "Distance" is the distance between the structure and edge of the pit area. The "Specific Limit" is the maximum limit for ground vibration at the specific structure or installation. The "Predicted PPV (mm/s)" is the calculated ground vibration for the structure and the "possible concern" indicates if there is any concern for structure damage or not or human perception. Indicators used are such as "perceptible", "unpleasant", "intolerable" which stems from the humans perception information given and indicators such as "high" or "low" is given whereby there is possibility of damage to a structure or no significant influence is expected and concern is low. Levels below 0.76 mm/s could be considered as to be low or negligible possibility of influence.

Ground vibration is calculated and modelled for the pit area at the minimum, medium and maximum charge mass at specific distances from the opencast mining area. The charge masses applied are according to blast designs in section 6. These levels are then plotted and overlaid with current mining plans to observe possible influences at structures identified. Structures or POI's for consideration are also plotted in this model. Ground vibration predictions were done considering distances ranging from 50 m to 3500 m around the opencast mining area.

Provided as well with each simulation are indicators of the ground vibration limits used: 6 mm/s, 12.5 mm/s and 25 mm/s. 6 mm/s is indicated as a “Solid Blue” line, 12.5 mm/s “Intermittent Blue” line and 25 mm/s as a “Intermittent Red” line. This enables immediate review of possible concerns that may be applicable to any of the privately owned structures, social gathering areas or installations. Consideration can also then be given to influence on sensitive installations within the mine boundary.

Data is provided as follows: Vibration contours followed by table with predicted ground vibration values and evaluation for each POI. Additional colour codes used in the tables indicates the following:

Vibration levels higher than proposed limit applicable to Structures / Installations is coloured “Mustard”
Vibration levels indicated as Intolerable on human perception scale is coloured “Yellow”

13.1.1 Calculated Ground Vibration Levels

Presented are simulations for expected ground vibration levels from minimum and maximum charge masses.

- **Minimum Charge per Delay – Pit Area – 195 kg**

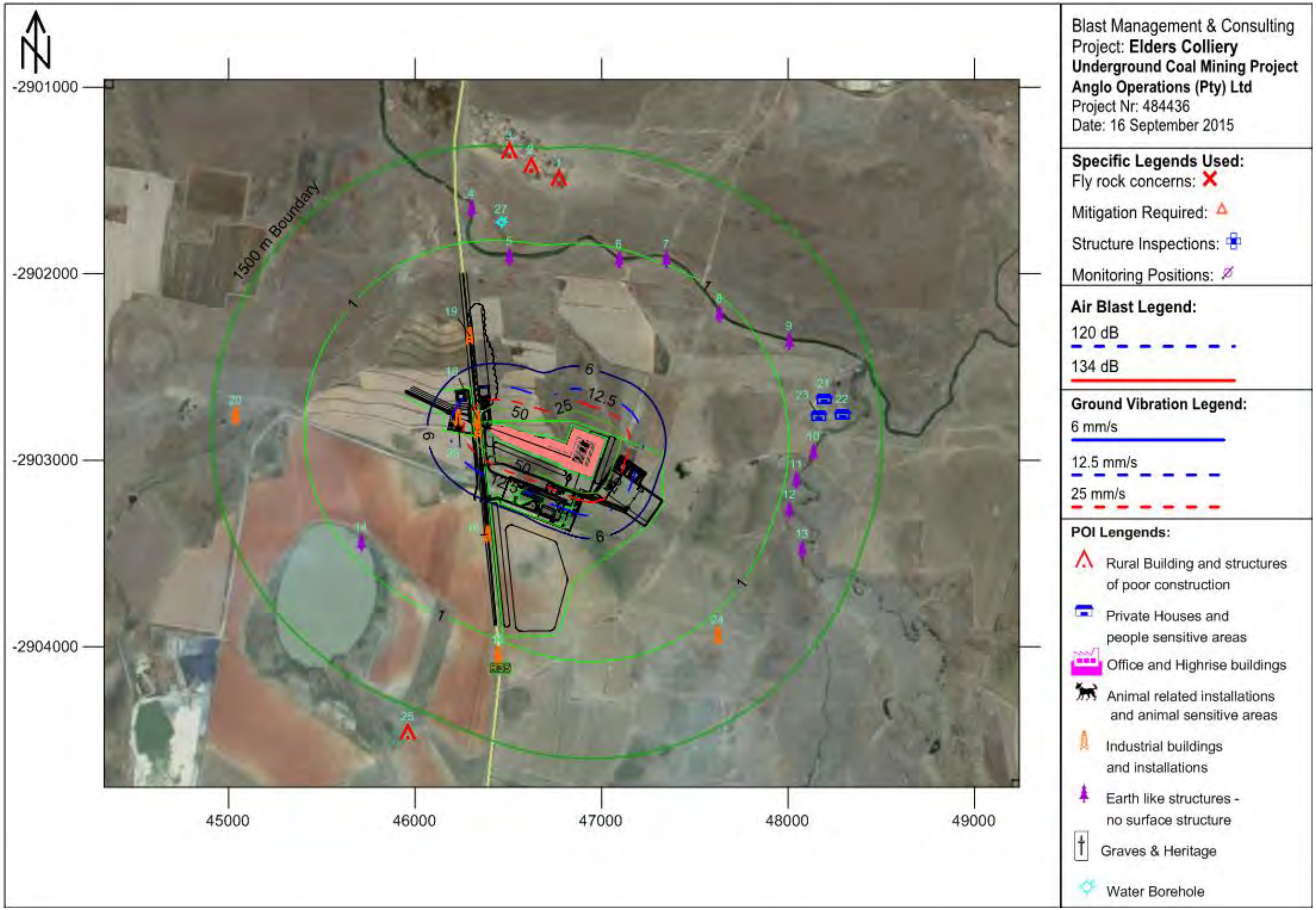

Figure 13: Ground vibration influence from minimum charge

Figure 14: Zoomed area for ground vibration influence from minimum charge

Table 8: Ground vibration evaluation for minimum charge

Tag	Description	Specific Limit (mm/s)	Distance (m)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
1	Informal Housing	6	1351	0.6	Acceptable	Too Low
2	Informal Housing	6	1413	0.6	Acceptable	Too Low
3	Informal Housing	6	1481	0.5	Acceptable	Too Low
4	Olifants River	150	1173	0.8	Acceptable	N/A
5	Olifants River	150	914	1.2	Acceptable	N/A
6	Olifants River	150	940	1.1	Acceptable	N/A
7	Olifants River	150	1025	1.0	Acceptable	N/A
8	Olifants River	150	923	1.1	Acceptable	N/A
9	Olifants River	150	1135	0.8	Acceptable	N/A
10	Viskuile River	150	1131	0.8	Acceptable	N/A
11	Viskuile River	150	1057	0.9	Acceptable	N/A
12	Viskuile River	150	1063	0.9	Acceptable	N/A
13	Viskuile River	150	1197	0.7	Acceptable	N/A
14	Pan	150	914	1.2	Acceptable	N/A
15	R35 Road	150	1072	0.9	Acceptable	N/A
16	R35 Road	150	499	3.1	Acceptable	N/A
17	R35 Road	150	64	93.0	Acceptable	N/A
18	R35 Road	150	91	52.2	Acceptable	N/A
19	R35 Road	150	501	3.1	Acceptable	N/A
20	Cement Dam	50	1366	0.6	Acceptable	N/A

Tag	Description	Specific Limit (mm/s)	Distance (m)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
21	Structure	25	1208	0.7	Acceptable	Too Low
22	Structure	25	1293	0.7	Acceptable	Too Low
23	Building/Structure	25	1165	0.8	Acceptable	Perceptible
24	Cement Dam	50	1096	0.9	Acceptable	N/A
25	Informal Settlement	12.5	1640	0.4	Acceptable	Too Low
26	Silo	50	183	16.4	Acceptable	N/A
27	Windmill	50	1096	0.9	Acceptable	N/A

- **Maximum Charge per Delay – Pit Area – 1570 kg**

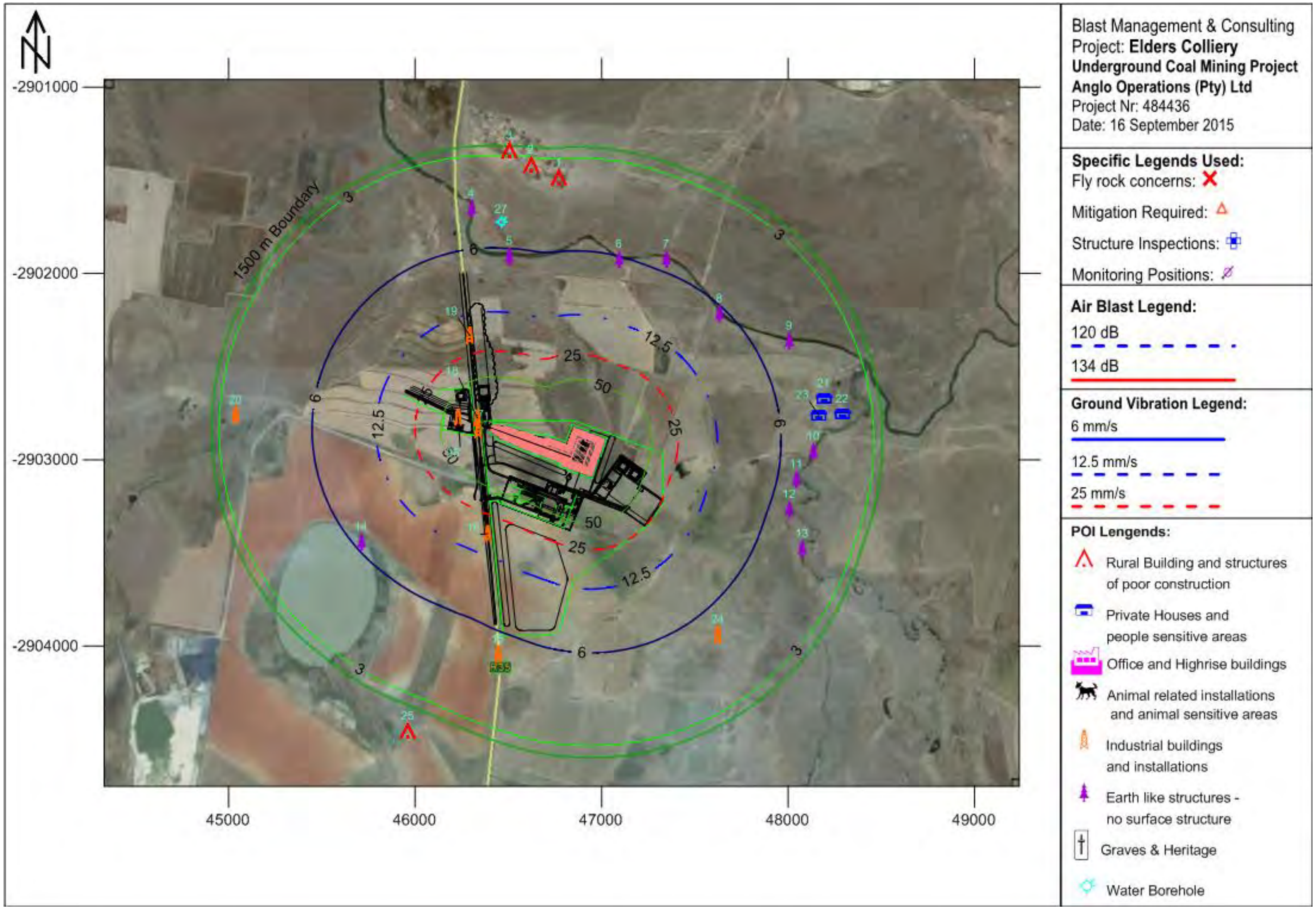

Figure 15: Ground vibration influence from maximum charge

Table 9: Ground vibration evaluation for maximum charge

Tag	Description	Specific Limit (mm/s)	Distance (m)	Predicted PPV (mm/s)	Structure Response @ 10Hz	Human Tolerance @ 30Hz
1	Informal Housing	6	1351	3.4	Acceptable	Perceptible
2	Informal Housing	6	1413	3.1	Acceptable	Perceptible
3	Informal Housing	6	1481	2.9	Acceptable	Perceptible
4	Olifants River	150	1173	4.3	Acceptable	N/A
5	Olifants River	150	914	6.4	Acceptable	N/A
6	Olifants River	150	940	6.2	Acceptable	N/A
7	Olifants River	150	1025	5.3	Acceptable	N/A
8	Olifants River	150	923	6.3	Acceptable	N/A
9	Olifants River	150	1135	4.5	Acceptable	N/A
10	Viskuile River	150	1131	4.5	Acceptable	N/A
11	Viskuile River	150	1057	5.1	Acceptable	N/A
12	Viskuile River	150	1063	5.0	Acceptable	N/A
13	Viskuile River	150	1197	4.1	Acceptable	N/A
14	Pan	150	914	6.4	Acceptable	N/A
15	R35 Road	150	1072	5.0	Acceptable	N/A
16	R35 Road	150	499	17.5	Acceptable	N/A
17	R35 Road	150	64	519.6	Problematic	N/A
18	R35 Road	150	91	291.9	Problematic	N/A
19	R35 Road	150	501	17.4	Acceptable	N/A
20	Cement Dam	50	1366	3.3	Acceptable	N/A
21	Structure	25	1208	4.1	Acceptable	Perceptible
22	Structure	25	1293	3.6	Acceptable	Perceptible
23	Building/Structure	25	1165	4.3	Acceptable	Perceptible
24	Cement Dam	50	1096	4.8	Acceptable	N/A
25	Informal Settlement	12.5	1640	2.5	Acceptable	Perceptible
26	Silo	50	183	91.7	Problematic	N/A
27	Windmill	50	1096	4.8	Acceptable	N/A

13.1.2 Summary of ground vibration levels

The box-cut operation was evaluated for expected levels of ground vibration from future blasting operations. Review of the site and the surrounding installations / houses / buildings showed that structures vary in distances from the opencast pit area. The structures identified range in distance from very close to very far for the pit area and could be problematic. The evaluation took mainly up to 1500 m from the mining areas into consideration. The closest structures found are the R35 Road at POI 17 and POI 18 and the Silo at POI 26. The planned maximum charge evaluated showed that it could be problematic.

The silo located at POI 26 will be part of the infrastructure for the mine. The limit current on the silo is 50 mm/s but what must be considered is the period during construction. The silo construction is a continuous concrete pouring process and during this period the limits on fresh concrete is very low at 5 mm/s. Coordination between blasting and erection of silo will specifically be required. It will probably be best to avoid blasting during the construction of the silo.

The Olifants and Viskuile Rivers are relatively far at 914m to 1197 m from the pit area and no problems with regards to ground vibration could be foreseen.

The distances between the structures and the box-cut area is the main contributing factor to the levels of ground vibration expected and the subsequent possible influences. It is observed that for the different charge masses evaluated that levels of ground vibration will change as well. In view of the maximum charge specific attention will need to be given to specific areas. The results clearly indicate that non mine owned installations that could possibly be influenced are the R35 road.

13.2 Ground Vibration and human perception

Considering the effect of ground vibration with regards to human perception, vibration levels calculated were applied to an average of 30Hz frequency and plotted with expected human perceptions on the safe blasting criteria graph (See Figure 15 below). The frequency range selected is the expected average range for frequencies that will be measured for ground vibration.

Review of the maximum charge in relation to human perception it is seen that within a 3500 m area people may experience levels of ground vibration as perceptible. At 1250 m the expected ground vibration levels are still less than the lower safe blasting limit – less than 6 mm/s but will be experienced by people as *"unpleasant"*. Distances closer than 950 m will exceed the minimum 6 mm/s proposed safe limit for poorly constructed structures. Figure 15 below shows this effect of ground vibration with regards to human perception for maximum charge. There are no private houses or farmsteads within a 1000 m but definitely within 1500 m from the box-cut area. There is possibility that people could experience the blasts done at the box-cut.

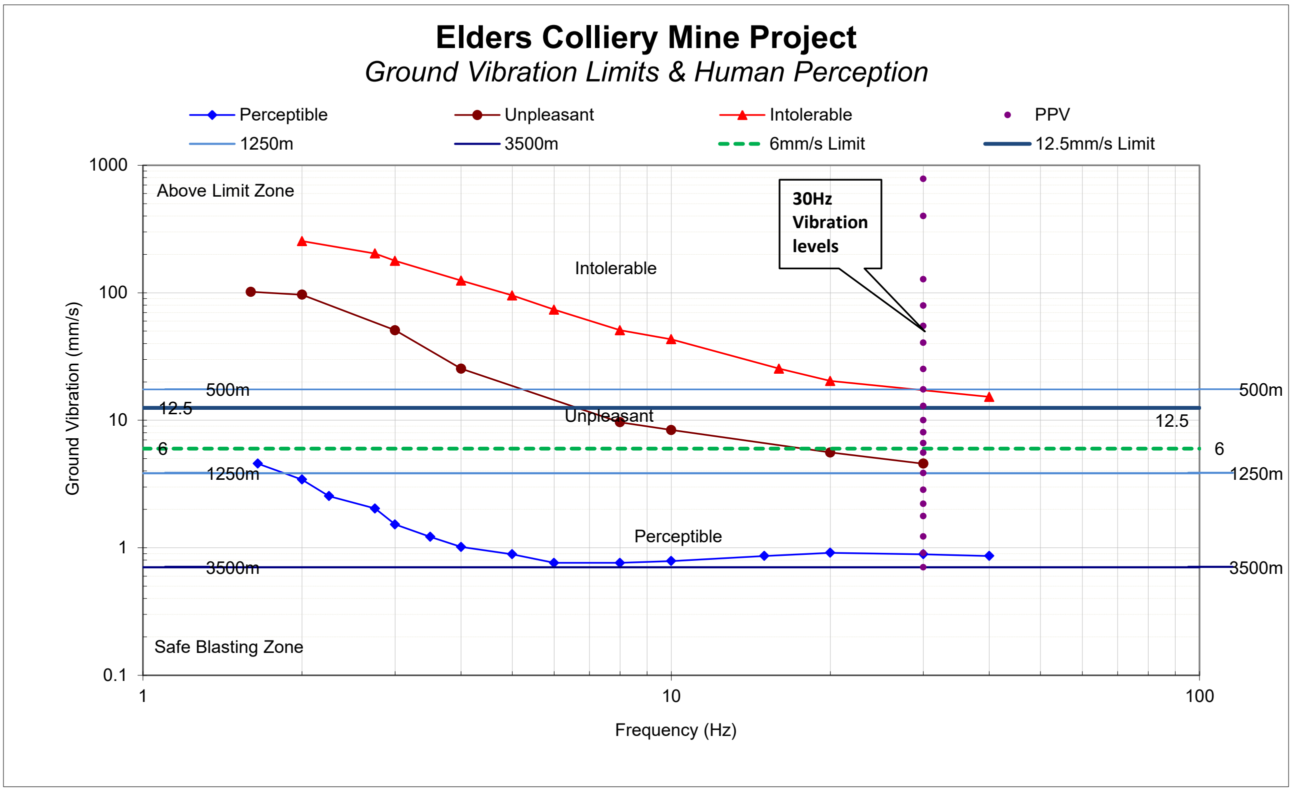

Figure 16: The effect of ground vibration with human perception and vibration limits

13.3 Vibration impact on roads

The R35 road is on the south western side of the box-cut area and is at closest 64m away from the planned box-cut area. Expected ground vibration levels at this road are higher than the recommended limits. The current maximum charge mass may not be used at the nearest point to the road as the ramp down into the box-cut is sloping down deeper away from the road. This means that at closest point to the road the required blasting will be much less than the maximum or minimum charge. Specific designs will be required to determine the actual possible influence at the road and only then can the exact possible levels determined and course of action then decided.

13.4 Potential that vibration will upset adjacent communities

Ground vibration and air blast generally upset people living in the vicinity of mining operations. There are communities, grazing areas and roads that are within the evaluated area of influence. The structures are located such that levels of ground vibration predicted are well within accepted norms and criteria. Ground vibration levels may be perceptible but not damaging.

The importance of good public relations cannot be under stressed. People tend to react negatively on experiencing of effects from blasting such as ground vibration and air blast. Even at low levels when damage to structures is out of the question it may upset people. Proper and appropriate communication with neighbours about blasting, monitoring and actions done for proper control will be required.

13.5 Air blast

The effect of air blast, if not controlled properly, is in my opinion a factor that could be problematic. Maybe not in the sense of damage being induced but rather having an impact – even at low levels of roofs and windows that could result in complaints from people. In more than one case this effect is misunderstood and people consider this effect as being ground vibration and damaging to their house structures. Section 6 gives detail on the selection of the charges sizes applied.

As with ground vibration, evaluation is given for each structure with regards to the calculated levels of air blast and concerns if applicable. Evaluation is done in form of the criteria what humans experience and where by structures could be damaged. This is according to accepted criteria for prevention of damage to structures and when levels are low enough to have no significant influence. Tables are provided for each of the different charge modelling done with regards to Tag, Description, Specific Limit, Distance (m), Predicted Air blast (dB), and Possible Concern. The "Tag" No. is number corresponding to the location indicated on POI figures. "Description" indicates the type of the structure. The "Distance" is the distance between the structure and edge of the pit area. The "Air Blast (dB)" is the calculated air blast level at the structure and the "possible concern" indicates if there is any concern for structure damage or not or human perception. Indicators used are "Problematic" where there is real concern for possible damage, "Complaint" where people will be complaining due to the experienced effect on structures – not necessarily damaging, "Acceptable" is if levels are less than 120 dB and low where there is very limited possibility that the levels will give rise to any influence on people or structures. Levels below 115 dB could be considered as to be low or negligible possibility of influence.

Table 10 shows the applied limits and recommended levels for each of the charges considered. The maximum charge may exceed limits at distances up to 250 m. The recommended limit of 120dB is observed at distance of 800 m. These distances are reduced to 150 m for the minimum charge allowed limit and 500 m for recommended limit. This clearly indicates that with increased charge masses the distances of influence increases. An area of 900 m influence would be possible if care is not taken to manage air blast levels.

Table 10: Expected air blast levels

No.	Distance (m)	Air blast (dB) for 195 kg Charge	Air blast (dB) for 1570 kg Charge
1	50.0	143	150
2	100.0	138	146
3	150.0	131	138
4	200.0	128	135
5	250.0	126	133

6	300.0	124	131
7	400.0	121	128
8	500.0	119	126
9	600.0	117	124
10	700.0	115	122
11	800.0	114	121
12	900.0	112	120
13	1000.0	111	119
14	1250.0	109	116
15	1500.0	107	114
16	1750.0	105	113
17	2000.0	104	111
18	2500.0	102	109
19	3000.0	100	107
20	3500.0	98	106

Presented herewith are the expected air blast level contours. Discussion of level of air blast and relevant influences are also given for the pit area. Air blast was calculated and modelled from the boundary for minimum, medium and maximum charge mass at specific distances from each of the pit areas. This means that air blast is taken from the edge – the most outer point of the pit area on plan as if it would be the closest place where drilling and blasting will be done to the area of influence. The calculated levels are then plotted and overlaid with current mining plans to observe possible influences at POI's identified. Air blast predictions were done considering distances ranging from 50 to 1500 m around the opencast mining area.

13.5.1 Review of expected air blast

Presented are simulations for expected air blast levels from two different charge masses. Minimum and maximum charge evaluations are shown in the figures below and summary table of outcome given after each charge configuration air blast contour.

Colour codes used in tables are as follows:

Air blast levels higher than proposed limit is coloured "Mustard"
Air blast levels indicated as possible Complaint is coloured "Yellow"

- **Minimum Charge per Delay – Pit Area - 195kg**

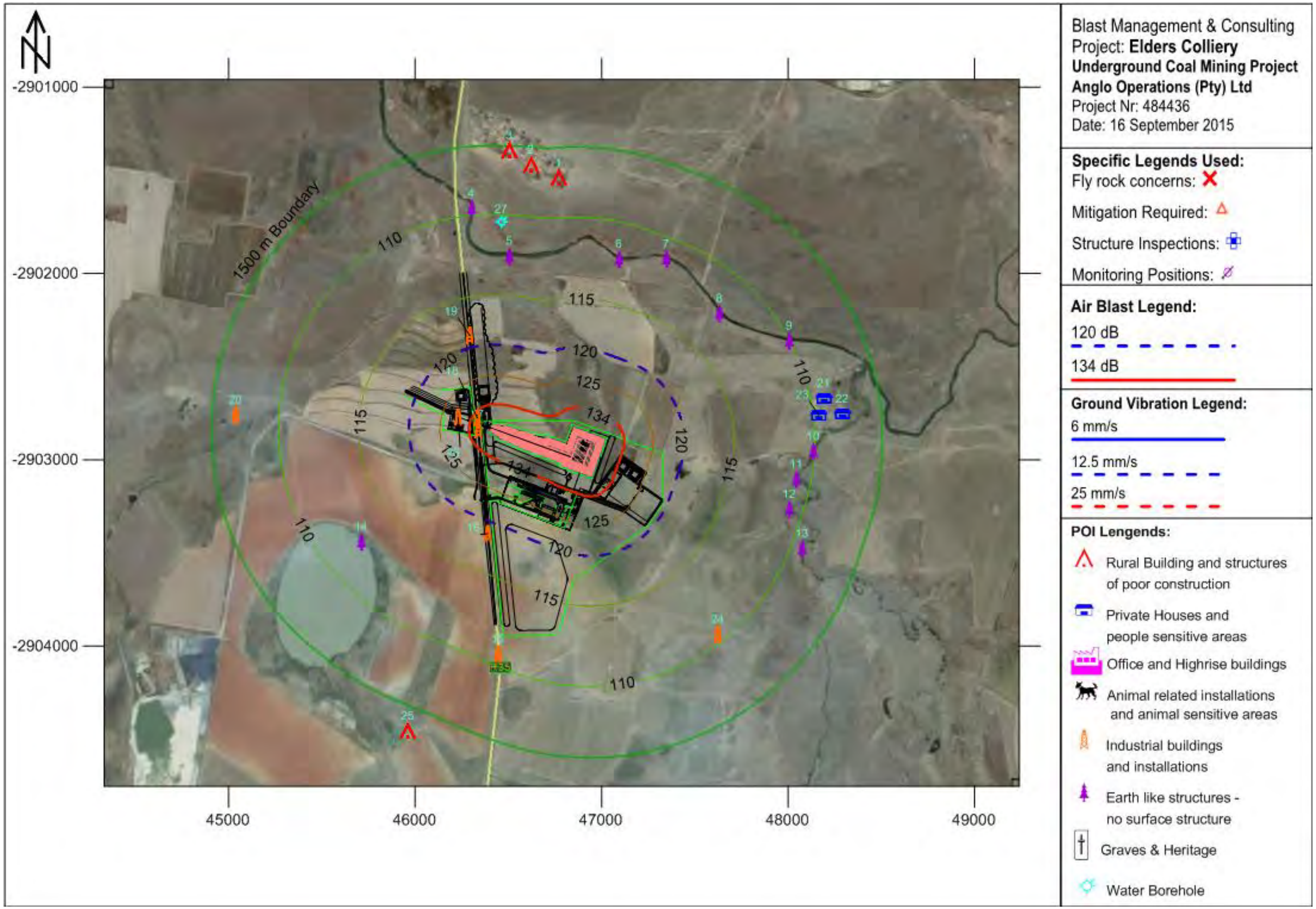

Figure 17: Air blast influence from minimum charge

Table 11: Air blast evaluation for minimum charge

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
1	Informal Housing	1351	108.2	Acceptable
2	Informal Housing	1413	107.7	Acceptable
3	Informal Housing	1481	107.2	Acceptable
4	Olifants River	1173	109.7	N/A
5	Olifants River	914	112.3	N/A
6	Olifants River	940	112.0	N/A
7	Olifants River	1025	111.1	N/A
8	Olifants River	923	112.2	N/A
9	Olifants River	1135	110.0	N/A
10	Viskuile River	1131	110.0	N/A
11	Viskuile River	1057	110.7	N/A
12	Viskuile River	1063	110.7	N/A
13	Viskuile River	1197	109.4	N/A
14	Pan	914	112.3	N/A
15	R35 Road	1072	110.6	N/A
16	R35 Road	499	118.6	N/A
17	R35 Road	64	140.0	N/A
18	R35 Road	91	136.3	N/A
19	R35 Road	501	118.5	N/A
20	Cement Dam	1366	108.1	N/A
21	Structure	1208	109.4	Acceptable
22	Structure	1293	108.6	Acceptable
23	Building/Structure	1165	109.7	Acceptable
24	Cement Dam	1096	110.4	N/A
25	Informal Settlement	1640	106.2	Acceptable
26	Silo	183	129.0	N/A
27	Windmill	1096	110.4	N/A

• **Maximum Charge per Delay – Pit Area – 1570 kg**

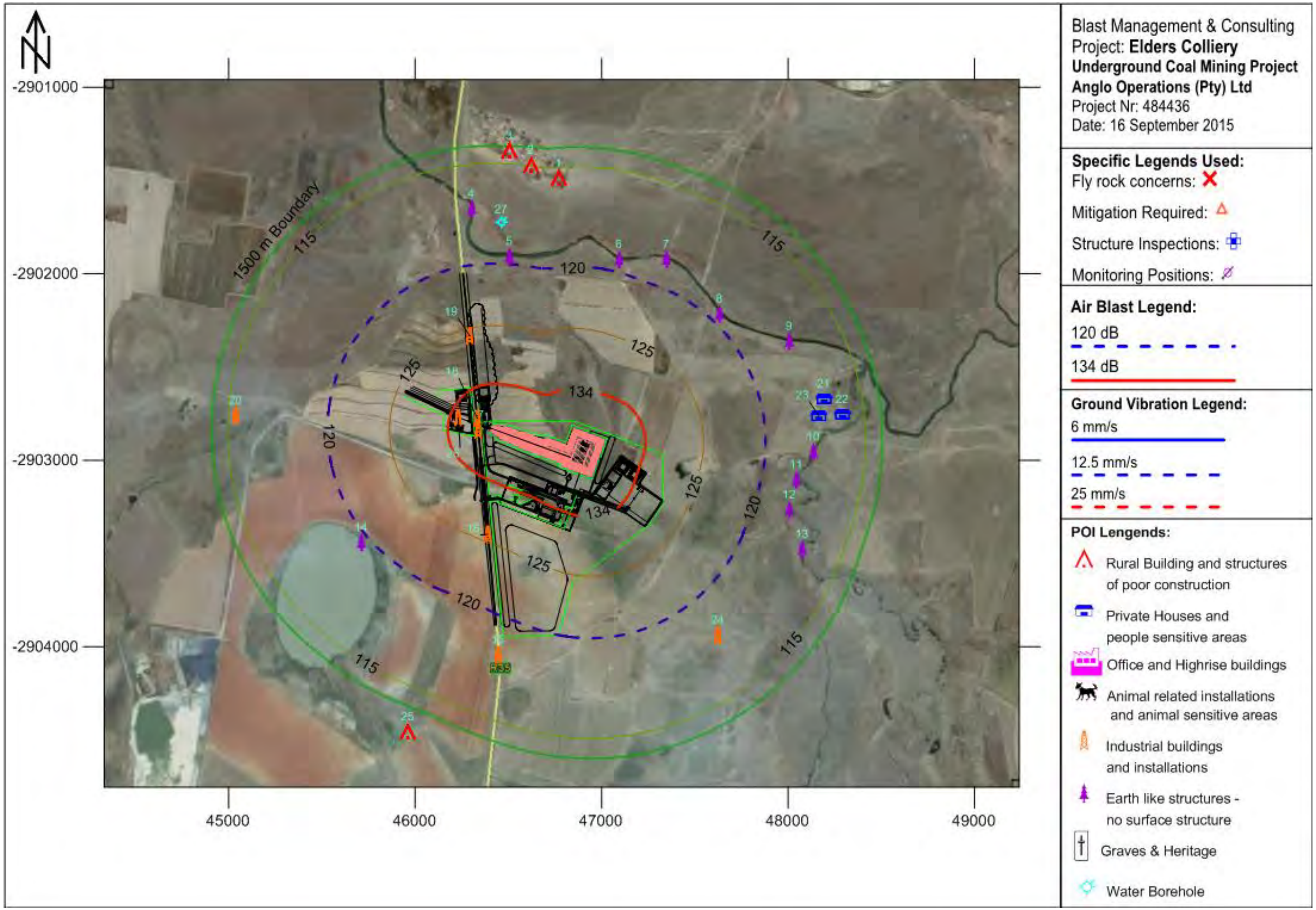

Figure 18: Air blast influence from maximum charge

Table 12: Air blast evaluation for maximum charge

Tag	Description	Distance (m)	Air blast (dB)	Possible Concern?
1	Informal Housing	1351	115.4	Acceptable
2	Informal Housing	1413	115.0	Acceptable
3	Informal Housing	1481	114.5	Acceptable
4	Olifants River	1173	116.9	N/A
5	Olifants River	914	119.5	N/A
6	Olifants River	940	119.2	N/A
7	Olifants River	1025	118.3	N/A
8	Olifants River	923	119.4	N/A
9	Olifants River	1135	117.2	N/A
10	Viskuile River	1131	117.3	N/A
11	Viskuile River	1057	118.0	N/A
12	Viskuile River	1063	117.9	N/A
13	Viskuile River	1197	116.7	N/A
14	Pan	914	119.5	N/A
15	R35 Road	1072	117.8	N/A
16	R35 Road	499	125.8	N/A
17	R35 Road	64	147.2	N/A
18	R35 Road	91	143.6	N/A
19	R35 Road	501	125.8	N/A
20	Cement Dam	1366	115.3	N/A
21	Structure	1208	116.6	Acceptable
22	Structure	1293	115.9	Acceptable
23	Building/Structure	1165	117.0	Acceptable
24	Cement Dam	1096	117.6	N/A
25	Informal Settlement	1640	113.4	Acceptable
26	Silo	183	136.3	N/A
27	Windmill	1096	117.6	N/A

13.5.2 Summary of findings for air blast

Review of the air blast levels indicates fewer concerns than ground vibration. Air blast predicted for the maximum charge ranges between 114.5 and 117 dB where structures are of concern. The predictions indicate that air blast levels at nearest house structures are low and not expected to have any significant influence or reason for damage concern.

Complaints from air blast are normally based on the actual effects that are experienced due to rattling of roof, windows, doors etc. These effects could startle people and raise concern of possible damage.

The possible negative effects from air blast are expected to be less than that of ground vibration. It is maintained that if stemming control is not exercised this effect could be greater with greater range of complaints or damage. This box-cut is located such that “free blasting” – meaning no controls on blast preparation – will not be possible.

13.6 Fly-rock Modelling Results and Impact of fly rock

Review of the factors that contribute to fly rock it is certain that if no stemming control is exerted there will be fly rock. A stemming length of 4.1 m as defined in the blast design is expected to yield fly rock that could travel as far as 207 m. Further reduction of stemming length will certainly see fly rock travelling further. At a distance of 207 m as the minimum exclusion zone the following POI's are of concern: 17, 18 and 26. Figure 18 below shows the relationship burden or stemming length towards expected throw distance. Throw distance considered here on the same level as the free face. Landing level of elements lower than free face could see longer distances. Optimal throw distance is also observed at 45 degree angles of departure and at the elevated levels of blasting care must be taken on fly rock as travel distance may be further than anticipated. Careful attention will need to be given to stemming control to ensure that fly rock minimised as much as possible. Figure 19 shows the area around pit area that incorporates the 207 m exclusion zone.

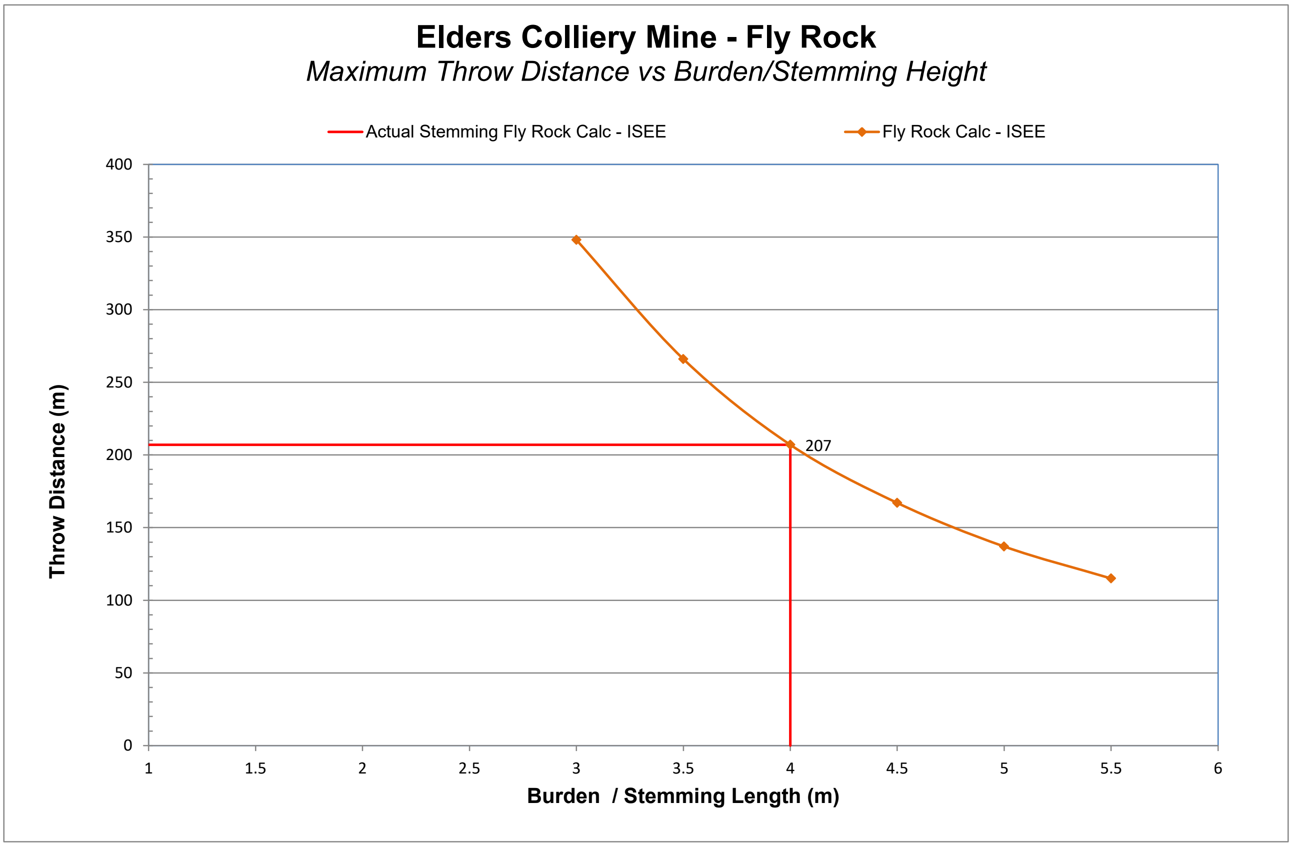

Figure 19: Predicted Fly rock

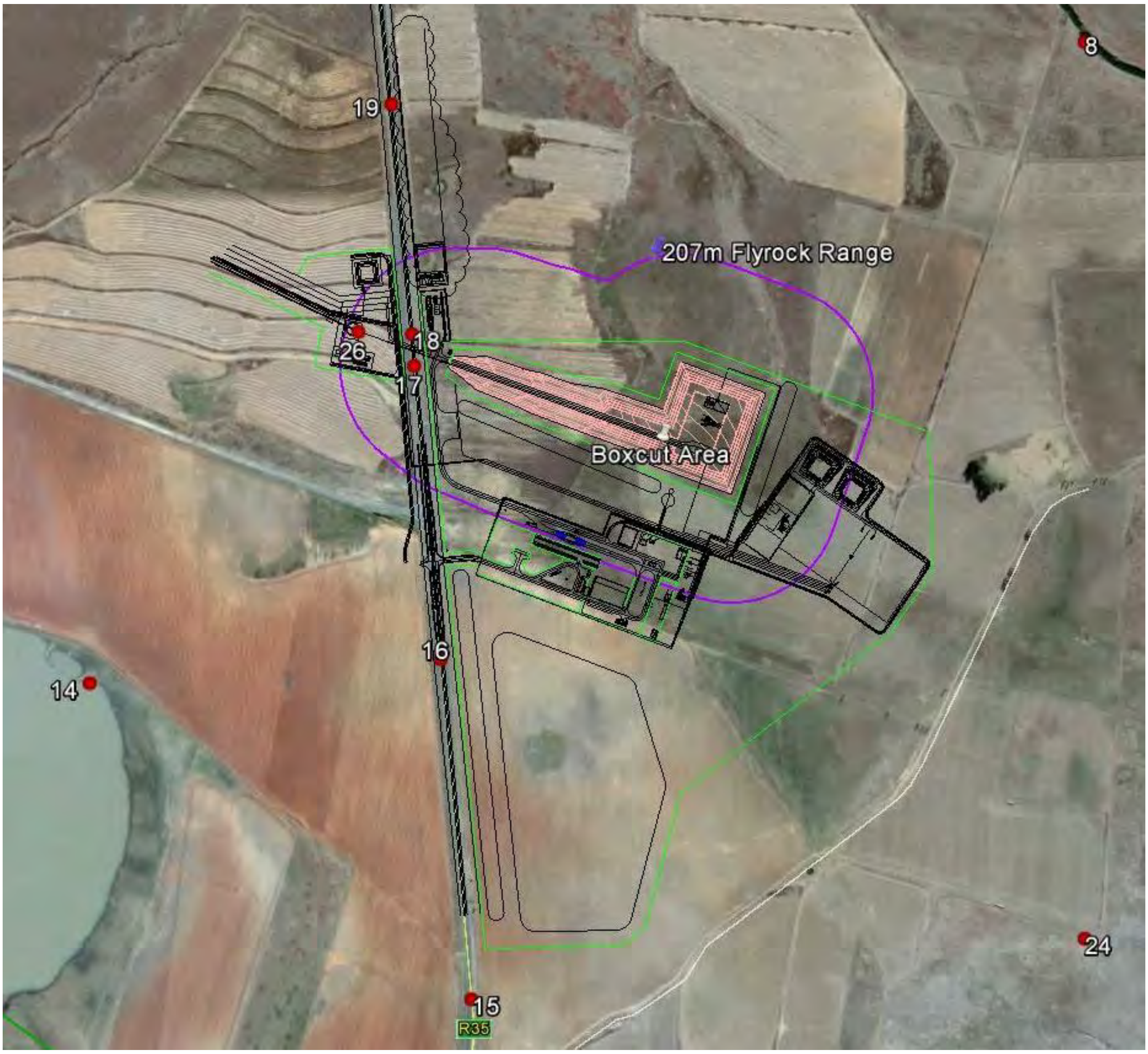

Figure 20: Predicted Fly rock Exclusion Zone

13.7 Potential Environmental Impact Assessment: Operational Phase

The following is the impact assessment of the various concerns covered by this report. The matrix below in Table 13 was used for analysis and evaluation of aspects discussed in this report. The outcome of the analysis is provided in Table 15 before mitigation and in Table 16 after mitigation. This risk assessment is a one sided analysis and needs to be discussed with role players in order to obtain a proper outcome and mitigation.

13.7.1 Impact Identification

The anticipated impacts to each environmental element documented are described. Mitigation measures for the additional impact are recorded and the residual impact calculated. Further, the cumulative impacts associated with the proposed development were assessed in terms of a local scale. The anticipated impacts associated with the proposed project were assessed according to SRK's standardised impact assessment methodology which is presented below. This methodology has been utilised for the assessment of environmental impacts where the consequence (severity of impact, spatial scope of impact and duration of impact) and likelihood (frequency of activity and frequency of impact) have been considered in parallel to provide an impact rating and hence an interpretation in terms of the level of environmental management required for each impact.

The first stage of any impact assessment is the identification of potential environmental activities[1], aspects[2] and impacts which may occur during the commencement and implementation of a project. This is supported by the identification of receptors[3] and resources[4], which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Environmental impacts[5] (social and biophysical) are then identified based on the potential interaction between the aspects and the receptors/resources.

The significance of the impact is then assessed by rating each variable numerically according to defined criteria as outlined in Table 13. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity[6], spatial scope[7] and duration[8] of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity[9] and the frequency of the impact[10] together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix table as shown in Table 14.

This matrix thus provides a rating on a scale of 1 to 150 (low, medium low, medium high or high) based on the consequence and likelihood of an environmental impact occurring.

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[1]An ***activity*** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or pieces of infrastructure that are possessed by an organisation.

[2]An ***environmental aspect*** is an 'element of an organisations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact.

[3]***Receptors*** comprise, but are not limited to people or man-made structures.

[4]***Resources*** include components of the biophysical environment.

[5]***Environmental impacts*** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. Receptors can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as aquifers, flora and palaeontology. In the case where the impact is on human health or well-being, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.

[6]***Severity*** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.

[7]***Spatial scope*** refers to the geographical scale of the impact.

[8]***Duration*** refers to the length of time over which the stressor will cause a change in the resource or receptor.

[9]***Frequency of activity*** refers to how often the proposed activity will take place.

[10]***Frequency of impact*** refers to the frequency with which a stressor (aspect) will impact on the receptor.

Natural and existing mitigation measures, including built-in engineering designs, are included in the pre-mitigation assessment of significance. Measures such as demolishing of infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

Table 13: Criteria for Assessing Significance of Impacts

SEVERITY OF IMPACT	RATING
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3

SPATIAL SCOPE OF IMPACT	RATING
Activity specific	1
Mine specific (within the mine boundary)	2
Local area (within 5 km of the mine boundary)	3

DURATION OF IMPACT	RATING
One day to one month	1
One month to one year	2
One year to ten years	3

CONSEQUENCE

FREQUENCY OF ACTIVITY / DURATION OF ASPECT	RATING
Annually or less / low	1
6 monthly / temporary	2
Monthly / infrequent	3

FREQUENCY OF IMPACT	RATING
Almost never / almost impossible	1
Very seldom / highly unlikely	2
Infrequent / unlikely / seldom	3
Often / regularly / likely / possible	4
Daily / highly likely / definitely	5

LIKELIHOOD

Table 14: Interpretation of Impact Rating

Consequence

Likelihood

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	20	30	40	50	60	70	80	90	100	110	120	1	140	150

	High	76 to 150	Improve current management
	Medium High	40 to 75	Maintain current management
	Medium Low	26 to 39	
	Low	1 to 25	No management required

SIGNIFICANCE = CONSEQUENCE x LIKELIHOOD

The reporting on all anticipated impacts must be done in a consistent manner and approach. The anticipated impacts must be reported separately for all phases of the proposed development, namely:

- Pre-construction;
- Construction Phase;
- Operational Phase;
- Decommissioning / Rehabilitation Phase;
- Post-Closure

Further, the following anticipated impacts must be reported on:

- Direct Impacts;
- Indirect Impacts;
- Residual Impacts;
- Cumulative Impacts.

13.7.2 Construction Phase Impact Assessment Outcome

The outcome of the impact assessment as evaluated is provided in Table 15 – before mitigation and Table 16 – after mitigation below. Due to the type of blasting anticipated there is no indirect, residual or cumulative impacts anticipated. The possibility of impact from blasting is only for that specific time of the blast occurring.

Table 15: Risk Assessment Outcome before mitigation

No.	Impact	Significance		Spatial Scale		Temporal Scale		Probability		Significance Before Mitigation	
		Score	**Magnitude**	**Score**	**Magnitude**	**Score**	**Magnitude**	**Score**	**Magnitude**	**Score**	**Magnitude**
Operational Phase											
1	Ground vibration Impact on houses	2	Low	3	Local	2	Short-term	3	Could Happen	1.40	Low
2	Ground vibration Impact on boreholes	0	No Impact	3	Local	2	Short-term	2	Unlikely	0.67	Very Low
3	Ground vibration Impact on roads	4	High	3	Local	2	Short-term	4	Very Likely	2.40	Moderate
4	Air blast Impact on houses	2	Low	3	Local	2	Short-term	3	Could Happen	1.40	Low
5	Air blast Impact on boreholes	0	No Impact	3	Local	2	Short-term	1	Impossible	0.33	Very Low
6	Air blast Impact on roads	0	No Impact	3	Local	2	Short-term	1	Impossible	0.33	Very Low
7	Fly Rock Impact on houses	2	Low	3	Local	2	Short-term	2	Unlikely	0.93	Very Low
8	Fly Rock Impact on boreholes	0	No Impact	3	Local	2	Short-term	1	Impossible	0.33	Very Low
9	Fly Rock Impact on roads	5	Very High	3	Local	2	Short-term	4	Very Likely	2.67	Moderate
Closure and Post-Closure Phase											
		0		0		0		0		0.00	Very Low

Table 16: Risk Assessment Outcome after mitigation

No.	Impact	Mitigation Measures	Significance		Spatial Scale		Temporal Scale		Probability		Significance after Mitigation	
			Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude
Operational Phase		**Operational Phase**										
1	Ground vibration Impact on houses	None	2	Low	3	Local	2	Short-term	3	Could Happen	1.40	Low
2	Ground vibration Impact on boreholes	None	0	No Impact	3	Local	2	Short-term	2	Unlikely	0.67	Very Low
3	Ground vibration Impact on roads	Specific blast design, reduce charge mass/delay over decreasing distance towards road.	2	Low	3	Local	2	Short-term	3	Could Happen	1.40	Low
4	Air blast Impact on houses	Stemming control must be part of the process	2	Low	3	Local	2	Short-term	3	Could Happen	1.40	Low
5	Air blast Impact on boreholes	None	0	No Impact	3	Local	2	Short-term	1	Impossible	0.33	Very Low
6	Air blast Impact on roads	None	0	No Impact	3	Local	2	Short-term	1	Impossible	0.33	Very Low
7	Fly Rock Impact on houses	None	2	Low	3	Local	2	Short-term	3	Could Happen	1.40	Low
8	Fly Rock Impact on boreholes	None	0	No Impact	3	Local	2	Short-term	1	Impossible	0.33	Very Low
9	Fly Rock Impact on roads	Specific blast design, increase stemming length, controls put in place for management of stemming lengths.	2	Low	3	Local	2	Short-term	3	Could Happen	1.40	Low
Closure and Post-Closure Phase		**Closure and Post-Closure Phase**										
	None		0		0		0		0		0.00	Very Low

13.7.3 Mitigations

In review of the evaluations made it is certain that specific mitigation will be required with regards to ground vibration. This is specific to the structures at POI 17, 18 and 26 – closest to the box-cut area. Figure 20 and Table 17 below shows the identified POI's of concern for blasting operations in pit area. Indication is given of structures of concern and structures where ground vibration levels are acceptable.

Ground vibration mitigation can be done in two ways: reduce the charge mass per delay – in other words, plan blasting operations considering different initiation and charging options. Reducing the charge mass per delay may include using of electronic initiation to facilitate a single blast hole firing option. This will reduce the charge mass to the mass loaded in a single blast hole. Secondly increase distance between the blast and the structure of concern. These are the main factors to be considered for mitigation.

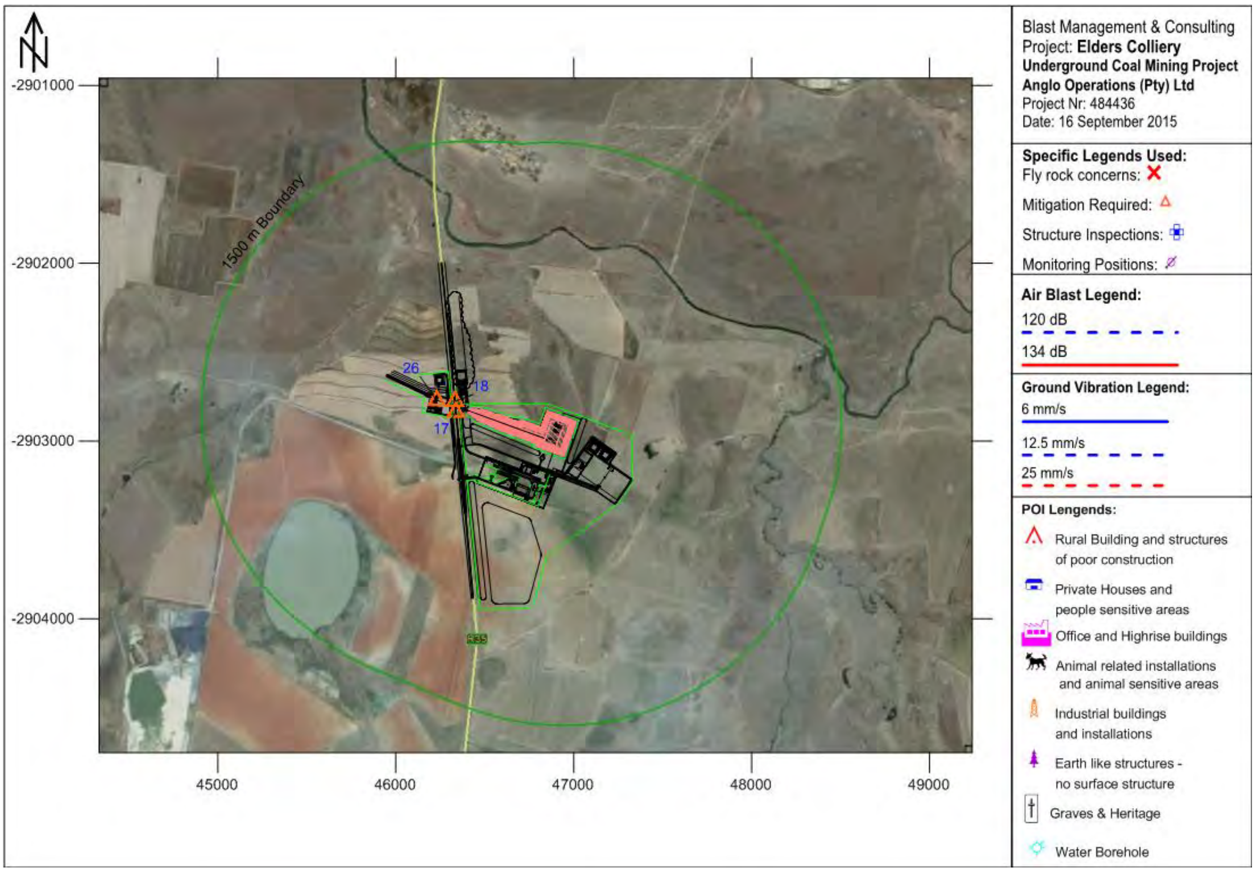

Figure 21: Structures at Pit Area that are identified where mitigation will be required.

Table 17: Structures at Pit Area identified as problematic

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz
17	R35 Road	-46337.78	2902836.67	150	64	1570	519.6	Problematic
18	R35 Road	-46333.67	2902775.92	150	91	1570	291.9	Problematic
26	Silo	-46230.65	2902771.15	50	183	1570	91.7	Problematic

In order to ensure that levels of ground vibration and that of air blast are within acceptable limits not to induce damage, the following tables show a combination of reduced charge mass per delay and increased distance from the structures of concern. The location of these structures is such that specific design changes are required for the blast operations on the southern side of the pit area. This will be dependent on the actual drill depths, quantity of charge per blast hole and the initiation system used. The recommendations made are based on minimum and maximum charge allowed to facilitate acceptable levels of ground vibration. Charge mass per delay less than that specified will allow for shorter distances. The possible options in order to obtain acceptable ground vibration are more than what is given here but without final blast design and actual position of the specific blast the table below gives the best solution for the moment. Air blast and fly rock can be controlled using proper charging methodology. Blasting operations in any area in the pit further than the distances given below will yield lower levels of ground vibration. It is advisable that a detail plan of action is put in place to manage ground vibrations in the areas of concern. Table 18 shows identified problematic POI's with reduced charge required to facilitate ground vibration levels within limits. Table 19 shows the minimum distance required between blast and POI at the maximum charge used to maintain accepted levels of ground vibration.

Table 18: Mitigation suggested for blasting operations – Reduced charge

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz
17	R35 Road	-46337.78	2902836.67	150	64	348	150.0	Acceptable
18	R35 Road	-46333.67	2902775.92	150	91	700	150.0	Acceptable
26	Silo	-46230.65	2902771.15	50	183	753	50.0	Acceptable

Table 19: Mitigation suggested for blasting operations – Minimum distance required

Tag	Description	Y	X	Specific Limit (mm/s)	Distance (m)	Total Mass/Delay (kg)	Predicted PPV (mm/s)	Structure Response @ 10Hz
17	R35 Road	-46337.78	2902836.67	150	126	1364	150.0	Acceptable
18	R35 Road	-46333.67	2902775.92	150	126	1364	150.0	Acceptable
26	Silo	-46230.65	2902771.15	50	246	1364	50.0	Acceptable

The construction of the silo at POI 26 has the following additional concerns during construction. The limits on cement during pouring should be considered and the following table shows the applicable limits. Only after 7 days the limit of 51 mm/s is achieved. Thus no blasting during construction and for at least 7 days after construction will need to be considered.

Table 20: Concrete limits

Aged of Concrete (Days)	Maximum Peak Particle Limit (mm/s)
< 3 Days	5
3 - 7 Days	51
8 - 10 days	102
10+ Days	203

14 Closure Phase

During the closure no mining drilling and blasting operations is expected. It is uncertain if any blasting will be done for demolition. If any demolition blasting will be required of plant it will be reviewed as civil blasting and addressed accordingly.

15 Alternatives (Comparison and Recommendation)

No specific mining method alternatives are currently under discussion or considered for drilling and blasting.

16 Monitoring

It is highly recommended that a blast monitoring program be put in place. This includes monitoring ground vibration and air blast for every blast. Ground vibration and air blast is monitored using a seismograph. Additionally to this it is recommended that a video of each blast is done as a standard. Monitoring of ground vibration and air blast is done to ensure that the generated levels of ground vibration and air blast comply with recommendations. Proposed positions were also selected to indicate the nearest points of interest at which levels of ground vibration and air blast should be within the accepted norms and standards as proposed in this report. The monitoring of ground vibration will also qualify the expected ground vibration and air blast levels and assist in mitigating these aspects properly. Currently 4 monitoring positions were identified around the mining areas. Monitor positions are indicated in Figure 21. The 4 monitoring points identified is mainly for the R35 road, the new silo, the Olifants River and the nearest informal housing structure at POI 1.

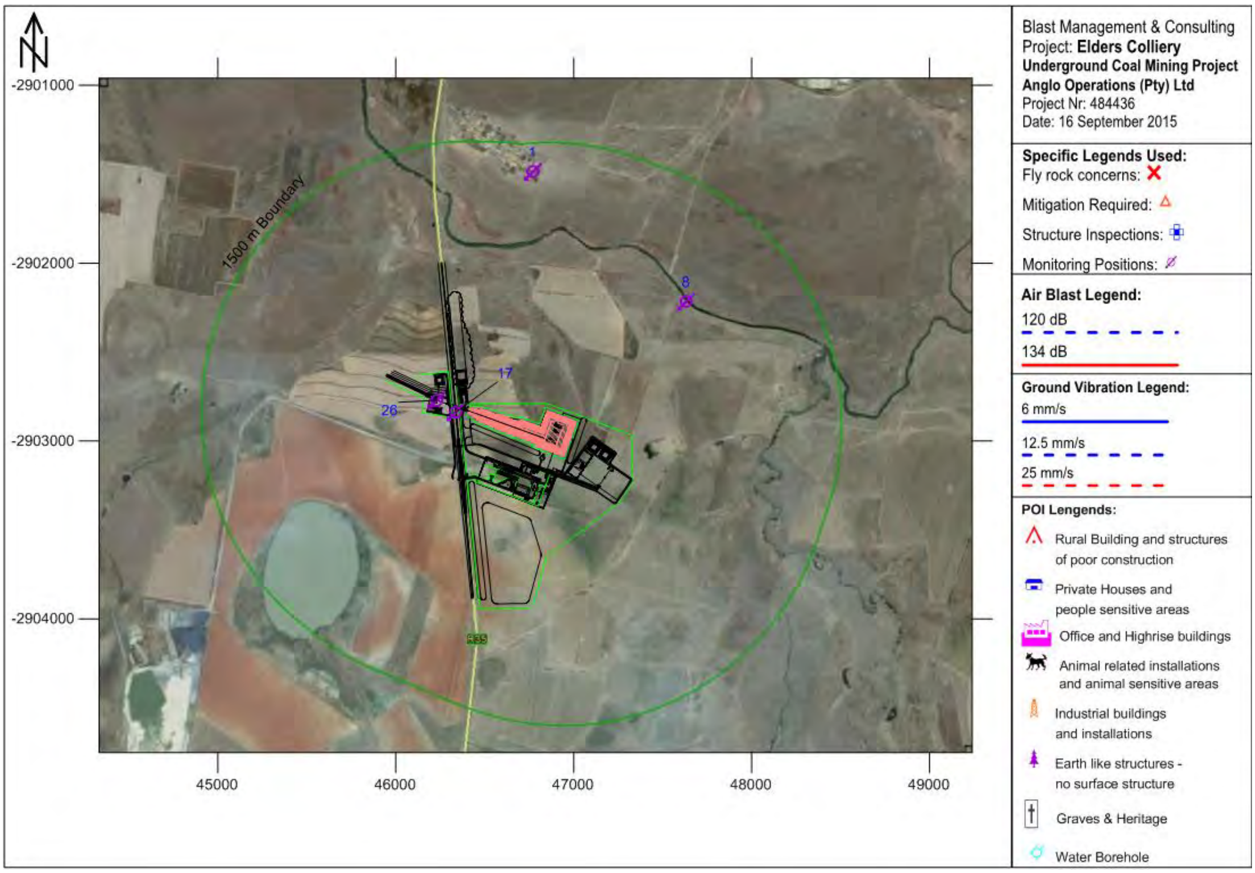

Figure 22: Monitoring Positions suggested.

Table 21: List of possible monitoring positions

Tag	Description	Classification	Y	X
1	Informal Housing	1	-46771.63	2901484.76
8	Olifants River	6	-47633.30	2902214.38
17	R35 Road	5	-46337.78	2902836.67
26	Silo	5	-46230.65	2902771.15

17 Recommendations

The following recommendations are proposed.

17.1 Blast Design and Initiation

A typical box-cut blast design was applied for this report. It is strongly recommended that the box-cut blast design be revisited and a proper detail design is done for the box-cut that will take these variables into consideration. In this design the initiation can be designed in such a way that ground vibration levels are managed at the points of concern identified.

17.2 Safe blasting distance

A minimum safe distance of 207 m is required but recommended is that a minimum of 500 m must be maintained from any blast done. This may be greater but not less. The blaster has a legal obligation concerning the safe distance and he needs to determine this distance.

17.3 Evacuation

All persons and animals within 500 m from a blast must be cleared and where necessary evacuation must be conducted with all the required pre-blast negotiations.

17.4 Road Closure

The R35 road is on the south western side of the box-cut area and is at closest 64m away from the planned box-cut area. Expected ground vibration levels at this road are higher than the recommended limits. Changed blasting parameters will have to be applied to ensure levels are within accepted norms. The road will also have to be closed during the time of blasting. The necessary authorisations from the roads agency / department will be required when blasting is done in the box-cut. It is recommended as well that all necessary precautions be taken for cleaning of the road should there be any material landing on the road.

17.5 Recommended ground vibration and air blast levels

The following general ground vibration and air blast levels are recommended for blasting operations in the box-cut area. Table 22 below gives limits for ground vibration and air blast. Table 23 shows the applicable limits for cement constructions.

Table 22: Recommended ground vibration air blast limits

Structure Description	Ground Vibration Limit (mm/s)	Air Blast Limit (dBL)
National Roads/Tar Roads:	150	N/A
Electrical Lines:	75	N/A
Railway:	150	N/A
Transformers	25	N/A
Water Wells	50	N/A
Telecoms Tower	50	134
General Houses of proper construction	USBM Criteria or 25 mm/s	Shall not exceed 134dB at point of concern but 120 dB preferred
Houses of lesser proper construction	12.5	
Rural building – Mud houses	6	

Table 23: Concrete limits

Aged of Concrete (Days)	Maximum Peak Particle Limit (mm/s)
< 3 Days	5
3 - 7 Days	51
8 - 10 days	102
10+ Days	203

17.6 Stemming length

The current proposed stemming lengths as defined in the blast design must be maintained to ensure control on fly rock. Specific designs where distances and blast is known should be considered with this.

17.7 Blasting times

Blasting times should consider the times where the road usage is low. This will reduce the impact on travellers using the road when road closure for blasting is done. A further consideration of blasting times is when weather conditions could influence the effects yielded by blasting operations. Recommended is not to blast 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 as well. Do not blast in fog. Do not blast in the dark. Refrain from blasting when wind is blowing strongly in the direction of an outside receptor. Do not blast with low overcast clouds. These ‘do not’s stem from the influence that weather has on air blast. The energy of air blast cannot be increased but it is distributed differently to unexpected levels where it was not expected.

It is recommended that a standard blasting time is fixed and blasting notice boards setup at various routes around the project area that will inform road users and farming community of blasting dates and times.

17.8 Third party monitoring

Third party consultation and monitoring should be considered for all ground vibration and air blast monitoring work. Additionally assistance may be sought when blasting is done close to the highways. This will bring about unbiased evaluation of levels and influence from an independent group. Monitoring could be done using permanent installed stations. Audit functions may also be conducted to assist the mine in maintaining a high level of performance with regards to blast results and the effects related to blasting operations.

18 Knowledge Gaps

Considering the stage of the project, the data observed was sufficient to conduct an initial study. Surface surroundings change continuously and this should be taken into account prior to any final blast design and review of this report. This report is based on data provided and international accepted methods and methodology used for calculations and predictions.

19 Conclusion

Blast Management & Consulting (BM&C) was contracted as part of Environmental Impact Assessment (EIA) to perform an initial review of possible impacts with regards to blasting operations in the proposed new opencast mining operation. Ground vibration, air blast, fly rock and fumes are some of the aspects as a result from blasting operations. The report concentrates on the ground vibration and air blast intends to provide information, calculations, predictions, possible influences and mitigations of blasting operations for this project.

The proposed new box-cut for the Elders project was evaluated for the effects yielded by blasting operations over an area as wide as 1500 m. The range of structures observed in this area is mainly the R35 tarred roads, the Middelkraal community, the Olifants River, the Viskuile River, other small informal settlement, farm steads and water boreholes. The project evaluated consists mainly of one box-cut that will provide access to underground mining operations. There are currently no blasting operations conducted on site.

The project area has possibility of presence of people and possibly farm animals at close distances to the operations when blasting of the box-cut is done. The location of structures around the box-cut area is such that the charge evaluated showed possible influences due to ground vibration. This is mainly for the R35 Road and new infrastructure for the project. Ground vibration mitigation will be required for these structures. Ground vibrations predicted ranged between very low levels and very high at 519 mm/s for points of interest identified. Ground vibration at structures and installations other than the identified problematic structures is well below any specific concern for inducing damage. There is a possibility that ground vibration may be perceptible at the Middelkraal settlement.

Air blast levels indicate fewer concerns than ground vibration. Air blast predicted for the maximum charge ranges between 113 and 117 dB where structures are of concern. The predictions indicate that air blast levels at nearest house structures are low and not expected to have any significant influence or reason for damage concern. Complaints from air blast are normally based on the actual effects that are experienced due to rattling of roof, windows, doors etc. These effects could startle people and raise concern of possible damage.

An exclusion zone for safe blasting was also calculated. The exclusion zone was established to be at least 207 m. Normal practice observed in mines is a 500 m exclusion zone. The use of 500 m exclusion zone is rather recommended.

There are various water boreholes that are located relatively far from the box-cut area. The locations are such that no possible permanent damage is likely.

Recommendations were made that should be considered. Specifically for monitoring of ground vibration and air blast, save blasting zones, blast design, road closures, safe ground vibration and air blast limits, stemming lengths, blasting times and monitoring of blasting operations.

This concludes this investigation for the Elders Colliery Underground Mine Project. It will be possible to develop the box-cut in a safe and effective manner provided attention is given to the areas of concern and recommendations as indicated.

20 Curriculum Vitae of Author

Author joined Permanent Force at the SA Ammunition Core for period Jan 1983 - Jan 1990. During this period I was involved in testing at SANDF Ammunition Depots and Proofing ranges. Work entailed munitions maintenance, proofing and lot acceptance of ammunition. For the period Jul 1992 - Des 1995 Worked at AECI Explosives Ltd. Initially I was involved in testing science on small scale laboratory work and large scale field work. Later on work entailed managing various testing facilities and testing projects. Due to the restructuring of Technical Department I was retrenched but fortunately could take up appointment with AECI Explosives Ltd.'s Pumpable Emulsion explosives group for underground applications. December 1995 to June 1997 I gave technical support to the Underground Bulk Systems Technology business unit and performed project management on new products. I started Blast Management & Consulting in June 1997. Main areas of concern were Pre-blast monitoring, Insitu monitoring, Post blast monitoring and specialized projects.

I have obtained the following Qualifications:

1985 - 1987	Diploma: Explosives Technology, Technikon Pretoria
1990 - 1992	BA Degree, University Of Pretoria
1994	National Higher Diploma: Explosives Technology, Technikon Pretoria
1997	Project Management Certificate: Damelin College
2000	Advanced Certificate in Blasting, Technikon SA

Member: International Society of Explosives Engineers

Blast Management & Consulting has been active in the mining industry since 1997 and work has been on various levels for all the major mining companies in South Africa. Some of the projects where BM&C has been involved are:

Iso-Seismic Surveys for Kriel Colliery in conjunction with Bauer & Crosby PTY Ltd, Iso-Seismic surveys for Impala Platinum Limited, Iso-Seismic surveys for Kromdraai Opencast Mine, Photographic Surveys for Kriel Colliery, Photographic Surveys for Goedehoop Colliery, Photographic Surveys for Aquarius Kroondal Platinum – Klipfontein Village, Photographic Surveys for Aquarius – Everest South Project, Photographic Surveys for Kromdraai Opencast Mine, Photographic Inspections for various other companies including Landau Colliery, Platinum Joint

Venture – three mini pit areas, Continuous ground vibration and air blast monitoring for various Coal mines, Full auditing and control with consultation on blast preparation, blasting and resultant effects for clients e.g. Anglo Platinum Ltd, Kroondal Platinum Mine, Lonmin Platinum, Blast Monitoring Platinum Joint Venture – New Rustenburg N4 road, Monitoring of ground vibration induced on surface in Underground Mining environment, Monitoring and management of blasting in close relation to water pipelines in opencast mining environment, Specialized testing of explosives characteristics, Supply and service of seismographs and VOD measurement equipment and accessories, Assistance in protection of ancient mining works for Rhino Minerals (PTY) LTD, Planning, design, auditing and monitoring of blasting in new quarry on new road project, Sterkspruit, with Africon, B&E International and Group 5 Roads, Structure Inspections and Reporting for Lonmin Platinum Mine Limpopo Pandora Joint Venture 180 houses – whole village, Structure Inspections and Reporting for Lonmin Platinum Mine Limpopo Section : 1000 houses / structures.

BM&C have installed a World class calibration facility for seismographs, which is accredited by Instantel, Ontario Canada as an accredited Instantel facility. The projects describe and discussed here are only part of the capability and professional work that is done by BM&C.

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Appendix G6: Archaeology and Cultural Heritage Specialist Study

CULTURAL HERITAGE ASSESSMENT FOR THE UPDATED ELDERS MINE ABOVE GROUND PROJECT AREAS, MPUMALANGA PROVINCE

Report No:	2015/JvS/068
Status:	Draft
Revision No:	0
Date:	October 2015

Prepared for:

SRK Consulting

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Copy Right:

Declaration:

I, J.A. van Schalkwyk, declare that I do not have any financial or personal interest in the proposed development, nor its developers or any of their subsidiaries, apart from the provision of heritage assessment and management services, for which a fair numeration is charged.

J A van Schalkwyk (D Litt et Phil)
Heritage Consultant
October 2015

EXECUTIVE SUMMARY

CULTURAL HERITAGE ASSESSMENT FOR THE UPDATED ELDERS COLLIERY ABOVE GROUND PROJECT AREAS, MPUMALANGA PROVINCE

SRK has been requested by Anglo American Thermal Coal (AATC) to submit a proposal for the development of an updated EIA/EMP and associated documentation for the Elders Underground Projects (including a WULA, Waste License and NEMA listed activities application in terms of NEMA).

At the specialist workshop in October 2013 for Elders Colliery, Anglo American Inyosi Coal (AAIC) presented a change in the mine plan of the mini pit, indicating an increase of the mini–pit footprint (and by implication, LOM). The new LOM for the mini-pit will be 2015 – 2027. In addition, there is a possibility that the coal will be trucked to Goedehoop for the entire LOM of the mini-pit. The conveyor belt will then be used exclusively for the transport of coal from underground. The underground mine will also be delayed by three years, first coal will be available from 2020. The overall LOM will now be 23 years.

As a result of this, it was decided to re-survey the areas where the mini pit and shaft complex and infrastructure will be developed. Subsequently, the mining plan was again changed, with the bulk of the infrastructure development being moved across the R35 from the western to the eastern side. The current report should therefore be read in conjunction with the previous reports completed for the same project (Van Schalkwyk 2006, 2012 & 2014).

The cultural landscape qualities of the study area essentially consist of a rural area in which the human occupation is made up of a largely of a colonial (farmer) and urban component.

Based on the previous surveys that were conducted in the mining area, we are confident of their results and are of the viewpoint that the area need not be subjected to another field survey at this point in time.

- In conclusion, as no site, features or objects of cultural significance are known to exist in the study area, there would be no impact as a result of the proposed development.

Therefore, from a heritage point of view we recommend that the proposed development can continue. We also recommend that if archaeological sites or graves are exposed during development activities, it should immediately be reported to a heritage practitioner so that an investigation and evaluation of the finds can be made.

J A van Schalkwyk
Heritage Consultant
October 2015

TECHNICAL SUMMARY

Property details	
Province	Mpumalanga
Magisterial district	Bethal
District municipality	Gert Sibande
Topo-cadastral map	2629AB, 2629AD, 2629BA, 2629BC
Closest town	Bethal
Farm name	Middelkraal 50IS, Vlakkuilen 76IS

Development criteria in terms of Section 38(1) of the NHR Act	Yes/No
Construction of road, wall, power line, pipeline, canal or other linear form of development or barrier exceeding 300m in length	Yes
Construction of bridge or similar structure exceeding 50m in length	No
Development exceeding 5000 sq m	Yes
Development involving three or more existing erven or subdivisions	No
Development involving three or more erven or divisions that have been consolidated within past five years	No
Rezoning of site exceeding 10 000 sq m	Yes
Any other development category, public open space, squares, parks, recreation grounds	No

Development	
Description	Development of coal mining activities, as well as infrastructural development
Project name	Elders Project

Land use	
Previous land use	Farming
Current land use	Farming

TABLE OF CONTENTS

LIST OF FIGURES

GLOSSARY OF TERMS AND ABBREVIATIONS

TERMS

Study area: Refers to the entire study area as indicated by the client in the accompanying Fig. 1 & 2.

Stone Age: The first and longest part of human history is the Stone Age, which began with the appearance of early humans between 3-2 million years ago. Stone Age people were hunters, gatherers and scavengers who did not live in permanently settled communities. Their stone tools preserve well and are found in most places in South Africa and elsewhere.

Early Stone Age	2 000 000 - 150 000 Before Present (BP)
Middle Stone Age	150 000 - 30 000 BP
Late Stone Age	30 000 - until c. AD 200

Iron Age: Period covering the last 1800 years, when new people brought a new way of life to southern Africa. They established settled villages, cultivated domestic crops such as sorghum, millet and beans, and they herded cattle as well as sheep and goats. As they produced their own iron tools, archaeologists call this the Iron Age.

Early Iron Age	AD 200 - AD 900
Middle Iron Age	AD 900 - AD 1300
Late Iron Age	AD 1300 - AD 1830

Historical Period: Since the arrival of the white settlers - c. AD 1840 - in this part of the country

ABBREVIATIONS

ADRC	Archaeological Data Recording Centre
ASAPA	Association of Southern African Professional Archaeologists
BP	Before Present
CS-G	Chief Surveyor-General
EIA	Early Iron Age
ESA	Early Stone Age
LIA	Late Iron Age
LSA	Later Stone Age
HIA	Heritage Impact Assessment
MSA	Middle Stone Age
NASA	National Archives of South Africa
NHRA	National Heritage Resources Act
PHRA	Provincial Heritage Resources Agency
SAHRA	South African Heritage Resources Agency

CULTURAL HERITAGE ASSESSMENT FOR THE UPDATED ELDERS COLLIERY ABOVE GROUND PROJECT AREAS, MPUMALANGA PROVINCE

1. INTRODUCTION

SRK has been requested by Anglo American Thermal Coal (AATC) to submit a proposal for the development of an updated EMPR and associated documentation for the Elders Underground Projects (including a WULA, Waste License and NEMA listed activities application in terms of MPRDA and NEMA).

Environmental and social baseline studies were completed for the project area between 2002 and 2006, and a draft Scoping Report and draft Environmental Impact Assessment Report were compiled in 2007. A public consultation process was undertaken, however, no formal submissions to government authorities were made at the time. The scope of the project during these studies assumed that both open cast and underground mining methods would be employed and the specialist studies were commissioned on this basis.

However, the scope was changed and AATC proposed to develop the Elders coal reserves using only underground mining methods (underground board and pillar operation). Mining activities will be conducted underneath the flood plains of the Viskuile, Vlakkuile and Olifants Rivers, owing to the sensitivity of the Viskuile wetland. The project will be located on portions of four farms, located about 30 km north of Bethal, Mpumalanga. It is planned for the coal to be taken to a tip adjacent to the underground mine shaft and transported via an overland conveyor to an existing washing plant at Goedehoop Mine.

At the specialist workshop in October 2013 for Elders Colliery, Anglo American Inyosi Coal (AAIC) presented a change in the mine plan of the mini pit, indicating an increase of the mini–pit footprint (and by implication, LOM). The new LOM for the mini-pit will be 2015 – 2027. In addition, there is a possibility that the coal will be trucked to Goedehoop for the entire LOM of the mini-pit. The conveyor belt will then be used exclusively for the transport of coal from underground. The underground mine will also be delayed by three years, first coal will be available from 2020. The overall LOM will now be 23 years.

As a result of this, it was decided to re-survey the areas where the mini pit and shaft complex and infrastructure will be developed. Subsequently, the mining plan was again changed, with the bulk of the infrastructure development being moved across the R35 from the western to the eastern side. The current report should therefore be read in conjunction with the previous reports completed for the same project (Van Schalkwyk 2006, 2012 & 2014).

This report forms part of the Environmental Impact Assessment (EIA) as required by the EIA Regulations in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and is intended for submission to the South African Heritage Resources Agency (SAHRA).

2. TERMS OF REFERENCE

2.1 **Scope of work**

The aim of this is to determine if any sites, features or objects of cultural heritage significance occur within the boundaries of the area where it is planned to develop the Elders mining activities, inter alia the mini-pit, the shaft area and the associated infrastructure for this.

This report does not deal with development projects outside of or even adjacent to the study area as is presented in Section 5 of this report. The same holds true for heritage sites, except in a generalised sense where it is used to create an overview of the heritage potential in the larger region.

The scope of work for this study consisted of:

- Conducting of a desk-top investigation of the area, in which available literature, reports, databases and maps were studied.

The objectives were to

- Identify possible archaeological, cultural and historic sites within the proposed development area;
- Evaluate the potential impacts of construction, operation and maintenance of the proposed development on archaeological, cultural and historical resources;
- Recommend mitigation measures to ameliorate any negative impacts on areas of archaeological, cultural or historical importance.

2.2 **Limitations**

The investigation has been influenced by the following factors:

- It is assumed that the description of the proposed project, provided by the client, is accurate.
- It is assumed that the public consultation process undertaken as part of the Environmental Impact Assessment (EIA) is sufficient and that it does not have to be repeated as part of the heritage impact assessment.
- The unpredictability of archaeological remains occurring below the surface.
- This report does not consider the palaeontological potential of the project site, as this is to be addressed by an appropriately qualified specialist.

3. HERITAGE RESOURCES

3.1 **The National Estate**

The NHRA (No. 25 of 1999) defines the heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations that must be considered part of the national estate to include:

- places, buildings, structures and equipment of cultural significance;
- places to which oral traditions are attached or which are associated with living heritage;
- historical settlements and townscapes;
- landscapes and natural features of cultural significance;
- geological sites of scientific or cultural importance;
- archaeological and palaeontological sites;
- graves and burial grounds, including-
    - ancestral graves;
    - royal graves and graves of traditional leaders;
    - graves of victims of conflict;
    - graves of individuals designated by the Minister by notice in the Gazette;

    - historical graves and cemeteries; and
    - other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);
- sites of significance relating to the history of slavery in South Africa;
- movable objects, including-
    - objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;
    - objects to which oral traditions are attached or which are associated with living heritage;
    - ethnographic art and objects;
    - military objects;
    - objects of decorative or fine art;
    - objects of scientific or technological interest; and
    - books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

3.2 **Cultural significance**

In the NHRA, Section 2 (vi), it is stated that ‘‘cultural significance’’ means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance. This is determined in relation to a site or feature’s uniqueness, condition of preservation and research potential.

According to Section 3(3) of the NHRA, a place or object is to be considered part of the national estate if it has cultural significance or other special value because of

- its importance in the community, or pattern of South Africa's history;
- its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;
- its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;
- its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;
- its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;
- its importance in demonstrating a high degree of creative or technical achievement at a particular period;
- its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;
- its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and
- sites of significance relating to the history of slavery in South Africa.

A matrix was developed whereby the above criteria were applied for the determination of the significance of each identified site (see Appendix 1). This allowed some form of control over the application of similar values for similar identified sites.

4. STUDY APPROACH AND METHODOLOGY

4.1 **Extent of the Study**

This survey and impact assessment covers the area as presented in Section 5 and as illustrated in Figures 1 and 2.

4.2 **Methodology**

4.2.1 *Preliminary investigation*

4.2.1.1 Survey of the literature
A survey of the relevant literature was conducted with the aim of reviewing the previous research done and determining the potential of the area. In this regard, various anthropological, archaeological, historical sources and heritage impact assessment reports were consulted.

- Information on events, sites and features in the larger region were obtained from these sources.

4.2.1.2 Data bases
The *Heritage Atlas Database,* the *Environmental Potential Atlas*, the *Chief Surveyor General* (CS-G) and the *National Archives of South Africa* (NASA) were consulted.

- Database surveys produced a number of sites located in the larger region of the proposed development.

4.2.1.3 Other sources
Aerial photographs and topocadastral and other maps were also studied - see the list of references below.

- Information of a very general nature was obtained from these sources.

4.2.2 *Field survey*

The area that had to be investigated was identified by **SRK Consulting** by means of maps. As the area falls into the larger site that were surveyed in the past (Van Schalkwyk 2006, 2012 & 2014) and we have all confidence in the results of those surveys, it was decided that a field survey would not be required.

5. DESCRIPTION OF THE AFFECTED ENVIRONMENT

5.1 **Site location and description**

The project areas are located about 30 km north of Bethal, Mpumalanga, west of the R35 running between Bethal and Middelburg to the north (Fig 2).

The area surveyed was determined by the proposed development as indicated in Fig. 2 and involve the following farms: Middelkraal 50IS, Vlakkuilen 76IS.For more information, please see the Technical Summary presented above (p. iii).

The topography of the area can be described as undulating hills, bisected by a number of smaller rivers. A few large pans occur in the study area.

The geology of the area consists of arenite, with some granite and rhyolite intrusions as outcrops.

The original vegetation of the area is classified as Highveld Grassland. Large sections are used for agricultural activities – ploughing and grazing – which changed the original vegetation drastically. Ploughing might also have had a detrimental effect on any heritage resources that might have occurred here in the past.

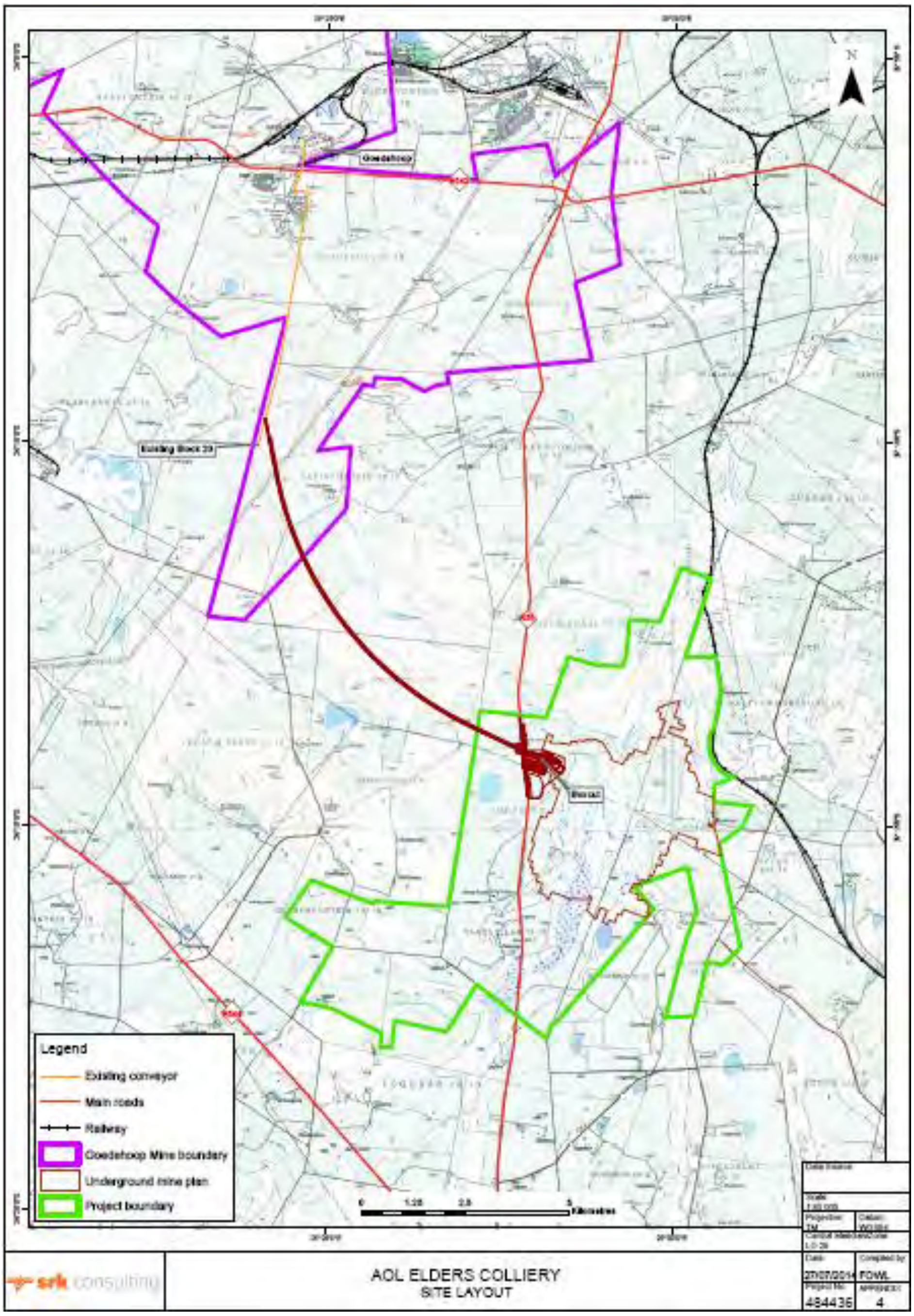

Fig. 1. Location of the study area (outlined in green) in regional context.

5.2 **Project Description**

Anglo American Thermal Coal (AATC) is proposing to develop the Elders coal reserves using underground mining methods (underground board and pillar operation). Mining activities will be conducted underneath the flood plains of the Viskuile, Vlakkuile and Olifants Rivers, owing to the sensitivity of the Viskuile wetland. The project will be located on portions of four farms, located about 30 km north of Bethal, Mpumalanga (Fig. 1).

At the specialist workshop in October 2013 for Elders Colliery, Anglo American Inyosi Coal (AAIC) presented a change in the mine plan of the mini pit, indicating an increase of the mini–pit footprint (and by implication, LOM). The new LOM for the mini-pit will be 2015 – 2027. In addition, there is a possibility that the coal will be trucked to Goedehoop for the entire LOM of the mini-pit. The conveyor belt will then be used exclusively for the transport of coal from underground. The underground mine will also be delayed by three years, first coal will be available from 2020. The overall LOM will now be 23 years.

The adit will be located on a section of land on the southern border of the farm Vlakkuilen (Fig. 2). The infrastructure for the adit is located just to the south of that (Fig. 2), with the overburden stockpile south of that, on the northern border of the farm Vlakkuilen 76IS (Fig. 2). The proposed shaft complex and substation site will be located to the west, across from the R35, on the northern border of the farm Middelkraal 50IS (Fig. 2).

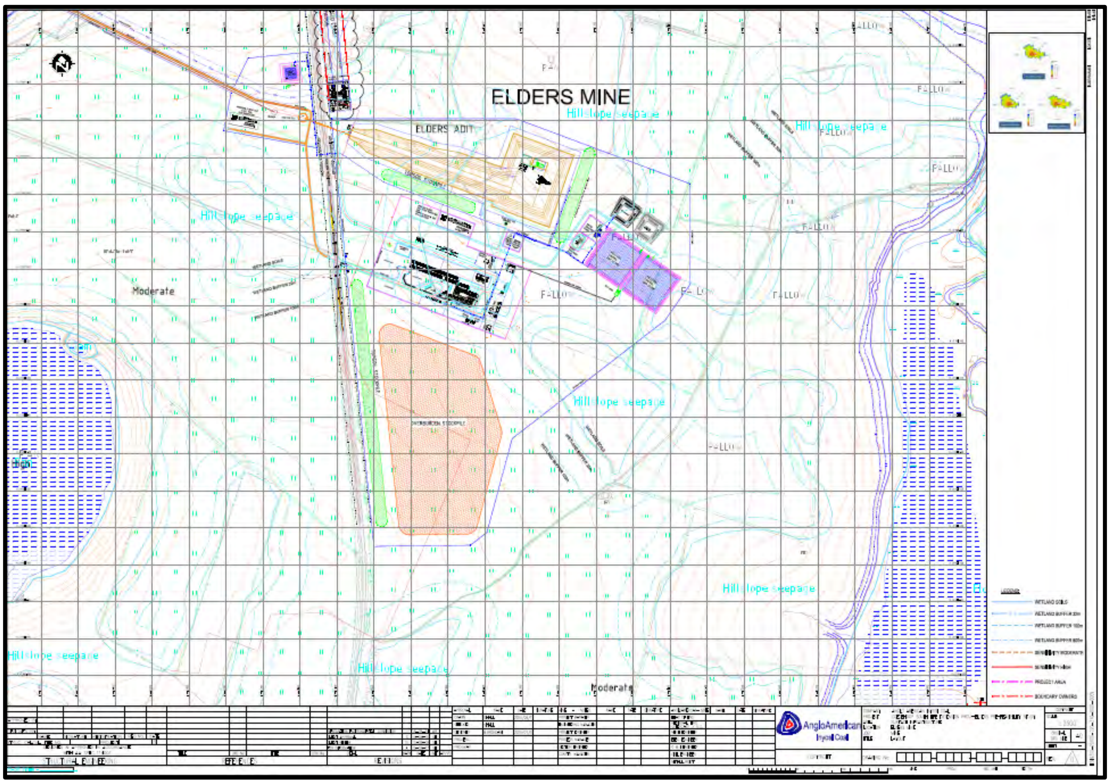

Fig. 2. Layout of the proposed development: proposed shaft complex.

Fig. 3. Views over the study area.

5.3 **Identified sites**

Based on the above sources, the following heritage sites, features and objects were identified in the proposed development area:

5.3.1 *Stone Age*

- No sites, features or objects dating to the Stone Age were identified in the study area.

5.3.2 *Iron Age*

- No sites, features or objects dating to the Iron Age were identified in the study area.

5.3.3 *Historic period*

- No sites, features or objects dating to the historic period were identified in the study area.

6. SITE SIGNIFICANCE AND ASSESSMENT

6.1 **Heritage assessment criteria and grading**

The NHRA stipulates the assessment criteria and grading of archaeological sites. The following categories are distinguished in Section 7 of the Act:

- **Grade I**: Heritage resources with qualities so exceptional that they are of special national significance;
- **Grade II**: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and
- **Grade III**: Other heritage resources worthy of conservation on a local authority level.

The occurrence of sites with a Grade I significance will demand that the development activities be drastically altered in order to retain these sites in their original state. For Grade II and Grade III sites, the applicability of mitigation measures would allow the development activities to continue.

6.2 **Statement of significance**

A matrix was developed whereby the above criteria, as set out in Sections 3(3) and 7 of the NHRA, No. 25 of 1999, were applied for each identified site (see Appendix 1). This allowed some form of control over the application of similar values for similar sites. Three categories of significance are recognized: low, medium and high. In terms of Section 7 of the NHRA, all the sites currently known or which are expected to occur in the study area are evaluated to have a grading as identified in the table below.

Table 1. Summary of identified heritage resources in the study area.

Identified heritage resources	
Category, according to NHRA	*Identification/Description*
Formal protections (NHRA)	
National heritage site (Section 27)	None
Provincial heritage site (Section 27)	None
Provisional protection (Section 29)	None
Place listed in heritage register (Section 30)	None
General protections (NHRA)	
structures older than 60 years (Section 34)	None
archaeological site or material (Section 35)	None
palaeontological site or material (Section 35)	None
graves or burial grounds (Section 36)	None
public monuments or memorials (Section 37)	None
Other	
Any other heritage resources (describe)	None

6.3 **Impact assessment**

Impact analysis of cultural heritage resources under threat of the proposed development, are based on the present understanding of the development.

- As no sites, features or objects of cultural heritage significance were identified in the study area, there would be no impact from the proposed development.

7. CONCLUSIONS

The aim of this survey was to locate, identify, evaluate and document sites, objects and structures of cultural significance found within the area of the proposed development, to assess the significance thereof and to consider alternatives and plan for the mitigation of any adverse impacts.

Based on the previous surveys that were conducted in the mining area, we are confident of their results and are of the viewpoint that the area need not be subjected to another field survey at this point in time.

In conclusion, as no site, features or objects of cultural significance are known to exist in the study area, there would be no impact as a result of the proposed development.

Therefore, from a heritage point of view we recommend that the proposed development can continue. We also recommend that if archaeological sites or graves are exposed during development activities, it should immediately be reported to a heritage practitioner so that an investigation and evaluation of the finds can be made.

8. REFERENCES

8.1 **Data bases**

Chief Surveyor General
Environmental Potential Atlas, Department of Environmental Affairs and Tourism.
Heritage Atlas Database, Pretoria.
National Archives of South Africa
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8.3 **Maps and aerial photographs**

1: 50 000 Topocadastral maps
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APPENDIX 1: CONVENTIONS USED TO ASSESS THE SIGNIFICANCE OF HERITAGE RESOURCES

Significance

According to the NHRA, Section 2(vi) the **significance** of heritage sites and artefacts is determined by it aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technical value in relation to the uniqueness, condition of preservation and research potential. It must be kept in mind that the various aspects are not mutually exclusive, and that the evaluation of any site is done with reference to any number of these.

Matrix used for assessing the significance of each identified site/feature

1. Historic value			
Is it important in the community, or pattern of history			
Does it have strong or special association with the life or work of a person, group or organisation of importance in history			
Does it have significance relating to the history of slavery			
2. Aesthetic value			
It is important in exhibiting particular aesthetic characteristics valued by a community or cultural group			
3. Scientific value			
Does it have potential to yield information that will contribute to an understanding of natural or cultural heritage			
Is it important in demonstrating a high degree of creative or technical achievement at a particular period			
4. Social value			
Does it have strong or special association with a particular community or cultural group for social, cultural or spiritual reasons			
5. Rarity			
Does it possess uncommon, rare or endangered aspects of natural or cultural heritage			
6. Representivity			
Is it important in demonstrating the principal characteristics of a particular class of natural or cultural places or objects			
Importance in demonstrating the principal characteristics of a range of landscapes or environments, the attributes of which identify it as being characteristic of its class			
Importance in demonstrating the principal characteristics of human activities (including way of life, philosophy, custom, process, land-use, function, design or technique) in the environment of the nation, province, region or locality.			
7. Sphere of Significance	High	Medium	Low
International			
National			
Provincial			
Regional			
Local			
Specific community			
8. Significance rating of feature			
1. Low			
2. Medium			
3. High			

APPENDIX 2. RELEVANT LEGISLATION

All archaeological and palaeontological sites, and meteorites are protected by the National Heritage Resources Act (Act no 25 of 1999) as stated in Section 35:

(1) Subject to the provisions of section 8, the protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority: Provided that the protection of any wreck in the territorial waters and the maritime cultural zone shall be the responsibility of SAHRA.

(2) Subject to the provisions of subsection (8)(a), all archaeological objects, palaeontological material and meteorites are the property of the State. The responsible heritage authority must, on behalf of the State, at its discretion ensure that such objects are lodged with a museum or other public institution that has a collection policy acceptable to the heritage resources authority and may in so doing establish such terms and conditions as it sees fit for the conservation of such objects.

(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.

(4) No person may, without a permit issued by the responsible heritage resources authority-

(a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;

(b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;

(c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or

(d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

In terms of cemeteries and graves the following (Section 36):

(1) Where it is not the responsibility of any other authority, SAHRA must conserve and generally care for burial grounds and graves protected in terms of this section, and it may make such arrangements for their conservation as it sees fit.

(2) SAHRA must identify and record the graves of victims of conflict and any other graves which it deems to be of cultural significance and may erect memorials associated with the grave referred to in subsection (1), and must maintain such memorials.

(3) No person may, without a permit issued by SAHRA or a provincial heritage resources authority-

(a) destroy, damage, alter, exhume or remove from its original position or otherwise disturb the grave of a victim of conflict, or any burial ground or part thereof which contains such graves;

(b) destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority; or

(c) bring onto or use at a burial ground or grave referred to in paragraph (a) or (b) any excavation equipment, or any equipment which assists in the detection or recovery of metals.

(4) SAHRA or a provincial heritage resources authority may not issue a permit for the destruction or damage of any burial ground or grave referred to in subsection (3)(a) unless it is satisfied that the applicant has made satisfactory arrangements for the exhumation and re-interment of the contents of such graves, at the cost of the applicant and in accordance with any regulations made by the responsible heritage resources authority.

APPENDIX 3. SPECIALIST COMPETENCY

Johan (Johnny) van Schalkwyk

J A van Schalkwyk, D Litt et Phil, heritage consultant, has been working in the field of heritage management for more than 30 years. Based at the National Museum of Cultural History, Pretoria, he has actively done research in the fields of anthropology, archaeology, museology, tourism and impact assessment. This work was done in Limpopo Province, Gauteng, Mpumalanga, North West Province, Eastern Cape, Northern Cape, Botswana, Zimbabwe, Malawi, Lesotho and Swaziland. Based on this work, he has curated various exhibitions at different museums and has published more than 60 papers, many in scientifically accredited journals. During this period he has done more than 2000 impact assessments (archaeological, anthropological, historical and social) for various government departments and developers. Projects include environmental management frameworks, road-, pipeline-, and power line developments, dams, mining, water purification works, historical landscapes, refuse dumps and urban developments.