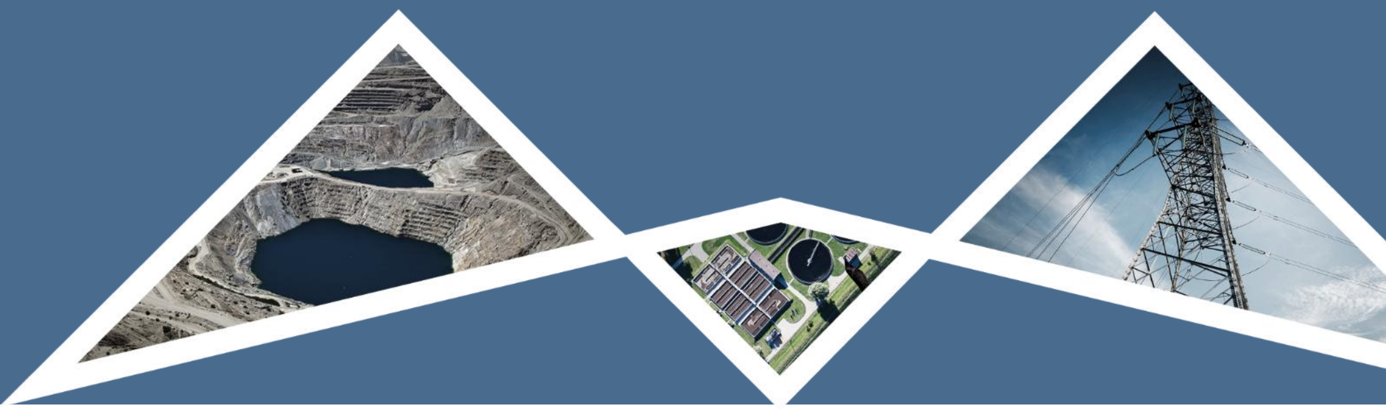
EIMS | ENVIRONMENTAL IMPACT MANAGEMENT SERVICES

T 011 789 7170 E info@eims.co.za W www.eims.co.za

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

12/3/386 EA APPLICATION:
MOTUOANE EXPLORATION RIGHT 386 APPLICATION, WITHIN VARIOUS FARMS IN MATJHABENG AND MOQHAKA LOCAL MUNICIPALITIES, LEJWELEPUTSWA AND FEZILE DABI DISTRICT MUNICIPALITIES, FREE STATE PROVINCE, SOUTH AFRICA

JUNE 2026



DOCUMENT DETAILS

EIMS REFERENCE:	1681
DOCUMENT TITLE:	Environmental Impact Assessment Report for Public and Authority Review: Motuoane Exploration Right 386 Application, Within Various Farms in Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezile Dabi District Municipalities, Free State Province, South Africa.

DOCUMENT CONTROL

	NAME	SIGNATURE	DATE
COMPILED:	Vukosi Mabunda		2026/04/23
CHECKED:	Liam Whitlow		2026/05/18
AUTHORIZED:	Liam Whitlow		2026/06/08

REVISION AND AMENDMENTS

REVISION DATE:	REV #	DESCRIPTION
2026/04/23	ORIGINAL DOCUMENT	Draft for Internal Review
2026/06/08	REVISION 1	Final for Public Review and Comment

Table of Contents

List of Figures

List of Tables

Appendices

ACRONYMS AND ABBREVIATIONS

2D	Two-dimensional
AA	Administrative Authority
AQIA	Air Quality Impact Assessment
AWD	Accelerated Weight Drop
BID	Background Information Document
CA	Competent Authority
CBA	Critical Biodiversity Area
CBL	Cement Bond Log
CH_4	Methane
CMA	Catchment Management Agency
CO	Carbon Monoxide
CO_2e	Carbon dioxide equivalent
CR	Critically Endangered
CSIR	Council for Scientific and Industrial Research
dBA	A-weighted decibels
DEA	Department of Environmental Affairs
DFFE	Department of Forestry, Fisheries, and the Environment
DMRE	Department of Mineral Resources and Energy
DMPR	Department of Mineral and Petroleum Resources
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
ECA	Environmental Conservation Act
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EIMS	Environmental Impact Management Services (Pty) Ltd.
ELWU	Existing Lawful Water Use
EMPR	Environmental Management Program
EMS	Environmental Management System
EN	Endangered
EPF	Exploration and Production Forum
ER	Exploration Right

ESA	Ecological Support Area
ESO	Environmental Site Officer
FEPA	Freshwater Ecosystem Priority Area
FIT	Formation Integrity Test
FRDCP	Final Rehabilitation, Decommissioning and Closure Plan
FSBP	Free State Biodiversity Plan
GA	General authorisation
GHG	Greenhouse Gases
GIS	Geographic Information Systems
GNR	Government Notice Regulation
GPS	Global Positioning System
Ha	Hectare
HGM	Hydrogeomorphic
HIA	Heritage Impact Assessment
Hz	Hertz
I&AP's	Interested and Affected Parties
IDP	Integrated Development Plan
IEP	Integrated Energy Plan
IUCN	International Union for Conservation of Nature
LC	Least Concern
MAE	Mean Annual Evaporation
mamsl	meters above mean sea level
MAP	Mean Annual Precipitation
mg/l	Milligrams per litre
mm/a	Millimetre per annum
MP	Marginally Protected
MPRDA:	Mineral and Petroleum Resources Development Act
MT	Magnetotellurics Survey
NAAQS	National Ambient Air Quality Standards
NEMA	National Environmental Management Act
NEMAQA:	National Environmental Management: Air Quality Act
NEMBA	National Environmental Management: Biodiversity Act
NEMWA:	National Environmental Management: Waste Act
NFEPA	National Freshwater Ecosystem Priority Areas
NGDB	National Groundwater Database
NHRA	National Heritage Resources Act

NO_2	Nitrogen Dioxide
NPAES	National Protected Area Expansion Strategy
NT	Near threatened
PASA	Petroleum Agency South Africa
PEG	Propelled Energy Generator
PES	Present Ecological State
PM	Particulate Matter
PM_{10}	Particles with a diameter of 10 micrometers or less
PM_{20}	Particles with a diameter of 2.5 micrometers or less.
PPP	Public Participation Process
Ptn	Portion
RE	Remaining Extent
SAHRA	South African Heritage Resources Agency
SAHRIS:	South African Heritage Resources Information System
SANBI	South African National Biodiversity Institute
SANS	South African National Standards
SAPAD	South African Protected Areas Database
SCC	Species of conservation concern
SEI	Site Ecological Importance
SO_2	Sulphur Dioxide
t	Tonne
TA	Target Area
TC	Total concentration
TCP	Technical Cooperation Permit
TDS	Total Dissolved Solids
TOPS	Threatened and Protected Species
TVD	True Vertical Depth
VOC	Volatile Organic Compounds
VU	Vulnerable
WMA	Water Management Area
WUL	Water Use Licence

GLOSSARY OF TERMS

This section provides a catalogue of terms and definitions, which may be used in this report and, or other documents drafted for the project.

Table 1: Glossary of terms.

Term	Definition	Reference
Clearing/Clearance	Clearing/Clearance refers to the removal of vegetation through permanent eradication and in turn no likelihood of regrowth. 'Burning of vegetation (e.g., fire- breaks), mowing grass or pruning does not constitute vegetation clearance, unless such burning, mowing or pruning would result in the vegetation being permanently eliminated, removed or eradicated'.	**Department of Environmental Affairs, 2017. Clearance of Indigenous Vegetation Explanatory Document**
Competent Authority	In respect of a listed activity or specified activity, means the organ of state charged by this Act with evaluating the environmental impact of that activity and, where appropriate, with granting or refusing an environmental authorisation in respect of that activity.	**National Environmental Management Act (NEMA), 1998 (Act 107 of 1998) as amended, NEMA 1998 hereafter**
Construction	According to the regulations this term is defined as – the building, erection or establishment of a facility, structure or infrastructure that is necessary for the undertaking of a listed or specified activity but excludes any modification, alteration or expansion of such a facility, structure or infrastructure and excluding the reconstruction of the same facility in the same location, with the same capacity and footprint'. In this application, construction refers to the site establishment, seismic surveys, and drilling activities.	**NEMA, EIA Regulations, 2014, as amended**
Critical Biodiversity Area	Areas that are deemed important to conserve ecosystems and species. For this reason, these areas require protection.	**SANBI**
Decommissioning	means to take out of active service permanently or dismantle partly or wholly, or closure of a facility to the extent that it cannot be readily recommissioned;	**NEMA, EIA Regulations, 2014, as amended**
Environment	the surroundings within which humans exist and that are made up of— the land, water and atmosphere of the earth; (ii) micro-organisms, plant and animal life; (iii) any part or combination of (i) and (ii) and the interrelationships among and between them; and (iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.	**National Environmental Management Act 1998 (Act No. 107 of 1998), as amended, NEMA hereafter**
Environmental Authorisation	This is a decision by a Competent Authority to authorise a listed activity in terms of the National Environmental Management Act (NEMA). The authorisation means that a project, either in totality or partially, can commence subject to certain conditions. The Competent Authority has a right to refuse to grant authorisation for a project in totality or partially.	**NEMA, EIA Regulations, 2014, as amended**
Environmental Assessment Practitioners	The individual responsible for the planning, management, coordination or review of environmental impact assessments, strategic environmental assessments, environmental management programmers or any other appropriate environmental instruments introduced through regulations.	**NEMA, 1998**

Term	Definition	Reference
Fatal Flaw	An environmental or social negative impact that is not possible to mitigate and significant enough to prevent the scheme from being able to be implemented.	**NEMA, 1998**
Fauna	Animal life that occurs in a specific geographical region and/habitat.	**SANBI**
Flora	plant life that occurs in a specific geographical region and/habitat.	**SANBI**
Geophysical data	Refers to measurements of the Earth's physical properties—such as gravity, magnetism, and electrical conductivity—used to map subsurface geology. It is critical for mineral and hydrocarbon exploration, groundwater mapping, infrastructure planning, and environmental monitoring	**Council for Geoscience**
Hydrogeomorphic	An assessment of the functions of a wetlands ecosystem by analysing the physical, chemical, and biological interactions of the ecosystem's structural components with the surrounding landscape. An Hydrogeomorphic (HGM) Unit is a classification of a wetland or aquatic ecosystem based on its geomorphic setting (where it is in the landscape), its dominant water source (where the water comes from), and its hydrodynamics (how water moves in and out)	**U.S. Army Corps of Engineers**
Indigenous vegetation	Refers to vegetation consisting of indigenous plant species occurring naturally in an area, regardless of the level of alien infestation and where the topsoil has not been lawfully disturbed during the preceding ten years.	**NEMA, EIA Regulations, 2014, as amended**
Interested and Affected Parties (IAPs)	a) any person, group of persons or organisation interested in or affected by such operation or activity; and (b) any organ of stale that may have jurisdiction over any aspect of the operation or activity.	**NEMA, 1998**
Protected Area	A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.	**International Union for Conservation of Nature (IUCN)**
	These are areas aimed at the protection and conservation of areas which are ecologically viable and have high biodiversity. Example of Protected Areas include but are not limited to National Parks, Nature Reserves, world heritage sites and marine protected areas	**National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)**
Public Participation Process	In relation to the assessment of the environmental impact of any application for an environmental authorisation, means a process by which potential Interested and Affected Parties are given opportunity to comment on, or raise issues relevant to, the application.	**NEMA, 1998, as amended**
Regulated Area of a watercourse	An area for which a General Authorisation or a Water Use Licence would need to be obtained prior to undertaking any activities.	**National Water Act 36 of 1998**
Screening	Screening determines whether or not a development proposal requires environmental assessment, and if so, what level of assessment is appropriate Screening is therefore a decision-making process that is initiated during the early stages of the development of a proposal.	**NEMA, EIA Regulations, 2014, as amended**
Species of Conservation Concern	IUCN Red List definition: Threatened species, and other species of significant conservation importance: Extinct, Extinct in the Wild, Near Threatened, Data Deficient. In South Africa, the following additional categories are added: Rare, Critically Rare.	**SANBI**

Term	Definition	Reference
Spud	In the drilling industry, to "spud" (or "spud in") means to begin the actual drilling process of a well. It marks the official starting point when the drill bit first makes contact with the earth to bore a hole.	**DrillingMatters.org**
True Vertical Depth	Is the vertical distance from a surface reference point (like the rig floor or sea level) straight down to a point in a wellbore. It is essential for calculating bottom-hole pressures and mapping geological formations in directional or horizontal drilling, where the actual borehole length is always longe.	**Energy Glossary**
Watercourse	Watercourse refers to: (a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which, water flows; and (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.	**National Water Act 36 of 1998**
Wetland	**land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil**	**National Water Act 36 of 1998**

EXECUTIVE SUMMARY

D3 Energy South Africa Pty Ltd (previously Motuoane Energy (Pty) Ltd) [1](hereafter referred to as D3 Energy / the Applicant) compiled and submitted an application for an Exploration Right (ER) to explore hydrocarbons, in terms of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 – MPRDA, as amended) to the Administrative Authority (AA), the Petroleum Agency South Africa (PASA) in 2024. The accepted (not yet approved) ER is located over an area of approximately 58 000 hectares (ha) / 580km^2, covering various farms near the towns of Welkom, Virginia, Hennenman and Odendaalsrus, within the Free State Province. The local municipalities in which the proposed exploration area is located are Matjhabeng and Moqhaka Local Municipalities, which are part of the Lejweleputswa and Fezile Dabi District Municipalities, respectively. Noticeable boundaries of ER386 are 28°13'28.95"S; 26°55'2.76"E in the South, 27°57'37.57"S; 26°48'49.15"E in the West, 27°59'13.57"S; 27°11'13.06"E in the East and 27°46'34.45"S; 26°57'44.05"E in the North, the central coordinates are approximately 27°58'23.27"S; 26°59'38.94"E.

D3 Energy proposes to explore all saleable gases including but not limited to Methane, Carbon Dioxide, Helium, and Nitrogen in the licensed area. Published reports, general experience, experience within D3 Energy and contacts with individuals familiar with the area indicate the presence of potentially commercial quantities of these gases. Direct evidence includes gas-emitting boreholes, nearby commercial gas production, gas encountered during drilling and underground mining operations. Due to the large area and complex exploration methodology, the ER will be required for an initial period of three years with the option to renew three additional periods of two years resulting in a total of nine years.

Exploration Right 386 is a consolidation of Technical Cooperation Permit (TCP) 235 and 240 & Exploration Right Application (ERA) 341 which were tenures in 2024 before ER386 application was submitted to PASA on the 8th of October 2024. TCP235 & TCP240 were granted in October 2023 for a 12 Month Term, an ER application was applied for in October 2024. TCP144 was granted in February 2017 for a 12 Month term at the end of which in February 2018 an ER application (ER341) was applied for. This application previously submitted to PASA was held up due to changing legislation and subsequently withdrawn. The areas (ERA341, TCP235 and TCP240) were then consolidated to one ER (ER386). The Applicant's application for an exploration ER for hydrocarbons was accepted on the 22nd of October 2024 in terms of Section 79 of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 – MPRDA, as amended). It is important to note that TCP 144 was granted in 2017 over the area of ERA 341, demonstrating security of tenure over the application area.

The Applicant previously submitted an Environmental Authorisation (EA) Application (12/3/386) to Petroleum Agency SA (PASA) as the AA on 15th May 2025 which effectively lapsed on the 1st of December 2025. A Final Scoping Report which was subjected to the 30-day legislated public review and comment period was submitted to PASA for consideration on 30th June 2025 and accepted on 13th August 2025. According to the National Environmental Management Act (NEMA) Environmental Impact Assessment (EIA) Regulation 23 (1), 2014 as amended, and as indicated in Scoping Acceptance Letter, an EIA Report which must have been subjected to a minimum of 30-day legislated public review and comment period was required to be submitted to PASA within 106 days from date of Acceptance of the Scoping Report (i.e., by 1st December 2025). Due to delays in finalizing access agreements for specialist studies within the Harmony Cluster, NEMA EIA Regulation 23 (1), 2014 as amended could not be met. As a result, the initial EA 12/3/386 Application lapsed and could not be considered further by the relevant authorities. Subsequently, all application and public participation processes and/or opportunities associated with the application were suspended.

The Applicant has resubmitted an EA Application (Amended) for the same activities (seismics and drilling wells for all saleable gases including but not limited to Methane, Carbon Dioxide, Helium, and Nitrogen), within the same approximate 58 000ha footprint (Exploration Right 386). It is important to note that although the

[1] It must be noted that that D3 Energy South Africa has recently changed its name from Motuoane Energy (Pty) Ltd. The EA Application / Project name will also be changed **from Motuoane Exploration Right 386 Application**, Within Various Farms in Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezile Dabi District Municipalities, Free State Province, South Africa **to D3 Energy Exploration Right 386 Application**, Within Various Farms in Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezile Dabi District Municipalities, Free State Province, South Africa during the final submission of the EIA Report and EA Application Form.

application area remains the same footprint (i.e., 58 000ha), the exploration activities have been reduced from eleven (11) drilling wells and sixteen (16) seismic transects to five (5) drilling wells and nine (9) seismic transects, respectively.

The proposed activities to be undertaken as part of the exploration activities include the following:

- Identifying existing blowers within the ER, undertaking well workover and intervention if necessary;
- The undertaking of new core exploration well drilling and undertaking well workover and intervention where necessary (at preidentified / new areas of interest);
- Undertaking seismic survey and/or magnetotellurics survey activities (at preidentified / new areas of interest);
- Perform gas composition analysis on gas from existing boreholes and newly drilled wells on the ER;
- Conduct borehole and well gas flow testing of existing boreholes and any new wells drilled; and
- Conduct borehole and well wireline logging of existing boreholes and any new wells drilled.

The main activities are exploration drilling and seismic survey activities. The proposed approach is to first determine and map the geographic extent of all boreholes currently emitting gas on and near the ER area. Then measure rates and monitor pressures where possible and perform gas composition analysis. The geophysical wireline logging of existing boreholes (where possible) will include monitoring of water levels. If no existing gas emitting boreholes are identified near a target area, new drilling activities are proposed within that area using percussion or rotary drilling method. Although up to five (5) Target Areas (TA) with 500m buffer (1km corridor) within the exploration right may be undertaken over the 9-year period, the current Works Program caters for only three (3) drilling wells. It must be noted that there may be a single, multiple or no drilling activities within some of the TA. Should more than 3 drilling wells be required within the ER, the current Works Program will be required to be updated accordingly. The previous TA's, Target Area 3 (ED G), Target Area 4 (ED H), Target Area 5 (ED J), Target Area 6 (ED I), Target Area 7 (ED F) and Target Area 8 (VEG A) as well as seven (7) seismic transects (Transects ED 1 to 5, VEG 1 & 2) which were proposed within the western section of the exploration right on the agricultural fields between Saaiplaas, Bronville, Thabong and Whites have been removed from the current application. The current application entails:

- Two Target Areas; Target Area 1 (RSB D) and Target Area 2 (RSB E) located in the south of ER386, approximately 7km southeast of Meloding;
- Target Area 9 (HF C) and associated transects (Transects HF 1, HF2 and HF7) located approximately 6km west the eastern boundary of ER386 (N1);
- Two Target Areas proposed within the northern section namely, Target Area 10 (GP B) and Target Area 11 (GP A) and three seismic transect (Transect G1, G2 and G3) R34 located between Odendaalsrus and Kroonstad.

Each exploration well will have an overall depth of up to 650m and a maximum width of 350mm, commencing with a 323mm width spud hole section drilled to 6m total vertical depth (TVD), followed by 254mm width conductor hole section drilled to 80m TVD, then an intermediate hole section of 203mm width drilled to 450m TVD and finally an open hole section of 144mm width drilled up to 650m TVD. The actual hole and casing sizes and configurations will vary depending on the specific geological characteristics and functional requirements. Each borehole will be steel cased and have cement barriers to prevent leaks as well as plugged at the end of exploration to prevent groundwater seepage.

The seismic survey activities are proposed throughout the exploration right as and when necessary. D3 Energy will search records at the Council for Geoscience and the Petroleum Agency for seismic data that was acquired on the Exploration Right in the past. If no data is available, D3 Energy will either acquire its own seismic or telluric data on the property, following proper environmental protocols and with the written permission of the landowner. There are nine (9) preliminary proposed transects for seismic / telluric survey, approximately 70km long around known structures and possible drill locations. Seismic and/or telluric locations and lengths are subject to be changed as knowledge increases. Although the vibroseis technique is the likely method to be undertaken for the seismic activities. There is also a potential alternative to the vibroseis known as the Propelled Energy Generators (PEGs), more commonly referred to as the Accelerated Weight Drop Seismic (AWD) which D3 Energy may consider over the vibroseis.

EIMS will compile and submit the required documentation in support of applications for:

- An Environmental Authorisation (EA) in accordance with the National Environmental Management Act (Act 107 of 1998) (NEMA), Environmental Impact Assessment (EIA) Regulations, 2014 as amended for the following listed activity:
    - EIA Regulations, 2014 as amended GNR 983 Activity 21C; and
    - EIA Regulations, 2014 as amended GNR 984 Activity 18.
- Other NEMA EIA Regulations, 2014 as amended applicable listed activities are:
    - EIA Regulations, 2014 as amended GNR 983 Activity 27; and
    - EIA Regulations, 2014 as amended GNR 985 Activity 12.
- Additional listed activities and/or water uses may be identified during the process.

NEED AND DESIRABILITY FOR THE ACTIVITY

Exploration for additional domestic hydrocarbon reserves is considered important, and any discoveries would be well received by the local market. The Department of Energy's Integrated Resource Plan (2010-2030) supports this view, stating that regional and domestic gas options should be pursued. The government's official position is that exploration and development of oil and gas fields should be encouraged. The identification of potential geological structures or "prospects" within the proposed exploration licence area for future exploration and possible well-drilling provides an opportunity to develop a South African oil and gas industry resulting in long-term benefits consisting of access to new energy sources, improved security of supply, major in-country investments in a development project and reduced dependence on the importation of hydrocarbons. There is also potential in the long-term for local economic stimulation through direct employment, future business opportunities, royalties, and tax revenues.

The Applicant has undertaken three authorised drilling activities (3 exploration boreholes) to date in the extended region, however the information recorded (observations) is inadequate to make a conclusive detailed reporting on the quantity of hydrocarbons and/or suitable drilling locations for production purposes. Therefore, the Applicant proposes to undertake up to five (5) new exploration boreholes and to acquire ground based seismic surveys (~70km of new seismic transects) within the ER386 area. The seismic survey will be used to better understand the subsurface discontinuities, layering, and probable rocks/structures. Analysis of the seismic surveys and additional drilling wells will provide more precise information to determine the viability of the exploration project into the production phase. The proposed activities, if approved, will allow the applicant to determine if there is an economically viable resource available in the area. It is important to note that the exploration right will not provide the required authorisation for production activities to be undertaken. As such, any future intention to undertake production of hydrocarbons within the exploration right area would require a further application, investigation, and public consultation process.

PURPOSE OF THE EIA REPORT

The previously completed Scoping Phase of the EIA process identified potential issues associated with the proposed project and defined the extent of the studies required for the EIA Phase. The Scoping Phase also identified potentially sensitive areas within the study site. This EIA Report addresses those identified potential negative and positive environmental impacts (direct, indirect, and cumulative impacts) associated with all phases of the project including design, construction, operation, decommissioning and closure. The EIA Phase recommended appropriate mitigation measures for potentially significant environmental impacts.

The EIA Phase is aimed to achieve the following:

- Provide an overall description and assessment of the social and biophysical environments affected by the proposed alternatives put forward as part of the project.
- Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed project.
- Comparatively assess identified feasible alternatives put forward as part of the project.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts; and
- Undertake a fully inclusive public involvement process to ensure that I&AP are afforded the opportunity to participate, and that their issues and concerns are recorded.

PUBLIC PARTICIPATION PROCESS

According to Section (2)(4)(f) of NEMA, the participation of all Interested and Affected Parties (I&APs) must be promoted, and all potential I&APs must be informed early and in an informative and proactive way regarding applications that may affect their lives or livelihood. To give effect to the above sections, it is essential to ensure that there is an adequate and appropriate opportunity for Public Participation (PP) in decisions that may affect the environment. The Public Participation Process (PPP) for the proposed project has been undertaken in accordance with the requirements of NEMA in line with the principles of Integrated Environmental Management (IEM). The PPP commenced on the 14th of March 2025 with an initial notification and call to register to interested and affected parties (I&APs). The comments received from I&APs during the initial call to register and commenting period so far have been captured in Public Participation Report in **Appendix C**.

Comments received during this EIA Report review period will be collated and added to the Public Participation Report submitted to the Competent Authority (CA). This EIA Report has been made available for public review and commenting for a period of 30 days**. Comments should be submitted to EIMS by no later than 13h July 2026** through the following means:

- Environmental Impact Management Services (Pty) Ltd (EIMS)
- P.O. Box 2083 Pinegowrie 2123
- Phone: 011 789 7170 / Fax: 011 787 3059
- Contact: Mbali Tshabalala
- EIMS Reference No: 1681
- Email: motuoane386@eims.co.za

PROJECT ALTERNATIVES

In terms of the EIA Regulations published in Government Notice (GN) R982 of 2014, as amended, feasible and reasonable alternatives must be identified and considered within the EIA process. According to the above-mentioned, an alternative is defined as *"…in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to the:*

(a) property on which or location where it is proposed to undertake the activity;

(b) type of activity to be undertaken;

(c) design or layout of the activity;

(d) technology or process to be used in the activity;

(e) operational aspects of the activity; and

(f) includes the option of not implementing the activity."

The alternatives discussed in this report are:

a) Locality Property Alternatives

   (i) Exploration Activities Within Preliminary Identified Target Exploration Locations; or
   (ii) Exploration Activities Within Preliminary Identified Target Exploration Locations excluding directly affected renewable energy projects; or
   (i) Exploration Activities Outside Preliminary Exploration Target Areas.

b) Process Alternatives:

   (i) Exploration Drilling Alternatives

      - Rotary Drilling Method;
      - Percussion Drilling Method;
      - Rotary-Percussion Drilling Method; or
      - Diamond Core Drilling Method.

   (ii) Seismic Survey Alternatives

      - vibroseis Technique;
      - Accelerated Weight Drop; or
      - Magnetotelluric Survey.

c) Scale Alternatives

   (i) Undertaking Limited Drilling and Seismic Activities within the ER; or
   (ii) Undertaking Unlimited Drilling and Seismic Activities within the ER.

d) Design or Layout Alternatives:

   (i) Traditional lined pond (drill sump pits); or
   (ii) Aboveground sumps with secondary containment (Pitless drilling).

- No-Go Alternative.

The preferred option under each category of alternatives is discussed in detail in **Section 5** of this report.

Each of the identified risks and impacts at the various project phases were assessed. The assessment criteria include the nature, extent, duration, magnitude / intensity, reversibility, probability, public response, cumulative impact, and irreplaceable loss of resources.

The most significant risks and impacts identified were those that remain high in terms of significance even post mitigation measures being considered. The following identified impacts were determined to have a potentially moderate final significance at this stage:

- Negative impact on groundwater quality during operation and closure phases;
- Negative impact on identified wetlands and aquatic species;
- Negative impact on soils and agricultural activities;
- Negative impact on vegetation and habitats;
- Mortality / disturbance of terrestrial species; and
- Positive socio-economic impact through employment opportunities.

The negative impacts will be further interrogated and assessed during the EIA phase of the project. Potential preliminary mitigation measures have been identified and will be refined based on input from the Environmental

Assessment Practitioner (EAP), public consultation, and specialist assessments during the EIA phase of the project. The associated EMPr (**Appendix H**) identifies appropriate mitigation mechanisms for avoidance, minimisation and / or management of the negative impacts and enhancement of the positive aspects.

SPECIALIST STUDIES

Various specialist assessments as identified through the DFFE National Web-Based Environmental Screening Tool Report and Site Sensitivity Verification will be undertaken to support the EA Application. The specialist assessments will be undertaken in compliance with the NEMA EIA and DFFE specialist guidelines / protocols (including Risk Assessment Matrix as per NWA) and any other applicable guidelines / protocols. The following EIA-phase specialist studies are to be conducted:

- Air Quality Impact Assessment (Airshed Planning Professionals);
- Agricultural Potential, Soils & Land Capability (The Biodiversity Company);
- Archaeological and Cultural Heritage Assessment (EIMS);
- Aquatics and Wetland Impact Assessment (The Biodiversity Company);
- Climate Change Assessment (Airshed Planning Professionals);
- Financial Provisions for Closure and Rehabilitation (EIMS);
- Geohydrological Impact Assessment (Gradient Groundwater Consulting);
- Noise Impact Assessment (Airshed Planning Professionals);
- Palaeontological Impact Assessment (Dr Heidi Fourie);
- Social Impact Assessment (Equispectives Research and Consulting Services); and
- Terrestrial Biodiversity Impact Assessment (The Biodiversity Company).

CONCLUSIONS AND RECOMMENDATIONS

The findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Despite the negative impacts caused by the project, it must be considered that there are positive impacts as well, mostly based on the employment opportunities (although minimal). Based on the nature and extent of the proposed and the predicted impacts as a result of the construction, operation and closure of the facility, the findings of the EIA, and the understanding of the mostly low - moderate post-mitigation significance level of potential environmental impacts, it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed D3 Energy ER386 activities can be mitigated to an acceptable level and the project should be authorized.

1 INTRODUCTION

D3 Energy South Africa (Pty) Ltd (previously Motuoane Energy (Pty) Ltd[2] (hereafter referred to as D3 Energy / the Applicant) has appointed Environmental Impact Management Services (Pty) Ltd (EIMS) as the Independent Environmental Assessment Practitioner (EAP) to assist with undertaking the required assessment and authorisation processes (including the statutory public participation), and to compile and submit the required documentation in support of application for an Environmental Authorisation (EA) in accordance with the National Environmental Management Act (Act 107 of 1998) (NEMA), Environmental Impact Assessment (EIA) Regulations, 2014 as amended.

It must be noted that a separate application for a Water Use Authorisation (WUA) may be required prior the construction phase depending on the proximity of the final drilling site to a watercourse. Should the final drilling sites be located within the regulated area for a watercourse, the Applicant must lodge a WUA application with the Department of Water and Sanitation (DWS) before commencement of the activities.

D3 Energy proposes to explore all saleable gases including but not limited to Methane, Carbon Dioxide, Helium, and Nitrogen in the licensed area. Published reports, general experience, experience within D3 Energy and contacts with individuals familiar with the area indicate the presence of potentially commercial quantities of these gases. Direct evidence includes gas-emitting boreholes, nearby commercial gas production, gas encountered during drilling and underground mining operations. Due to the large area and complex exploration methodology, the Exploration Right (ER) will be required for an initial period of three years with the option to renew three additional periods of two years resulting in a total of nine years.

Exploration Right 386 is a consolidation of Technical Cooperation Permit (TCP) 235 and 240, and Exploration Right Application (ERA) 341 which were tenures in 2024 before ER386 application was submitted to the Administrative Authority, the Petroleum Agency South Africa (PASA) on the 8th of October 2024. The areas (ERA341, TCP235 and TCP240) were then consolidated to one ER (ER386). D3 Energy's application for an ER for hydrocarbons was accepted on the 22nd of October 2024 in terms of Section 79 of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 – MPRDA, as amended). The accepted application for an Exploration Right (ER386) is located over an area of approximately 58 000 hectares (ha), covering various farm portions in Welkom near the towns of Virginia, Hennenman and Odendaalsrus, Free State Province. The boundaries of ER386 are 28°13'28.95"S; 26°55'2.76"E in the South, 27°57'37.57"S; 26°48'49.15"E in the West, 27°59'13.57"S; 27°11'13.06"E in the East and 27°46'34.45"S; 26°57'44.05"E in the North, the central coordinates are approximately 27°58'23.27"S; 26°59'38.94"E.

The proposed activities to be undertaken as part of the exploration include the following:

- Identifying existing blowers within the ER, undertaking <u>well workover and intervention</u> if necessary;
- The undertaking of new core <u>exploration well drilling</u> and undertaking well workover and intervention where necessary (at preidentified / new areas of interest);
- Undertaking <u>seismic survey and/or magnetotellurics survey</u> activities (at preidentified / new areas of interest);
- Perform testing and gas composition analysis on gas from existing boreholes and newly drilled wells on the ER;
- Conduct borehole and well gas flow testing of existing boreholes and any new wells drilled; and
- Conduct borehole and well wireline logging of existing boreholes and any new wells drilled.

[2] It must be noted that that D3 Energy South Africa has recently changed its name from Motuoane Energy (Pty) Ltd. The EA Application / Project name will also be **changed from Motuoane Exploration Right 386 Application**, Within Various Farms in Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezile Dabi District Municipalities, Free State Province, South Africa **to D3 Energy Exploration Right 386 Application**, Within Various Farms in Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezile Dabi District Municipalities, Free State Province, South Africa during the final submission of the EIA Report and EA Application Form.

The main activities are exploration drilling and seismic survey activities. The proposed approach is to first determine and map the geographic extent of all boreholes currently emitting gas on and near the ER area. Then measure rates and monitor pressures where possible and perform gas composition analysis. The geophysical wireline logging of existing boreholes (where possible) will include monitoring of water levels. If no existing gas emitting boreholes are identified near a target area, new drilling activities are proposed within that area using percussion or rotary drilling method.

Although up to five (5) Target Areas (TA) for the drilling activities with 500m buffer within the exploration right may be undertaken over the 9-year period, the current Works Program caters for only three (3) drilling wells. It must be noted that there may be a single, multiple or no drilling activities within some of the target areas. Should more than 3 drilling wells be required within the ER, the current Works Program will be required to be updated accordingly.

The previous TA's and associated seismic transects, Target Area 3 (ED G), Target Area 4 (ED H), Target Area 5 (ED J), Target Area 6 (ED I), Target Area 7 (ED F) and Target Area 8 (VEG A) as well as seven (7) seismic transects (Transects ED 1 to 5, VEG 1 & 2) which were proposed within the western section of the exploration right on the agricultural fields between Saaiplaas, Bronville, Thabong and Whites have been removed from the current application (may be revisited at a later stage in line with the necessary processes i.e., authorisations, licensing, etc.). The current application entails:

- Two Target Areas; Target Area 1 (RSB D) and Target Area 2 (RSB E) and associated seismic transects (Transects RSB1, RSB2 and RSB3) located in the south of ER386, approximately 7km southeast of Meloding;
- Target Area 9 (HF C) and associated transects (Transects HF 1, HF2 and HF7) located approximately 6km west the eastern boundary of ER386 (N1);
- Two Target Areas proposed within the northern section namely, Target Area 10 (GP B) and Target Area 11 (GP A) and three associated seismic transects (Transect G1, G2 and G3) R34 located between Odendaalsrus and Kroonstad.

The seismic survey activities are proposed throughout ER386, as and when necessary. D3 Energy will search records at the Council for Geoscience and the Petroleum Agency for seismic data that was acquired on the Exploration Right in the past. If no data is available, D3 Energy will either acquire its own seismic or telluric data on the property, following proper environmental protocols and with the written permission of the landowner. There are nine (9) preliminary proposed transects for seismic / telluric survey, approximately 70km long around known structures and possible drill locations.

It must be noted that there are at least fourteen (14) approved renewable energy projects from various applicants located within ER386. However, it should also be noted that the majority of the overlaps between ER386 and the renewable energy developments is largely within TA 3 (EDG) and Transects EDG1 and EDG2 which have since been removed from the current application. Therefore, **the previously affected renewable energy developments namely, Nepal Solar PV Project (ref: 14/12/16/3/3/2/2429), Middelpunt Solar PV Project (ref: 14/12/16/3/3/2/2414), Lebone Solar Farm Project (ref: 14/12/13/3/3/2/580), and Thabong Solar Farm Project (ref: 14/12/16/3/3/2/581) as well as Anker Solar PV Project (ref: 14/12/16/3/3/2/2415) are currently not intersecting with any proposed drilling site nor any seismic transect. It is also important to note that TCP 144 was granted in 2017 over the area of ERA 341, demonstrating security of tenure over the application area before the renewable energy developments were granted any Authorisation over the same area**. Additionally, the 14 projects were only recently brought to the applicant's attention through the scoping phase screening process. It is the EAP's recommendation that D3 Energy and the affected renewable energy developers / applicants should discuss the way forward and/or make necessary arrangements for potential future overlaps within the ER. Furthermore, **the affected landowner/s and the renewable energy developer should be consulted accordingly by the Applicant (through a consultation process different to that undertaken by EIMS for the EIA Process)** to ensure necessary agreements are in place as per the requirements stipulated in the Environmental Management Programme (EMPr) attached as **Appendix H** of this EIA Report.

1.1 REPORT STRUCTURE

This report has been compiled in accordance with the 2014 NEMA EIA Regulations, as amended. A summary of the report structure, and the specific sections that correspond to the applicable regulations, is provided in **Table 2** below.

Table 2: Report structure.

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(a):	Details of – i. The EAP who prepared the report; and ii. The expertise of the EAP, including a curriculum vitae;	**Section 1.4**
Appendix 3(b):	The location of the activity, including: (i) the 21-digit Surveyor General code of each cadastral land parcel; (ii) where available, the physical address and farm name; (iii) where the required information in items (i) and (ii) is not available, the coordinates of the boundary of the property or properties on which the activity is to be undertaken;	As indicated in **Section 1.7**, ER386 is located over an area of approximately 58 000 hectares (ha) / 580km^2, covering various farms near the towns of Welkom, Virginia, Hennenman and Odendaalsrus, within the Free State Province. Refer to **Appendix A** for the list of affected properties.
Appendix 3(c):	A plan which locates the proposed activity or activities applied for as well as the associated structures and infrastructure at an appropriate scale, or, if it is - (i) a linear activity, a description, and coordinates of the corridor in which the proposed activity or activities is to be undertaken; (ii) on land where the property has not been defined, the coordinates within which the activity is to be undertaken;	**Section 1.7 and Section 2**
Appendix 3(d):	A description of the scope of the proposed activity, including. (i) all listed and specified activities triggered and being applied for; and	**Section 2**

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	(ii) a description of the associated structures and infrastructure related to the development;	
Appendix 3(e):	A description of the policy and legislative context within which the development is located and an explanation of how the proposed development complies with and responds to the legislation and policy context;	**Section 3**
Appendix 3(f):	A motivation for the need and desirability for the proposed development, including the need and desirability of the activity in the context of the preferred location;	**Section 2.6** and **Section 5.1**
Appendix 3(g):	A motivation for the preferred development footprint within the approved site;	**Section 5**
Appendix 3(h):	A full description of the process followed to reach the proposed development footprint within the approved site, including: (i) details of the development footprint alternatives considered; (ii) details of the public participation process undertaken in terms of regulation 41 of the Regulations, including copies of the supporting documents and inputs; (iii) a summary of the issues raised by interested and affected parties, and an indication of the manner in which the issues were incorporated, or the reasons for not including them; (iv) the environmental attributes associated with the development footprint alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects;	**Section 4** **Section 5** **Section 6** **Section 7** **Section 10.2**

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	(v) the impacts and risks identified including the nature, significance, consequence, extent, duration, and probability of the impacts, including the degree to which these impacts (aa) can be reversed; (bb) may cause irreplaceable loss of resources; and (cc) can be avoided, managed or mitigated; (vi) the methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks; vii) positive and negative impacts that the proposed activity and alternatives will have on the environment and on the community that may be affected focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects; (viii) the possible mitigation measures that could be applied and level of residual risk; (ix) if no alternative development locations for the activity were investigated, the motivation for not considering such; and (x) a concluding statement indicating the preferred alternative development location within the approved site;	
Appendix 3(i)	A full description of the process undertaken to identify, assess and rank the impacts the activity and associated structures and infrastructure will impose on the preferred location through the life of the activity, including (i) a description of all environmental issues and risks that were identified during the environmental impact assessment process; and (ii) an assessment of the significance of each issue and risk and an indication of the extent to which the issue and risk could be avoided or addressed by the adoption of mitigation measures;	**Section 7.1** and **Section 7.1.2**

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(j)	An assessment of each identified potentially significant impact and risk, including (i) cumulative impacts; (ii) the nature, significance and consequences of the impact and risk; (iii) the extent and duration of the impact and risk; (iv) the probability of the impact and risk occurring; (v) the degree to which the impact and risk can be reversed; (vi) the degree to which the impact and risk may cause irreplaceable loss of resources; and (vii) the degree to which the impact and risk can be mitigated;	**Section 7.3**
Appendix 3(k):	Where applicable, a summary of the findings and recommendations of any specialist report complying with Appendix 6 to these Regulations and an indication as to how these findings and recommendations have been included in the final assessment report;	**Section 7.3** **Section 10.1**
Appendix 3(l):	An environmental impact statement which contains (i) a summary of the key findings of the environmental impact assessment: (ii) a map at an appropriate scale which superimposes the proposed activity and its associated structures and infrastructure on the environmental sensitivities of the preferred site indicating any areas that should be avoided, including buffers; and (iii) a summary of the positive and negative impacts and risks of the proposed activity and identified alternatives;	**Section 8** **Section 0** **Appendix A**
Appendix 3(m)	Based on the assessment, and where applicable, recommendations from specialist reports, the recording of proposed impact management	**Section 7.3** **Section 10.1**

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	objectives, and the impact management outcomes for the development for inclusion in the EMPr as well as for inclusion as conditions of authorisation;	**Section 10.4** **Appendix F**
Appendix 3(n)	The final proposed alternatives which respond to the impact management measures, avoidance, and mitigation measures identified through the assessment;	**Section 10.2**
Appendix 3(o)	Any aspects which were conditional to the findings of the assessment either by the EAP or specialist which are to be included as conditions of authorisation;	**Section 10.4**
Appendix 3(p)	Description of any assumptions, uncertainties and gaps in knowledge which relate to the assessment and mitigation measures proposed;	**Section 11**
Appendix 3(q)	A reasoned opinion as to whether the proposed activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation;	**Section 10.4**
Appendix 3(r)	Where the proposed activity does not include operational aspects, the period for which the environmental authorisation is required and the date on which the activity will be concluded and the post construction monitoring requirements finalised;	Not Applicable. The proposed activities and listed activities triggered and applied for as indicated in **Section 2** is for exploration activities and not limited to the construction phase. The activities include operational aspects. Therefore, the duration of the EA validity should align with the validity of the ER.
Appendix 3(s)	An undertaking under oath or affirmation by the EAP in relation to: (i) the correctness of the information provided in the reports; (ii) the inclusion of comments and inputs from stakeholders and I&APs; (iii) the inclusion of inputs and recommendations from the specialist reports where relevant; and (iv) any information provided by the EAP to interested and affected parties and any responses by the EAP to comments or inputs made by interested or affected parties;	**Section 12** **Section 13**

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(t)	where applicable, details of any financial provisions for the rehabilitation, closure, and ongoing post decommissioning management of negative environmental impacts;	Closure objectives are included in **Section 9** and **Appendix F**
Appendix 3(u)	An indication of any deviation from the approved scoping report, including the plan of study, including (i) any deviation from the methodology used in determining the significance of potential environmental impacts and risks; and (ii) a motivation for the deviation;	It should be noted that there is no deviation from the Plan of Study in the accepted Scoping Report to this EIA Report. However, as previously indicated, the Applicant previously submitted an EA Application (12/3/386) to PASA as the AA on 15th May 2025 which effectively lapsed on the 1st of December 2025. A Final Scoping Report which was subjected to the 30-day legislated public review and comment period was submitted to PASA for consideration on 30th June 2025 and accepted on 13th August 2025. According to the NEMA EIA Regulation 23 (1), 2014 as amended, and as indicated in Scoping Acceptance Letter, an EIA Report which must have been subjected to a minimum of 30-day legislated public review and comment period was required to be submitted to PASA within 106 days from date of Acceptance of the Scoping Report (i.e., by 1st December 2025). Due to delays in finalizing access agreements for specialist studies within the Harmony Cluster, NEMA EIA Regulation 23 (1), 2014 as amended could not be met. As a result, the initial EA 12/3/386 Application lapsed and could not be considered further by the relevant authorities. Subsequently, all application and public participation processes and/or opportunities associated with the application were suspended. The Applicant resubmitted an EA Application (Amended) for the same activities (seismics and drilling wells for all saleable gases including but not limited to Methane, Carbon Dioxide, Helium, and Nitrogen), within the same approximate 58 000ha footprint (Exploration Right 386) in April 2026. It is important to note that although the application area remains the same footprint (i.e., 58 000ha), the exploration activities have been reduced from eleven (11) drilling wells and sixteen (16) seismic transects to five (5) drilling wells and nine (9) seismic transects, respectively.
Appendix 3(v)	Any specific information that may be required by the competent authority; and	Information included in various sections of the report to address PASA / DMPR comments in the scoping acceptance letter.

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
Appendix 3(w)	Any other matters required in terms of section 24(4)(a) and (b) of the Act	Not Applicable. In addition to the specific information requirements set out in Appendix 3, this EIA Report has been prepared to give effect to the procedural requirements of section 24(4)(a) and (b) of the National Environmental Management Act (NEMA). The report provides: (i) a description of the environment likely to be significantly affected (**Section 4**); (ii) a systematic investigation and assessment of the potential environmental consequences and the significance of those impacts (**Section 7**); and (iii) a transparent public information and participation process that afforded organs of state and all registered interested and affected parties a reasonable opportunity to participate (**Section 6** and **Appendix C**). The assessment further includes: (i) consideration of reasonable and feasible alternatives, including the “no-go” option (**Section 5**); (ii) identification of mitigation measures to avoid, minimise and manage adverse impacts (**Section 7**); (iii) disclosure of gaps, assumptions and uncertainties (**Section 11**); and (iv) proposed arrangements for monitoring and management to evaluate the effectiveness of mitigation after implementation (**Appendix H**). Where applicable, the report also: (i) addresses potential impacts on heritage resources (**Section 7.3.14**); (ii) considers relevant environmental sensitivity attributes identified through available mapping/screening information (**Section 8**); and (iii) confirms that requirements of other applicable specific environmental management legislation are considered in the impact management measures and EMPr commitments (**Section 3** and **Appendix H**).

1.2 PURPOSE OF THE REPORT

The Scoping Phase of the EIA process identified potential issues associated with the proposed project and defined the extent of the studies required for the EIA Phase. The Scoping Phase also identified potentially sensitive areas within the study site. This EIA Phase Report addresses those identified potential environmental impacts and benefits (direct, indirect, and cumulative impacts) associated with all phases of the project including design, construction, operation, decommissioning, and closure. The EIA Phase recommends appropriate mitigation measures for potentially significant environmental impacts.

The EIA Report aimed at achieving the following:

- Provide an overall description and assessment of the social and biophysical environments affected by the proposed alternatives put forward as part of the project.
- Assess potentially significant impacts (direct, indirect, and cumulative, where required) associated with the proposed project.
- Comparatively assess identified feasible alternatives put forward as part of the project.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts; and
- Undertake a fully inclusive public involvement process to ensure that I&AP are afforded the opportunity to participate, and that their issues and concerns are recorded.

1.3 THE SCOPING AND EIA REQUIREMENTS

The list of activities applied for in terms of the NEMA EIA Regulations 2014 as amended is discussed in **Section 2.5**. These listed activities triggered by the proposed development of D3 Energy ER386 must follow the EIA process as required by NEMA EIA Regulations 2014, as amended. Based on these Regulations, a Scoping and EIA process must be followed. The Application Form was submitted to the Competent Authority (CA), the Department of Mineral and Petroleum Resources (DMPR), previously the Department of Mineral Resources and Energy (DMRE) through the Administrative Authority (AA), the Petroleum Agency of South Africa (PASA). The DMPR is the relevant CA stipulated in the 2014 NEMA EIA Regulations application procedures as the applicant is a private company and the proposed D3 Energy ER386 is a petroleum rights application, thus, is in line with the identified activities which the Member of the Executive Council of the National Department of Forestry, Fisheries and the Environment (DFFE) has delegated to the DMPR as the CA.

1.4 DETAILS OF THE EAP

EIMS is appointed by D3 Energy as the independent EAP to assist in preparing and submitting the EA application, Scoping and EIA Reports, and undertaking a Public Participation Process (PPP) in support of the proposed exploration. The contact details of the EIMS consultant and EAP who compiled this Report are indicated in **Table 3**.

Table 3: Details of the Environmental Assessment Practitioner

EAP:	Mr. Vukosi Mabunda
Tel No:	+27 11 789 7170
Fax No:	+27 86 571 9047
E-mail:	vukosi@eims.co.za
Qualifications	• MSc Geography (University of Johannesburg, 2021). • BSc Honours in Geography (University of Johannesburg, 2017). • BSc Life & Environmental Sciences (University of Johannesburg, 2016). • Environmental Law – Short Course (North-West University, 2025). • ISO14001:2015 – Short Course (North-West University, 2025). • Environmental Management Systems – Lead Auditor Short Course, North-West University, 2025
Professional Registrations:	• Registered Environmental Assessment Practitioner with Environmental Assessment Practitioner Association of South Africa – EAPASA (Reg. No: 2019/867). • Professional Natural Scientist with the South African Council for Natural Scientific Professions – SACNASP (Reg. No: 134178). • Registered Provisional Auditor (SAATCA: #LC5544) ISO 37301:2021 Legal Compliance Management Systems. • Registered Provisional Auditor (SAATCA: #LC5544) ISO 14001:2015 Environmental Management Systems

1.5 EXPERTISE OF THE EAP

EIMS is a private and independent environmental management-consulting firm that was founded in 1993. EIMS is an independent specialised environmental consulting firm offering the full spectrum of environmental management services across all sectors within the African continent. EIMS has successfully completed hundreds of assignments over the years with an excess of 30 years' experience in conducting EIA's for both the government and private sector. Please refer to the EIMS website (www.eims.co.za) for examples of EIA documentation currently available.

In terms of Regulation 13 of the EIA Regulations (GN R. 982) as amended, an independent EAP, must be appointed by the applicant to manage the application. EIMS is compliant with the definition of an EAP as defined in Regulations 1 and 13 of the EIA Regulations, as well as Section 1 of the NEMA. This includes, inter alia, the requirement that EIMS is:

- Objective and independent;
- Has expertise in conducting EIA's;
- Comply with the NEMA, the environmental regulations and all other applicable legislation;
- Considers all relevant factors relating to the application; and
- Provides full disclosure to the applicant and the relevant environmental authority.

This EIA Report was prepared by Vukosi Mabunda, a Registered EAP employed by EIMS. His CV is included in **Appendix B** of this report. Vukosi Mabunda is currently a Senior Environmental Assessment Practitioner (EAP) & Geographic Information Systems (GIS) Consultant with over eight (8) years' working experience. Vukosi is a Registered EAP with the Environmental Assessment Practitioners Association of South Africa (EAPASA). He is one of the few dual registered professionals with the South African Council for Natural Scientific Professions (SACNASP) as a Professional Environmental Scientist and Geospatial Scientist. Vukosi is also one of the few dual registered auditors, currently registered with the South African Auditor & Training Certification Authority

(SAATCA) as a Registered Provisional Auditor for ISO 37301:2021 Legal Compliance Management Systems (one of four registered auditors) and Registered Provisional Auditor for ISO 14001:2015 Environmental Management Systems (one of forty-four registered auditors). Vukosi has dual professional background in Geographic and Environmental Sciences having academic qualifications which focused on these disciplines as well as relevant work experience. Vukosi's highest qualification is a Master of Science Degree in Geography obtained from the University of Johannesburg in 2021. Vukosi has recently completed short courses on Environmental Law, ISO 14001:2015 Environmental Management Systems and ISO 14001:2015 Environmental Management Systems Lead Auditor from the North-West University in March 2025 and October 2025, respectively.

Vukosi has experience in various environmental assessment projects ranging from Environmental Screening, Basic Assessments, Section 102 Amendments and Scoping & Environmental Impact Assessments processes. Vukosi has also undertaken Water Use Authorisations applications through both the General Authorisation and Water Use Authorisation processes. Vukosi is also an Environmental Auditor and Environmental Control Officer who has experience in various environmental and legal compliance audits assessing compliance against the requirements of Environmental Authorisations, Environmental Management Programmes, Operational Environmental Management Plan, Waste Management License, Atmospheric Emission Licenses, Water Use Authorisations, General Authorisations as well as Legal & Environmental Performance Audits. Vukosi's career highlights include the crucial role in the City of Johannesburg's Revised Bioregional Plan, where he was the lead GIS personnel as well as successfully completing the first Environmental Registration under the Standard for the Development and Expansion of Power Lines and Substations within Identified Geographical Areas Revision 2 in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended in Mpumalanga Province in 2024 in which he also assisted the Provincial Department Officials to understand the Standard, their roles and process of reviewing and making decisions on such applications.

1.6 SPECIALIST CONSULTANTS

One of the objectives of a Scoping Report was to identify the required specialist assessments to be undertaken during this EIA Phase. Based on a review of the National Web-Based Environmental Screening Tool Report (DFFE Screening Tool), the EAP's Site Sensitivity Verification, and review of available information, the following specialist assessments were identified as necessary assessments required for the EIA phase and undertaken to inform this EIA Report.

Table 4: Details of the specialist team.

Discipline	Consultant / Company	Representative / Specialist
Agricultural Potential, Soils & Land Capability	The Biodiversity Company	Andrew Husted
Air Quality	Airshed Planning Professionals	Reneé von Gruenewaldt
Climate Change Assessment	Airshed Planning Professionals	Reneé von Gruenewaldt
Noise Impact Assessment	Airshed Planning Professionals	Nick Grobler
Archaeological and Cultural Heritage Assessment	EIMS (Pty) Ltd	Dr Lucien James
Palaeontological Impact Assessment	Dr Heidi Fourie	Dr Heidi Fourie
Terrestrial Biodiversity Assessment	The Biodiversity Company	Andrew Husted
Aquatics and Wetland Assessment	The Biodiversity Company	Andrew Husted
Geohydrological Assessment	Gradient Groundwater Consulting	JFW Mostert

Discipline	Consultant / Company	Representative / Specialist
Social Assessment	Equispectives Research and Consulting Services	Dr Ilse Aucamp
Financial Provisions	EIMS (Pty) Ltd	Liam Whitlow

The specialist studies listed above in **Table 4** will involve the gathering of data relevant to identifying and assessing preliminary environmental impacts that may occur as a result of the proposed project. These potential impacts were assessed according to pre-defined impact rating methodology (**Section 7.1**). Mitigation / management measures to minimise potential negative impacts or enhance potential benefits are put forward in this EIA Report (**Section 7.1**) and will be adjusted where relevant based on input from Interested and Affected Parties (I&APs) during the public review and comment of this report.

1.7 DESCRIPTION OF THE PROPERTY

Table 5 provides the locality details for the proposed D3 Energy ER386. See **Figure 1** and **Figure 2** for the locality map including the proposed exploration activities.

Table 5: Locality details.

Property **Property Name, 21-digit Surveyor General Code and Ownership**	D3 Energy ER386 is located on various farms / farm portions, refer to **Appendix A**
Application Area (Ha)	D3 Energy ER386 is approximately 58 000 ha.
Magisterial District	The project area falls within the Matjhabeng and Moqhaka Local Municipalities, Lejweleputswa and Fezile Dabi District Municipalities.
Distance and direction from nearest towns	• 6km east of southern Virginia (Meloding), 7km east of central Virginia, 1.5km northeast of northern Virginia (Saaiplaas); • 6.5km east of central Welkom, adjacent to west Welkom (Thabong); • 1km southeast of Riebeeckstad; • Adjacent to Hennenman. The boundaries of ER386 are: 28°13'28.95"S; 26°55'2.76"E in the South, 27°57'37.57"S; 26°48'49.15"E in the West, 27°59'13.57"S; 27°11'13.06"E in the East and 27°46'34.45"S; 26°57'44.05"E in the North, the central coordinates are approximately 27°58'23.27"S; 26°59'38.94"E. Refer to **Appendix A** for the locality map and for the List of Affected Properties.
Surrounding land uses	The study area can be subdivided into four sections namely, the northern section, southern section, western section, and the eastern section (refer to **Figure 1** for the site locality). • The northern section is closer to the R34 and located between Odendaalsrus and Kroonstad. There are currently two target areas proposed within this section namely, Target Area 10 (GP B) and Target Area 11 (GP A) and three seismic transects (Transect G1, G2 and G3). This section consists almost primarily of cultivated land with several natural and artificial watercourses. • The eastern section is located immediately north of Ventersburg and bounded by the N1 and Phomolong. This section is primarily dominated by cultivated land, open areas, and game farms. There are distinctive watercourses within this area including the Kromspruit which is immediately to the north of the sole proposed drilling site, Target

	Area 9 (HF C) 500m assessment area within this section. There are three proposed transects within this section, namely, Transects HF1, HF2 and HF7. Which intersect the Kromspruit, Rietspruit and Slootspruit. • The tip of the southern section is approximately 8.5km south of southern Virginia (Meloding) while the two target areas, Target Area 1 (RSB D) and Target Area 2 (RSB E) are approximately 7km east of southern Virginia. The R73 cuts across this section. Similarly to the northern and eastern sections, the southern section is primarily dominated by cultivated land, open areas and game farms, several natural and artificial watercourses. Although the two target areas within this section, two of the three seismic transects intersect the Sandrivier. There is also a canal that separates the two target areas. • The western section is the section where majority of the exploration activities were previously proposed but have since been removed from the current EA application. This section is within a mining area and adjacent to mining towns. The edges of the residential areas of Saaiplaas, Bronville and Thabong form part of the eastern boundary of this section and ER386. There are currently no proposed drilling sites nor seismic activities within this section. Although this section also consists largely of cultivated land, open areas and minor game farms, several natural and artificial watercourses, it is the most transformed section within the ER comprising of mining activities, residential areas, road, and electrical infrastructure. This section also comprises of several farms which are earmarked for renewable energy developments. Refer to **Section 4.1** for more details.

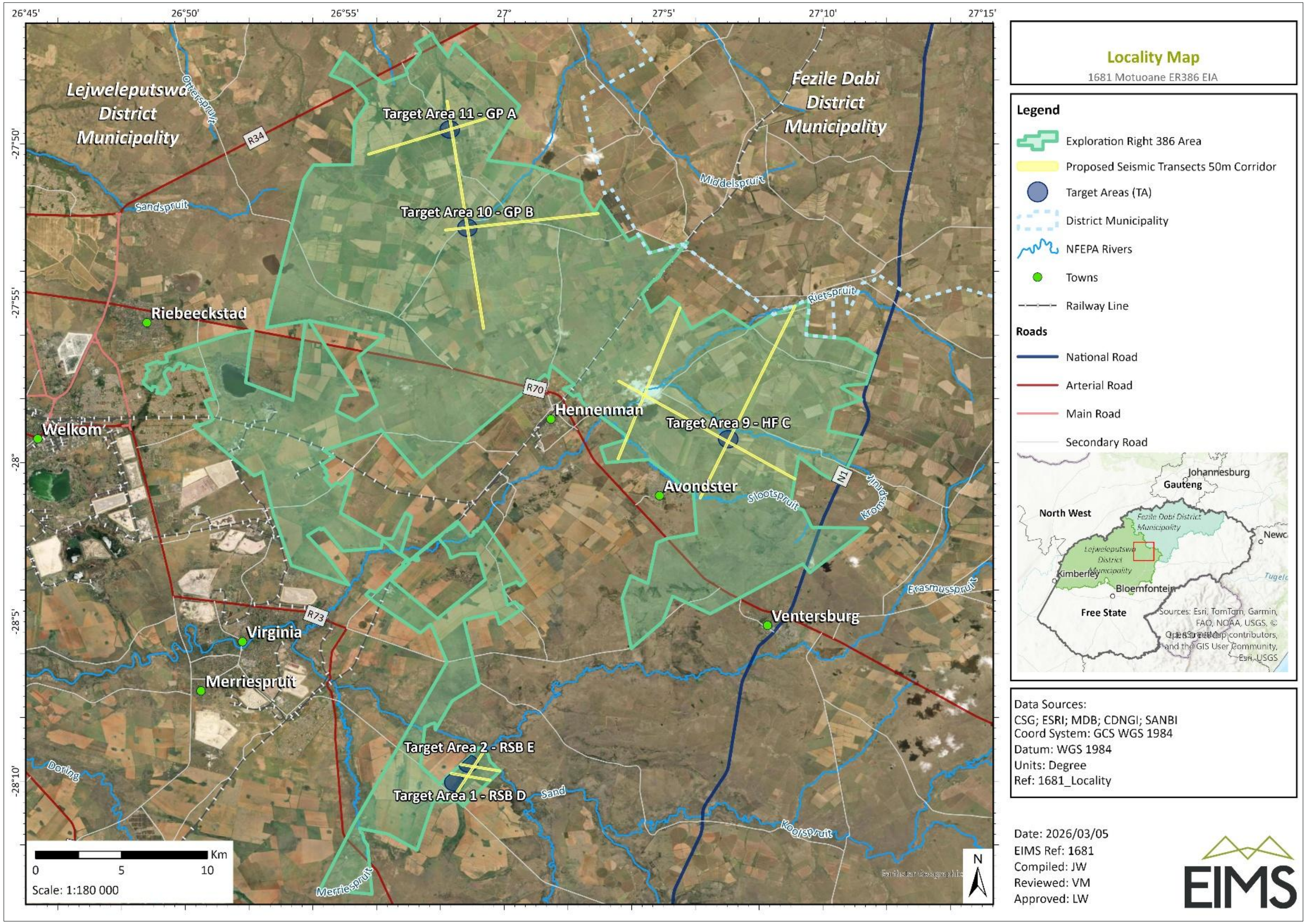


Figure 1: Aerial imagery locality map indicating the location of the proposed D3 Energy ER386.

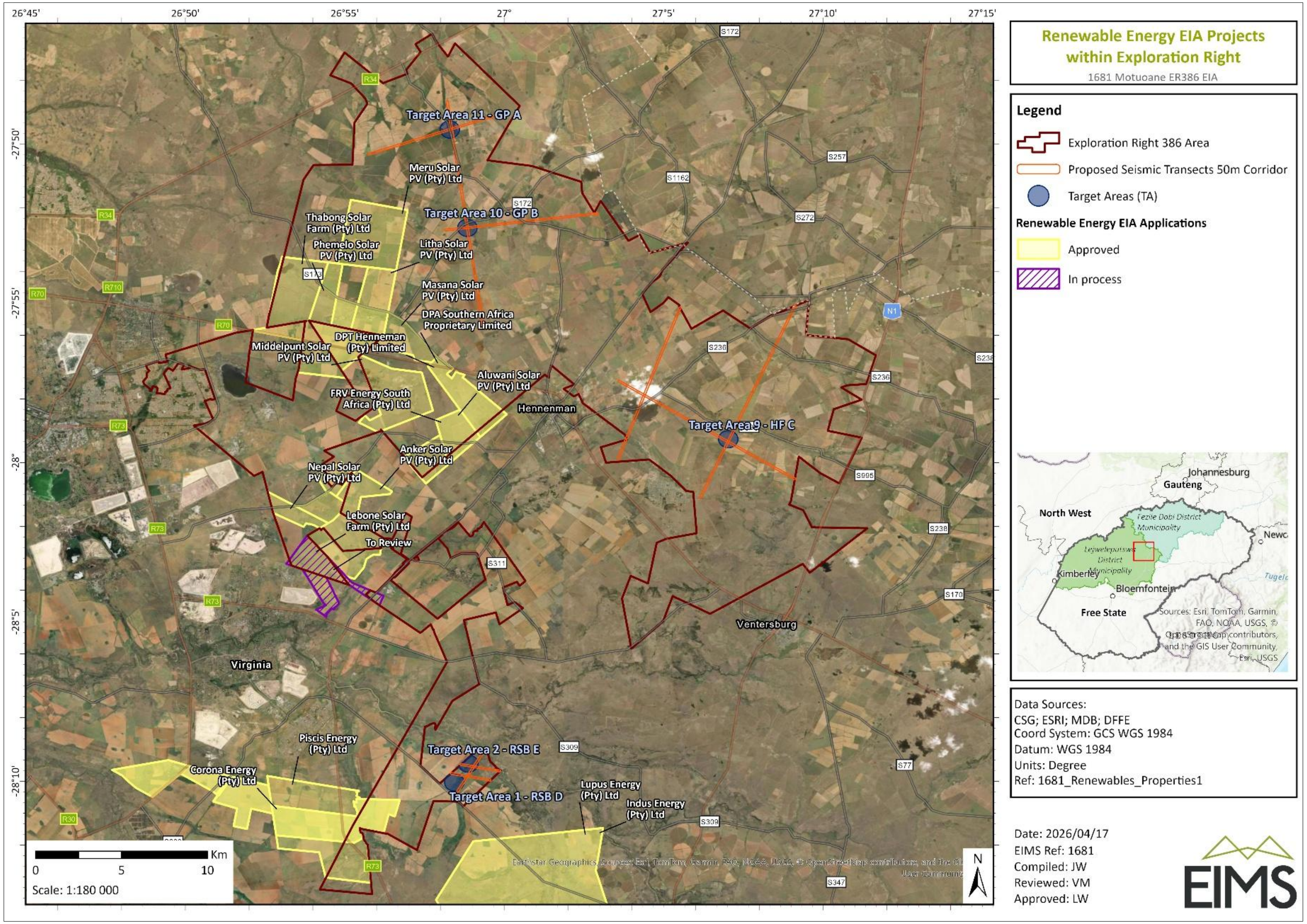


Figure 2: Locality map indicating the renewable energy developments within the ER386 footprint.

2 DESCRIPTION AND SCOPE OF THE PROPOSED PROJECT

This section provides a detailed description for the proposed ER386 project. Most of the key information presented in this chapter was obtained from the applicant. The aim of the project description is to describe the proposed activities planned to take place at the D3 Energy ER386 project area. Furthermore, the project description is designed to facilitate the understanding of the proposed project related activities which are anticipated to lead to the potential impacts identified and assessed in this EIA Report, and for which management measures have been, or will be designed. Important project aspects, and their respective locations, are indicated in **Table 6**. The exploration activities include both non-invasive and invasive activities. As both the target areas (drilling) and seismic transects are pre-liminary at this stage (defined based on existing data that was available to inform the Environmental Worls Programme) and will only be finalized after review of available of background information, bigger footprints were assessed around each target area and seismic transect to allow for adjustments of final target area and seismic transect. 500m was assessed around each TA and 25m around each seismic transect.

Onshore natural gas exploration is inherently progressive and iterative, comprising phased activities that are implemented in a structured and adaptive manner. Each phase generates data that informs the need for, and design of, subsequent phases, including the refinement of locations, methods, and scope of further exploration.

Initial activities establish a preliminary understanding of subsurface conditions and resource potential, while later phases are progressively defined based on the results of earlier investigations. As such, the full spatial extent and intensity of exploration activities are not fixed upfront but evolve over time in response to new information.

In this context, the EIA adopts an approach that assesses impacts associated with preliminary and reasonably foreseeable exploration activities within a defined envelope (as described herein), while remaining sufficiently flexible to accommodate changes as the exploration programme progresses. The purpose of the EIA is therefore to ensure that environmental impacts are appropriately identified, assessed, and managed on an ongoing basis, allowing environmental considerations to inform decision-making throughout the exploration lifecycle. Refer to **Figure 1** and **Appendix A** for the locality map of the proposed activities.

Table 6: Details of main project aspects.

Aspect	Details		Latitude	Longitude
Drilling Site (Target Area)	Target Area 1: RSB D – 500m Buffer Drilling Area		28°10'2.21"S	26°58'26.26"E
	Target Area 2: RSB E – 500m Buffer Drilling Area		28° 9'26.86"S	26°58'52.57"E
	Target Area 9: HF C – 500m Buffer Drilling Area		27°59'16.03"S	27° 7'1.82"E
	Target Area 10: GP B – 500m Buffer Drilling Area		27°52'38.16"S	26°58'50.81"E
	Target Area 11: GP A – 500m Buffer Drilling Area		27°49'32.99"S	26°58'17.68"E
Seismic Transect	Transect G1 (13.5km long) - 50m corridor	G1 Start point G1 Endpoint	27°48'39.11"S 27°55'46.58"S	26°58'12.51"E 26°59'21.34"E
	Transect G2 (7.5km long) - 50m corridor	G2 Start point G2 Endpoint	27°50'20.21"S 27°49'1.96"S	26°55'46.11"E 26°59'58.28"E
	Transect G3 (8km long) -50m corridor	G3 Start point G3 Endpoint	27°52'41.75"S 27°52'10.53"S	26°58'10.21"E 27° 2'57.40"E

Aspect	Details		Latitude	Longitude
	Transect H1 (12km long) - 50m corridors	HF1 Start point HF1 Endpoint	28° 1'7.36"S 27°55'3.47"S	27° 6'9.01"E 27° 9'10.29"E
	Transect H2 (9.5km long) - 50m corridor	HF2 Start point HF2 Endpoint	27°59'53.41"S 27°55'7.17"S	27° 3'34.59"E 27° 5'30.54"E
	Transect H7 (11km long) - 50m corridor	HF7 Start point HF7 Endpoint	27°57'25.83"S 28° 0'31.28"S	27° 3'35.90"E 27° 9'8.00"E
	Transect RSB1 (3.5km long) - 50m corridor	G3 Start point G3 Endpoint	28°10'35.47"S 28° 9'4.72"S	26°58'22.20"E 26°59'21.22"E
	Transect RSB2 (2km long) - 50m corridor	G3 Start point G3 Endpoint	28° 9'45.45"S 28° 9'57.70"S	26°58'20.75"E 26°59'33.85"E
	Transect RSB3 (2km long) - 50m corridor	G3 Start point G3 Endpoint	28° 9'27.69"S 28° 9'40.51"S	26°58'39.14"E 26°59'51.37"E

2.1 NON-INVASIVE EXPLORATION

2.1.1 BACKGROUND DATA COLLECTION AND DATA MANAGEMENT

Affected landowners will be identified and contacted in preparation for the ground exploration activities. Existing gas emitting boreholes will be sought if they exist, photographed, measured, and analysed. Meetings will be set up with mining companies in the vicinity to see if they have had any experience with gas and gas emitting boreholes. Any gas emitting boreholes found will then be mapped and analysed.

In order to acquire information from the existing gas wells, wellhead control and measurement equipment will be designed and installed to measure pressure, flow rate and collect gas samples for analysis. In addition, existing gravity/magnetic data will be obtained and analysed. Any available cores and cuttings from previous mining/exploration activities will also be analysed. The need to undertake additional aerial gravity/magnetic surveys can only be determined once all available existing data has been reviewed and analysed, however if required, a risk assessment is to be prepared prior to undertaking this activity and compliance with the mitigation measures put forward in the EMPr (**Appendix H**) will be binding on the applicant once approved by the CA. Geophysical data will be acquired and reprocessed where practical so as to analyse and interpret the data. Surface mapping (surface geological features and outcrops) of the various parts of the exploration area will also be undertaken during this phase. Data from surface mapping along with initial data gathered will be analysed and geological maps prepared. Reservoir studies using magnetic, geological, and geophysical data will be conducted.

2.1.2 PREPARATIONS FOR SEISMIC SURVEYS

D3 Energy will search available records (e.g. Council for Geoscience, PASA) for seismic data that was acquired on the ER in the past. If no data is available, D3 Energy will either acquire its own seismic or telluric data on the ER, following proper environmental protocols and with the written permission of the landowner. Background information from the drilling programme as well as existing wells where conditions permit, and geological maps, will be used to identify the final seismic transect routes within the approved area. A team will be assembled to effectively prepare and plan the transect routes. The team / applicant will identify and contact landowners in preparation for activities. The team's plan will detail the period of surveying, the access routes, transects path to be followed, temporary site camp and laydown area, among other aspects which will be used to inform and prepare the applicant for environmental compliance audits. Once all preconstruction requirements are in place, the team will mobilize to undertake the seismic surveys which should last for a couple of weeks if weather conditions permit.

2.1.3 GEOLOGICAL AND GEOPHYSICAL LOGGING

Geological and geophysical logging will be undertaken using samples collected from the drilling programme, as well as from existing wells where feasible. The samples will be analysed for the presence of hydrocarbons as well as to determine the physical properties of the rocks. This analysis will allow for the determination of the lithology and associated properties as well as the presence of hydrocarbons. Geophysical logging and surface structures data (surface geological features and outcrops) will be integrated into maps.

2.1.4 SEISMIC SURVEYS

Seismic surveying along the transects through a vibroseis technique will be undertaken by a small team (approximately 15 personnel) by deploying an array of energy sources from a small-sized Seismic Vibrator and an array of sensors or receivers (geophones) on the identified area of interest (**Figure 3**). A single Seismic Vibrator consisting of a vibrating baseplate that is placed on the ground will be used. The vibrating plate emits a low frequency signal (4-80 Hertz (Hz)) into the ground, called a sweep. The vibroseis vehicle moves slowly along the pre-determined lines (transects) using GPS for navigation. It stops, emits a signal 8-20 seconds long, moves approximately 10 meters ahead, stops, emits a signal and so on until all the transects have been traversed (**Figure 3**). Several small geophones will be used to convert the ground movements or seismic waves from the seismic vibrator into voltage, which will be recorded at a nearby recording station (**Figure 3**). The team will then generate and analyse the 2-D sub-surface geological network and identify areas of interest for further exploration. The outcome of the seismic survey will be used to inform preferable drilling locations.

Although the vibroseis technique is the likely method to be undertaken for the seismic activities. There are also potential alternatives to the vibroseis known as the Propelled Energy Generators (PEGs), more commonly referred to as the Accelerated Weight Drop Seismic (AWD) as well as Magnetotellurics Survey (MT) which D3 Energy may consider over, or in conjunction with, the vibroseis. AWD are light weight, highly portable seismic energy sources designed for a multitude of applications within the fields of geology, geophysics, civil engineering, and more. AWD systems utilize simple and effective elastomer band technology to propel the hammer to a high velocity. The AWD is comprised of two easily manageable components for fast and efficient installation and de-installation in the field. The AWD's lightweight, streamlined design also affords its users economy in shipping. The AWD-40Kg is designed to easily mount on trucks, bakkie, trailers, and all-terrain vehicles (**Figure 3**). AWD is a variant of seismic source of the “weight drop” type. The hammer is equipped with an inclined platform, allowing it to be installed at an angle of 45 degrees, and a special stop, adding stability in an upright position, what allows to perform survey on shear waves (**Figure 3**). The source AWD-40PS is mounted on a compact lightweight frame equipped with reliable wheel blocks. The source can be used on a rugged terrain. The total weight of the source without battery pack is less than 120 kg. The energy of a single impact reaches 1000J.

Magnetotellurics (MT) is a passive geophysical technique that uses naturally occurring electromagnetic fields to image the subsurface electrical resistivity structure by measuring the Earth's natural time-varying electric and magnetic fields. The MT method utilizes naturally occurring, broadband electromagnetic waves over the earth's surface to image subsurface resistivity structure. The electromagnetic waves originate from regional and worldwide thunderstorm activity and from the interaction of solar wind with the earth's magnetosphere. Due to the remote nature of the sources and the high refractive index of the earth relative to air, the electromagnetic waves are assumed to be planar and to propagate vertically into the earth. However, the scattering of electromagnetic waves by subsurface structure can be arbitrary in polarization, necessitating a tensor description (Wannamaker *et al*., 2005). Accordingly, two components of electric field (Ex and Ey) and three components of magnetic field (Hx, Hy and Hz) are measured. The frequencies of the waves (signals) range from about 1 Hz to a fraction of milli Hertz, which allows to image a wide depth range. A detailed account of the MT method is given in Vozoff (1991).

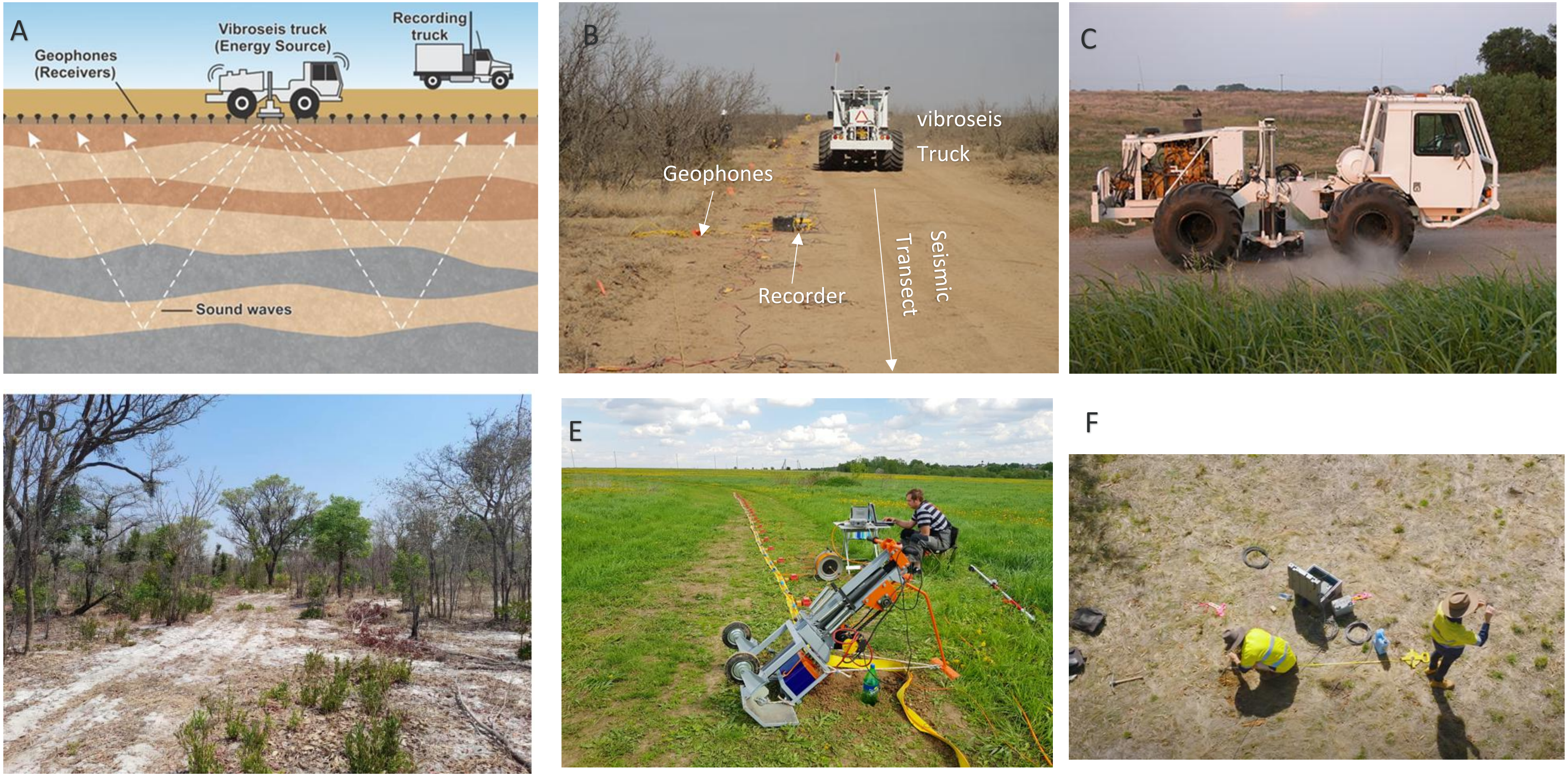


Figure 3: Seismic surveying process and potential impacts. (A) Showing an animated vibroseis process, (B) Showing a real life vibroseis process, (C) Showing minimal dust generated from the process, (D) Showing minimal vegetation impact associated with a new access path (transect route), (E) Showing the weight drop alternative method and (F) showing magnetotelluric survey.

2.2 INVASIVE EXPLORATION ACTIVITIES

2.2.1 GEOTECHNICAL INVESTIGATIONS

Once the seismic, geological and geophysical data has been analysed this information will delineate the areas susceptible for further geotechnical investigations. As the non-invasive exploration will define the locations for further exploration drilling. Drilled explorations wells will be evaluated based on gas flow, pressure, and gas composition, prior to deciding to either complete the well as a production well or to suspend or abandon it. The information from the seismic survey and drilling will be used to map the geology of the area.

2.2.2 WELL WORKOVER AND INTERVENTION

The proposed activities to be undertaken as part of the exploration activities including identifying existing blowers within the ER, undertaking well workover and intervention if necessary. Well intervention and workover are both remedial operations performed on gas wells to maintain or enhance production, but they differ in scope and the level of intervention required. Well intervention is a broader term encompassing any operation to access the wellbore for maintenance, repair, or production enhancement, often using tools and equipment lowered into a live well with the wellhead in place. Workover, on the other hand, typically involves more extensive operations, including removing the wellhead tree and potentially replacing the production tubing string after killing the well[3].

2.2.2.1 **WELL WORKOVER**

Well workover stands as a comprehensive operation within the gas industry, strategically undertaken on existing wells to rejuvenate or amplify their production capabilities. This process encompasses substantial interventions and the deployment of significant equipment to address a spectrum of issues, ultimately aiming to improve the overall performance of the well. Well workovers become imperative when a well experiences a decline in production or encounters mechanical challenges that necessitate remedial action. The process of well workover will be one or a combination of the following:

a. Restoring Flow:

Well workovers are often initiated with the goal of restoring or enhancing production rates. This may involve the removal of obstructions, thorough cleaning of the wellbore, or the repair of damaged equipment. By addressing these impediments, operators can optimize the well's functionality and boost production.

b. Changing Completion Design:

Modification of the well's completion design is a common facet of well workovers. This may entail actions such as replacing tubing, installing new downhole equipment, or optimizing the artificial lift system. These adjustments are geared towards improving the efficiency and effectiveness of the well's completion design.

c. Sidetracking Operations:

Some well workovers encompass sidetracking, a process that involves drilling a new borehole from an existing wellbore. This technique is employed to access additional reservoir zones, effectively bypass damaged sections, or maximize recovery from the reservoir. Sidetracking adds a layer of flexibility to well workovers, allowing operators to strategically tap into untapped resources.

2.2.2.2 **WELL INTERVENTION**

Well intervention in the context of gas wells refers to a set of activities aimed at diagnosing, maintaining, or enhancing the performance of a well without resorting to major workovers. These interventions are crucial for optimizing production, addressing specific issues, and ensuring the continued functionality of the well. Unlike

[3] In the oil and gas industry, killing a well (often referred to as a "well kill") is a critical safety operation used to permanently or temporarily stop the flow of formation fluids (oil, gas, or water) from the reservoir into the wellbore.

major workovers, which involve substantial interventions, interventions are generally minor in nature and focus on improving well productivity (flow) and efficiency. The process of well intervention will be one or a combination of the following:

a. Well Logging and Diagnostics:

Well logging and diagnostics involve the deployment of specialized tools and instruments downhole. These tools gather data on reservoir properties, wellbore conditions, and fluid characteristics. The collected data aids in reservoir evaluation and helps optimize production strategies by providing insights into the well's current status.

b. Maintenance and Servicing:

Maintenance and servicing interventions encompass routine activities aimed at preserving the well's functionality. This includes cleaning the wellbore to remove debris and scale, replacing damaged or worn-out equipment, and addressing minor mechanical issues. Regular maintenance is essential to prevent larger problems and maintain the well's efficiency over time.

The exploration activities **exclude** any well stimulation activities, such as hydraulic fracturing or 'fracking'.

2.2.2.3 PROCESS FOR IMPLEMENTATION

Onshore well interventions and workovers can lead to various environmental, health, and safety impacts. These include water and air pollution, risks to worker health and safety, and potential impacts on surrounding communities. Mitigation strategies involve implementing best management practices, employing advanced technologies, and ensuring robust emergency response plans. The process to be followed will include:

- Assessment of existing conditions and process required: D3 Energy will first assess the conditions and issues of each existing blower (gas emitting well) with the ER. If the well is found to be suffering from significant gas flow decline, blocked completions, or severe casing damage, a workover is likely to be undertaken. However, if less critical issues like instrumentation malfunction, scale buildup, or needing to perform diagnostics, a well intervention is the more efficient, cost-effective, and likely the option to be undertaken.
- Development of an emergency response plan: an emergency response plan will be developed including spill response, fire prevention protocols, and blowout response.
- Training and personal protective equipment: providing comprehensive training on safety procedures, emergency response, and the use of personal protective equipment (PPE) will be undertaken.
- Preventing blowouts: maintaining well control through hydrostatic pressure management, utilizing robust Diverter systems, and implementing thorough planning and risk assessment, as well as implementation of early detection systems and well-defined kill procedures for mitigating potential blowouts.
- Equipment maintenance: regularly inspecting and maintaining equipment to prevent malfunctions.
- Closed-loop systems: implementing closed-loop drilling systems and using covered tanks with secondary containment to minimize spills and leaks.
- Chemical management: proper handling, storage, and disposal of chemicals.
- Casing and plugging of the wells: additional steel casing and cement barriers to prevent leaks as well as plugging at the end of exploration to prevent groundwater seepage.
- Rehabilitation: each well site will be rehabilitated to support the existing land-use.

2.2.3 WELL DRILLING

Using the data gathered during the preceding background review and surveying, up to five (5) exploration boreholes will be sited. The proposed percussion drilling process entails the construction of exploration wells using a two-string telescopic casing design. The well construction is outlined below and illustrated in **Figure 4**:

- The Spud casing will be set and cemented to case off the unconsolidated material to approximately 6m True Vertical Depth (TVD);
- Drilling will be continued past the unconsolidated material to approximately 80mTVD, conductor casing will be cemented from shoe to surface;
- The hole is then drilled ahead and into the Ventersdorp Lavas below the base of the Karoo at approximately 450 m TVD; Intermediate casing will be run and cemented to surface;
- Integrity of this section will be tested by running a Cement Bond Log (CBL) and the pressure tested prior to drilling out the casing shoe. After installing and cementing a casing string, the drilling crew drills out the bottom of that casing (the “shoe”), and then performs a Formation Integrity Test (FIT) to confirm that the surrounding formation can safely withstand drilling pressures before continuing deeper; and
- The next section (open hole section) will be percussion drilled through the primary target, the Ventersdorp Supergroup, to a depth ± 650 m TVD. This section TVD maybe called earlier if significant gas flows are encountered.

The proposed activities will involve the drilling of a well within each of the assessed 500m buffer areas (Target Areas). Each exploration well will have an overall depth of up to 650m and a maximum diameter of 350mm, commencing with a 323mm width spud hole section drilled to 6m total vertical depth (TVD), followed by 254mm width conductor hole section drilled to 80m TVD, then an intermediate hole section of 203mm width drilled to 450m TVD and finally an open hole section of 144mm width drilled up to 650m TVD. The actual hole and casing sizes and configurations will vary depending on the specific geological characteristics and functional requirements. Each borehole will be steel cased and have cement barriers to prevent leaks as well as plugged at the end of exploration to prevent groundwater seepage (**Figure 5D**).

Drilling activities are estimated to be one to two weeks per hole during which time there will be a truck mounted drill rig, a service truck, and a light duty vehicle on site. Intermittent use of a Tractor-Loader-Backhoe (TLB) may be used during site establishment and demobilisation. In order to establish the gas contents a mobile desorption laboratory may be established.

The construction of each drill pad will disturb an area of up to 50 x 50 m (**Figure 5B**). Within the disturbed area, the drill rig and drilling rods will be located. **Impermeable, lined and fenced-off sumps (4m x 4m and 1.5m deep) will be used to circulate wastewater and temporary store the drill cuttings and the excess cement** returns. These sumps are compulsory for well cementing, the pits safely catch cement returns, equipment wash water, and cement slurry overflows. As the proposed drilling process is air drilling, which is a technique that uses compressed air, nitrogen, or gases instead of conventional liquids (like drilling mud) to cool the drill bit and lift rock cuttings out of the wellbore (no chemicals), no drilling chemicals will be contained within the sumps. **The Safety Data Sheet (SDS), formerly known as Material Safety Data Sheet (MSDS) for the chemicals which will be present on the sumps is available on request**. Exploration trays, temporary hazardous and general waste storage areas, chemical toilets, and any site offices required will also be placed inside the drill pad area (**Figure 5**). Each drill site will be suitably secured before drilling continues at the next drill site. Depending on the results of the sampling, each borehole will either be plugged entirely and abandoned (refer to **Section 2.4**) or left as is for future monitoring or analysis. Regardless of which of these options is chosen, the borehole will be capped with a steel cap that is engraved with the borehole number or for future monitoring or analysis a wellhead according to industry specifications.

Motuoane Energy (Pty) Ltd

TYPE	OH	CASING	DEPTH
SPUD	323mm	273mm	6m
CONDUCTOR	254mm	217mm	80m
INTERMEDIATE	203mm	140mm	450m
PRODUCTION	114mm	OH	650m

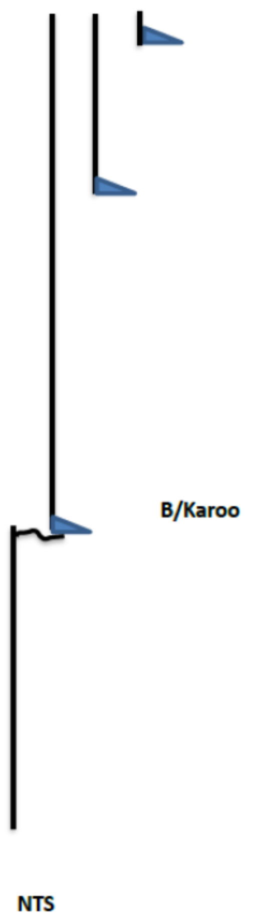


Figure 4: Vertical Well Plan (iKapa Resources, 2024)[4]

[4] OH = open hole

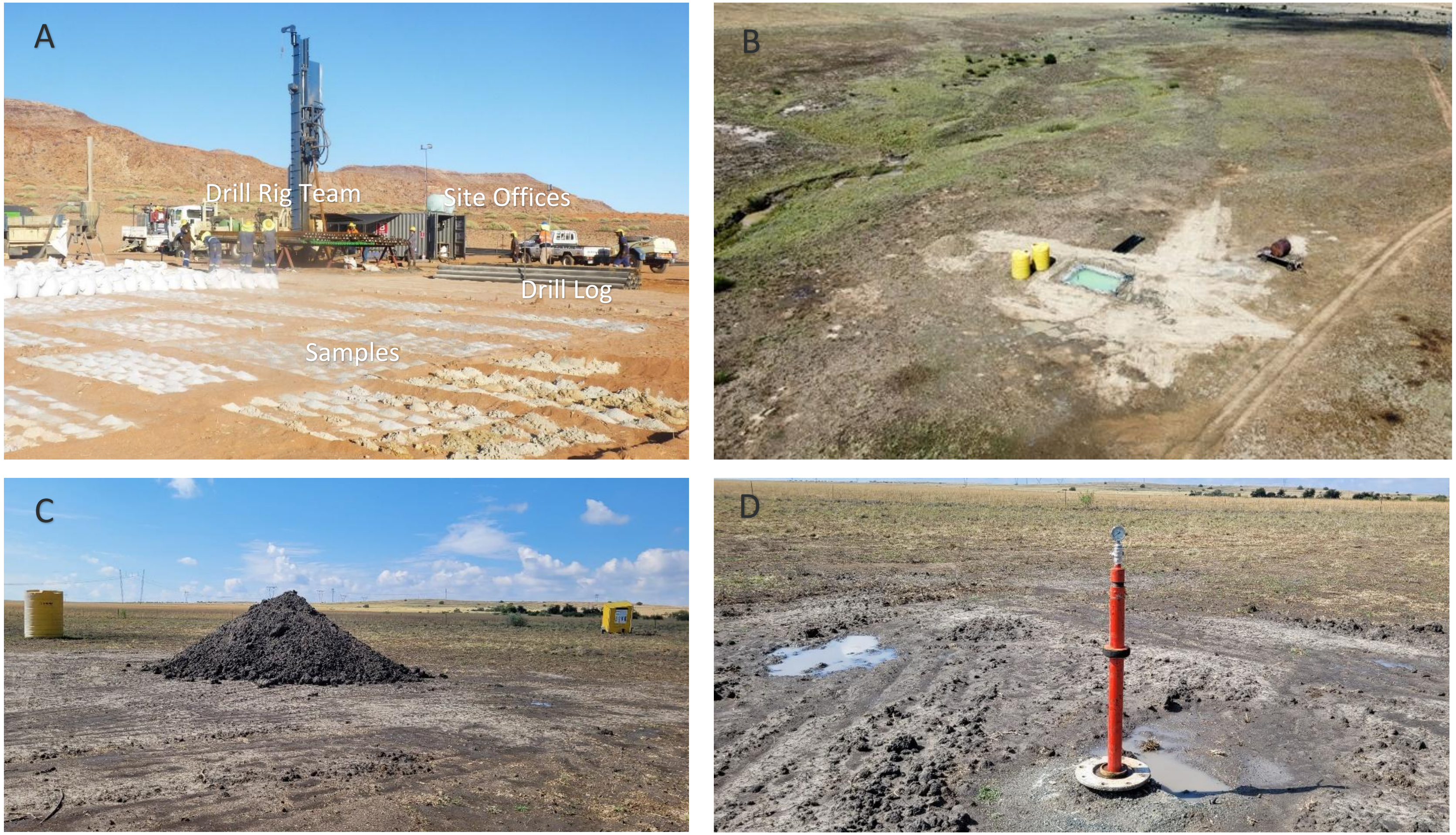


Figure 5: Exploration drilling and potential impacts. (A) Showing the drilling process and associated infrastructure, (B) Showing the drill pad footprint at one of the active D3 Energy drilling sites, (C) Showing some of impacts associated with drilling activities including controlled vegetation clearance and topsoil stockpiles and (D) Showing the final borehole, steel cased and have cemented to prevent leaks.

2.3 SUPPORTING INFRASTRUCTURE

None of the proposed exploration activities require the establishment of any permanent infrastructure. Sites will be accessed via existing roads or farm tracks as far as possible. Where existing access is not available, access tracks to accommodate a vehicle, approximately 3.5m wide will be created. These are temporary, unsurfaced, and similar to a farm two-spoor track. These will be rehabilitated accordingly at the end of exploration. Existing accommodation in the area will be utilised for staff and not on site.

Specialist contractors will provide equipment for seismic surveys and drilling. The majority of equipment, consumables and even labour for these services is specialised. Contractors and suppliers will be encouraged to source locally as much as is feasible. Electricity, if required, will be provided by on-site generators which must be placed on impermeable surfaces. Water required for the operation of the drilling rig, as well as potable water will be obtained locally, by agreement with landowners or the local municipality. The daily water requirements for drilling operations will be a maximum of 5000 litres per day.

Chemical toilets will be provided for the personnel. The toilets will be supplied and managed by a specialist contractor and the sewage disposed of at the nearest licenced wastewater management facility, or as required by the local authority. All general and hazardous waste generated at the survey and/or drilling site will be separated and stored in containers, before being removed from site and disposed at an appropriate licenced waste disposal facility. The geological material recovered from the drilling will most likely be stored in a shed for analysis and record keeping. Water from the drilling operations will be disposed of in accordance with the provisions of the National Water Act and the National Environmental Management Waste Act (as applicable). It should be noted that it is anticipated that there will be low volumes of mineral residue temporary stored on site based on the proposed activities.

2.4 DECOMMISSIONING AND CLOSURE

A rehabilitation plan has been included in the EMPr (**Appendix H**). The EMPr outlines the closure objectives that are aimed at re-instating the landform, land use, and vegetation units to the same state as before exploration operations take place, unless a specific, reasonable alternate land use is requested by the landowner. As such, the intended end use for the disturbed exploration areas and the closure objectives will be defined in consultation with the relevant landowner. Proof of such consultation shall be submitted together with the Application for Closure Certificate. The overall aim of the rehabilitation plan is to rehabilitate the environment to a condition as close as possible to that which existed prior to exploration. This shall be achieved with a number of specific objectives.

- Making the area safe. i.e.: Decommission exploration activities so as to ensure that the environment is safe for people and animals. This entails refilling excavations, sealing and grouting exploration wells etc.
- Reshape disturbed land to stable and suitable conditions similar to surrounding landscape. Return disturbed land to a capability similar to which existed prior to exploration.
- Recreating a free draining landform. This entails earthworks infilling, reshaping, levelling, etc. to recreate as close as possible the original topography and to ensure a free draining landscape.
- Re-vegetation. This involves either reseeding or allowing natural succession depending on the area, climate etc.
- Storm water management and erosion control. Management of storm water and prevention of erosion during rehabilitation. E.g. cut off drains, berms, etc. and erosion control where required.
- Removal of surface infrastructure. All surface infrastructures within disturbed areas will be removed before rehabilitation commences.

- Verification of rehabilitation success. Entails monitoring of rehabilitation. Each area will be maintained and monitored for a period of three to five years following re- vegetation and, if this monitoring shows that the objectives have been met, an application for closure will be made;
- To demolish and remove salvageable infrastructure, dump unsalvageable material and rubble in the adit, seal the access ways and rehabilitate the adit or box cut;
- To ensure that the areas mined by underground methods do not subside and that it will be safe to conduct normal farming operations above these workings by using appropriate safety factors and designs.
- To close off all entries to the underground workings so that the water table will be restored thereby preventing the ingress of air and preventing spontaneous combustion of the pillars. Any access to the working will also be restricted in accordance with the MPRDA.

Once exploration has been completed, all areas disturbed by exploration activities will be rehabilitated. This will be undertaken in accordance with the rehabilitation and closure plan as required by the Regulations Pertaining to the Financial Provision for Prospecting, Exploration, Mining or Production Operations, GNR 1147, gazetted in November 2015. This includes the determination of the financial provision as well. A closure certification application must be applied for in accordance with section 43 of the Mineral and Petroleum Resources Development Act, 2002.

2.5 LISTED AND SPECIFIED ACTIVITIES TRIGGERED

In terms of Section 24(2) of NEMA, the Minister and/or any Member of the Executive Council (MEC) in concurrence with the Minister may identify activities which require authorisation as these activities may negatively affect the environment. The NEMA EIA Regulations were promulgated in 2014 and amended in 2021 in terms of Section 24(5) and Section 44 of the National Environmental Management Act (NEMA), Act 107 of 1998 and consist of the following:

- *Regulation 982* provide details on the processes and procedures to be followed when undertaking an Environmental Authorisation process (also referred to as the EIA Regulations);
- *Listing Notice 1* (Regulation 983, as amended) defines activities which will trigger the need for a Basic Assessment process;
- *Listing Notice 2* (Regulation 984, as amended) defines activities which trigger an Environmental Impact Assessment (EIA) process. If activities from both R 983 and R 984 are triggered, then an EIA process will be required; and
- *Listing Notice 3* (Regulations 985, as amended) defines certain additional listed activities for which a Basic Assessment process would be required within identified geographical areas.

The above regulations were assessed to determine whether the proposed project will trigger any of the above listed activities, and if so, which Environmental Authorisation Process would be required. The triggered listed activities presented in **Table 7** and the applicant will require an Environmental Authorisation (EA) in terms of GNR 984 Listing Notice 2 of the NEMA EIA Regulations 2014 as amended. A Scoping and EIA process is required in line with all the requirements of the NEMA EIA Regulations, 2014, as amended.

Table 7: Relevant NEMA listed activities relevant to the proposed development.

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
GNR 983 Activity 21C	Any activity including the operation of that activity associated with an onshore seismic survey which requires an exploration right in terms of section 79 of the Mineral and Petroleum Resources Development Act, as well as any other applicable activity as contained in this Listing Notice or in Listing Notice 3 of 2014, required to exercise the exploration right,	The proposed activities include the undertaking of onshore seismics / telluric survey over 70km long around known structures and possible drill locations.

Activity No(s):	Activity	Portion of the proposed project to which the applicable listed activity relates.
	excluding (a) any desktop study, (b) any arial survey, and (c) a hydraulic fracturing activity which is included in activity 20A in Listing Notice 2 of 2014, in which case that activity applies	
GNR984, Activity 18[5]	Any activity including the operation of that activity which requires an exploration right in terms of section 79 of the Mineral and Petroleum Resources Development Act, as well as any other applicable activity as contained in this Listing Notice, in Listing Notice 1 of 2014 or in Listing Notice 3 of 2014 required to exercise the exploration right, excluding (a) any desktop study; (b) any arial survey; (c) any onshore seismic survey which is included in activity 21C in Listing Notice 1 of 2014, in which case that activity applies; (d) a hydraulic fracturing activity which is included in activity 20A, in which case activity 20A of this Notice applies; and (e) the processing of a petroleum resource, including the beneficiation or refining of gas, oil or petroleum products, in which case activity 5 of this Notice applies	The proposed activities include the undertaking of up to five (5) Diamond Core / Percussion Drilling activities for hydrocarbons, which requires an exploration right in terms of section 79 of the MPRDA
Other NEMA EIA Regulations, 2014 as amended applicable listed activities to be assessed in the EIA		
GNR 983 Activity 27	Clearance of an area of 1 hectares or more, but less than 20 hectares of indigenous vegetation, except where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan	The proposed activities will require the Clearance of an area of 1 hectares or more, but less than 20 hectares of indigenous vegetation for up to five (5) 50m x 50m drilling pads and access roads where necessary.
GNR 985 Activity 12	The clearance of an area of 300 square meters or more of indigenous vegetation except where such clearance of indigenous vegetation is required for maintenance purposes undertaken in accordance with a maintenance management plan (b). Free State: i. Within any critically endangered or endangered ecosystem listed in terms of section 52 of the NEMBA or prior to the publication of such a list, within an area that has been identified as critically endangered in the National Spatial Biodiversity Assessment 2004; ii. Within critical biodiversity areas identified in bioregional plans; iv. Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland.	The proposed activities will require the clearance of an area of 300 square meters or more of indigenous vegetation for up to five (5) 50m x 50m drilling pads and access roads where necessary.

There are currently no additional listed activities and/or water uses identified for the project. However, should the final drilling / surveying location be within the regulated area for a watercourse as per DWS regulations (refer to Section 3.1.5), then the applicant must apply for a Water Use Authorisation for the triggered Section 21 activity of the National Water Act.

[5] It is the EAPs reading and understanding of the NEMA EIA Regulations as confirmed with the Department that once GNR984 Activity 18 is triggered and applied for, there is no actual need to apply for the other associated listed activiteis as GNR984 Activity 18 LA covers all other triggered Listed Activities in GNR983, GNR984 and GNR985. However, to ensure that the resultant EA and EIA has considered relevant associated activities, these have been listed for completeness.

2.6 NEED AND DESIRABILITY OF THE PROPOSED ACTIVITY

The needs and desirability analysis component of the "Guideline on need and desirability in terms of the EIA Regulations (Notice 819 of 2014)" includes, but is not limited to, describing the linkages and dependencies between human well-being, livelihoods and ecosystem services applicable to the area in question, and how the proposed development's ecological impacts will result in socio-economic impacts (e.g., on livelihoods, loss of heritage site, opportunity costs, etc.). This section of the report provides the need and desirability for the proposed D3 Energy ER386.

The current available information recorded (observations) in the region is inadequate to make a conclusive detailed reporting on the quantity of hydrocarbons and/or suitable drilling locations for production purposes. Therefore, D3 Energy proposes to undertake up to five (5) new exploration boreholes and to acquire ground based seismic surveys (~70 km of new seismic transects). The seismic survey will be used to better understand the subsurface discontinuities, layering, and probable rocks/structures. Analysis of the seismic surveys and additional drilling wells will provide more precise information to determine the viability of the exploration project into the production phase. All of the proposed activities fall within the D3 Energy ER386 extent. There will be no additional areas or petroleum resources added to the exploration right.

The proposed activities, if approved, will allow the applicant to determine if there is an economically viable resource (natural gas including Helium) available in the area. It is important to note that the exploration right will not provide the required authorisation for production activities to be undertaken. As such, any future intention to undertake production of hydrocarbons within the exploration right area would require a further application, investigation, and public consultation process.

Helium is a non-renewable natural resource that is mostly recovered from natural gas deposits. Thus, helium is typically a by-product of natural gas fields. It is important to note that helium is found in recoverable quantities in only a few locations around the world, many of which are being depleted. In the gas fields of Virginia in the Free State, the source of helium in recent studies indicated as being unique given the high helium content in the gas field. This makes this development a potential "game changer" in the helium industry in that D3 Energy could produce helium as its prime product, with methane potentially being a by-product. This is a different strategy to how helium is currently recovered worldwide. The uniqueness of this situation is that as pressure increases on reducing gas production worldwide, helium production will also decline. However, in the case of D3 Energy, this status quo is reversed, meaning that the Virginia Gas fields may well become a significant strategic helium resource in the world. The importance of the demand for helium is that an economic need and desirability would be low if a sufficient demand now, or in the future, could not be established. In this regard, all indications are that the demand for helium is strong and sustainable, thus contributing strongly to the economic need and desirability of this exploration.

The White Paper on the Energy Policy (1998) is the overarching policy document that guides future policy and planning in the energy sector. It states that the government will, inter alia, "promote the development of South Africa's oil and gas resources…" and "ensure private sector investment and expertise in the exploitation and development of the country's oil and gas resources". The successful exploitation of these natural resources would contribute to the growth of the economy.

The National Development Plan (NDP) (2012) provides the context for all development in South Africa, with the overarching aim of eradicating poverty and inequality between people in South Africa. The NDP identifies the need to diversify the current energy mix and to reduce carbon emissions. Gas will play a more significant role in the energy mix and the exploration of gas as an alternative to coal for energy production has been recognised as a planning priority. The position of the NDP is reiterated in the Draft Integrated Energy Plan (IEP) (2013), which seeks to determine how current and future energy needs can be addressed efficiently. Main objectives outlined in the plan include security of supply, increased access to energy, diversity in supply sources and primary sources of energy and minimising emissions. The plan indicates that projected demand for natural gas between 2010 and 2050 would be second only to petroleum products, primarily due to increased growth in the industrial sector. It also identifies significant potential for natural gas in terms of power generation and direct thermal uses.

An increase in domestic natural gas reserves would also contribute to security of supply in the gas to liquids industry, which currently relies on feedstock from coal, oil and gas reserves. The Draft IEP points out the vulnerability of the liquid fuels industry and its economy to fluctuations in the global oil market, given that South Africa is a net importer of oil. Furthermore, existing gas stocks in the domestic offshore are declining, and new sources of feedstock are required to support and increase production in the gas to liquids industry (NDP, 2012).

As such, exploration for additional domestic hydrocarbon reserves is considered important and any discoveries would be well received by the local market. South Africa's Department of Electricity and Energy gazetted the updated Integrated Resource Plan 2025 (IRP 2025). The plan outlines the country's electricity generation roadmap up to 2050, unlocking over R2.23 trillion in investments to drastically shift the energy mix, reduce coal reliance, and achieve long-term energy security. The IRP 2025 aims to install 105 000 Megawatts of new generation capacity by 2039, lowering coal dependency from 58% to 27% by 2042 while boosting nuclear and gas capacities The government's official position is that exploration and development of oil and gas fields should be encouraged.

The identification of potential geological structures or "prospects" within the proposed exploration licence area for future exploration and possible well-drilling provides an opportunity to develop a South African oil and gas industry resulting in long-term benefits consisting of access to new energy sources, improved security of supply, major in-country investments in a development project and reduced dependence on the importation of hydrocarbons. There is also potential in the long-term for local economic stimulation through direct employment, future business opportunities, royalties, and tax revenues.

In summary, exploration success would result in long-term benefits for South Africa consisting of access to new energy sources, improved security of supply, major in-country investments in a development project and reduced dependence on the importation of hydrocarbons. It should be noted that SA is pursuing a diverse energy mix which include significant renewable power generation.

It is acknowledged that the potential for downstream production activities may, if they materialise, give rise to both significant positive and negative environmental and socio-economic impacts. This EIA process recognises that exploration is typically an early, iterative phase intended to establish the presence, extent, and recoverability of a resource, and does not in itself authorise or predetermine subsequent development or production.

In this context, any references to potential downstream benefits are presented to provide a high-level understanding of the broader resource development pathway, rather than to pre-empt or justify future decision-making. It is equally recognised that downstream production activities could introduce a distinct and potentially more intensive set of impacts, including those associated with infrastructure development, processing, water use, emissions, and cumulative effects. However, as these downstream activities are not currently proposed, defined, or applied for, there remains insufficient project-specific information (including location, scale, technology, and design parameters) to enable a meaningful and robust assessment of such impacts at this stage. In line with the principles of the NEMA EIA Regulations, impact assessment must be based on reasonably foreseeable, clearly described activities. Accordingly, any future transition from exploration to appraisal, development, or production would be subject to its own regulatory approval processes, including separate and comprehensive impact assessments, wherein the full suite of potential negative and positive impacts would be identified, assessed, and mitigated in detail based on site-specific information.

This approach ensures that:

- Impact assessments remain evidence-based and proportionate to the level of project definition;
- Decision-making is not prejudiced by speculative or hypothetical assessments; and
- All material impacts of downstream activities are subjected to appropriate, dedicated scrutiny at the relevant stage of project development.

Table 8: Needs and desirability analysis for the proposed exploration activities.

Ref No.	Question	Answer
1	Securing ecological sustainable development and use of natural resources	
1.1	How were the ecological integrity considerations taken into account in terms of: Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Systems, Conservation Targets, Ecological drivers of the ecosystem, Environmental Management Framework, Spatial Development Framework (SDF), and global and international responsibilities.	Although the study area has been disturbed through the active mining operations and agricultural activities, based on the proposed development and site sensitivity verification, several specialist studies form part of this environmental impact assessment including: • Agricultural Potential, Soils & Land Capability • Air Quality & Climate Change Assessment; • Aquatics and Wetland Assessment; • Archaeological and Cultural Heritage Assessment; • Palaeontological Impact Assessment; • Terrestrial Biodiversity Assessment; • Financial Provisions; • Geohydrological Assessment; • Social Assessment; and • Noise Assessment. These studies assisted in identifying any Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Areas, Conservation Targets, Ecological drivers of the ecosystem and other environmental sensitives. Where sensitive areas, species or ecosystem drivers were identified, relevant mitigation measures have been put forward to prevent or minimise the impacts. Specialist studies (soils/agriculture, biodiversity, wetlands, heritage, palaeontology, air, noise, hydrogeology, climate, social) and sensitivity mapping identify sensitive features and inform avoidance/buffers and micro-siting within the ER. The EIA has applied the mitigation hierarchy.
1.2	How will this project disturb or enhance ecosystems and / or result in the loss or protection of biological diversity? What measures were explored to avoid these negative impacts, and where these negative impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	The overall ER footprint is approximately 58 000ha. Activities are exploration-only with limited physical footprints (up to 5 drill sites and 9 transects within the broader ER envelope). Based on the specialist assessments, the study area's natural state has been disturbed through mining, agriculture, and other infrastructure developments, it is not anticipated that there will be major areas of increased ecological importance that will be identified by the specialists. However, the proposed project entails the exploration drilling using core and percussion methods which can have detrimental environmental and health impacts if not controlled. Impacts are managed via route/site selection, pre-construction walkdowns, avoidance of sensitive habitats, and rehabilitation to pre-existing land use. Best environmental practices has been recommended (mitigation hierarchy) for the identified sensitive areas and areas of species of conservation concern and/or major health risks. As stipulated in the mitigation hierarchy, the EAP / specialist has
1.3	How will this development pollute and / or degrade the biophysical environment? What measures were explored to either avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	

Ref No.	Question	Answer
		recommended to first avoid adverse impacts, then minimize impacts that cannot be avoided, and lastly offset, or compensate for, unavoidable impacts. Pollution pathways are addressed through drilling controls (casing/cement barriers, plugging), contained storage/handling of fuels/chemicals, waste segregation and off-site licensed disposal, and groundwater/surface-water protection measures in the EMPr. Refer to baseline ecological conditions in **Section 4** and the impact assessment in **Section 7** of this report.
1.4	What waste will be generated by this development? What measures were explored to avoid waste, and where waste could not be avoided altogether, what measures were explored to minimise, reuse and / or recycle the waste? What measures have been explored to safely treat and/or dispose of unavoidable waste?	This development will possibly generate various general and minor hazardous waste, the majority of which will be generated during the construction phase. The general waste will be stored in designated areas and through the process of recovery and recycling, the volume of general waste being disposed to landfill will be minimised. The hazardous portion of the waste stream will also be adequately stored prior to disposal at a suitably licenced hazardous waste disposal facility. Safe disposal certificates will be obtained from the disposal facility used. Waste has been identified as an impact and assessed in **Section 7**. However, it is anticipated that the following measures can be utilised to reduce the impact of the waste on the receiving environment: Waste must be stored correctly. All hazardous waste such as oil must be stored separately and disposed of at a registered facility. The Applicant must keep proof of disposal.
1.5	How will this project disturb or enhance landscapes and / or sites that constitute the nation's cultural heritage? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	A heritage impact assessment was conducted as part of this EIA to determine areas of archaeological and/or cultural heritage and associated mitigation measures. Based on the National Web-Based Screening Tool Report, the relative Archaeological and Cultural Heritage Theme relative sensitivity is *Very High.* Therefore, the proposed project area intersects landscapes and / or sites that constitute the provincial and/or nation's cultural heritage. The heritage specialist has identified six (6) additional heritage features. Based on the specialist's findings, direct impact on the identified feature can be easily avoided and stipulated buffer requirements in line with SAHRA Guidelines. In addition, a Chance Find Protocol procedure has been recommended (refer to **Section 4.6**). Impacts are expected to be **low with mitigation**.
1.6	How will this project use and / or impact on non-renewable natural resources? What measures were explored to ensure responsible and equitable use of the resources? How have the consequences of the depletion of the non-renewable natural resources been considered? What measures were explored to firstly avoid these impacts, and where impacts could not be avoided altogether, what measures were explored to minimise and remedy the impacts? What measures were explored to enhance positive impacts?	Refer to the impact assessment in **Section 7** of this report. It is acknowledged that due to the nature of gas resources, an onshore (potentially non-renewable) gas resource will be depleted should the project proceed to production phase. It has not yet been conclusively determined if the gas field is biogenic (renewable) or thermogenic (non-renewable). Gas production has the potential to contribute to the country's economy as well as the transition from dirtier energy production (coal) to renewable energy production in the future, the current project is an exploration project, and minimal gas will be used or lost during this project and therefore the exploration project will have minor impact on the natural non-renewable gas resource. The current phase is resource appraisal/ exploration, and not production; any depletion of non-renewable resource considerations relate to
1.7	How will this project use and / or impact on renewable natural resources and the ecosystem of which they are part? Will the use of the resources and / or impacts on the ecosystem jeopardise	

Ref No.	Question	Answer
	the integrity of the resource and / or system taking into account carrying capacity restrictions, limits of acceptable change, and thresholds? What measures were explored to firstly avoid the use of resources, or if avoidance is not possible, to minimise the use of resources? What measures were taken to ensure responsible and equitable use of the resources? What measures were explored to enhance positive impacts?	a future production phase which would require a separate authorisation process if this is pursued. This EIA assesses exploration-phase impacts and management measures. Although there are currently no direct overlaps between the drilling site and seismic transects with proposed renewable energy infrastructure, it must be noted that there are at least 14 approved renewable energy projects from various applicants located within ER386. D3 Energy and the renewable energy applicants will need to discuss the way forward and/or make necessary arrangements to coexist for potential future overlaps. Coexisting arrangements has been successfully arranged for the D3 Energy ER315 footprint and therefore, it is anticipated that the same can be achieved for the ER386 which will result in no to minimal impact on the planned solar farms. It is anticipated that the project will have a low impact on the localised ecology. Refer to the impact assessment in **Section 7** of this report.
1.7.1	Does the proposed project exacerbate the increased dependency on increased use of resources to maintain economic growth or does it reduce resource dependency (i.e., de-materialised growth)?	The proposed project, if it successfully identifies economical viable gas field in the area will provide an opportunity for South Africa to move away from dirtier energy (coal) while transitioning to a more renewable energy source. This can be translated into a “reduced dirty resource dependency”. If a viable gas resource is confirmed, such could support energy diversification in the longer term. It is emphasised that this application is exploration only (data-gathering) and does not authorise production.
1.7.2	Does the proposed use of natural resources constitute the best use thereof? Is the use justifiable when considering intra- and intergenerational equity, and are there more important priorities for which the resources should be used?	It should be noted that the current project is an exploration project and not a production project. The harvesting of this gas resource (during production) would constitute a better use thereof as it is currently not being harvested in this area for any commercial beneficial use. In fact, several historically drilled gold prospecting boreholes in the area are undergoing uncontrolled release of Methane into the atmosphere without being flared or burned (to only release CO_2 which is a lower order GHG pollutant).
1.7.3	Do the proposed location, type and scale of development promote a reduced dependency on resources?	The location, type and scale of the proposed development currently do not promote a reduced dependency on the importation of gas resources from other countries as at this stage, the activities are at the exploration phase. However, if the project proceeds to the production phase, it will further provide an opportunity to reduce dependency on more harmful resources such as coal for energy production. As such, this project should not be viewed in isolation in terms of resources but in a holistic manner both nationally and globally.
1.8	How were a risk-averse and cautious approach applied in terms of ecological impacts:	
1.8.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	In order to prevent repetition, the reader is directed to the assumptions and limitations presented in **Section 11**.

Ref No.	Question	Answer
1.8.2	What is the level of risk associated with the limits of current knowledge?	The level of risk is considered low.
1.8.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	As final drilling locations, seismic transects and associated infrastructure cannot be identified at this stage, it is fortunate that a strategic assessment of Target Areas (500m buffers) and seismic transects (50m corridors) is able to be undertaken as part of this EIA process in order to identify areas of high sensitivity and even no-go areas. Adaptive environmental management is provided for in the assessment and resultant EMPr. In this manner, a risk-averse and cautious approach is able to be more fully realised in future project planning.
1.9	How will the ecological impacts resulting from this development impact on people's environmental right in terms following?	
1.9.1	Negative impacts: e.g. access to resources, opportunity costs, loss of amenity (e.g. open space), air and water quality impacts, nuisance (noise, odour, etc.), health impacts, visual impacts, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	The application and proposed development footprint occur predominantly on properties that are of commercial agricultural activities. The final well placing and seismic transect will be discussed and agreed with each affected landowner prior to commencement of drilling and surveying and where necessary, appropriate compensation negotiated. Furthermore, as mentioned above, this EIA process is undertaken at a more strategic level assessment of the receiving environment within proposed development corridors which allows input from numerous specialist disciplines to identify highly sensitive or no-go areas which can then be excluded from development where necessary. The positive impact of job creation has been identified by the social specialist and the requirement for local upliftment in the form of employment creation or social programmes put forward. Negative impacts are localised and short-term (site establishment, noise/dust, vegetation disturbance, water risks) and mitigated through EMPr controls. Positive impacts are primarily indirect (limited local jobs/procurement during exploration) and conditional on implementation. Refer to the impact assessment in **Section 7** in this report.
1.9.2	Positive impacts: e.g. improved access to resources, improved amenity, improved air or water quality, etc. What measures were taken to enhance positive impacts?	
1.10	Describe the linkages and dependencies between human wellbeing, livelihoods and ecosystem services applicable to the area in question and how the development's ecological impacts will result in socio-economic impacts (e.g. on livelihoods, loss of heritage site, opportunity costs, etc.)?	Key linkages relate to agriculture, water resources, and community nuisance/health and safety. These are assessed as part of the impact assessment and managed through landowner engagement, access controls, water protection measures, and rehabilitation. A medium to low potential impact on third party wellbeing, livelihoods and ecosystem services is currently foreseen at this stage of this application as the predominant land use of the affected properties is commercial agriculture as mentioned above, and the site sensitivities from a socio-economic and biophysical point of view have been identified prior to the final placement of infrastructure. Refer to the impact assessment in **Section 7** of this report.
1.11	Based on all of the above, how will this development positively or negatively impact on ecological integrity objectives / targets / considerations of the area?	As discussed above, this project is anticipated to have a low overall potential impact on the ecological integrity objectives or targets as consideration of these aspects will be undertaken prior to final placement of infrastructure. Ecological integrity is protected through avoidance of mapped

Ref No.	Question	Answer
		sensitivities, regulated-area controls for watercourses/wetlands, heritage buffers, and rehabilitation. Residual impacts are intended to be low to moderate depending on receptor sensitivity, and will be subject to EMPr compliance. Refer to the impact assessment in **Section 7** in this report.
1.12	Considering the need to secure ecological integrity and a healthy biophysical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the "best practicable environmental option" in terms of ecological considerations?	As part of this EIA Report, suitable alternatives have been considered and will be finalised once the public review of the EIA Report has been completed. Refer to **Section 5** for the details of the alternatives considered for the project.
1.13	Describe the positive and negative cumulative ecological / biophysical impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and existing and other planned developments in the area?	Cumulative impacts are considered across project phases and in combination with existing land uses (agriculture, mining, infrastructure, renewable energy projects). The EIA assesses cumulative effects (e.g., water, habitat, noise, traffic) and provides mitigation/monitoring through the EMPr. Refer to **Section 7** of this report for the identified potential impacts, their assessment and recommended mitigation measures.
2	**Promoting justifiable economic and social development**	
2.1	What is the socio-economic context of the area, based on, amongst other considerations, the following:	
2.1.1	The IDP (and its sector plans' vision, objectives, strategies, indicators and targets) and any other strategic plans, frameworks or policies applicable to the area	Refer to **Section 4.5** of this report for a breakdown of the demographics and social environment in the project area. Details of the IDP's for the Lejweleputswa District Municipality (LDM), Fezile Dabi District Municipality (FDM) as well as the Matjhabeng and Moqhaka Local Municipalities are included in **Section 4.5.** The proposed project will promote and support the sustainability of existing business in the local and regional economy and assist in increasing local beneficiation and shared economic growth.
2.1.2	Spatial priorities and desired spatial patterns (e.g., need for integrated of segregated communities, need to upgrade informal settlements, need for densification, etc.),	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom, Virginia, and Hennenman.
2.1.3	Spatial characteristics (e.g., existing land uses, planned land uses, cultural landscapes, etc.), and	Refer to the baseline environment in **Section 4** of this report.
2.1.4	Municipal Economic Development Strategy ("LED Strategy").	Considering the location of the activities, it is not anticipated to significantly promote or facilitate spatial transformation and sustainable urban development.

Ref No.	Question	Answer
2.2	Considering the socio-economic context, what will the socio-economic impacts be of the development (and its separate elements/aspects), and specifically also on the socio-economic objectives of the area?	This project will result in positive socio-economic impacts in the local, regional, and national economy. Refer to the impact assessment in **Section 7** in this report
2.2.1	Will the development complement the local socio-economic initiatives (such as local economic development (LED) initiatives), or skills development programs?	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom, Virginia, and Hennenman.
2.3	How will this development address the specific physical, psychological, developmental, cultural and social needs and interests of the relevant communities?	While the baseline receiving environment is presented in **Section 4**. The process includes ongoing stakeholder engagement and documentation of issues and concerns through the EIA public participation process. Landowner access arrangements and grievance/communications mechanisms are addressed through the PPP and included in the EMPr commitments. Concerns raised by I&APs have been captured, addressed and considered in this report. Recommendations by PASA for additional public meetings in previously disadvantaged communities and stakeholder meetings with renewable energy developers have also been considered as part of the EIA Public Participation Process. All comments and concerns raised will captured, responded to and submitted to the CA.
2.4	Will the development result in equitable (intra- and inter-generational) impact distribution, in the short- and long-term? Will the impact be socially and economically sustainable in the short- and long-term?	None of the identified impacts are anticipated to have a high negative impact significance post mitigation. It is therefore not anticipated that this project will result in negative equitable impact distribution in the short- and long-term. Primary directly affected parties are landowners and local receptors near activity areas, their equity is addressed through inclusive stakeholder notification and consultation, landowner negotiations, mitigation to avoid disproportionate burdens, and monitoring/auditing requirements. Residual impacts are intended to be manageable if EMPr is implemented.
2.5	**In terms of location, describe how the placement of the proposed development will:**	
2.5.1	Result in the creation of residential and employment opportunities in close proximity to or integrated with each other.	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom, Virginia and Hennenman (to a limited extent) both locally and regionally.
2.5.2	Reduce the need for transport of people and goods.	The activities are not anticipated to have an impact on the transportation of goods and people.

Ref No.	Question	Answer
2.5.3	Result in access to public transport or enable non-motorised and pedestrian transport (e.g. will the development result in densification and the achievement of thresholds in terms of public transport),	The activities are not anticipated to have any significant impact on the public transport.
2.5.4	Compliment other uses in the area,	The proposed project has a small footprint (~ $1m^2$) per drilling site after closure and rehabilitation which allows it to coexist with the other uses in the area.
2.5.5	Be in line with the planning for the area.	Refer to item 2.1.1 of this table (above).
2.5.6	For urban related development, make use of underutilised land available with the urban edge.	Not applicable. The proposed project is not located in an urban area.
2.5.7	Optimise the use of existing resources and infrastructure,	The proposed approach is to first determine and map the geographic extent of all boreholes currently emitting gas on and near the ER area. Then measure rates and monitor pressures where possible and perform gas composition analysis. D3 Energy will also search records at the Council for Geoscience and the Petroleum Agency for seismic data that was acquired on the Exploration Right in the past. Existing access roads will be used as far as possible.
2.5.8	Opportunity costs in terms of bulk infrastructure expansions in non-priority areas (e.g., not aligned with the bulk infrastructure planning for the settlement that reflects the spatial reconstruction priorities of the settlement),	
2.5.9	Discourage "urban sprawl" and contribute to compaction / densification.	This project is located in a rural setting and is not anticipated to have an impact on or any control over urban sprawl in the nearby towns.
2.5.10	Contribute to the correction of the historically distorted spatial patterns of settlements and to the optimum use of existing infrastructure in excess of current needs,	Refer to items 2.5.7 – 2.5.9 of this table (above).
2.5.11	Encourage environmentally sustainable land development practices and processes	This project is anticipated to have a minimal impact on the current land uses in the application area as the wells are insignificantly small in area (~ $1m^2$ each). This will allow for existing land uses to continue while this exploration project is ongoing.
2.5.12	Take into account special locational factors that might favour the specific location (e.g., the location of a strategic mineral resource, access to the port, access to rail, etc.),	Refer to alternative analysis in **Sections 5** and the introduction part of this section.
2.5.13	The investment in the settlement or area in question will generate the highest socio-economic returns (i.e. an area with high economic potential).	As mentioned on item 2.5.11 above, this project will not sterilise existing land uses and therefore it will in fact result in higher economic returns per land area as both agriculture and gas exploration can occur simultaneously.
2.5.14	Impact on the sense of history, sense of place and heritage of the area and the socio-cultural and cultural-historic characteristics and sensitivities of the area, and	The proposed activities will have a minimal impact on the existing sense of place. Furthermore, a detailed Heritage Impact Assessment was undertaken which has identified existing cultural and

Ref No.	Question	Answer
		heritage sites which allows for their protection from potential negative impacts (refer to **Section 994.6** and **Section 7**).
2.5.15	In terms of the nature, scale and location of the development promote or act as a catalyst to create a more integrated settlement?	Given the scale of the development, it is not anticipated that the activities will contribute significantly to settlements or areas in terms of direct socio-economic returns however the development will have limited temporary employment opportunities for the locals.
2.6	**How was a risk-averse and cautious approach applied in terms of socio-economic impacts:**	
2.6.1	What are the limits of current knowledge (note: the gaps, uncertainties and assumptions must be clearly stated)?	Refer to **Section 11** of this report.
2.6.2	What is the level of risk (note: related to inequality, social fabric, livelihoods, vulnerable communities, critical resources, economic vulnerability and sustainability) associated with the limits of current knowledge?	The level of risk is considered low as the project is not expected to have far reaching negative impacts on socio-economic conditions.
2.6.3	Based on the limits of knowledge and the level of risk, how and to what extent was a risk-averse and cautious approach applied to the development?	The information relating to the final site-specific location of drill sites will likely be raised by the landowners. D3 Energy should provide as much additional information as possible during landowner consultation.
2.7	How will the socio-economic impacts resulting from this development impact on people's environmental right in terms following:	
2.7.1	Negative impacts: e.g., health (e.g. HIV-Aids), safety, social ills, etc. What measures were taken to firstly avoid negative impacts, but if avoidance is not possible, to minimise, manage and remedy negative impacts?	Refer to the impact assessment in **Section 7** of this report. Both positive and negative socio-economic impacts have been identified and relevant mitigation measures put forward to reduce negative impacts and enhance positive impacts as far as practicable.
2.7.2	Positive impacts. What measures were taken to enhance positive impacts?	
2.8	Considering the linkages and dependencies between human wellbeing, livelihoods and ecosystem services, describe the linkages and dependencies applicable to the area in question and how the development's socioeconomic impacts will result in ecological impacts (e.g. over utilisation of natural resources, etc.)?	
2.9	What measures were taken to pursue the selection of the "best practicable environmental option" in terms of socio-economic considerations?	
2.10	What measures were taken to pursue environmental justice so that adverse environmental impacts shall not be distributed in such a manner as to unfairly discriminate against any person,	

Ref No.	Question	Answer
	particularly vulnerable and disadvantaged persons (who are the beneficiaries and is the development located appropriately)? Considering the need for social equity and justice, do the alternatives identified, allow the "best practicable environmental option" to be selected, or is there a need for other alternatives to be considered?	
2.11	What measures were taken to pursue equitable access to environmental resources, benefits and services to meet basic human needs and ensure human wellbeing, and what special measures were taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination?	By conducting an EIA Process, the applicant ensures that equitable access has been considered. The potential impact on existing land uses has been identified from the start of this application process and an assessment of this impact as well as mitigation measures put forward to prevent undue negative impacts in this regard. Refer to the impact assessment in **Section 7** of this report.
2.12	What measures were taken to ensure that the responsibility for the environmental health and safety consequences of the development has been addressed throughout the development's life cycle?	Refer to the impact assessment in **Section 7** of this report. The EMPr (**Appendix H**) specifies timeframes within which mitigation measures must be implemented.
2.13	What measures were taken to:	
2.13.1	Ensure the participation of all interested and affected parties.	Refer to **Section 6** of this report, describing the public participation process undertaken for the proposed project.
2.13.2	Provide all people with an opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation,	Refer to **Section 6** of this report, describing the public participation process undertaken for the proposed project. advertisement, notification letter, and site notice have been made available in English, Afrikaans, and Sesotho to assist in understanding of the project. Further public consultation including public meetings is underway during the review period of this EIA Report.
2.13.3	Ensure participation by vulnerable and disadvantaged persons,	
2.13.4	Promote community wellbeing and empowerment through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means,	
2.13.5	Ensure openness and transparency, and access to information in terms of the process,	
2.13.6	Ensure that the interests, needs and values of all interested and affected parties were taken into account, and that adequate recognition were given to all forms of knowledge, including traditional and ordinary knowledge,	
2.13.7	Ensure that the vital role of women and youth in environmental management and development were recognised and their full participation therein will be promoted?	

Ref No.	Question	Answer
2.14	Considering the interests, needs and values of all the interested and affected parties, describe how the development will allow for opportunities for all the segments of the community (e.g. a mixture of low-, middle-, and high-income housing opportunities) that is consistent with the priority needs of the local area (or that is proportional to the needs of an area)?	
2.15	What measures have been taken to ensure that current and / or future workers will be informed of work that potentially might be harmful to human health or the environment or of dangers associated with the work, and what measures have been taken to ensure that the right of workers to refuse such work will be respected and protected?	Potential future workers will have to be educated on a regular basis as to the environmental and safety risks that may occur within their work environment. Furthermore, adequate measures will have to be taken to ensure that the appropriate personal protective equipment is issued to workers based on the conditions that they work in and the requirements of their job.
2.16	Describe how the development will impact on job creation in terms of, amongst other aspects:	
2.16.1	The number of temporary versus permanent jobs that will be created.	It is anticipated that the use of local labour will be utilised as far as possible. Labourers will mostly be sourced from surrounding towns and areas such as Welkom, Virginia, and Hennenman. It must be noted that work opportunities during the exploration phase will be very minimal.
2.16.2	Whether the labour available in the area will be able to take up the job opportunities (i.e. do the required skills match the skills available in the area).	
2.16.3	The distance from where labourers will have to travel.	
2.16.4	The location of jobs opportunities versus the location of impacts.	
2.16.5	The opportunity costs in terms of job creation.	
2.17	What measures were taken to ensure:	
2.17.1	That there were intergovernmental coordination and harmonisation of policies, legislation and actions relating to the environment.	The Scoping and EIA Process requires governmental departments to communicate regarding any application. In addition, all relevant departments are notified at various phases of the project by the EAP and any feedback received from government departments is considered where relevant.
2.17.2	That actual or potential conflicts of interest between organs of state were resolved through conflict resolution procedures.	
2.18	What measures were taken to ensure that the environment will be held in public trust for the people, that the beneficial use of environmental resources will serve the public interest, and that the environment will be protected as the people's common heritage?	Environmental attributes that may be impact by this project have been identified and where relevant, specialist input has been solicited to ensure that a rigorous impact assessment process is undertaken. Where positive impacts on the interests of the public have been identified (e.g. job creation, impact on existing land use, etc.), mitigation measures are put forward to enhance positive impacts and/or reduce negative impacts.

Ref No.	Question	Answer
2.19	Are the mitigation measures proposed realistic and what long-term environmental legacy and managed burden will be left?	The majority of the proposed mitigation measures for this application are in alignment with the approved adjacent exploration right (D3 Energy ER315) EMPr mitigation measures and therefore these measures have been tested in the real world. Refer to the impact assessment and mitigation measures in **Section 7** of this report.
2.20	What measures were taken to ensure that the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects will be paid for by those responsible for harming the environment?	The proposed survey activities are not anticipated to produce significant pollution, environmental damage, or adverse health effects in the long term. Financial provisioning for closure and rehabilitation as well as the rehabilitation plan have been undertaken to support the EA and ER Applications. Refer to **Appendix F** and **Appendix H**.
2.21	Considering the need to secure ecological integrity and a healthy bio-physical environment, describe how the alternatives identified (in terms of all the different elements of the development and all the different impacts being proposed), resulted in the selection of the best practicable environmental option in terms of socio-economic considerations?	Refer to **Section 5.1**, description of the process followed to reach the proposed preferred site.
2.22	Describe the positive and negative cumulative socio-economic impacts bearing in mind the size, scale, scope and nature of the project in relation to its location and other planned developments in the area?	Refer to the impact assessment and mitigation measures in **Section 7**.

3 POLICY AND LEGISLATIVE CONTEXT

This section provides an overview of the governing legislation identified which may relate to the proposed project. The primary legal requirement for this project stems from the need for an EA to be granted by the competent authority, which is the DMPR, in accordance with the requirements of the NEMA EIA Regulations 2014, as amended. In addition, there are numerous other pieces of legislation governed by many acts, regulations, standards, guidelines, and treaties on an international, national, provincial, and local level, which should be considered in order to assess the potential applicability of these for the proposed activity. The key legislation applicable to this project is discussed in the subsections below. The contents of this report are based on a review of the information that was available at the time of the compilation of the report. The discussion in this chapter is by no means an exhaustive list of the legal obligations of the applicant in respect of environmental management for the proposed D3 Energy ER386 project.

3.1 NATIONAL POLICY AND LEGISLATION

3.1.1 CONSTITUTION OF THE REPUBLIC OF SOUTH AFRICA

The constitution of any country is the supreme law of that country. The Bill of Rights in chapter 2 section 24 of the Constitution of South Africa Act (Act No. 108 of 1996) makes provisions for environmental issues and declares that: *"Everyone has the right -*

a) to an environment that is not harmful to their health or well-being; and

b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

i. prevent pollution and ecological degradation;

ii. promote conservation; and

iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

The State must therefore respect, protect, promote, and fulfil the social, economic, and environmental rights of everyone and strive to meet the basic needs of previously disadvantaged communities. The Constitution therefore recognises that the environment is a functional area of concurrent national and provincial legislative competence, and all spheres of government and all organs of state must cooperate with, consult and support one another if the State is to fulfil its constitutional mandate. The application for the D3 Energy ER386 project will ensure that the environmental right enshrined in the Constitution contributes to the protection of the biophysical and social environment.

3.1.2 THE MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT, 2002

The Mineral and Petroleum Resources Development Act, 2002 (MPRDA) aims to "make provision for equitable access to and sustainable development of the nation's mineral and petroleum resources". The MPRDA outlines the procedural requirements that need to be met to acquire mineral and hydrocarbon rights in South Africa.

In terms of the MPRDA an Exploration Right was required and issued prior to the commencement of any exploration activities. The MPRDA also requires adherence with related legislation, chief amongst them is the National Environmental Management Act (Act No. 107 of 1998, NEMA) and the National Water Act (Act No. 36 of 1998, NWA). Several amendments have been made to the MPRDA. These include, but are not limited to, the amendment of Section 102, concerning amendment of rights, permits, programmes and plans, to requiring the written permission of the Minister for any amendment or alteration; and the section 5A(c) requirement that landowners or land occupiers receive twenty-one (21) days' written notice prior to any activities taking place on their properties. One of the most recent amendments requires all mining related activities to follow the full NEMA process as per the 2014 EIA Regulations, which came into effect on 8 December 2014.

An Exploration Right is exclusive, transferable, valid for 3 years, and renewable for a maximum of 3 periods of 2 years each. Exploration is very similar to prospecting, in that an Exploration Right only allows the holder of the right to conduct such activities as per the Exploration Works Programme to establish the presence of economically viable hydrocarbon resources. An exploration right does not grant the holder the right to conduct any production related activities. D3 Energy applied for an ER in October 2024 and was accepted on the 22nd of October 2024 (PASA Ref: 12/3/386). In support of the ER application, the applicant is required to conduct an EIA process comprising of the preparation of environmental Scoping and EIA Reports, an EMPr, as well as Interested and Affected Party (I&AP) consultations, all of which must be submitted to the PASA for adjudication. This report has been compiled in accordance with Regulation 49 of the MPRDA and Regulation 23 and Appendix 3 of the EIA Regulations (2014, as amended) in order to satisfy the criteria for an EIA Report.

It is important to note that the Upstream Petroleum Resources Development Act, 23 of 2024 (UPRDA) has been promulgated but is pending enactment. Section 111 provides that the Act will come into operation on a date fixed by the President by proclamation in the Gazette. The UPEDA is an important legislative mechanism supporting local gas and petroleum development. According to Section 2, the objects of the Upstream Petroleum Resources Development Act 23 of 2024 are to:

a. recognise the internationally accepted right of the State to exercise sovereignty over all the petroleum resources within the Republic;

b. give effect to the principle of the State's custodianship of the nation's petroleum resources;

c. promote equitable access to the nation's petroleum resources to all the people of South Africa;

d. substantially and meaningfully expand opportunities for black persons, to enter into and actively participate in the upstream petroleum sector and to benefit from the exploitation of the nation's petroleum resources;

e. promote local employment, skills development, technology transfer and national industry participation through supply of goods and services;

f. promote economic growth and petroleum resources development in the Republic;

g. advance the social and economic welfare of all South Africans;

h. provide for security of tenure in respect of exploration and production operations;

i. give effect to section 24 of the Constitution by ensuring that the nation's petroleum resources are developed in an orderly and ecologically sustainable manner while promoting justifiable social and economic development;

j. accelerate exploration and production, and maximise the economic recovery of petroleum for the benefit of the people of South Africa;

k. provide the framework for developing third party access arrangements to upstream petroleum infrastructure; and

l. promote and facilitate acquisition of petroleum geo-technical data.

3.1.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998

The main aim of the National Environmental Management Act, 1998 (Act 107 of 1998 – NEMA) is to provide for co-operative governance by establishing decision-making principles on matters affecting the environment. In South Africa, EIAs became a legal requirement in 1997 with the promulgation of regulations under the Environment Conservation Act (ECA). Subsequently, NEMA was passed in 1998. Section 24(2) of NEMA empowers the Minister and any MEC, with the concurrence of the Minister, to identify activities which must be considered, investigated, assessed, and reported on to the competent authority responsible for granting the relevant EA. On 21 April 2006, the Minister of Environmental Affairs and Tourism (now Department of Forestry, Fisheries, and the Environment – DFFE) promulgated regulations in terms of Chapter 5 of the NEMA. These regulations, in terms of the NEMA, were amended several times between 2010 and 2022. The NEMA EIA Regulations, 2014, as amended, are the current regulations.

The objective of the EIA Regulations is to establish the procedures that must be followed in the consideration, investigation, assessment, and reporting of the listed activities that are triggered by the proposed project. The purpose of these procedures is to provide the competent authority with adequate information to make informed decisions which ensure that activities which may impact negatively on the environment to an unacceptable degree are not authorised, and that activities which are authorised are undertaken in such a manner that the environmental impacts are managed to acceptable levels. In accordance with the provisions of Sections 24(5) and Section 44 of the NEMA the Minister has published Regulations (GN R. 982) pertaining to the required process for conducting EIAs in order to apply for, and be considered for, the issuing of an EA. These EIA Regulations provide a detailed description of the EIA process to be followed when applying for EA for any listed activity.

Based on review on the NEMA EIA Regulations, 2014 as amended, the applicant is required to appoint an EAP to undertake a Scoping and EIA Application process for the proposed project, which includes conducting the public participation process (refer to **Section 6**). An environmental Scoping and Impact Assessment process is reserved for activities which have the potential to result in significant impacts which are complex to assess. Scoping and Impact Assessment studies accordingly provide a mechanism for the comprehensive assessment of activities that are likely to have more significant environmental impacts. **Figure 6** below provides a graphic representation of all the components of a full EIA process. The listed activities the proposed project triggers and consequently requires authorisation prior to commencement are detailed in **Section 2.5** (**Table 7**).

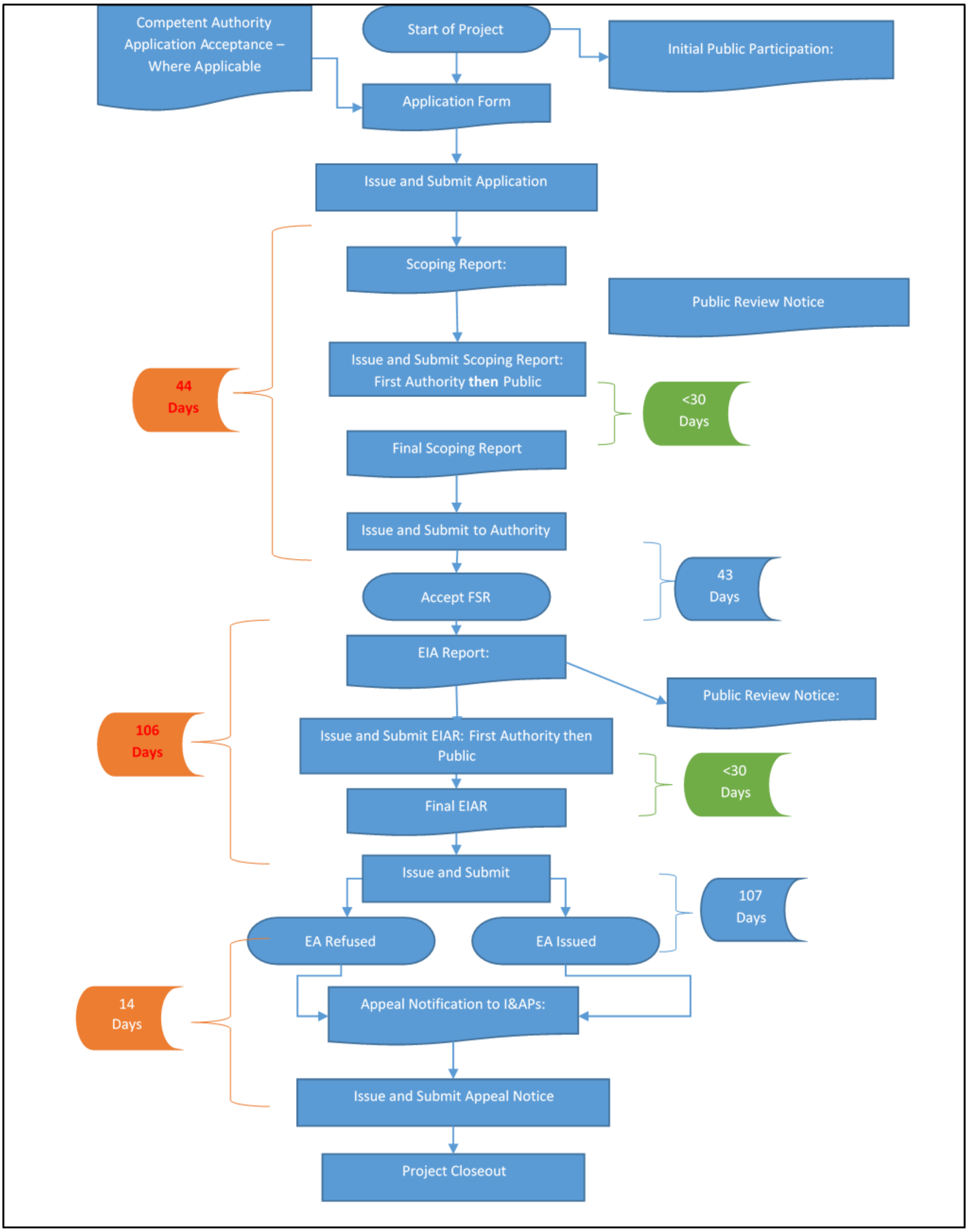


Figure 6: EIA process diagram.

NEMA is the main Environmental Legislation in South Africa and other Specific Environmental Management Acts (SEMA's) support its objectives. Examples of SEMA's include the following:

- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008);
- National Water Act, 1998 (Act No. 36 of 1998);
- National Heritage Resources Act, 1999 (Act No. 25 of 1999);

- National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004); and
- National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004).

Some specific Environmental Management Legislation is discussed in **Sections 3.1.5 to 3.2.3.** The key principles of NEMA as outlined in Chapter 3 can be summarised as follows:

- sustainability must be pursued in all developments to ensure that biophysical and socio-economic aspects are protected; or
- there must be equal access to environmental resources, services and benefits for all citizens including the disadvantaged and the vulnerable. Adverse environmental impacts shall be distributed fairly among all citizens;
- environmental governance must include the participation of all interested and affected parties who must be catered for to allow their effective participation; and
- Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably.

The polluter pays principle (Section 28 of NEMA) must be applied in all cases where any person has caused pollution or undertaken any action that led to the degradation of the environment.

3.1.4 NEMA ENVIRONMENTAL IMPACT ASSESSMENT REGULATIONS, 2014 AS AMENDED

In terms of section 24(2) of NEMA, the Minister and or any MEC in concurrence with the Minister may identify activities that require authorisation as these activities may negatively affect the environment. The Act requires that in such cases the impacts must be considered, investigated and assessed before their implementation, and reported to the organ of state charged by law with authorising, permitting, or otherwise allowing the implementation of an activity. The NEMA EIA Regulations guide the processes required for the assessment of impacts of Listed Activities.

The requirement for the undertaking of Environmental Impact Assessments or Basic Assessments began in 1997 with the promulgation of the EIA Regulations under the Environment Conservation Act, 1989 (ECA) (Act No. 73 of 1989). These were followed by the 2006, 2010 and 2014 regulations. **Table 9** is a summary of the progression of the EIA regulations to date. Refer to **Section 2.5** for the identified triggered listed activities.

Table 9: Summary of the South African EIA regulations from inception to date.

EIA Regulations	Government Gazette
EIA Regulations promulgated in terms of the ECA, Act No 73 of 1989	GNR 1182 & 1183: Government Gazette No 18261, 5 September 1997
Amendment of the ECA EIA Regulations	GNR 670 and GNR 672 of 10 May 2002, Government Gazette No 23401
2006 EIA Regulations promulgated in terms of the NEMA, Act No 107 of 1998	GNR 385, 386 and 387 Government Gazette No 28753, Pretoria, 21 April 2006
2010 EIA Regulations promulgated in terms of the NEMA, Act No 107 of 1998	GNR 543, 544, 545 and 546 Government Gazette No 33306, Pretoria, 18 June 2010
2014 EIA Regulations promulgated in terms of the NEMA, Act No 107 of 1998	GNR 982, 983, 984 and 985 Government Gazette No 38282, Pretoria, 04 December 2014
Current Amendment of the 2014 EIA Regulations promulgated in terms of the NEMA, Act No 107 of 1998	GNR 982, 983, 984 and 985 Government Gazette No 44701, Pretoria, 2021 as amended

3.1.5 THE NATIONAL WATER ACT, 1998

National Water Act, 1998 (Act 36 of 1998 – NWA) makes provision for two types of applications for water use licences, namely individual applications, and compulsory applications. The NWA also provides that the responsible authority may require an assessment by the applicant of the likely effect of the proposed licence on the resource quality, and that such assessment be subject to the NEMA EIA Regulations. A person may use water if the use is –

- Permissible as a continuation of an existing lawful water use (ELWU);
- Permissible in terms of a general authorisation (GA);
- Permissible under Schedule 1; or
- Authorised by a licence.

The water use processes are described in **Figure 7.**

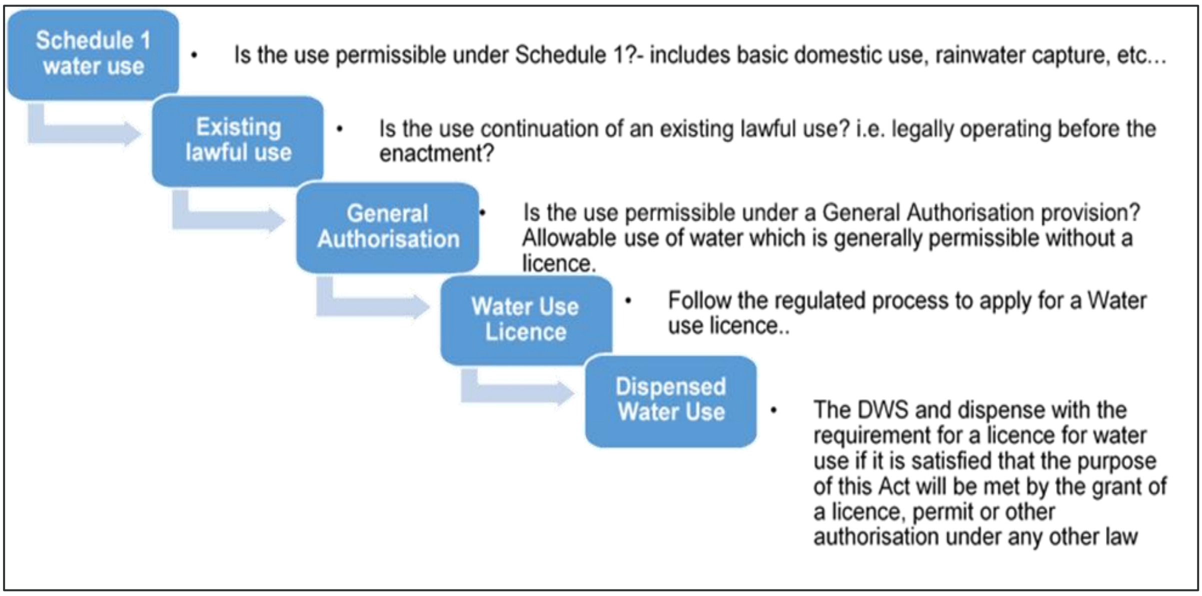


Figure 7: Authorisation processes for new water uses.

The purpose of the NWA is to ensure that the nation's water resources are protected, used, developed, conserved, and managed in ways that take into account:

- Meeting basic human needs of present and future generations;
- Promoting equitable access to water;
- Redressing the results of past racial discrimination;
- Promoting the efficient, sustainable and beneficial use of water in the public interest; facilitation social and economic development;
- Providing for the growing demand for water use;
- Protecting aquatic and associated ecosystems and their biological diversity;
- Reducing and preventing pollution and degradation of water resources;
- Meeting international obligations;
- Promoting dam safety; and
- Managing floods and drought.

The NWA defines 11 water uses in Section 21 of the Act. A water use may only be undertaken if authorised by the Department of Water and Sanitation (DWS). The water uses for which an authorisation or licence can be issued include:

a) Taking water from a water resource;

b) Storing water;

c) Impeding or diverting the flow of water in a watercourse;

d) Engaging in a stream flow reduction activity contemplated in section 36;

e) Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

f) Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduits;

g) Disposing of waste in a manner which may detrimentally impact on a water resource;

h) Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i) Altering the bed, banks, course or characteristics of a watercourse;

j) Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k) Using water for recreational purposes.

The regulated area of a watercourse for section 21 activities of the Act water uses is similarly defined in terms of the Act as follows:

a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;

b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or

c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

As part of the NWA, and with specific reference the GNR704 of 1999 has been published. These regulations impose specific restrictions on activities in terms of its locality. One of these restrictions are in terms of Regulation 4(c) saying that no person in control of a mine or activity, may place or dispose of any residue or substance which causes or is likely to cause pollution of water resources, prospecting diggings, pit or any other excavation. If the waste classification results reflect pollution potential, an applicant will therefore have to apply for exemption from GNR704 in order to undertaken concurrent rehabilitation. If no pollution potential is revealed by the classification results, no exemption is required. GNR704 also prescribes the design and construction of pollution control dams. Based on the wetland delineation as per the Aquatics and Wetland Impact Assessment (Refer to **Appendix F** or **Sections 4.10 and 7.3.9**), there may be a need for a General Authorisation (GA) for the drilling wells within the ER which will be based on final drilling location. Therefore, **the applicant must ensure that the final drilling locations either do not trigger the NWA or an authorisation is obtained prior to undertaking the activities within the regulated area of a watercourse**.

3.1.6 THE NATIONAL ENVIRONMENTAL MANAGEMENT LAWS AMENDMENT ACT, 2022

The National Environmental Laws Amendment Act, known as 'the NEMLA Bill' or 'NEMLAA4' (Act No. 2 of 2022), finally became an Act on 24 June 2022 and will introduce a major shift in South Africa's environmental legislation on a date to be fixed and proclaimed by the President. Act No. 2 of 2022 – undoubtedly the most significant piece of environmental legislation that has been published since the implementation of the One Environmental System (OES) in 2014 – has finally been signed into law (the Act). Many of the changes under NEMLA are intended to clean up a range of issues associated with the roll-out of the OES – which overhauled the manner in which environmental issues are regulated on mine sites, among other things. Overall, the changes imposed by the Act aim to deter non-compliance with environmental laws by, among other things, introducing new offences, increasing the quantum of fines and administrative penalties where laws or licenses have been contravened, and extending enforcement powers to enable more widespread enforcement of environmental laws. The applicant must ensure that the activities take into consideration the changes stipulated under NEMLA. A review of NEMLA and its impact on the development may be applicable should the developer fail to comply with the legislation discussed in this report, the EA and/or any other authorizations / licenses applicable to the development. The applicant (D3 Energy) may face harsh penalty fines should they fail to comply with NEMA EIA Regulations, 2014 as amended and/or specific conditions which will be stipulated in the Environmental Authorization by the competent authority.

3.1.7 THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT, 2008

On 2 June 2014, the National Environmental Management: Waste Amendment Act came into force. The Waste Act places a general duty on a holder of waste to avoid the generation of waste and where such generation cannot be avoided, to minimise the toxicity and amounts of waste that are generated; reduce, re-use, recycle and recover waste; where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner; manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odour or visual impacts; prevent any employee or any person under his or her supervision from contravening the Act; and prevent the waste from being used for an unauthorised purpose. Waste is accordingly no longer governed by the MPRDA but is subject to all the provisions of the National Environmental Management: Waste Act, 2008 (NEMWA).

Section 16 of the NEMWA must also be considered which states as follows:

1. A holder of waste must, within the holder's power, take all reasonable measures to-
    a) "*Avoid the generation of waste and where such generation cannot be avoided, to minimise the toxicity and amounts of waste that are generated;*
    b) *Reduce, re-use, recycle and recover waste;*
    c) *Where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner;*
    d) *Manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odour, or visual impacts;*
    e) *Prevent any employee or any person under his or her supervision from contravening the Act; and*
    f) *Prevent the waste from being used for unauthorised purposes.*"

These general principles of responsible waste management will be incorporated into the requirements in the EMPr to be implemented for this project. Waste can be defined as either hazardous or general in accordance with Schedule 3 of the NEMWA (2014) as amended. "Schedule 3: Defined Wastes" has been broken down into two categories – Category A being hazardous waste; and Category B being general waste.

In order to attempt to understand the implications of these waste groups, it is important to ensure that the definitions of all the relevant terminologies are defined:

- Hazardous waste: means "*any waste that contains organic or inorganic elements or compounds that may, owning to the inherent physical, chemical or toxicological characteristic of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste, residue deposits and residue stockpiles*."
- Residue deposits: means "*any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right*."

- Residue stockpile: means "*any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, mineral processing plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated within the mining area for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or, production right or an old order right, including historic mines and dumps created before the implementation of this Act*."

- General waste: means "*waste that does not pose an immediate hazard or threat to health or to the environment and includes – domestic waste; building and demolition waste; business waste; inert waste; or any waste classified as non-hazardous waste in terms of the regulations made under Section 69*."

The Waste Classification and Management Regulations (GNR 634) pertain to waste classification and management, including the management and control of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation which is relevant to the proposed project. The purpose of these Regulations is to –

- Regulate the classification and management of waste in a manner which supports and implements the provisions of the Act;
- Establish a mechanism and procedure for the listing of waste management activities that do not require a Waste Management Licence;
- Prescribe requirements for the disposal of waste to landfill;
- Prescribe requirements and timeframes for the management of certain wastes; and
- Prescribe general duties of waste generators, transporters and managers.

Waste classification, as presented in Chapter 4 of these regulations, entails the following:

- Wastes listed in Annexure 1 of these Regulations do not require classification in terms of SANS 10234;
- Subject to sub regulation (1), all waste generators must ensure that the waste they generate is classified in accordance with SANS 10234 within one hundred and eighty (180) days of generation;
- Waste must be kept separate for the purposes of classification in terms of sub regulation (2), and must not be mixed prior to classification;
- Waste-must be re-classified in terms of sub regulation (2) every five (5) years, or within 30 days of modification to the process or activity that generated the waste, changes in raw materials or other inputs, or any other variation of relevant factors;
- Waste that has been subjected to any form of treatment must be re-classified in terms of sub regulation (2), including any waste from the treatment process; and
- If the Minister reasonably believes that a waste has not been classified correctly in terms of sub regulation (2), he or she may require the waste generator to have the classification peer reviewed to confirm the classification.

Furthermore, Chapter 8 of the Regulations stipulates that unless otherwise directed by the Minister to ensure a better environmental outcome, or in response to an emergency so as to protect human health, property or the environment –

- Waste generators must ensure that their waste is assessed in accordance with the Norms and Standards for Assessment of Waste for Landfill Disposal set in terms of section 7(1) of the Act prior to the disposal of the waste to landfill;
- Waste generators must ensure that the disposal of their waste to landfill is done in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7(1) of the Act; and

- Waste managers disposing of waste to landfill must only do so in accordance with the Norms and Standards for Disposal of Waste to Landfill set in terms of section 7 (1) of the Act.

The NEMWA Listed Activities were assessed if they would be triggered by the proposed activities. A review of NEMWA Listed Activities revealed potential triggers, however these are not applicable to the proposed activities due to the low volume of waste generate and the short nature of temporal storage on site. The anticipated waste to be generated based on similar adjacent work (D3 Energy ER315) includes both general and hazardous waste streams. The waste are to be managed accordingly and be disposed by a certified hazardous waste service provider at a registered hazardous landfill site. Although it is not anticipated that hazardous waste will be stored for prolonged periods on site (i.e., over 3 months), should for unforeseen reasons the hazardous waste be stored on site exceeding 3 months, the storage and disposal of the drill waste must be handled accordingly and therefore the relevant waste listed activities for storage of waste must be applied for.

3.1.8 THE NATIONAL HERITAGE RESOURCES ACT, 1999

The National Heritage Resources Act (Act 25 of 1999 – NHRA) stipulates that cultural heritage resources may not be disturbed without authorisation from the relevant heritage authority. Section 34(1) of the NHRA states that, "*no person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority…*" The NHRA is utilised as the basis for the identification, evaluation and management of heritage resources and in the case of Cultural Resource Management (CRM) those resources specifically impacted on by development as stipulated in Section 38 of NHRA, and those developments administered through the NEMA, the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA) and the Development Facilitation Act (FDA) legislation. In the latter cases the feedback from the relevant heritage resources authority is required by the State and Provincial Departments managing these Acts before any authorisations are granted for a development. The last few years have seen a significant change towards the inclusion of heritage assessments as a major component of Environmental Impact Processes required by the NEMA and MPRDA.

The MPRDA defines 'environment' as it is in the NEMA and, therefore, acknowledges cultural resources as part of the environment. Section 39(3)(b) of this Act specifically refers to the evaluation, assessment and identification of impacts on all heritage resources as identified in Section 3(2) of the NHRA that are to be impacted on by activities governed by the MPRDA. Section 40 of the same Act requires the consultation with any State Department administering any law that has relevance on such an application through Section 39 of the MPRDA. This implies the evaluation of Heritage Assessment Reports in Environmental Management Plans or Programmes by the relevant heritage authorities.

A Heritage Impact Assessment for the proposed activities was undertaken by Dr Lucien James of EIMS and discussed in detail in **Sections 4.6** and **7.3.14**. Based on the HIA Report, the heritage of the landscape has been altered over the years through the extensive farming activities which took place and has been taking place. Hennenman was noted as the most central urban space in proximity to the ER. Six (6) features of archaeological significance were identified in addition to the thirty-two (32) heritage features inclusive of structures, buildings, or complexes as well as three grave sites identified through the desktop assessment. These features consisted of three (3) additional grave sites, as well as three (3) structures or in-situ features related to mid-20th Century farming activities. Features noted included abandoned farmhouses, windmills or windpumps, farm dams, whole farm complexes including several buildings of the mid-20th Century, as well as in-situ farming implements and devices. The graves and graveyards are protected by the National Heritage Resources Act (NHRA) and have been provisionally graded as Grade III A or of High significance. All structures, buildings, complexes, or ruins thereof have been provisionally graded as Grade IV A or of High to Medium significance. This suggests that mitigation must take place should proposed activities have the potential to disturb these features. The two large artefacts identified have been graded as Grade IV B or Medium sensitivity.

Some of these features were identified occurring along the seismic transects, as well as in the proposed well Target Areas. It is unlikely that these features will be disturbed by the proposed activities as they can be easily avoided. It is here proposed that buffers be placed around each of these features, with proposed activities not taking place within 30 meters of the buildings or structures, and 50 meters of the grave sites. It is here argued that the features should be avoided, and in doing so, there will be little to no impact on the features. Altogether, post-mitigation of the identified heritage impacts is rated a Medium to Low Negative, given that the impacts can be avoided, and the potential for a heritage procedure to allow for the documentation, recording, and further assessment of undiscovered finds and sites. The South African Heritage Resources Agency (SAHRA), the Free State Heritage Resources Authority (FSHRA) and Association of Southern African Professional Archaeologists (ASAPA) were provided with copies of the Scoping and will further be provided with a copy of this EIA Report for review and comment. It should be noted that during the compilation of this report, there were no objections / concerns raised by the stakeholders regarding the heritage features.

3.1.9 THE NATIONAL ENVIRONMENTAL MANAGEMENT AIR QUALITY ACT, 2004

The National Environmental Management: Air Quality Act (Act No. 39 of 2004 as amended – NEMAQA) is the main legislative tool for the management of air pollution and related activities. The Object of the Act is:

To protect the environment by providing reasonable measures for –

i. the protection and enhancement of the quality of air in the republic;
ii. the prevention of air pollution and ecological degradation; and
iii. securing ecologically sustainable development while promoting justifiable economic and social development.

Generally, to give effect to Section 24(b) of the constitution in order to enhance the quality of ambient air for the sake of securing an environment that is not harmful to the health and well-being of people. The NEMAQA 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 of November 2013 (Government Gazette No. 37054).

According to the NEMAQA, 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.

Listed Activities and Associated Minimum Emission Standards Identified in terms of Section 21 of the NEMAQA Published under GN 893 in GG 37054 of 22 November 2013 were assessed to determine if the proposed development triggers any of the identified activities. Based on the assessment, the proposed project, the activities do not trigger listed activities under NEMAQA. Subsequently, there is no requirement to apply for an Atmospheric Emission Licences (AEL) for the proposed activities.

The National Pollution Prevention Plans Regulations were published in March 2014 (Government Gazette 37421) and tie in with the National Greenhouse Gas (GHG) Emission Reporting Regulations which took effect on 3 April 2017. In summary, the Regulations aim to prescribe the requirements that pollution prevention plans of greenhouse gases declared as priority air pollutants, need to comply with in terms of the NEMAQA. The Regulations specify who needs to comply, and by when, as well as prescribing the content requirements. Based on the proposed activities (exploration), the applicant does not trigger listed activities and therefore does not need to report GHG Emissions. However, should the activities proceed to production phase, the applicant will be obligated to report on the GHG emissions under these Regulations due to 1b2 listed activities. There will be a requirement to account for the amount of pollutants discharged into the atmosphere (total emissions for one or more specific GHG pollutants) by 31 March each year.

3.1.10 THE NATIONAL ENVIRONMENTAL MANAGEMENT BIODIVERSITY ACT, 2004

The objective of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA) is to provide for the management and conservation of South Africa's biodiversity within the framework of NEMA; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bio-prospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute; and for matters connected therewith. The objectives of NEM:BA are within the framework of the National Environmental Management Act, to provide for:

- the management and conservation of biological diversity within the Republic and of the components of such biological diversity;
- the use of indigenous biological resources in a sustainable manner; and
- the fair and equitable sharing among stakeholders of benefits arising from bioprospecting involving indigenous biological resources;
- to give effect to ratified international agreements relating to biodiversity which are binding on the Republic;
- to provide for co-operative governance in biodiversity management and conservation; and
- to provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

3.1.10.1 **THREATENED OR PROTECTED SPECIES REGULATIONS, 2015**

Chapter 4, Part 2 of NEMBA provides for the listing of Threatened or Protected Species (TOPS). Species listed as such, in terms of the TOPS Regulations (2015) and the TOPS Lists of Species (2015), are further classified as Threatened (Critically Endangered, Endangered and Vulnerable) or Protected. The Act defines these classes as follows:

- Critically Endangered species: any indigenous species facing an extremely high risk of extinction in the wild in the immediate future;
- Endangered species: any indigenous species facing a high risk of extinction in the wild in the near future, although it is not a critically endangered species;
- Vulnerable species: any indigenous species facing an extremely high risk of extinction in the wild in the medium-term future; although it is not a critically endangered species or an endangered species; and
- Protected species: any species which is of such high conservation value or national importance that it requires national protection. Species listed in this category include, among others, species listed in terms of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, according to the terrestrial biodiversity studies that were undertaken, the project area is not located within any protected areas or formal conservation areas.

The TOPS Regulations (2015) further regulate the permit system set out in NEMBA as it applies to restricted activities involving specimens of listed threatened or protected species, where restricted activities involve those activities that have a direct impact on listed species such as hunting, catching, collecting, picking, chopping off, damaging or destroying, importing and export from Republic, possessing, keeping or exercising physical control over, breeding or propagating, conveying or translocating, selling or buying, receiving or donating or any other prescribed activity involving a TOPS specimen.

According to the Terrestrial Biodiversity Assessment Report (**Appendix F**), undertaken by The Biodiversity Company (2026), the project area is situated within the Grassland biome. The Grassland biome is centrally located in southern Africa, and adjoins all except the desert, fynbos and succulent Karoo biomes (Mucina &

Rutherford, 2006. The project area overlaps with the Central Free State Grassland (Vulnerable), Highveld Alluvial Vegetation (Least Threatened), Vaal-Vet Sandy Grassland (Endangered) and Winburg Grassy Shrubland (Least Threatened) vegetation units.

The ER overlaps with one (1) South Africa Protected and Conservation Areas Data (SAPAD), namely Thabong Game Ranch (previously a conservation area but now a transformed are part of the Harmony mining area and Thabong residential area), an Endangered vegetation type (Vaal-Vet Sandy Grassland) as well as National Protected Area Expansion Strategy (NPAES) areas. There are three (3) bird Species of Conservation Concern (SCC) namely *Anas undulata* (Yellow-billed Duck), *Elanus caeruleus* (Black-winged Kite), and *Scopus umbrette* (Hamerkop) and one (1) mammal SCC (*Leptailurus serval* (Serval)) recorded within the ER. Although there are no identified floral Species of Conservation Concern (SCC), there are two (2) species of provincially protected plant were recorded for the Target areas – *Ammocharis coranica* (Karoo lily or sore-eye flower) and *Helichrysum nudifolium* (Hairy Everlasting/Hottentots Tea). These species occurred in close proximity to water resources and the associated grassland. They are protected under the Free State Nature Conservation Ordinance No. 8 of 1969. According to the list of protected species under Schedule, if any individuals of these plant species are to be disturbed, permits must be obtained from the Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA).

3.1.10.2 ALIEN AND INVASIVE SPECIES REGULATIONS, 2014

NEMBA is the most recent legislation pertaining to alien invasive plant (AIP) species. In August 2014, the list of Alien Invasive Species was published in terms of the NEMBA. The Alien and Invasive Species Regulations were published in the Government Gazette No. 44182, 24th of February 2021. The legislation calls for the removal and / or control of AIP species (Category 1 species). In addition, unless authorised thereto in terms of the NWA, no land user shall allow Category 2 plants to occur within 30 meters of the 1:50 year flood line of a river, stream, spring, natural channel in which water flows regularly or intermittently, lake, dam or wetland. Category 3 plants are also prohibited from occurring within proximity to a watercourse. Below is a brief explanation of the three categories in terms of the NEMBA:

- Category 1a: Invasive species requiring compulsory control. Remove and destroy. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.
- Category 2: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.
- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Category 3 plants to exist in riparian zones.

Note that according to the Alien and Invasive Species Regulations, a person who has under his or her control a category 1b listed invasive species must immediately:

- Notify the competent authority in writing.
- Take steps to manage the listed invasive species in compliance with:
  - Section 75 of the NEMBA; and
  - The relevant invasive species management programme developed in terms of regulation 4.

An assessment of IAP species within the project area was assessed as part of the Terrestrial Biodiversity Assessment (The Biodiversity Company, 2026). Based on the study, twelve (12) AIP species were recorded within the ER (refer to **Table 10**) These species are listed under the Alien and Invasive Species List 2020, Government Gazette No. GN1003. Nine (9) of these species are National Environmental Management: Biodiversity Act (NEMBA) category 1b AIP species that must be controlled by implementing an AIP Management Programme, in compliance with section 75 of NEMBA.

Table 10: Alien Invasive Plants observed within the study area (The Biodiversity Company, 2026)

Species	Common Name	Category
Cirsium vulgare	Spear thistle	NEMBA 1b
Bidens pilosa	Blackjack	Naturalised Exotic
Tagetes minuta	Kakiebos	Naturalised Exotic
Erigeron bonariensis	Flax-leaf Fleabane	Naturalised Exotic
Opuntia ficus-indica	Sweet Prickly Pear	NEMBA 1b
Cylindropuntia imbricata	Imbricate Cactus	NEMBA 1b
Prosopis velutina	Velvet Mesquite	NEMBA 1b
Melia azedarach	Syringa	NEMBA 1b
Eucalyptus camaldulensis	River Red Gum	NEMBA 1b
Datura ferox	Large thorn apple	NEMBA 1b

3.1.11 THE MINING AND BIODIVERSITY GUIDELINES

The Mining and Biodiversity Guidelines (2013) was developed by the Department of Mineral Resources, the Chamber of Mines, the SANBI and the South African Mining and Biodiversity Forum, with the intention to find a balance between economic growth and environmental sustainability. The Guideline is envisioned as a tool to "foster a strong relationship between biodiversity and mining, which will eventually translate into best practice within the mining sector. It provides a tool to facilitate the sustainable development of South Africa's mineral resources, in a way that enables regulators, industry and practitioners to minimise the impact of mining on the country's biodiversity and ecosystem services. It provides the mining sector with a practical, user- friendly manual for integrating biodiversity considerations into the planning processes and managing biodiversity during the operational phases of a mine, from exploration through to closure. The Guideline provides explicit direction in terms of where: mining-related impacts are legally prohibited; biodiversity priority areas may present high risks for mining projects; and biodiversity may limit the potential for mining."

In identifying biodiversity priority areas, which have different levels of risk against mining, the Guideline categorises biodiversity priority areas into four categories of biodiversity priority areas in relation to their importance from a biodiversity and ecosystem service point of view as well as the implications for mining in these areas:

A) Legally protected areas, where mining is prohibited;

B) Areas of highest biodiversity importance, which are at the highest risk for mining;

C) Areas of high biodiversity importance, which are at a high risk for mining; and

D) Areas of moderate biodiversity importance, which are at a moderate risk for mining.

The proposed activities are located with Category B (highest risk for mining) but importantly does not fall within Category A and therefore, not prohibited from mining activities (**Figure 8**). The implications for the proposed activity in terms of the risk categories implies that environmental screening, environmental impact assessment (EIA) and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision-making for mining, water use licenses, and EAs. This assessment should fully consider the environmental sensitivity of the area, the overall environmental and socio-economic costs, and benefits of mining, as well as the potential strategic importance of the minerals to the country. Authorisations may well not be granted. If granted, the authorisation may set limits on allowed activities and impacts and may specify biodiversity offsets that would be written into license agreements and/or authorisations.

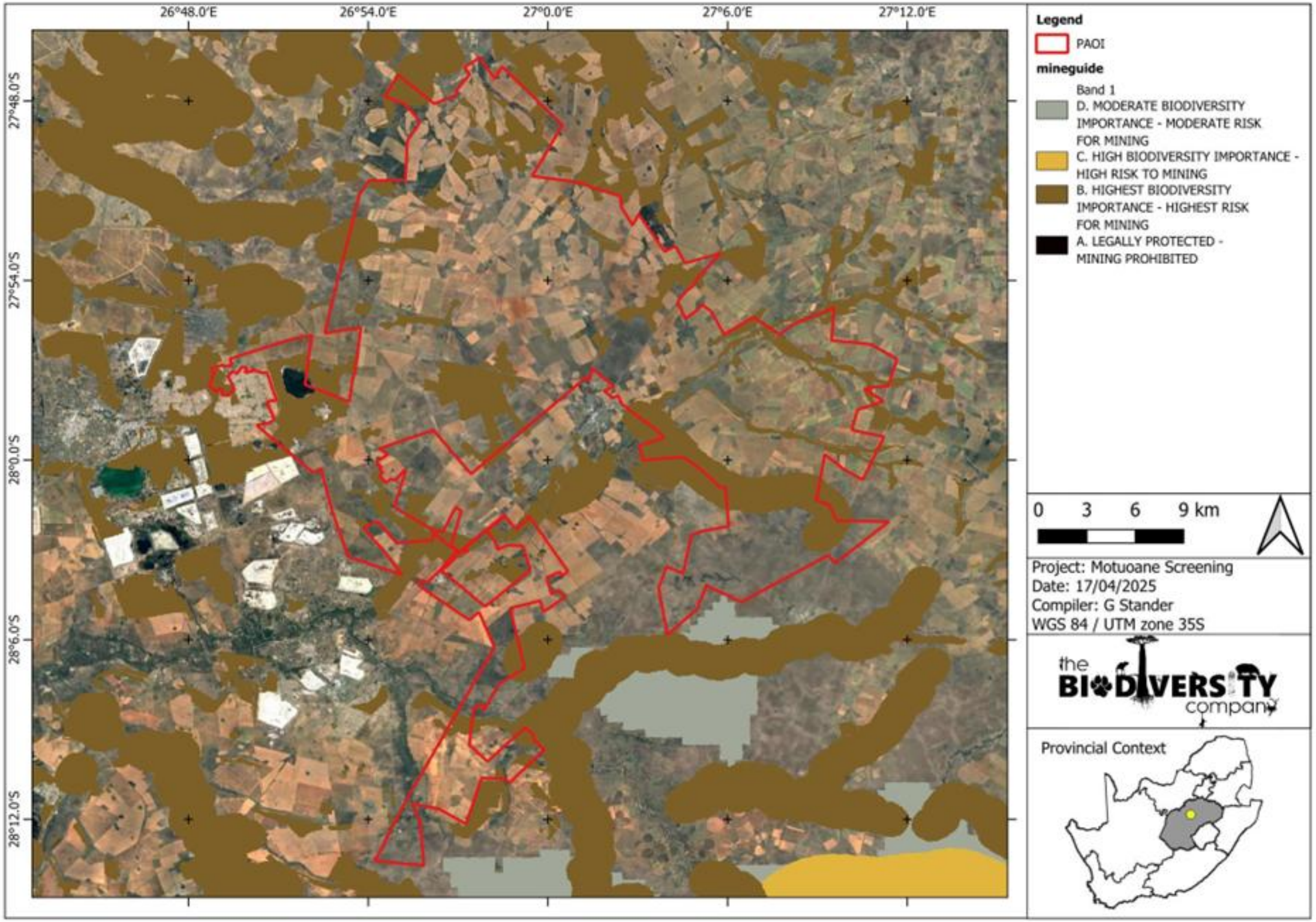


Figure 8: The project area in relation to the Mining and Biodiversity Guidelines (The Biodiversity Company, 2026).

3.1.12 THE NATIONAL ENVIRONMENTAL MANAGEMENT PROTECTED AREAS ACT, 2003

The National Environmental Management: Protected Areas Act (Act 57 of 2003) serves to: "provide for the protection and conservation of ecologically viable areas representative of South Africa's biological biodiversity and its natural landscapes and seascape; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas; for the continued existence, governance and functions of South African National Parks; and for matters in connection therewith.

The objectives of this Act are –

a) to provide, within the framework of the national legislation, including the National Environmental Management Act, for the declaration and management of protected areas;

b) to provide for co-operation governance in the declaration and management of protected areas;

c) to effect a national system of protected areas in South Africa as part of a strategy to manage and conserve its biodiversity;

d) to provide for a diverse and representative network of protected areas on state land, private land, communal land and marine water;

e) to promote sustainable utilisation of protected areas for the benefit of people, in a manner that would preserve the ecological character of such areas;

f) to promote participation of local communities in the management of protected areas, when appropriate; and

g) to provide for the continued existence of South African National Parks

According to the Baseline Terrestrial Biodiversity Assessment undertaken by the Biodiversity Company (**Appendix F**), the project area overlaps with the Thabong Game Reserve and falls within >5 km of Tara Wildlife Safaris, Newlands Game Ranch, De Rust Private Nature Reserve and Goliatskraal Private Nature Reserve. However, it must be noted that the Thabong Game Reserve remains a game reserve only on outdated GIS information. The area earmarked as Thabong Game Reserve is currently known as Harmony Cluster, it is used for mining, residential and grazing activities. Subsequently, the ER is considered not to overlap an area which fits the SAPAD classification.

3.1.13 THE NATIONAL ENERGY ACT, 2008

The National Energy Act (Act 34 of 2008) provides to ensure that diverse energy resources are available, in sustainable quantities and at affordable prices, to the South African economy in support of economic growth and poverty alleviation, taking into account environmental management requirements and interactions amongst economic sectors; to provide for energy planning, increased generation and consumption of renewable energies, contingency energy supply, holding of strategic energy feedstock's and carriers, adequate investment in, appropriate upkeep and access to energy infrastructure; to provide measures for the furnishing of certain data and information regarding energy demand, supply and generation; to establish an institution to be responsible for promotion of efficient generation and consumption of energy and energy research; and to provide for all matters connected therewith. Importantly, the Department of Energy (DoE) is mandated to provide for energy planning and measures for the furnishing of certain data and information regarding energy demand, supply and generation. The objectives of this Act are to-

a) ensure uninterrupted supply of energy to the Republic;

b) promote diversity of supply of energy and its sources;

c) facilitate effective management of energy demand and its conservation;

d) promote energy research;

e) promote appropriate standards and specifications for the equipment, systems and processes used for producing, supplying and consuming energy;

f) ensure collection of data and information relating to energy supply, transportation and demand;

g) provide for optimal supply, transformation, transportation, storage and demand of energy that are planned, organised and implemented in accordance with a balanced consideration of security of supply, economics, consumer protection and a sustainable development;

h) provide for certain safety, health and environment matters that pertain to energy;

i) facilitate energy access for improvement of the quality of life of the people of Republic;

j) commercialise energy-related technologies;

k) ensure effective planning for energy supply, transportation and consumption; and

l) contribute to sustainable development of South Africa's economy.

The Act provides for the establishment of the South African National Energy Development Institution (SANEDI), whose functions include:

a) energy efficiency-

i. undertake energy efficiency measures as directed by the Minister;

ii. increase energy efficiency throughout the economy;

iii. increase the gross domestic product per unit of energy consumed; and

iv. optimise the utilisation of finite energy resources;

b) energy research and development-

i. direct, monitor, conduct and implement energy research and technology development in all fields of energy, other than nuclear energy; and

ii. promote energy research and technology innovation;

iii. provide for-

(aa) training and development in the field of energy research and technology development;

(bb) establishment and expansion of industries in the field of energy; and

(cc) commercialisation of energy technologies resulting from energy research and development programmes;

i. register patents and intellectual property in its name resulting from its activities;

ii. issue licences to other persons for the use of its patents and intellectual property;

iii. publish information concerning its objects and functions;

iv. establish facilities for the collection and dissemination of information in connection with research, development and innovation;

v. undertake any other energy technology development related activity as directed by the Minister, with the concurrence of the Minister of Science and Technology;

vi. promote relevant energy research through cooperation with any entity, institution or person equipped with the relevant skills and expertise within and outside the Republic;

vii. make grants to educational and scientific institutions in aid of research by their staff or for the establishment of facilities for such research;

viii. promote the training of research workers by granting bursaries or grants-in-aid for research;

ix. undertake the investigations or research that the Minister, after consultation with the Minister of Science and Technology, may assign to it; and

x. advise the Minister and the Minister of Science and Technology on research in the field of energy technology.

The White Paper on the Energy Policy (1998) is the overarching policy document that guides future policy and planning in the energy sector. It states that the government will, inter alia, “promote the development of South Africa’s oil and gas resources…” and “ensure private sector investment and expertise in the exploitation and development of the country’s oil and gas resources”. The successful exploitation of these natural resources would contribute to the growth of the economy. The applicant is line with the National Development Plan (NDP) and the Draft Integrated Energy Plan (IEP).

3.1.14 THE MINE HEALTH AND SAFETY ACT, 1996

The Mine Health and Safety Act, 1996 (Act No. 29 of 1996) provides for protection of the health and safety of employees and other persons at mines and, for that purpose-

- to promote a culture of health and safety;
- to provide for the enforcement of health and safety measures;
- to provide for appropriate systems of employee, employer and State participation in health and safety matters;
- to establish representative tripartite institutions to review legislation, promote health and enhance properly targeted research;
- to provide for effective monitoring systems and inspections, investigations and inquiries to improve health and safety;
- to promote training and human resources development;
- to regulate employers’ and employees’ duties to identify hazards and eliminate, control and minimise the risk to health and safety;
- to entrench the right to refuse to work in dangerous conditions; and
- to give effect to the public international law obligations of the Republic relating to mining health and safety;
- and to provide for matters connected therewith.

With specific reference to the Regulations (GN R93 of 1997) published under this Act, the following has reference to this proposed project:

17(6) The employer must take reasonable measures to ensure that the competent person referred to in regulation 17(2)(a) in writing notifies the employer, which notification must be dated, of any workings being advanced to come within: -

> *(a) a horizontal distance of 100 (one hundred) metres from reserve land, buildings, roads, railways, dams, waste dumps or any other structure whatsoever including structures beyond the mining boundaries, or from any surface, which it may be necessary to protect in order to prevent any significant risk;*
>
> *(b) 50 (fifty) metres from any excavation, workings, restricted area or any other place where there is, or is likely to be a dangerous accumulation of fluid material, noxious or flammable gas. Such notification must include a sketch plan giving the distance to such place from the nearest survey station.*

17(7) The employer must take reasonable measures to ensure that: -

> *(a) no mining operations are carried out within a horizontal distance of 100 (one hundred) metres from reserve land, buildings, roads, railways, dams, waste dumps, or any other structure whatsoever*

including such structures beyond the mining boundaries, or any surface, which it may be necessary to protect in order to prevent any significant risk, unless a lesser distance has been determined safe by risk assessment and all restrictions and conditions determined in terms of the risk assessment are complied with;

(b) workings coming within 50 (fifty) metres, from any other excavation, workings, restricted area or any other place where there is, or is likely to be a dangerous accumulation of fluid material, noxious or flammable gas are mined subject to such restrictions and stopped at such positions as determined by risk assessment.

(c) where ground movement, as a result of mining operations, poses significant risk, an effective ground movement monitoring system is in place.

(d) survey records and plans relating to conditions described in paragraphs (a) and (b) above, are made available to the persons doing the risk assessment.

17(8) No person may erect, establish or construct any buildings, roads, railways, dams, waste dumps, reserve land, excavations or any other structures whatsoever within a horizontal distance of 100 (one hundred) metres from workings, unless a lesser distance has been determined safe:-

(a) in the case of the employer, by risk assessment and all restrictions and conditions determined in terms of the risk assessment are complied with; or

(b) in the case of any other person, by a professional geotechnical specialist and all restrictions and conditions determined by him or her or by the Chief Inspector of Mines are complied with.

The Mine Health and Safety Act and associated Regulations will be applicable to the D3 Energy Exploration Rights project.

3.1.15 THE CONSERVATION OF AGRICULTURAL RESOURCES ACT, 1983

The Conservation of Agricultural Resources (Act 43 of 1983) aims to provide for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants. In order to achieve the objectives of this Act, control measures related to the following may be prescribed to land users to whom they apply:

- The cultivation of virgin soil;
- The utilisation and protection of land which is cultivated;
- The irrigation of land;
- The prevention or control of waterlogging or salination of land;
- The utilisation and protection of vleis, marshes, water sponges, water courses and water sources;
- The regulating of the flow pattern of run-off water;
- The utilisation and protection of the vegetation;
- The grazing capacity of veld, expressed as an area of veld per large stock unit;
- The maximum number and the kind of animals which may be kept on veld;
- The prevention and control of veld fires;
- The utilisation and protection of veld which has burned;
- The control of weeds and invader plants;
- The restoration or reclamation of eroded land or land which is otherwise disturbed or denuded;

- The protection of water sources against pollution on account of farming practices;
- The construction, maintenance, alteration or removal of soil conservation works or other structures on land; and
- Any other matter which the Minister may deem necessary or expedient in order that the objects of this Act may be achieved.

Further, different control measures may be prescribed in respect of different classes of land users or different areas or in such other respects as the Minister may determine. Preliminary impacts on the agriculture and soil, biodiversity and water resources have been identified with regards to this project, and mitigation and management measures recommended.

3.1.16 THE NATIONAL WEB-BASED ENVIRONMENT SCREENING TOOL, 2019

On the 5th of July 2019, The Department of Forestry, Fisheries and the Environment (DFFE) issued a Notice of the requirement to submit a report generated by the National Web-based Environmental Screening Tool in terms of section 24(5)(h) of the NEMA, 1998 (Act No 107 of 1998) and Regulation 16(1)(b)(v) of the EIA regulations, 2014, as amended. The submission of this report is compulsory when applying for environmental authorisation in terms of Regulation 19 and Regulation 21 of the Environmental Impact Assessment Regulations, 2014 effective from the 4th of October 2019. The DFFE Screening Tool Report was initially generated on the 10th of January 2025 then revised on the 16th of April 2025 due to a slight change in ER footprint. The Screening report is provided in **Appendix D** of this report. The main findings to be discussed from the screening report are listed below.

The following summary of the study area's environmental sensitivities were identified in the Environmental Screening Report. The environmental sensitivities for the proposed development footprint are indicated in **Table 11**.

Table 11: Environmental Sensitivity of Project Area as per the DFFE Screening Tool Report.

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme	X			
Animal Species Theme		X		
Aquatic Biodiversity Theme	X			
Archaeological and Cultural Heritage Theme	X			
Civil Aviation Theme		X		
Defence Theme				X
Palaeontology Theme	X			
Plant Species Theme				X
Terrestrial Biodiversity Theme	X			

The information collected by the specialists and EAP's assessment may be used to confirm or dispute (as may be applicable) the environmental sensitivity ratings identified by the National Screening Tool. The outcome of the verification process by the specialists' assessments &EAP's site sensitivity verification of the sensitivity ratings identified by the Screening Tool are summarized in **Table 12** below. Pages 36 and 37 on the DFFE Screening Report indicates that certain Specialist Assessments must be undertaken for the proposed development. There is however an allowance of the EAP to motivate for the reasons for not including certain assessments in the assessment report. **Table 13** presents these Specialist Assessments/Studies as well as the motivations behind the EAP's decision of recommending or not recommending the undertaking of certain Specialist Assessments.

Table 12: DFFE's Screening Tool Report Sensitivity Verification by Specialist Assessments.

Assessment Theme	Sensitivity Rating as per Screening Report	Sensitivity Rating (Specialist Verification)	EAP / Specialist's Response
Agriculture Theme	High	**Medium**	Relative Agricultural Sensitivity was confirmed to be *Medium* by the Site Sensitivity Verification Report (SSVR) attached as **Appendix E** as well as by the Soils Specialist (**Appendix F**). The specialist found that considering the soil properties, agricultural potential as well as the current land use of the proposed target drilling areas, the area has a predominately "Medium" agricultural sensitivity, with "High" and marginal "Low" sensitive areas. There are numerous agricultural activities within the application area with various agricultural activities being undertake especially in the southern, eastern and northern sections. However, the proposed exploration activities are limited to a maximum footprint of 50m x 50m drill pad and 10m wide transects which will have an acceptable overall impact on the soils and agricultural potential. In addition, post exploration, the disturbed areas will be rehabilitated and will have a final blower (gas emitting well) footprint of 2m x 2m.
Animal Species Theme	High	**Medium**	According to the Terrestrial Biodiversity Assessment (**Appendix F**), certain habitats have generally intact vegetation, potential habitats of fauna species. Within the Alluvial Vegetation, Water resources, Disturbed Vaal Vet Sandy Grassland, Alluvial Vegetation (Target Area) Dam habitats, fauna SCCs are unlikely to resident within these identified habitats, although some may make use of the ER area for foraging and movement. Within the Artificial Drainage Features, Non-Perennial Drainage, Secondary Vaal Vet Sandy Grassland and Modified habitats, no SCCs were recorded. These habitats are unlikely to support SCCs.
Plant Species Theme	Low	**Low**	According to the SSVR (**Appendix E**), certain habitats are generally intact, and various floral species were noted. The composition, species diversity and number of plant species recorded were noted during the site assessment. However, as per the Terrestrial Biodiversity Assessment (**Appendix F**), no SCCs were recorded or are expected within the target areas.
Terrestrial Biodiversity Theme	Very High	**Medium**	According to the SSVR (**Appendix E**), certain habitat sensitivities are regarded as high sensitivity due to the role of this intact habitat to biodiversity within an area being more fragmented locally, this is however not for the entire project area. As per the Terrestrial Biodiversity Assessment (**Appendix F**), the sensitivity ranges from Very Low to High-sensitive based on the different habitats identified. The modified habitat has been transformed in nature and currently and/or historically used for agricultural activities with limited potential to support SCC. Severe levels of disturbance present. Whereas there are natural habitats, although they have been disturbed by fragmentation, livestock grazing, and human encroachment, particularly in areas adjacent to roads, they are viable CBA and EN ecosystem, however the proposed activity should not result in major impacts. There are also semi-natural habitats, although they have been disturbed by fragmentation, livestock grazing, and human encroachment, particularly in areas adjacent to roads, they are viable CBA.
Aquatic Biodiversity Theme	Very High	**High**	Some Target Areas and Transects were noted to be within / transecting or located within close proximity of watercourses and wetlands from desktop studies and site sensitivity verification. As per the Aquatics and Wetlands Assessment (**Appendix F**), the wetlands and instream dams are larger intact valley-bottom systems with good landscape connectivity and that support high levels of ecological benefit. These wetlands are important for maintaining ecological processes and supporting biodiversity but have experienced some degree of modification resulting in some change of ecological process and benefit provision.

Assessment Theme	Sensitivity Rating as per Screening Report	Sensitivity Rating (Specialist Verification)	EAP / Specialist's Response
Archaeological and Cultural Heritage Theme	Very High	**High**	There are known heritage features including cemeteries and graves with potential HIGH local heritage significance based on the Relative Archaeological and Cultural Heritage sensitivity of the area and previous heritage studies in the region. As per the Heritage Impact Assessment (**Appendix F**), The heritage of the landscape has been altered over the years through the extensive farming activities which took place and has been taking place. Hennenman was noted as the most central urban space in proximity to the ER. Six (6) features of archaeological significance were identified in addition to the thirty-two (32) heritage features inclusive of structures, buildings, or complexes as well as three grave sites identified through the desktop assessment. These features consisted of three (3) additional grave sites, as well as three (3) structures or in-situ features related to mid-20th Century farming activities. Features noted included abandoned farmhouses, windmills or windpumps, farm dams, whole farm complexes including several buildings of the mid-20th Century, as well as in-situ farming implements and devices. Some of the farm buildings identified through the desktop assessment were verified through the field survey. The graves and graveyards in question are protected by the National Heritage Resources Act (NHRA) and have been provisionally graded as Grade III A or of High significance. All structures, buildings, complexes, or ruins thereof have been provisionally graded as Grade IV A or of High to Medium significance. This suggests that mitigation must take place should proposed activities have the potential to disturb these features. The two large artefacts identified have been graded as Grade IV B or Medium sensitivity.
Civil Aviation Theme	High	**Low**	Relative Civil Aviation Theme Sensitivity was assessed to be *Low-Sensitive*. The proposed project which entails the establishment of up to five (5) new exploration boreholes and ~70km seismic transects do not reflect light which may have an impact on civil aviation. The proposed activities do not interfere with surface and air transmission and therefore, no anticipated impacts on civil aviation emanating from the project. The proposed development does not entail the establishment of high-rise structures, use of aboveground high frequency electromagnetic radiation nor reflecting infrastructure. In addition, the area has low air traffic.
Defence Theme	Very High	**Low**	Relative Defence Theme Sensitivity was assessed to be *Low-Sensitive* as there are no known military bases / facilities present within the vicinity of the project site. The nearest defence facility is the military base in Kroonstad, approximately 30 km northeast of the site and there are no anticipated impacts on defence theme emanating from the proposed activities
Palaeontology Theme	Very High	**Medium**	As per the Palaeontological Impact Assessment (**Appendix F**), the bulk of the site is underlain by the Karoo Supergroup Formations covered by vegetation, grass, trees, roads, and buildings. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of all Karoo Supergroup geological formations are ranked as Very Low to Very High, and here the impact is potentially Very High for the Beaufort Group, High for Quaternary (Qs), Moderate for Ecca rocks and the Quaternary (Qc). A wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. The Jurassic Dolerite does not contain fossils. However, it is anticipated that no visible evidence of fossiliferous outcrops will be found in within the target areas and seismic transects based on previous studies in the area and thus an overall medium palaeontological significance is likely to be allocated for the project area. It is therefore, currently considered that the proposed development will not lead

Assessment Theme	Sensitivity Rating as per Screening Report	Sensitivity Rating (Specialist Verification)	EAP / Specialist's Response
			to detrimental impacts on the palaeontological reserves of the area and construction of the development may be authorised in its whole extent.

Table 13: Summary of discussions regarding the undertaking of specialist assessments.

Specialist Assessment	Discussion and Motivation
Agricultural Impact Assessment	Although the DFFE Screening tool indicated that the proposed development is located within a *High* Agricultural Sensitivity theme. Relative Agricultural Sensitivity was confirmed to be *Medium* by the SSVR. The SSVR found there are numerous agricultural activities within the application area with various agricultural activities being undertake especially in the southern, eastern and northern sections. However, the proposed exploration activities are limited to a maximum footprint of 50m x 50m drill pad and 10m wide transects which will have an acceptable overall impact on the soils and agricultural potential. In addition, post exploration, the disturbed areas will be rehabilitated and will have a final blower (gas emitting well) footprint of 2m x 2m. **The EAP recommended that an Agricultural Impact Assessment be undertaken for the project** based on the Protocol for The Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Agricultural Resources (GN 320, 2020, as amended), an Agricultural Compliance Statement as a minimum must be undertaken for the application.
Landscape/Visual Impact Assessment	**A Landscape/Visual Impact Assessment was not recommended by the EAP** as the proposed project seismic and drilling activities within the exploration area will have no visual intrusion in the area. The project and its locality do not trigger the need for this specialist study based on the triggers as identified by Oberholzer (2005) and presented in **Figure 9**. Visual sensitivities would arise from receptors living in and visiting the study area and observing changes to the aesthetic baseline, currently rated low within the context of the sub-region.
Archaeological and Cultural Heritage Impact Assessment	The National Web-Based Screening Tool Report found that the Relative Archaeological and Cultural Heritage Theme Sensitivity is *Very High-Sensitive*. The protocols required that a Compliance Statement as a minimum be undertaken to verify the archaeological heritage sensitivity of the area. There are known heritage features including cemeteries and graves with potential High local heritage significance based on the Relative Archaeological and Cultural Heritage sensitivity of the area and previous heritage studies in the region. Therefore, a **Heritage Impact Assessment (HIA) was recommended by the EAP** to identify the heritage features and provide mitigation measures (if any).
Palaeontology Impact Assessment	Based on the 1:250 000 SAHRIS PalaeoMap and the National Web-Based Screening Tool Report, the study area is located within a *Very-High Palaeo-Sensitivity* area. The protocols require that a Compliance Statement as a minimum be undertaken to verify the palaeontological sensitivity of the area. Due to the known cultural heritage features on site and the high possibility of palaeontological finds, a **Palaeontological Impact Assessment is recommended** to identify palaeontological heritage features and provided mitigation measures. In addition, according to the DFFE Guidance on the Preparation of a Palaeontological Impact Assessment, Palaeontology resources are widely dispersed and can occur on any development site in South Africa. Therefore, Palaeontological Impact Assessments (PIAs) must be undertaken for all developments as per the PalaeoSensitivity Map provided on SAHRIS, irrespective of the sensitivity shown on the palaeontology theme layer.
Terrestrial Biodiversity Impact Assessment	The National Web-Based Screening Tool Report found that the Relative Terrestrial Biodiversity Impact Assessment Theme Sensitivity is *Very High-Sensitive*. Based on known occurrence of sensitive terrestrial biodiversity ecosystems from the previous study undertaken during the original EA Application, the **EAP recommended that a Terrestrial Biodiversity Impact Assessment** be undertaken in line with the Protocol for The Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Biodiversity (GN 320, 2020 as amended) to confirm presence of Flora or Fauna, Avifauna, SCC, or protected species within the development site, verify site terrestrial biodiversity sensitivity and

Specialist Assessment	Discussion and Motivation
	provide necessary mitigation measures.
Plant Species Assessment	Similarly, to the findings and rationale for Terrestrial Biodiversity Impact Assessment in this table above, this study was recommended by the EAP and forms part of the Terrestrial Biodiversity Impact Assessment.
Animal Species Assessment	Similarly, to the findings and rationale for Terrestrial Biodiversity Impact Assessment in this table above, this study was recommended by the EAP and forms part of the Terrestrial Biodiversity Impact Assessment.
Aquatic Biodiversity Impact Assessment	The Relative Aquatic Biodiversity Theme Sensitivity was assessed to be *Very High-Sensitive* by the National Web-Based Screening Tool Report. Some Target Areas and Transects were noted to be within / transecting or located within close proximity of watercourses and wetlands from desktop studies and site sensitivity verification. There are potential impacts on surface and groundwater through the establishment of exploration boreholes and new seismic transects. The protocols require that a Compliance Statement as a minimum be undertaken to verify the aquatic biodiversity sensitivity of the area. The **EAP recommended that a Full Aquatic Biodiversity Impact Assessment** be undertaken in line with the Protocol for The Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Aquatic Biodiversity (GN 320, 2020 as amended) to amongst others, provide a description of the aquatic biodiversity and ecosystems on the site, the threat status of the ecosystem and species as identified by the screening tool, an indication of the national and provincial priority status of the aquatic ecosystem, a description of the ecological importance and sensitivity of the aquatic ecosystem and a detailed assessment of the potential impacts of the proposed development and buffer requirements.
Hydrology Assessment & Geohydrological Assessment	In engineering, a hydrological assessment is carried out to quantify the flow or volume of water in a river or stream, over land, in soils, in a pond or in a reservoir. A hydrological study is usually undertaken for projects with potential contamination to groundwater such as mining and surface deposition (Tailings Storage Facilities). The proposed activity will entail the drilling and sampling at depth using a two-string telescopic casing design as outlined in **Section 2.2.3**. Each borehole will be steel cased and have cement barriers to prevent leaks as well as plugged at the end of exploration to prevent groundwater seepage. Therefore, it was the **EAPs recommendation that a hydrological assessment is not required for the proposed exploration activities. However, the EAP recommended that a geohydrological study** be undertaken instead to establish a site baseline and background geohydrological conditions and identify sensitive environmental receptors. This will entail a hydrocensus to cover the target areas, determine the current status quo of the regional groundwater system delineation and vulnerability and qualify the potential impact of the gas extraction as well as simulate potential saline water migration towards the shallow aquifer.
RFI Assessment	The project site falls outside of the Karoo Central Astronomy Advantage Area (KCAAA). AAAs that have been declared to date are: • The Northern Cape Province, excluding Sol Plaatje Municipality; • The Karoo Core AAA (consisting of 13 406 hectares of land owned by the National Research Foundation, 90 km north of Carnarvon); and • The Karoo Central AAAs, as published in the Government Gazette on 12 March 2014. The protocols require that a Site Sensitivity Verification (SSV) Requirements be undertaken where a Specialist Assessment is required, but no specific assessment protocol has been prescribed, gazetted on 20 March 2020. A SSV was undertaken by the EAP in March 2025 and attached as **Appendix E.** Based on the SSVR, the project will have minimal to no impact on astronomy and related scientific endeavours, therefore **an RFI Assessment was not recommended by the EAP**.
Noise Impact Assessment	Noise studies are crucial for exploration activities to assess potential impacts on the environment and communities, identify noise sources, and implement mitigation strategies, ultimately ensuring compliance with regulations and minimizing negative impacts. Noise studies establish baseline noise levels in the area before exploration activities begin, allowing for a comparison of noise levels before and after the start of operations. They help identify potential noise impacts on the environment, including wildlife, ecosystems, and human

Specialist Assessment	Discussion and Motivation
	communities. Therefore, it was a **recommendation by the EAP that a Noise Impact Assessment be undertaken for the project**.
Geotechnical Assessment	When evaluating a site for development, a geotechnical assessment is often needed to identify the type of earth that exists below the ground. The proposed activity is an exploration project which entails the undertaking of seismic surveys with the intention of understanding the geological conditions for hydrocarbons. Therefore, the proposed activity forms part of Geotechnical Assessment. This aspect will form part of the geohydrological study.
Health Impact Assessment	Health Impact Assessment is a tool that can help communities, decision makers, and practitioners make choices that improve public health. Health Impact Assessment can be used to evaluate objectively the potential health effects of a project or policy before it is built or implemented. Health Impact Assessment is usually undertaken for projects which can have health impacts on the surrounding communities. Based on the proposed project description, there are no foreseen associated health impacts. Therefore, **the EAP did not recommend a Health Impact Assessment for the project**.
Ambient Air Quality Impact Assessment	Air Quality Impact Assessment (AQIA) is an evaluation, using approved computer models, of the ambient air quality impacts that the public may be expected to be exposed to due to air pollution emissions from one or more facilities. AQIA is an important technique for determining the relative contribution to ground level pollutant concentrations of specific current or future source emissions at receptor sites. AIQA is usually undertaken is for projects which will potentially emit and/or increase pollutant concentrations during construction and/or operational phases. Based on the project information, the **EAP recommended that an Air Quality Impact Assessment be undertaken for the project** as the project may potentially emit and/or increase pollutant concentrations. The air quality study will help determine the potential impact of exploration activities on the surrounding environment, including air pollution from dust, gases, and other emission.

PART B: TRIGGERS AND KEY ISSUES

5. TRIGGERS FOR SPECIALIST INPUT

The need for visual input is often determined by issues relating to visual impact that may be raised by local residents or organisations, by the local authority, or on the recommendation of the EIA Practitioner of a project, or the visual specialist.

The following are indicators that could suggest the need for visual input based on the nature of the receiving environment and the nature of the project.

The nature of the receiving environment:

- Areas with protection status, such as national parks or nature reserves;
- Areas with proclaimed heritage sites or scenic routes;
- Areas with intact wilderness qualities, or pristine ecosystems;
- Areas with intact or outstanding rural or townscape qualities;
- Areas with a recognized special character or sense of place;
- Areas lying outside a defined urban edge line;
- Areas with sites of cultural or religious significance;
- Areas of important tourism or recreation value;
- Areas with important vistas or scenic corridors;
- Areas with visually prominent ridgelines or skylines.

The nature of the project:

- High intensity type projects including large-scale infrastructure;
- A change in land use from the prevailing use;
- A use that is in conflict with an adopted plan or vision for the area;
- A significant change to the fabric and character of the area;
- A significant change to the townscape or streetscape;
- Possible visual intrusion in the landscape;
- Obstruction of views of others in the area.

Figure 9: Triggers for Visual Impact Assessment (Oberholzer, 2005).

3.1.17 THE NATIONAL DUST CONTROL REGULATIONS, 2026

On 31 March 2026, the Minister of the DFFE officially repealed the 2013 National Dust Control Regulations, replacing them with a modernized framework: the National Dust Control Regulations, 2026. The 2026 Regulations apply to:

a) *Mining & Prospecting: Any holder of a right or permit under the MPRDA.*

b) *Reclamation: Anyone extracting value from historical mine dumps.*

c) *Listed Activities: Those required to have an atmospheric emission license (AEL).*

d) *Controlled Emitters: Any activity with the potential to generate dust.*

e) *Nuisance Creators: Anyone an AQO suspects is causing a "nuisance" by dust.*

While the 2013 version focused heavily on "dustfall standards," the new law explicitly states its purpose is to prevent nuisance and requires Dust Management Plans to include specific measures to manage it. The New Standard mandates the use of SANS 1137. Entities with existing plans have a six-month window to transition their monitoring methods from the old ASTM standard to the new SANS 113. **New holders under the National**

Dust Control Regulations, 2026 (effective 31 March 2026) must have a Dust Management Plan (DMP) approved by their Air Quality Officer prior operations. An approved DMP must be implemented immediately, or within 30 days of approval. This proactive plan requires, among other items, a 5km radius site description, time-bound control measures, and a complaint register. All monitoring must now follow SANS 1137 standards using SANAS-accredited labs, with a 6-month transition period. Companies have until the end of September 2026 to transition to the new monitoring standards

3.1.18 GAS ACT

The Gas Act (Act 48 of 2001) aims to promote the orderly development of the piped gas industry; to establish a national regulatory framework; to establish a National Gas Regulator as the custodian and enforcer of the national regulatory framework; and to provide for matters connected therewith. The D3 Energy ER386 and potentially production right in the future will contribute towards the development of the gas industry in South Africa.

3.1.19 GAS MASTER PLAN AND INTEGRATED RESOURCE PLAN

The South African Gas Master Plan (GMP 2024), published by the Department of Mineral Resources and Energy in April 2024 for public comment, is a strategic policy framework intended to guide the development of the country's gas sector and ensure long-term security of supply. The Plan seeks to diversify gas supply sources through a combination of domestic production, regional imports and liquefied natural gas (LNG), while outlining the role of natural gas within the national energy mix and broader energy transition. It provides policy direction across the full gas value chain, including demand projections, supply options, infrastructure requirements (such as pipelines, import terminals and gas-to-power facilities), and distribution networks, based on least-cost modelling and multiple demand scenarios. The GMP further aims to catalyse investment, support industrial growth, and enable a transition away from a coal-dominated energy system, while recognising gas as a flexible and relatively lower-emission energy source for power generation and thermal applications. As of 2025, the Plan has undergone stakeholder consultation and technical modelling and is progressing through internal government review processes toward Cabinet approval.

The Integrated Resource Plan 2025 (IRP 2025), finalised and published on 28 October 2025 by the Department of Electricity and Energy, reinforces the role of natural gas as a key component of South Africa's future energy mix. The Plan provides for a material allocation of gas-fired power generation capacity, primarily to deliver flexible, dispatchable energy that complements the increasing penetration of variable renewable energy sources such as wind and solar. In this context, gas—particularly in the form of locally produced or imported liquefied natural gas (LNG)—is positioned as a strategic enabler of grid stability and energy security, capable of meeting peak demand and addressing supply intermittency. The IRP 2025 further signals government's commitment to advancing enabling infrastructure, including LNG import terminals and associated gas-to-power projects, thereby supporting both electricity generation and broader industrial energy requirements as part of a pragmatic, lower-emission energy transition pathway.

3.2 PROVINCIAL POLICY AND LEGISLATION

3.2.1 FREE STATE NATURE CONSERVATION ORDINANCE 8 OF 1969

This Ordinance makes provision with respect to the protection and conservation of wildlife in the Free State Province. It makes provision for, among other things, hunting and the protection of wild animals, fishing and the protection of aquatic resources, the protection of indigenous plants and the establishment and management of nature reserves. The Ordinance defines, in Schedule1, protected game and, in Schedule 2, ordinary game and sets out specific rules relating to hunting of each class of game. It also defines prohibited acts in respect of wild or exotic game and rules regarding the importation and exportation of endangered or exotic animals. According to the list of protected species under the Schedule, if any individuals of these plant species are to be disturbed, permits must be obtained from the FSDESTEA.

According to the Terrestrial Biodiversity Assessment Report (**Appendix F**), undertaken by The Biodiversity Company (2026), the project area overlaps with the Central Free State Grassland (Vulnerable), Highveld Alluvial Vegetation (Least Threatened), Vaal-Vet Sandy Grassland (Endangered) and Winburg Grassy Shrubland (Least Threatened) vegetation units. The ER overlaps with one (1) South Africa Protected and Conservation Areas Data (SAPAD), namely Thabong Game Ranch (previously a conservation area but now a transformed are part of the Harmony mining area and Thabong residential area). There are three (3) bird Species of Conservation Concern (SCC) namely *Anas undulata* (Yellow-billed Duck), *Elanus caeruleus* (Black-winged Kite), and *Scopus umbrette* (Hamerkop) and one (1) mammal SCC (*Leptailurus serval* (Serval)) recorded within the ER. Although there are no identified floral Species of Conservation Concern (SCC), there are two (2) species of provincially protected plant were recorded for the Target areas – *Ammocharis coranica* (Karoo lily or sore-eye flower) and *Helichrysum nudifolium* (Hairy Everlasting/Hottentots Tea). These species occurred in close proximity to water resources and the associated grassland. They are protected under the Free State Nature Conservation Ordinance No. 8 of 1969. Accordingly, if any individuals of these plant species are to be disturbed, permits must be obtained from the FSDESTEA.

3.2.2 FREE STATE PROVINCIAL SPATIAL DEVELOPMENT PLAN

The Free State Provincial Spatial Development Framework is a policy document that promotes a 'developmental state' in accordance with national and provincial legislation and directives. It aligns with the Free State Provincial Growth and Development Strategy which has committed the Free State to 'building a prosperous, sustainable and growing provincial economy which reduces poverty and improves social development'. The Provincial Spatial Development Framework includes comprehensive plans and strategies that collectively indicate which type of land-use should be promoted in the Free State Province, where such land-use should take place, and how it should be implemented and managed. The proposed exploration activities are within an approved exploration right.

3.2.3 FREE STATE BIODIVERSITY PLAN, 2015

Bioregional plans are one of a range of decision support tools provided for in the Biodiversity Act that can be used to enable biodiversity conservation in priority areas. The purpose of a bioregional plan is to inform land-use planning, environmental assessment and authorisations, and natural resource management, by a range of sectors whose policies and decisions impact on biodiversity (Desmet et al., 2013). The purpose of the conservation plans is to inform land-use planning and development on a provincial scale and to aid in natural resource management, with one of the outputs being a map of Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs). These are classified into different categories, namely Protected Areas, CBA1 areas, CBA2 areas, ESA1 areas, ESA2 areas, Other Natural Areas (ONAs) and areas with No Natural Habitat Remaining (NNR) based on biodiversity characteristics, spatial configuration and requirements for meeting targets for both biodiversity patterns and ecological processes.

Critical Biodiversity Areas (CBAs) – Areas considered critical for meeting biodiversity targets and thresholds, and which are required to ensure the persistence of viable populations of species and the functionality of ecosystems. Ecological Support Areas (ESAs) - Areas are required to support and sustain the ecological functioning of Critical Biodiversity Areas (CBAs). For terrestrial and aquatic environments, these areas are functional but are not necessarily pristine natural areas. They are however required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within the CBAs, and which also contributes significantly to the maintenance of Ecological Infrastructure

The Free State Biodiversity Plan (FSBP) focuses on the mapping of biodiversity priority areas within the Free State Province. The FSBP was consulted in order to determine the location of areas of increased ecological or conservation importance and sensitivity within the vicinity of the study area. This is done by providing a map of biodiversity priority areas, referred to as CBAs and ESAs. According to information obtained from South African National Biodiversity Institute (SANBI), CBAs are areas required to meet biodiversity targets for ecosystems, species and ecological processes, as identified in a systematic biodiversity plan. Ecological Support Areas are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of CBAs and/or in delivering ecosystem services. The primary purpose of a map of CBAs and ESAs is to guide decision-making about where best to locate development. It should inform land-use planning, environmental assessment and authorisations, and natural resource management, by a range of sectors whose policies and decisions impact on biodiversity. It is the biodiversity sector's input into multi-sectoral planning and decision-making processes

The key output of a systematic biodiversity plan is a map of biodiversity priority areas. The Conservation plan delineates CBAs, ESAs, ONAs, PAs, and areas that have been irreversibly modified from their natural state. The conservation of CBAs is crucial, in that if these areas are not maintained in a natural or near-natural state, biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity compatible land uses and resource uses (SANBI-BGIS, 2017). According to the latest Free State Terrestrial CBA Plan dataset, the ER site falls within areas of CBA 1, ESA 1, ESA 2, ONA and Degraded Areas (**Figure 10**).

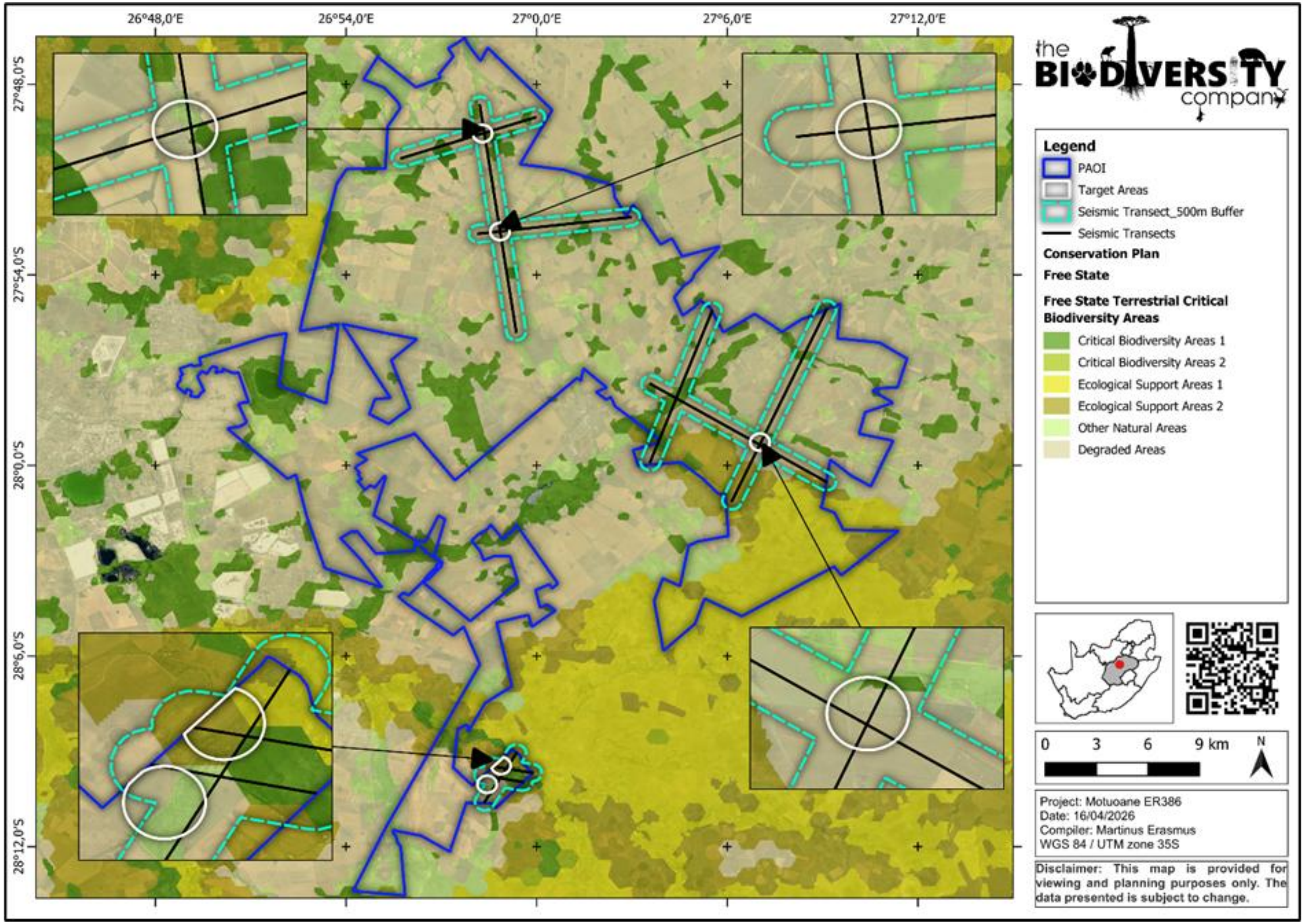


Figure 10: Map illustrating the ER in relation to the Free State Terrestrial CBA Plan (The Biodiversity Company, 2026).

3.3 OTHER APPLICABLE ACTS AND GUIDELINES

Other applicable acts and guidelines include the Green House Gases and International Finance Corporation Requirements, and International Agreements.

3.3.1 GHG AND CLIMATE CHANGE

Greenhouse gases (GHG) are "those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the GHG effect. Water vapour (H_2O), CO_2, nitrous oxide (N_2O), methane (CH_4) and O_3 are the primary greenhouse gases in the earth's atmosphere. Moreover, there are a number of entirely human-made GHG gases in the atmosphere, such as the halocarbons and other chlorine and bromine containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with the greenhouse gases sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) (IPCC, 2007). Human activities since the beginning of the Industrial Revolution (taken as the year 1750) have produced a 40% increase in the atmospheric concentration of carbon dioxide, from 280 ppm in 1750 to 406 ppm in early 2017 (NOAA, 2017). This increase has occurred despite the uptake of a large portion of the emissions by various natural "sinks" involved in the carbon cycle (NOAA, 2017). Anthropogenic CO_2 emissions (i.e., emissions produced by human activities) come from combustion of fossil fuels, principally coal, oil, and natural gas, along with deforestation, soil erosion and animal agriculture (IPCC, 2007).

The International Finance Corporation (IFC) lists methods that countries and projects can reduce GHG impacts. These include carbon financing; improvement of energy efficiency; GHG sinks and reservoir protection and improvements; that environmentally friendly agriculture and forestry be encouraged; the increased use of renewable energy methods; implementation of carbon capture and sequestration methods; and improved waste management (recovery and use of methane emissions) as well as reducing GHG emissions from vehicle use and industrial, construction and energy production processes (IFC, 2007). Carbon financing may have much potential in developing countries as well as sustainable agriculture and forestry practices (IFC, 2012), and when supported by governments may be a way of reducing the country's GHG impacts, where projects receive carbon credits and financing for reducing GHG emissions and installing more environmentally friendly alternatives. Because different industries contribute various amounts of GHG emissions, the IFC performance standards suggests that for industrial processes the CO_2-equivalent (CO_2-e) emissions per year do not exceed 100 000 tonnes, this including direct (Scope 1) and indirect (Scope 2) sources (IFC, 2012).

According to the Climate Change Impact Assessment by Airshed Planning Professionals (**Appendix F**), Project specific information together with local and internationally published emission factors were used to calculate Scope 1 (direct), Scope 2 (indirect) and Scope 3 (indirect) GHG emissions for the project. Based on the study, the project is likely to result in an estimated total GHG emissions as follows:

- Scope 1 direct emissions:
    - 21 236 tonne (t) Carbon dioxide equivalent (CO_2e) over a 9-year period
    - 2 360 t CO_2e per annum
- Scope 2 indirect emissions:
    - None
- Scope 3 indirect emissions:
    - 288 t CO_2e over a 9-year period
    - 32 t CO_2e per annum

The GHG emissions from the project was calculated to represent 0.0007% of the remaining South African annual budget for 2030 and 2035, respectively. The contribution to the South African annual budget will also progressively increase throughout the life of the project as the country's NDCs decrease. The impact of the project on climate change was assessed to have a low negative risk rating for GHG emissions.

3.3.2 INTERNATIONAL AGREEMENTS

In 1992, countries joined an international treaty, the United Nations Framework Convention on Climate Change, (UNFCCC) as a framework for international cooperation to combat climate change by limiting average global temperature increases and the resulting climate change, and coping with impacts that were, by then, inevitable.

By 1995, countries launched negotiations to strengthen the global response to climate change, and, two years later, adopted the Kyoto Protocol. The Kyoto Protocol legally binds developed country parties to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. As agreed in Doha in 2012, the second commitment period began on 1 January 2013 and will end in 2020 (UNFCCC, 2017) but due to lack of ratification has not come into force.

The Paris Agreement (2016) builds upon the Convention and – for the first time – brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort.

The central aim of the Paris Agreement is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2.0°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Additionally, the agreement aims to strengthen the ability of countries to deal with the impacts of climate change. To reach these ambitious goals, appropriate financial flows, a new technology framework and an enhanced capacity building framework will be put in place, thus supporting action by developing countries and the most vulnerable countries, in line with their own national objectives.

The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

In 2018, Parties contemplated progress towards the goal set in the Paris Agreement and to inform the preparation of NDCs. There will also be a global stocktake every five years to assess the collective progress towards achieving the purpose of the Agreement and to inform further individual actions by Parties.

As of October 2022, 194 Parties of the 197 Parties to the UNFCCC Convention, including South Africa, had ratified the Paris Agreement. South Africa submitted its NDC to the UNFCCC on 25 September 2016 and an updated NDC in September 2021.

3.3.3 GLOBAL GHG EMISSION INVENTORY

The proposed D3 Energy ER386 would most likely fall under the category of "energy" for the global GHG inventory. According to the "mitigation of climate change" document as part of the Intergovernmental Panel on Climate Change (IPCC) fifth Assessment Report (AR5) (IPCC, 2014) the 2010 global GHG emissions were 49 (±4.5) Gt CO_2-e, of which 35% (17 Gt CO_2-e) was a result of the energy sector. The World Resources Institute Climate Watch global GHG emissions from the "industrial processes" sector were 2.7711 Gt CO_2-e in 2016 (6% of total anthropogenic GHG emissions).

3.3.4 SOUTH AFRICA'S STATUS IN TERMS OF CLIMATE CHANGE AND QUANTIFICATION OF GREENHOUSE GASES

3.3.4.1 PARIS AGREEMENT - NATIONALLY DETERMINED CONTRIBUTION

South Africa ratified the UNFCCC in August 1997 and acceded to the Kyoto protocol in 2002, with effect from 2005. However, since South Africa is an Annex 1 country it implies no binding commitment to cap or reduce GHG emissions. The South African Intended Nationally Determined Contribution (INDC) was completed in 2015 and submitted to the UNFCCC on 1 November 2016. This was undertaken to comply with decision 1/CP.19 and 1/CP.20 of the Conference of the Parties to the UNFCC. This document describes South Africa's INDC on adaptation, mitigation and finance and investment necessities to undertake the resolutions.

As part of the adaption portion the following goals have been assembled:

- Goal 1: Development and implementation of a National Adaption Plan. The implementation of this will also result in the implementation of the National Climate Change Response Plan (NCCRP) per the 2011 policy.
- Goal 2: In the development of national, sub-national and sector strategy framework, climate concerns must be taken into consideration.
- Goal 3: An official institutional function for climate change response planning and implementation needs to be assembled.
- Goal 4: The creation of an early warning, vulnerability, and adaptation monitoring system
- Goal 5: Develop policy regarding vulnerability assessment and adaptation needs.
- Goal 6: Disclosure of undertakings and costs with regards to past adaptation strategies.

As part of the mitigation portion the following have been, or can be, implemented at National level:

- The approval of 79 (5 243 MW) renewable energy Independent Power Producer (IPP) projects as part of a Renewable Energy Independent Power Producer Procurement Programme (REI4P). An additional 6 300 MW is being deliberated.
- A "Green Climate Fund" has been created to back green economy initiatives. This fund will be increased in the future to sustain and improve successful initiatives.
- It is intended that by 2050 electricity will be decarbonised.
- Carbon Capture and Sequestration (or Carbon Capture and Storage) (CCS).
- To support the use of electric and hybrid electric vehicles.
- Reduction of emissions can be achieved through the use of energy efficient lighting; variable speed drives and efficient motors; energy efficient appliances; solar water heaters; electric and hybrid electric vehicles; solar photovoltaic; wind power; CCS; and advanced bioenergy.

A draft update of the first NDC was published for public comment on the 30th of March 2021 and the final updated of the first NDC was published and submitted to the UNFCCC on the 27th of September 2021 in preparation for the 26th Conference of the Parties (to held in Glasgow, Scotland in November 2021). The final update of the first NDC South Africa has not submitted its second NDC to UNFCCC. The draft document describes South Africa's NDC on adaptation, mitigation and finance and investment necessities to undertake the resolutions with updated revisions to the adaptation goals and mitigation targets.

As part of the updated adaption portion the following goals have been assembled:

- Goal 1: Enhance climate change adaptation governance and legal framework.
- Goal 2: Develop an understanding of the impacts on South Africa of 1.5 and 2°C global warming and the underlying global emission pathways through geo-spatial mapping of the physical climate hazards, and adaptation needs in the context of strengthening the key sectors of the economy. This will provide the scientific basis for strengthening the national and provincial governments' readiness to respond to climate risk.
- Goal 3: Implementation of National Climate Change Adaptation Strategy (NCCAS) adaptation interventions for the period 2021 to 2030, where priority sectors have been identified as biodiversity and ecosystems; water; health; energy; settlements (coastal, urban, rural); disaster risk reduction, transport infrastructure, mining, fisheries, forestry and agriculture.
- Goal 4: Mobilise funding for adaptation implementation through multilateral funding mechanisms.
- Goal 5: Quantification and acknowledgement of the national adaptation and resilience efforts.

Updated targets based on revised 100-year global warming potential (GWP) factors (published in the Annex to decision 18/CMA.1 of the IPCC 5th assessment report) and based on exclusion of land sector emissions arising from natural disturbance. The updated NDC mitigation targets, consistent with South Africa's fair share, are presented in **Table 14**.

Table 14: South Africa's NCD mitigation targets.

Year	Target	Corresponding period
2025	South Africa's annual GHG emissions will be in a range between 398 - 510 Mt CO_2-e.	2021-2025
2030	South Africa's annual GHG emissions will be in a range between 398 - 440 Mt CO_2-e.	2026-2030

3.3.4.2 NATIONAL CLIMATE CHANGE RESPONSE POLICY

The National Climate Change Response White Paper stated that in responding to climate change, South Africa has two objectives: to manage the inevitable climate change impacts and to contribute to the global effort in stabilising GHG emissions at a level that avoids dangerous anthropogenic interference with the climate system. The White Paper proposes mitigation actions, especially a departure from coal-intensive electricity generation, be implemented in the short- and medium-term to match the GHG trajectory range. Peak GHG emissions are expected between 2020 and 2025 before a decade long plateau period and subsequent reductions in GHG emissions.

The White Paper also highlighted the co-benefit of reducing GHG emissions by improving air quality and reducing respiratory diseases by reducing ambient particulate matter, ozone and SO_2 concentrations to levels in compliance with NAAQS by 2020.

In order to achieve these objectives, the Department of Forestry, Fisheries and the Environment (DFFE) has appointed a service provider to establish a national GHG emissions inventory, which will report through SAAQIS.

South Africa's Climate Change Act 22 of 2024, signed into law in July 2024 and proclaimed into effect on March 17, 2025, establishes a framework for a coordinated national response to climate change, including mitigation and adaptation strategies, and a just transition to a low-carbon economy. The Act is aligned with international policies guidelines and South Africa's Nationally Determined Contribution and aim to reduce GHG emissions as primary driver to anthropogenic climate change. The aim of the Act is to achieve an effective climate change response through a long-term just transition to a low carbon economy that is climate resilient and allows for sustainable development of South Africa. The Act provides for the following:

- Establish provincial and municipal forums on climate change which will be responsible for coordinating climate change response actions in each province.
- Strengthen the establishment of the Presidential Climate Change Coordinating Commission (4PC). Although, the 4PC has already been established and has been working for the Government since December 2020, however, its establishment only carries legal force after the Bill becomes an Act.
- Within one year of the coming into force of the Act, establish a National Adaptation Strategy. This strategy will guide South Africa's adaptation to the impacts of climate change and develop adaptation scenarios which anticipate the likely impacts over the short, medium, and long term.
- Determine a national GHG emissions trajectory, which must be reviewed every five years, and which indicates an emissions reduction objective.
- Put in place a 5-yearly sectoral emission targets for identified sectors and sub-sectors. The sectoral targets must be aligned with the national GHG emissions trajectory and include quantitative and qualitative GHG emission reduction goals.
- Bring into force the carbon budget allocation mechanism, which will replace the current National Pollution Prevention Plan mechanism which is enforced under the National Environmental

Management: Air Quality Act (NEM:AQA). The carbon budget will be linked to the Carbon Tax Act, in relation to carbon tax rates which will be charged on emissions above the carbon budget.

While the Act is now in effect, not all of its provisions have come into operation. A large part of the Act's commencement has been deferred to a later date to allow for the promulgation of necessary regulations. The Act states that the minister will need to develop the following:

- Within one year, sectors and sub-sectors emitting greenhouse gases have published emissions targets;
- Develop sector-specific emissions frameworks and targets in consultation with relevant Ministers;
- Publish a list of greenhouse gases contributing to climate change;
- Assign a carbon budget for a minimum of 15 years to entities involved in emitting listed greenhouse gases.

3.3.4.3 GREENHOUSE GAS EMISSIONS REPORTING

Regulations pertaining to GHG reporting using the National Atmospheric Emissions Inventory System (NAEIS) were published in 2017 (Republic of South Africa, 2017) (as amended by GN R994, 11 September 2020). The South African mandatory reporting guidelines focus on the reporting of Scope 1 emissions only.

The South African Greenhouse Gas Emission Reporting System (SAGERS) web-based monitoring and reporting system will be used to collect GHG information in a standard format for comparison and analyses. The system forms part of the national atmospheric emission inventory component of South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP). D3 Energy will have to report their GHG emissions to SAGERS since there is no threshold for annual GHG emissions reporting for the Natural Gas producers as per the amended GHG reporting guidelines (GG43712, 7 September 2020).

The DFFE is working together with local sectors to develop country specific emissions factors in certain areas; however, in the interim the IPCC default emission figures may be used to populate the SAAQIS GHG emission factor database. These country specific emission factors will replace some of the default IPCC emission factors. Technical guidelines for GHG emission estimation have been issued.

Also, the Carbon Tax Act (No 15 of 2019) (Republic of South Africa, 2019) includes details on the imposition of a tax on the CO_2-e of GHG emissions. Certain production processes indicated in Annexure A of the Declaration of Greenhouse Gases as Priority Pollutants (Republic of South Africa, 2017) with GHG more than 0.1 mega tonnes (Mt) or million metric tonnes, measured as CO_2-e, are required to submit a pollution prevention plan to the Minister for approval.

3.3.4.4 NATIONAL GHG EMISSIONS INVENTORY

South Africa is perceived as a global climate change contributor and is undertaking steps to mitigate and adapt to the changing climate. DFFE is categorised as the lead climate change institution and is required to coordinate and manage climate related information such as development of mitigation, monitoring, adaption, and evaluation strategies (DEA, 2019). This includes the establishment and updating of the National GHG Inventory. The National Greenhouse Gas Improvement Programme (GHGIP) has been initiated; it includes sector specific targets to improve methodology and emission factors used for the different sectors as well as the availability of data.

The 2000 to 2017 National GHG Inventory was prepared using the 2006 IPCC Guidelines (IPCC, 2006) based on updated sector information and emission estimation techniques. According to the 4th Biennial Update Report to the UNFCCC (DFFE, 2021), the total GHG emissions in 2017 were estimated at approximately 512.14 million metric tonnes CO_2-e (excluding Forestry and Other Land Use [FOLU]). This was a 14.2% increase from the 2000 total GHG emissions (excluding FOLU) and 2.8% decrease from the 2015 total GHG emissions (excluding FOLU). FOLU is estimated to be a net carbon sink which reduces the 2017 GHG emissions to 482.02 million metric tonnes CO_2-e. The estimated GHG emissions (excluding FOLU) for 2017 showed the Industrial Processes and Product Use (IPPU) sector contributed 6.3% to the total GHG emissions (excluding FOLU). The estimated CO_2-e emissions (excluding FOLU) for 2017 for the IPPU sector is 32.08 million metric tonnes.

3.3.4.5 DRAFT NATIONAL GUIDELINE FOR CONSIDERATION OF CLIMATE CHANGE IN DEVELOPMENT APPLICATIONS, 2025

The draft National Environmental Management Act (NEMA): National Guideline for Consideration of Climate Change Implications in Applications for Environmental Authorisations, Atmospheric Emission Licences and Waste Management Licences (published for public comment in 2025) introduces a formalised approach to integrating climate change considerations into South Africa’s environmental authorisation and permitting framework. The guideline is issued under the National Environmental Management Act, 1998 (Act No. 107 of 1998) and is intended to provide competent authorities, applicants, and environmental assessment practitioners with a consistent methodology for assessing both greenhouse gas (GHG) emissions and climate change resilience within development applications.

The guideline applies across Environmental Authorisations (EAs), Atmospheric Emission Licences (AELs), and Waste Management Licences (WMLs), thereby ensuring that climate change is addressed in a coordinated manner across key environmental regulatory instruments. It requires proponents to identify, quantify where appropriate, and evaluate the significance of project-related GHG emissions, including direct and indirect emissions, while also considering feasible mitigation measures in line with the mitigation hierarchy. In addition, it introduces the requirement to assess climate change vulnerability and adaptation needs of proposed developments, including exposure to climate-related hazards such as extreme temperatures, flooding, drought, and other physical climate risks over the project lifecycle.

A key feature of the guideline is its emphasis on decision-making alignment with national climate policy commitments, including South Africa’s Nationally Determined Contribution (NDC), long-term low-emissions development strategy, and the principles of a just transition. It further encourages consideration of reasonable alternatives, including low-carbon design options and technologies, and requires that climate-related impacts and risks be explicitly documented in environmental assessment reports and decision-making records.

Overall, the draft guideline represents a significant strengthening of South Africa’s environmental regulatory framework by embedding climate change considerations as a mandatory component of environmental decision-making across authorisation, emissions licensing, and waste management processes.

4 ENVIRONMENTAL ATTRIBUTES AND BASELINE ENVIRONMENT

This section of the EIA Report provides a description of the environment that may be affected by the proposed project. Aspects of the biophysical, social and economic environment that could be directly or indirectly affected by, or could affect, the proposed development have been described. This information has been sourced from existing information available for the area as well as baseline information received from specialist's assessments (refer to affected environment in the various specialist studies attached in **Appendix F)**. The DFFE screening tool was also used to inform this section, and a copy of the screening report is included in **Appendix D**.

4.1 LOCATION AND LAND USES

The accepted (not yet approved) ER is located over an area of approximately 58 000 hectares (ha) / 580km^2, covering various farms near the towns of Welkom, Virginia, Hennenman and Odendaalsrus, within the Free State Province. The local municipalities in which the proposed exploration area is located are Matjhabeng and Moqhaka Local Municipalities, which are part of the Lejweleputswa and Fezile Dabi District Municipalities, respectively. Noticeable boundaries of ER386 are 28°13'28.95"S; 26°55'2.76"E in the South, 27°57'37.57"S; 26°48'49.15"E in the West, 27°59'13.57"S; 27°11'13.06"E in the East and 27°46'34.45"S; 26°57'44.05"E in the North, the central coordinates are approximately 27°58'23.27"S; 26°59'38.94"E. The locality map is included in **Figure 1.**

The study area can be subdivided into four sections namely, the northern section, southern section, western section, and the eastern section (refer to **Figure 1** for the site locality). The northern section is closer to the R34 and located between Odendaalsrus and Kroonstad. There are currently two target areas proposed within this section namely, Target Area 10 (GP B) and Target Area 11 (GP A) and three seismic transect (Transect G1, G2 and G3). This section consists almost entirely of cultivated land with several natural and artificial watercourses. The eastern section is located immediately north of Ventersburg and bounded by the N1 and Phomolong. This section is primarily dominated by cultivated land, open areas and minor game farms. There are distinctive watercourses within this area including the Kromspruit which is immediately to the north of the sole proposed drilling site, Target Area 9 (HF C) 500m assessment area within this section. There are three proposed transects within this section, namely, Transect HF1, HF2 and HF7. Which intersect the Kromspruit, Rietspruit and Slootspruit.

The tip of the southern section is approximately 8.5km south of southern Virginia (Meloding) while the two target areas, Target Area 1 (RSB D) and Target Area 2 (RSB E) are approximately 7km east of southern Virginia. The R73 cuts across this section. Similarly to the northern and eastern sections, the southern section is primarily dominated by cultivated land, open areas and minor game farms, several natural and artificial watercourses. Although there are two target areas within this section, two of the three seismic transects intersect the Sandrivier. There is also a canal that separated the two target areas.

The western section is the section where majority of the exploration activities were previously proposed but have since been removed from the current application. This section is within a mining area and adjacent to mining towns. The edges of the residential areas of Saaiplaas, Bronville and Thabong form part of the eastern boundary of this section and ER386. There are currently no proposed drilling sites nor seismic activities within this section. Although this section also consists largely of cultivated land, open areas and minor game farms, several natural and artificial watercourses, it is the most transformed section within the ER comprising of mining activities, residential areas, road and electrical infrastructure. This section also comprises of several farms earmarked for renewable energy developments (see **Figure 2**). Site conditions are presented in **Figure 11** to **Figure 25** below.

Figure 11: The southern section consists of a mixture of low-lying grassland with shrubs and areas of thick vegetation supporting the various game in the area.

Figure 12: A view of the Sandrivier at a meandering and escarpment section north of Target Area 1 and 2 and where the Transect RSB 1 ends.

Figure 13: Southern view of the southern section showing thick intact vegetation.

Figure 14: Eastern view of the southern section showing a canal supporting the agricultural activities and low laying grasslands and shrubs within agricultural activities further east

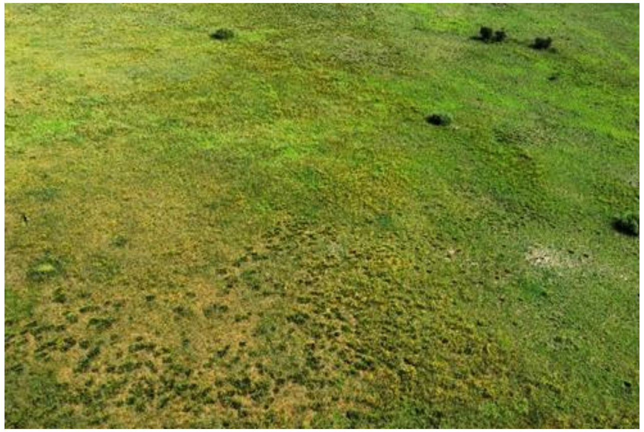


Figure 15: Southern view from the western section showing low-lying disturbed grassland with sparsely distributed shrubs

Figure 16: Northern view from the western section showing low-lying disturbed grassland with sparsely distributed shrubs. Thabong residential area and Doringpan can be seen further north.

Figure 17: Western view of the western section showing uniform vegetation of low-lying grass and sparsely distributed shrubs and Thabong residential area.

Figure 18: A large wetland located on the western edge of the western section, adjacent to a Harmony Tailings Facility.

Figure 19: A view of some of the activities (grazing) located within the western section.

Figure 20: Northern view from the central area of the ER showing low-lying grass within thick vegetation (further north) and some of the game within the area.

Figure 21: The eastern section consists primarily of agricultural and grazing activities. Small dairy farming activities were noted close to Target Area 9 (HF C).

Figure 22: Although the main land use of the northern section is cultivated land and grazing, there are some open spaces within medium-thick vegetation consisting of various floral species.

Figure 23: Some of the infrastructure within the ER include surfaced and gravel roads. The conditions of the roads vary from good, maintained roads to roads which have been severely deteriorated roads in poor condition.

Figure 24: A railway line which appears to be still operational was noted in the western section.

Figure 25: Eskom infrastructure including high voltage powerlines were also noted in the western section of the ER.

4.2 TOPOGRAPHY

Information on the area's topography was obtained from the Geohydrological Assessment Report undertaken by Gradient Groundwater Consulting (**Appendix F**). The topography of the greater study area generally has a jagged topography and can be classified as a central interior plain or plateau. Large dolerite intrusions are observed throughout the study area and because of its relative resistance to erosion, the Karoo dolerite sheets generally give rise to very prominent high-standing topographic features (DWAF, 2004). The relief of the area varies between 0 – 130.0m towards the western perimeter and 30 – 210.0m to the south and northern boundaries. Elevations within the study area range between 1 300 and 1 533 meters above mean sea level (mamsl) based on elevations extracted from the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) raster interpolation. Elevations generally increase towards the south and east of the study area, with the lowest elevation of 1 300 mamsl in the central-western parts of the study area and the greatest elevation of 1 533 mamsl in the eastern parts of the study area. Based on calculations performed using GIS, the slope of the study area ranges between 0% (indicating water bodies such as wetlands, pans, and dams) and 45.17% (indicating steep hillslopes), while the average slope is calculated as 3.58% with a standard deviation of 2.35%. The greater study flattens out towards the northwest and west which also correlates to the general drainage direction. **Figure 26** shows the regional topographical contours and setting.

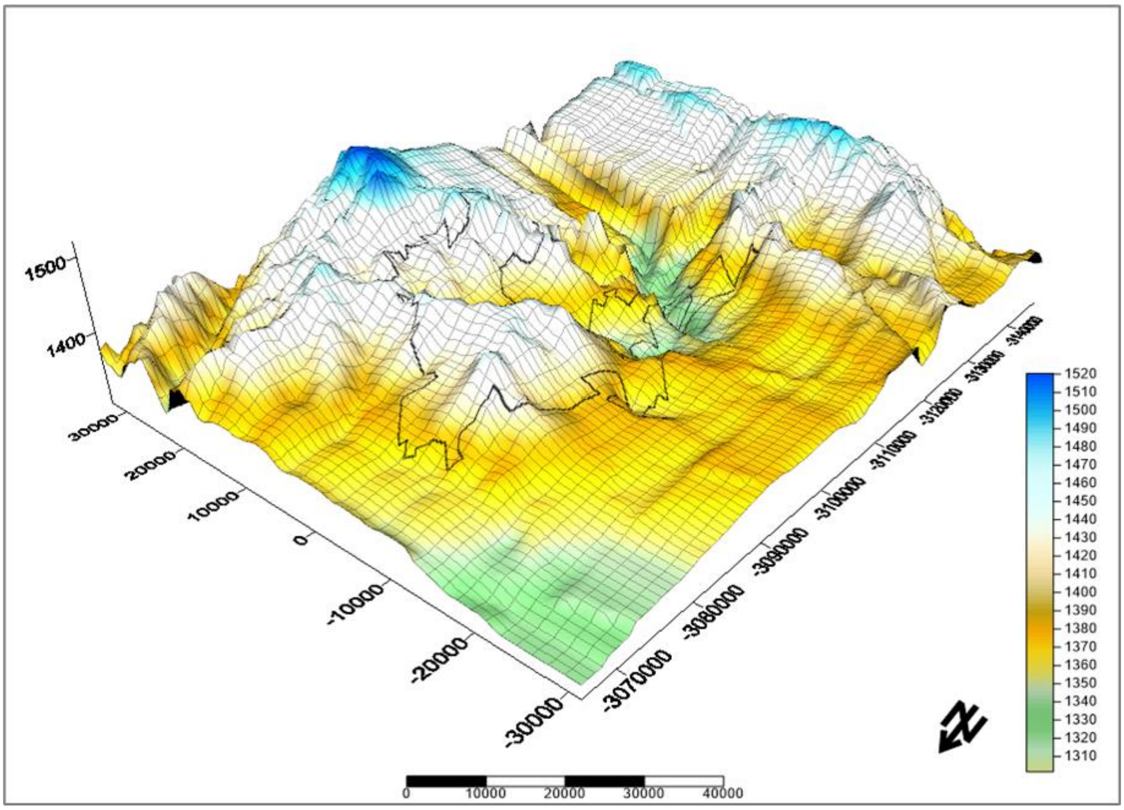


Figure 26: General (vertically exaggerated) topography of the study area (Gradient Groundwater Consulting, 2026).

4.3 GEOLOGY

According to information obtained from the Baseline Geohydrological Assessment Report undertaken by Gradient Groundwater Consulting (**Appendix F**), based on the Council for Geoscience (CGS) 1:250 000 geological maps (Geological Map Sheet 2726 Kroonstad and Geological Map Sheet 2826 Winburg) the surface geology of the study area is characterized by a variety of lithologies, formations, and intrusions. These include geologically recent Quaternary deposits; sediments of the Beaufort and Ecca Groups within the Karoo Supergroup; dolerite dykes, sheets, and sills associated with the Karoo Dolerite Suite; and post-Karoo kimberlite pipes and dykes. **Figure 27** depicts the regional geology and stratigraphy.

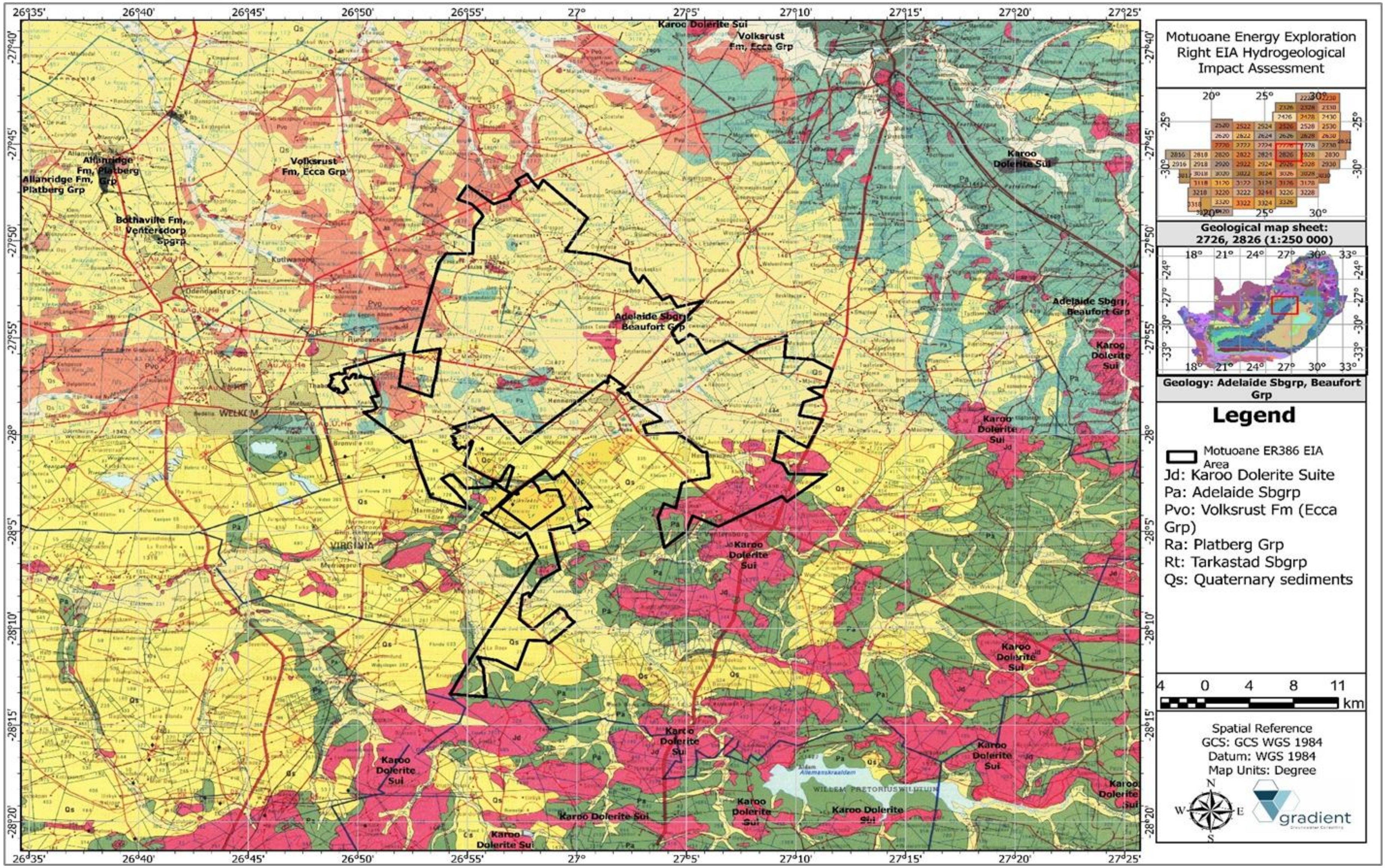


Figure 27: Regional geology and stratigraphy from Geological map sheet 2726: Kroonstad and 2826: Winburg at 1:250 000 scale (Gradient Groundwater Consulting, 2026).

The Quaternary deposits, which were deposited less than 0.01 million years ago (DWA, 2012), cover most of the northern and central parts of the study area, while also being present in the southern parts of the study area. These deposits include aeolian (wind-blown) dune sand in the northern and central parts of the study area; alluvium, including calcified alluvium and river gravel, in the northern, northeastern, central, and southern parts of the study area along the banks and floodplains of surface water drainage features; and patches of calcrete and surface limestone in the western and northwestern parts of the study area.

The sediments of the Beaufort Group, which are primarily of fluvial and deltaic origin (Baran, 2003), were deposited during the late Permian Period between approximately 248 and 239 million years ago and are associated with the orogeny and tectonic paroxysm of the Cape Fold Belt (Woodford and Chevallier, 2002). The Adelaide Subgroup within the Beaufort Group occurs toward the northeastern parts of the study area, while also being present in the central and southern parts of the study area. Specifically, the Normandien Formation within the Adelaide Subgroup occurs towards the northeast of the study area and comprises of greenish grey (bottom of formation) to red (top of formation) mudstone and siltstone, grey shale and rhythmite, and sandstone. The Adelaide Subgroup covering the central and southern parts of the study area is not differentiated into specific formations and comprises of mudstone with subordinate sandstone.

The sediments of the Ecca Group were deposited during the Permian Period between approximately 290 and 248 million years ago (Woodford and Chevallier, 2002). The Volksrust Formation within the Ecca Group occurs toward the northwestern parts of the study area. Fluvial and deltaic sediments were supplied to the Volksrust Formation as a result of continental provenance towards the north and northeast of the Karoo Basin (Woodford and Chevallier, 2002). The Volksrust Formation, which interfingers with the overlying Beaufort Group (Woodford and Chevallier) is a primarily argillaceous formation comprising of mudstone, siltstone, and shale.

A vast network of dolerite dykes, sheets, and sills associated with the Karoo Dolerite Suite occurs throughout the study area and is especially prominent in the southern and central parts of the study area. The Karoo Dolerite Suite intruded into the Karoo Supergroup approximately 180 million years ago during the early stages of the break-up of Gondwanaland (Woodford and Chevallier, 2002). Furthermore, kimberlite and associated alkaline-rich intrusive rocks, including carbonatite and olivine melelitite, intruded into the Karoo Basin between approximately 130 and 70 million years ago (Woodford and Chevallier).

4.4 CLIMATE

This section provides the climatic conditions as per the Climate Impact Assessment by Airshed Planning Professionals (**Appendix F**).

4.4.1 BASELINE CLIMATE

According to the Koppen-Geiger climate classification system, the climate of the study area is classified as BSk (Climate Change & Infectious Diseases Group, 2023). This classification indicates that the study area has a cold, semi-arid climate characterized by cold, dry winters and warm summers. The average temperature in the Welkom area ranges between 9.7 °C in the winter (July) and 23.3 °C in the summer (January), while the mean annual temperature is 17.7 °C (Climate-Data, 2021). Refer to **Figure 28** for the Mean Yearly Temperature Distribution of the greater study area. Based on the Climate Change Assessment by Airshed Planning Professionals (**Appendix F**). Baseline annual average temperature was in the range 16.2°C (10th percentile) and 16.31°C (90th percentile) with the number of very hot days varying between 1.68 (10th percentile) and 3.92 (90th percentile) days per year. High inter-annual rainfall variability is noticed (Figure 3-3) as the range between the 10th and 90th percentiles was 1016.84 mm and 1107.52 mm. Extreme rainfall days varied between 12.36 (10th percentile) and 13.48 (90th percentile) days per year.

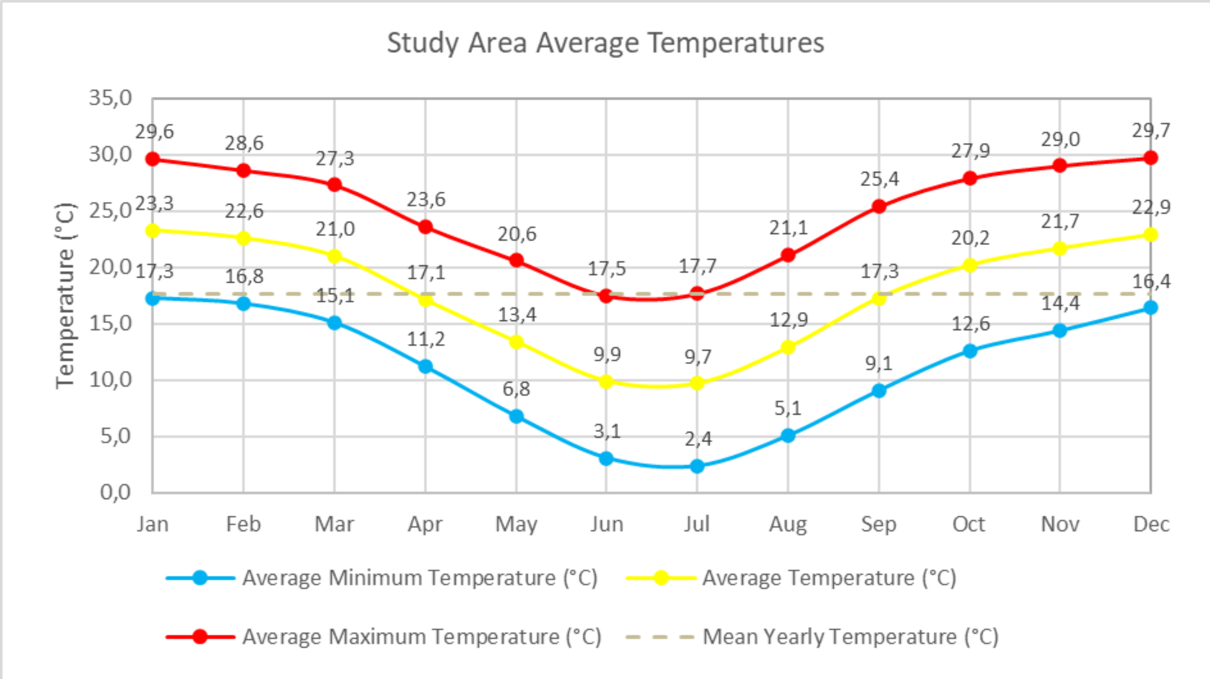


Figure 28: Climate summary Mean Yearly Temperature Distribution of the greater study area, 1991 – 2021 (Climate-Data, 2021).

Recent change in climatic conditions near the project site were accessed from MeteoBlue[6] a weather forecasting platform developed at the University of Basel, Switzerland and based on models of National Oceanic and Atmospheric Administration (NOAA) or National Centres for Environmental Prediction (NCEP). The data sets also include historical climate data tracking changes in climate by referencing ERA5, the fifth generation ECMWF (European Centre for Medium-Range Weather Forecasts) atmospheric reanalysis of the global climate, for the period between 1979 to 2024, with a spatial resolution of 30 km. Based on Hennenman (located within the study area), an increasing trend in the annual average temperatures has been observed with temperatures measuring 16.7°C in 1979 to 18.1°C in 2024 (**Figure 29**– top panel). The lower part the graph shows the so-called warming stripes. Each coloured stripe represents the average temperature for a year - blue for colder and red for warmer years. The change in rainfall over the same period (1979 – 2024) displays a slight decreasing trend (**Figure 29**– bottom panel), where the difference from long-term average for each year in the data set is visualised by the stripes in the lower panel of (**Figure 29** (brown stripes indicate lower than average rainfall and green stripes above average rainfall).

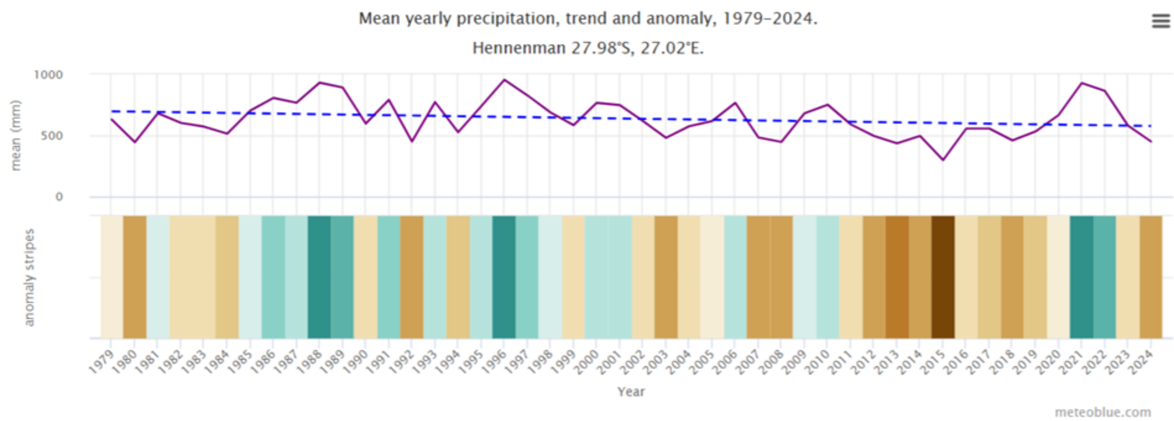


Figure 29: Annual average rainfall (top panel) and rainfall anomaly (lower panel) between 1979 and 2024 (meteoblue AG, 2025).

[6] https://www.meteoblue.com

The mean annual precipitation (MAP) for the study area is estimated at approximately 531.66 mm/a, based on MAP data obtained from Water Resources of South Africa, 2012 study (WRC, 2016). Using patched monthly precipitation data (ranging from 1920 to 2009), obtained from the WR2012 database (WRC, 2016), the MAP for the study area is calculated as 531.81 mm/a. The 5th percentile of the dataset, which approximately represents a 1:20 year drought, is calculated as 345.32 mm/a. The 95th percentile of the dataset, which approximately represents the 1:20 year flood, is calculated as 760.66 mm/a. The results from the analysis of the WR2012 datasets indicate that the study area has a summer rainfall regime, with the majority of the precipitation occurring from October to March (80.02%) as high intensity thunderstorms, while June, July, and August are particularly dry. Refer to **Figure 30** for graphical representations of the monthly precipitation distributions for the study area.

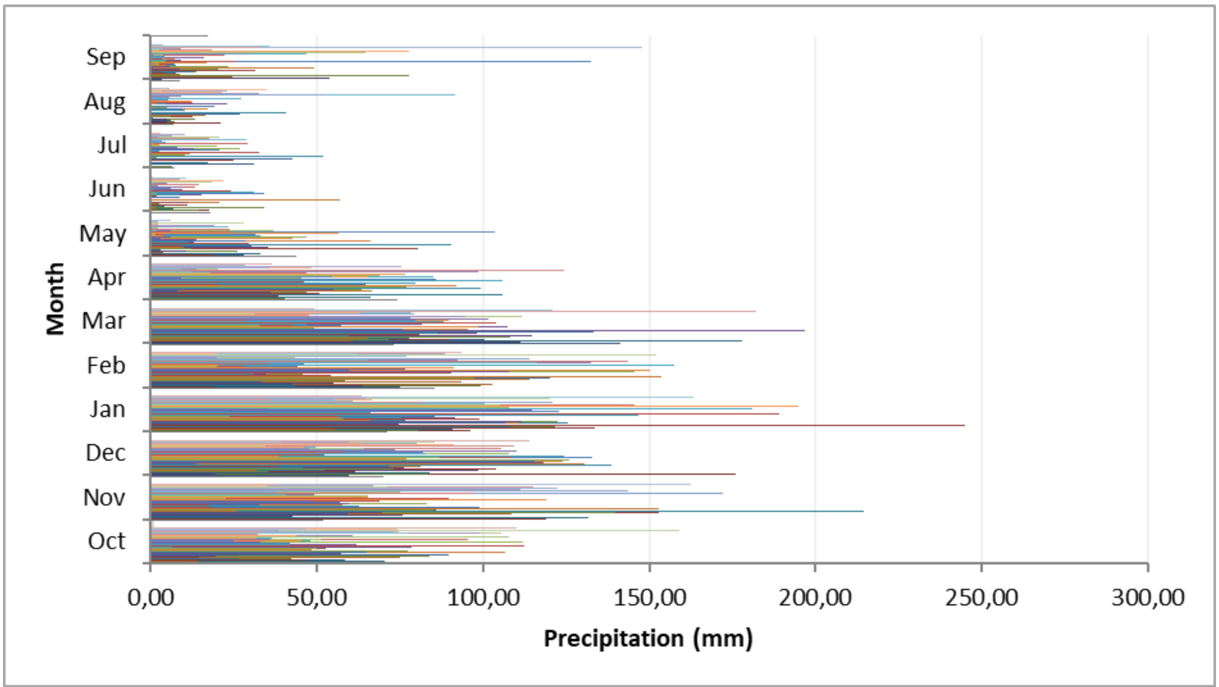


Figure 30: Monthly Precipitation Distribution, 1920 – 2009 (WRC, 2016).

The study area falls within evaporation zones 9A, 11A, and 19C (WRC, 2016). The mean annual evaporation (MAE), measured by Symons Pan, for the study area ranges between 1 540 and 1 750 mm/a (WRC, 2016).

4.4.2 PROJECTED FUTURE CLIMATE

In 2017 the South African Weather Services (SAWS) published an updated Climate Change Reference Atlas (CCRA) based on Global Climate Change Models (GCMs) projections (SAWS, 2017). It must be noted that as with all atmospheric models there is the possibility of inaccuracies in the results because of the model's physics and accuracy of input data. The Rossby Centre regional model (RCA4) was used in the predictions for the CCRA which included the input of nine GCMs results. The RCA4 model was used to improve the spatial resolution to 0.44° x 0.44°- the finest resolution GCMs in the ensemble were run at resolutions of 1.4° x 1.4° and 1.8° x 1.2°. Findings from downscaled climatic simulations using six GCMs, at an 8 km x 8 km resolution over South Africa, for the time slab 2021 to 2050 were included in the Green Book (Engelbrecht, 2019).

In both the CCRA and the Green Book, two trajectories are included based on the four Representative Concentration Pathways (RCPs) discussed in the IPCC's fifth assessment report (AR5) (IPCC, 2013). RCPs are defined by their influence on atmospheric radiative forcing in the year 2100. RCP4.5 represents an addition to the radiation budget of 4.5 W/m^2 as a result of an increase in GHGs. The two RCPs selected were RCP4.5 representing the medium-to-low pathway and RCP8.5 representing the high pathway. RCP4.5 is based on a CO_2 concentration of 560 ppm and RCP8.5 on 950 ppm by 2100. RCP4.5 is based on if current interventions to reduce GHG emissions being sustained (after 2100 the concentration is expected to stabilise or even decrease). RCP8.5

is based on if no interventions to reduce GHG emissions being implemented (after 2100 the concentration is expected to continue to increase.

4.4.2.1 **REPRESENTATIVE CONCENTRATION PATHWAYS 4.5 TRAJECTORY**

The Green Book projected temperature changes in the near future (up to 2050) indicate a 50th percentile increase of 2.2°C and a 90th percentile increase of 2.8°C (Engelbrecht, et al., 2019). The number of very hot days are expected to increase to between 10.8 and 18.2 days per year. Between 2021 and 2050 the annual rainfall near the project site was projected to increase by 52 mm per year (50th percentile) (Engelbrecht, et al., 2019), with extreme rainfall days potentially increasing by 0.6 days (50th percentile) in the near future (Engelbrecht, et al., 2019).

4.4.2.2 **REPRESENTATIVE CONCENTRATION PATHWAYS 8.5 TRAJECTORY**

The Green Book projected temperature changes in the near future (up to 2050) indicate a 50th percentile increase of 2.6°C and a 90th percentile increase of 3.2°C (Engelbrecht, *et al.*, 2019). The number of very hot days are expected to increase to 14.5 days per year (50th percentile). Between 2021 and 2050 the annual rainfall near the project site was projected to increase by 112 mm per year between 2021 and 2050 (50th percentile) (Engelbrecht, *et al.*, 2019), with extreme rainfall days potentially increasing by 1.5 days (50th percentile) in the near future (Engelbrecht, *et al.*, 2019).

4.4.2.3 **IPCC'S SIXTH ASSESSMENT REPORT: TEMPERATURE AND RAINFALL PROJECTIONS**

The most recent IPCC data are from the Coupled Model Intercomparison Project (CMIP) which were derived from the sixth phase of the CMIPs (CMIP6) and supports the IPCC's Sixth Assessment Report (AR6) which was released on 9 August 2021 (Working Group I), 28 February 2022 (Working Group II and 4 April 2022 (Working Group III). Projection data is presented at a 1.0º x 1.0º (100 km x 100 km) resolution. The scenarios are the result of complex calculations that depend on how quickly humans curb greenhouse gas emissions, whilst also capturing socioeconomic changes in areas such as population, urban density, education, land use and wealth. For example, a rise in population is assumed to lead to higher demand for fossil fuels and water. Education can affect the rate of technology developments. Emissions increase when land is converted from forest to agricultural land. Each scenario is labelled to identify both the emissions level and the so-called Shared Socioeconomic Pathway, or SSP, used in those calculations. This first scenario is the only one that meets the Paris Agreement's goal of keeping global warming to around 1.5°C above preindustrial temperatures, with warming hitting 1.5°C but then dipping back down and stabilizing around 1.4°C by the end of the century. Projected changes are defined relative to a historical 20-year period (1995 to 2014).

The AR6 projections for the study area for the scenario RCP4.5 indicate an increase in annual average temperatures of 1.6°C for the period 2041 to 2060 and 2.2°C for the period 2081 to 2100. The projections for the RCP8.5 indicate an increase in annual average temperatures of 2.1°C for the period 2041 to 2060, to 4.9°C for the period 2081 to 2100 (IPPC, 2022). The AR5 projections, for comparison, estimate an increase in annual average temperatures (50th percentile) of 2.2°C for RCP4.5 and 2.6°C for RCP8.5 for the period 2021 to 2050.

The AR6 projections for rainfall in the study area for RCP4.5 indicate a decrease in annual rainfall of 0.9% for the period 2041 to 2060, to 1.2% for the period 2081 to 2100. The projections for RCP8.5 indicate an increase in rainfall of 1.1% for the period 2041 to 2060, to a decrease of 5.8% for the period 2081 to 2100 (IPPC, 2022)

4.5 SOCIO-ECONOMIC

Information on the area's social fabric was obtained from the Social Assessment Report undertaken by Equispectives Research and Consulting Services (**Appendix F**). The proposed project is located in Wards 1, 2, 3, 4, 8, 10, 11, 12, 13,15, 16, 17, 23 and 25 of the Matjhabeng Local Municipality that forms part of the Lejweleputswa District Municipality and Ward 2 in the Moqhaka Local Municipality which falls in Fezile Dabi District the in the Free State Province. The baseline description of the environment will include these areas. **Figure 31** shows the location of the proposed project as well as social and physical infrastructure in the area.

The Free State is a rural province, and its economic activities are dominated by mining, agriculture, and manufacturing. The province is the fifth-largest producer of gold in the world and is also home to Sasol, a large synthetic fuels company. About 90% of the Free State is used for crop production (www.municipalities.co.za). About 34% of the total maize production of South Africa, 37% of wheat, 53% of sorghum, 33% of potatoes, 18% of red meat, 30% of groundnuts and 15% of wool is produced in the Free State.

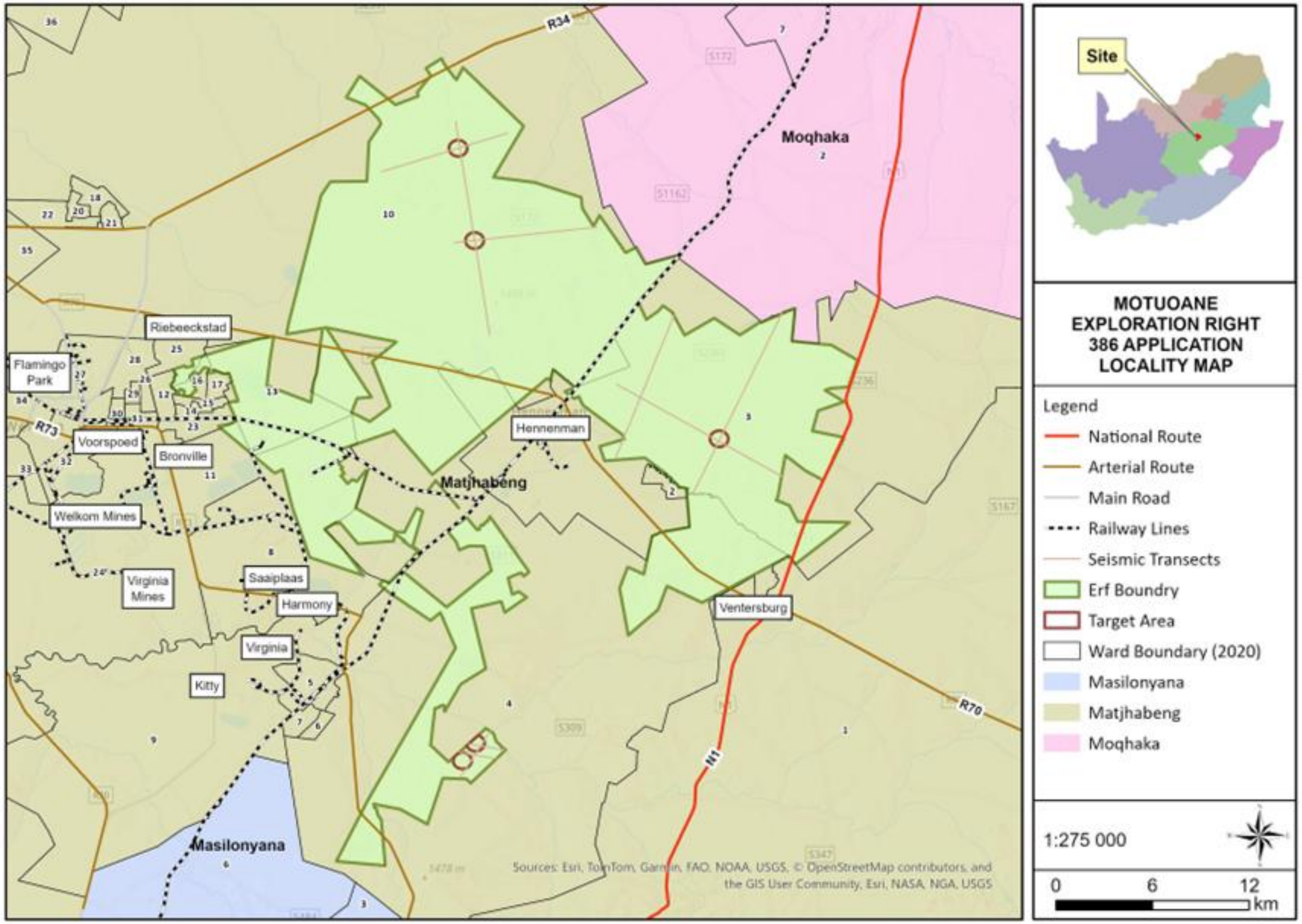


Figure 31: Location of the proposed D3 Energy ER386 (Equispectives Research and Consulting Services, 2026).

4.5.1 LEJWELEPUTSWA DISTRICT MUNICIPALITY

The Lejweleputswa District Municipality (LDM) is situated in the north western part of the Free State and borders the North West Province to the north; the Fezile Dabi and Thabo Mofutsanyane District Municipalities to the north-east and east respectively; the Xhariep District Municipality and Mangaung Metropolitan Municipality to the south; and the Northern Cape Province to the west. The LDM is accessible from Johannesburg, Cape Town, Klerksdorp and Kimberley through one of South Africa's main national roads, the N1. The district covers an area of 32 286 km^2 and make up almost a third of the Free State province. It consists of the Masilonyana, Matjhabeng, Nala, Tokologo and Tswelopele Local Municipalities (www.lejweleputswa.co.za). The economy of the district relies heavily on the gold mining sector which is dominant in the Matjhabeng and Masilonyana Local Municipalities (Lejweleputswa DM IDP 2021/22). The mining sector is on a downward trend and many businesses that have traditionally depended on the mining sector have either closed down are in the process of closing down. The other municipalities are dominated by agriculture.

4.5.1.1 **MATJHABENG LOCAL MUNICIPALITY**

The main towns in the Matjhabeng Local Municipality are Welkom, Odendaalsrus, Virginia, Hennenman, Allanridge and Ventersburg (www.matjhabeng.fs.gov.za). The economy of the municipality is centred on mining activities in and around Welkom, Allanridge, Odendaalsrus and Virginia. Manufacturing aimed at the mining sector exists to a limited extent in the above towns, with other activities being limited. Other main economic sectors include manufacturing, tourism, agriculture, gold jewellery, transportation (logistics), and retail (Matjhabeng LM IDP 2022/2023).

4.5.2 FEZILE DABI DISTRICT MUNICIPALITY

The Fezile Dabi District Municipality covers an area of approximately 20,668 km^2. The main towns in the District are Kroonstad, Parys, Sasolburg, Heilbron, Frankfort, Villiers, Deneysville, Oranjeville, Vredefort, Steynsrus, Viljoenskroon, Edenville, Koppies, Tweeling, and Cornelia. These towns are distributed across the four local municipalities within the district, namely the Metsimaholo, Mafube, Moqhaka, and Ngwathe Local Municipalities. The economy of Fezile Dabi District Municipality is diverse, with agriculture (crop farming and livestock) and manufacturing (particularly chemical and petrochemical industries in Sasolburg) serving as primary sectors. Mining contributes to the economy but is less dominant than agriculture and manufacturing. Tourism utilizes natural and cultural attractions to support local businesses and employment. The service sector, including community and social services, plays a crucial role. Trade represents the largest share at 22% of economic activities, while households contribute 13%. Other significant sectors include finance (7%), construction (6%), and transport (5%). This economic profile shows a balanced mix of primary industries, manufacturing, and service sectors with trade being the most significant individual component (Fezile Dabi DM IDP 2022-2027).

4.5.2.1 **MOQHAKA LOCAL MUNICIPALITY**

The main towns in the Moqhaka Local Municipality are Kroonstad, Viljoenskroon, Steynsrus, Vierfontein, Renovaal. The economy of the Moqhaka Local Municipality is primarily based on agriculture, including crop farming and livestock farming. Other significant sectors include mining, industrial activities, manufacturing, trade, services, and tourism. Public services, such as the Department of Correctional Services and military bases, also contribute to the local economy. There is ongoing local economic development initiatives aimed at promoting economic growth, job creation, and poverty reduction (Moqhaka LM IDP 2022-2027).

4.5.3 DESCRIPTION OF THE POPULATION

The baseline description of the population will take place on three levels, namely provincial, district and local. Impacts can only truly be comprehended by understanding the differences and similarities between the different levels. The baseline description will focus on the Matjhabeng Local Municipality in the Lejweleputswa District Municipality in the Free State Province (referred to in the text as the study area), as these are the areas that will be most affected by the proposed project. Where possible, the data will be reviewed on a ward level. The data used for the socio-economic description was sourced from Census 2022, Community Survey 2016, and Census 2011. Both Census 2022 and Census 2011 were de facto censuses where individuals were counted based on where they were on the census reference night. For Census 2022 the reference night was the night of 2 February 2022 and for Census 2011 it was the night of 9 October 2011. The results should be viewed as indicative of the population characteristics in the area and should not be interpreted as absolute.

StatsSA released limited data for Census 2022 on 10 October 2023 and will release more detailed data in future following a phased approach. ***The data that was released is only available up to local municipal level, and not on ward level.*** As such the data from Census 2022 will be supplemented by data from Census 2011 and Community Survey 2016. Census 2011 that contains the latest ward level data has been categorised according to the 2016 ward delineations, but not according to the current ward delineations. For this reason, the baseline data according to ward level will be analysed according to the 2016 delineations, which in this instance are the same as the latest ward delineations. Perhaps the most striking feature of Census 2022 is the very high undercount of 31% of people and 30% of households. While census undercounts are the norm rather than the exception (about a 5% undercount is acceptable), the undercount of this census may set a new international record (www.wits.ac.za). At aggregate level Census 2022 is robust, but at sub-national, and especially sub-provincial levels it might be less so.

4.5.3.1 POPULATION AND HOUSEHOLD SIZES

According to the Census 2022, the population of South Africa is approximately 62 million and has shown an increase of about 19.8% since 2011. The household density for the country is estimated on approximately 3.48 people per household, indicating an average household size of 3-4 people for most households, which is down from the 2011 average household size of 3.58 people per household. Smaller household sizes are in general associated with higher levels of urbanisation. The greatest increase in population since 2011 has been on local level (**Table 15**), but still lower than the national average. Population density refers to the number of people per square kilometre and the population density on a national level has increased from 42.4 people per km^2 in 2011 to 50.8 people per km2 in 2022. In the study area the population density has increased since 2011 with the highest density in the Matjabeng LM.

Table 15: Population density and growth estimates (sources: Census 2011, Census 2022).

Area	Size in km2	Population 2011	Population 2022	Population density 2011	Population density 2022	Growth in population (%)
Free State Province	129,825	2,745,590	2,964,412	21.15	22.83	7.97
Lejweleputswa DM	31,930	624,746	679,746	19.35	21.05	8.80
Matjhabeng LM	5,155	407,020	439,034	71.53	77.16	7.87
Fezile Dabi DM	20,674	488,036	509,912	23.61	24.66	4.48
Moqhaka LM	7,925	160,532	155,410	20.26	19.61	-3.19

Poverty is a complex issue that manifests itself in economic, social, and political ways and to define poverty by a unidimensional measure such as income or expenditure would be an oversimplification of the matter. Poor people themselves describe their experience of poverty as multidimensional. The South African Multidimensional Poverty Index (SAMPI) (Statistics South Africa, 2014) assess poverty on the dimensions of health, education, standard of living and economic activity using the indicators child mortality, years of schooling, school attendance, fuel for heating, lighting, and cooking, water access, sanitation, dwelling type, asset ownership and unemployment.

The poverty headcount refers to the proportion of households that can be defined as multi-dimensionally poor by using the SAMPI's poverty cut-offs (Statistics South Africa, 2014). The poverty headcount has increased on all levels since 2011 (**Table 16**), indicating an increase in the number of multi-dimensionally poor households.

The intensity of poverty experienced refers to the average proportion of indicators in which poor households are deprived (Statistics South Africa, 2014). The intensity of poverty has increased slightly on all levels. The intensity of poverty and the poverty headcount is used to calculate the SAMPI score. A higher score indicates a very poor community that is deprived on many indicators. The SAMPI score in the Matjhabeng LM area has decreased between 2011 and 2016, suggesting an improvement in some respects relating to poverty in this area. In the Moqhaka LM the SAMPI score has increased, indicating an increase in poverty in the area. SAMPI scores based on the 2022 Census data is not yet available.

Table 16: Poverty and SAMPI scores (sources: Census 2011 and Community Survey 2016).

Area	Poverty headcount 2011 (%)	Poverty intensity 2011 (%)	SAMPI 2011	Poverty headcount 2016 (%)	Poverty intensity 2016 (%)	SAMPI 2016
Free State Province	5.5	42.2	0.023	5.5	41.7	0.023
Lejweleputswa DM	5.6	42.8	0.024	4.8	42.2	0.020
Matjhabeng LM	5.5	43.0	0.024	4.3	41.8	0.018
Fezile Dabi DM	4.4	42.2	0.019	4.9	41.9	0.021
Moqhaka LM	2.7	41.4	0.011	2.9	42.7	0.012

4.5.3.2 POPULATION COMPOSITION, AGE, GENDER AND HOME LANGUAGE

In all the areas under investigation, the majority of the population belongs to the Black population group except in Ward 11 where almost half of the population belongs to the Coloured population group. The age distribution of the areas under investigation shows that the population on local, district or provincial level tend to be slightly older, with older populations in Wards 3, 8, and 25 of Matjhabeng LM and Ward 2 of Moqhaka LM (**Figure 32**).

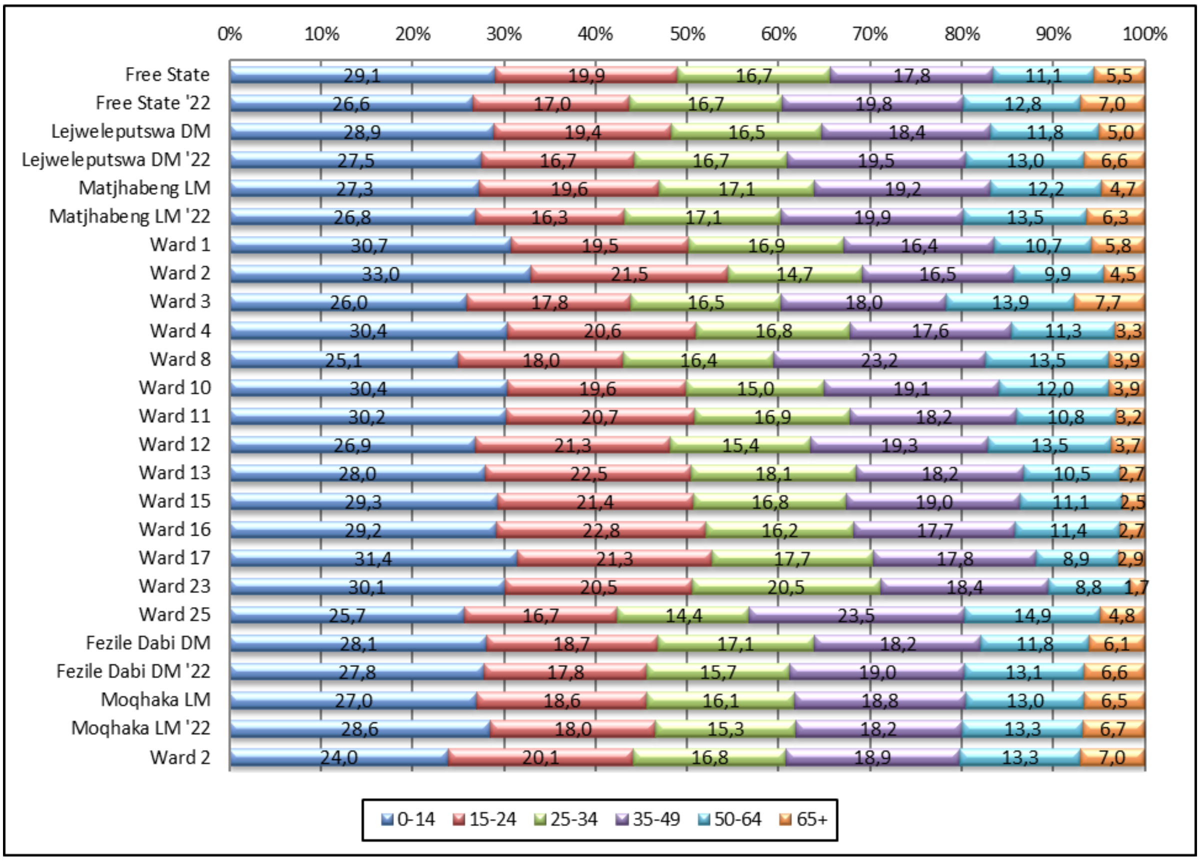


Figure 32: Age distribution (shown in percentage, source: Census 2011), Census 2022.

4.5.3.3 LANGUAGE

The majority of people in the area under investigation have Sesotho as home language, except in Ward 11 where more than half of people have Afrikaans as home language. Wards 3, 8 and 25 also have a relatively high incidence of people with Afrikaans as home language. Home language should be taken into consideration when communicating with the local communities and based on the profile of the area communication should take place in Sesotho, Afrikaans, and English. It must be noted that the public participation process for the project is undertaken in the three main languages spoken in the area namely, Sesotho, Afrikaans, and English (refer to **Appendix C**).

4.5.3.4 ACCESS TO WATER AND SANITATION

Ward 2 of the Moqhaka LM has the lowest incidence of households that access to water from a local or a regional water scheme, but the highest incidence of households that get their water from another source (**Figure 33**). Census 2011 does not specify what the 'other' water sources include. Almost 16% of households in Ward 3 get their water from a borehole. It is therefore important that all drilling sites each borehole shall be steel cased and have cement barriers to prevent leaks as well as plugged at the end of exploration to prevent groundwater seepage as per the proposed drilling procedure.

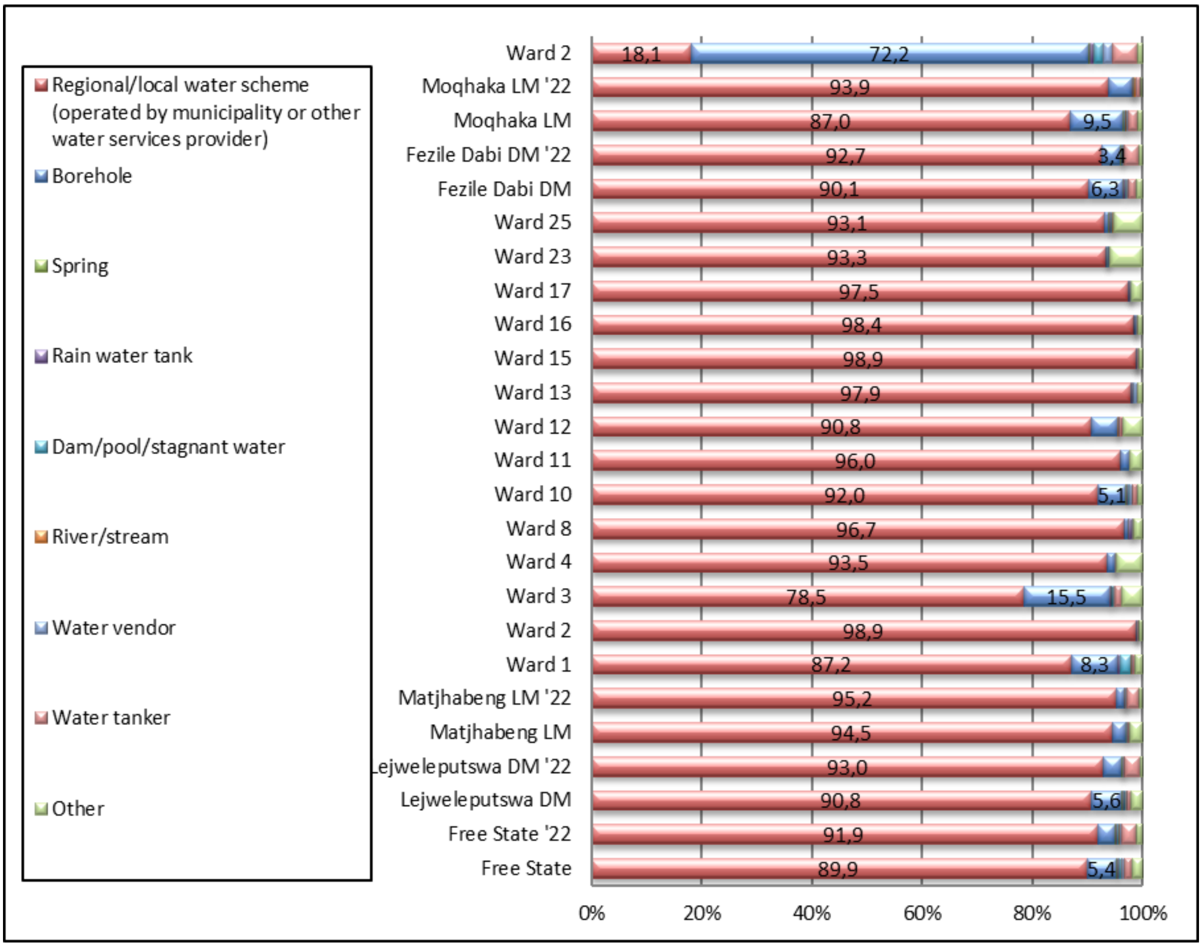


Figure 33: Water source (shown in percentage, source: Census 2011, Census 2022).

Access to piped water, electricity and sanitation relate to the domain of Living Environment Deprivation as identified by Noble et al (2006). Just over three quarters of households in Ward 8 has access to piped water inside the dwelling (**Figure 34**). This is much higher than on local, district and provincial level. The proportion of households in Wards 1, 2, 17, and 23 with access to water inside their dwellings are much lower that on local, district and provincial level.

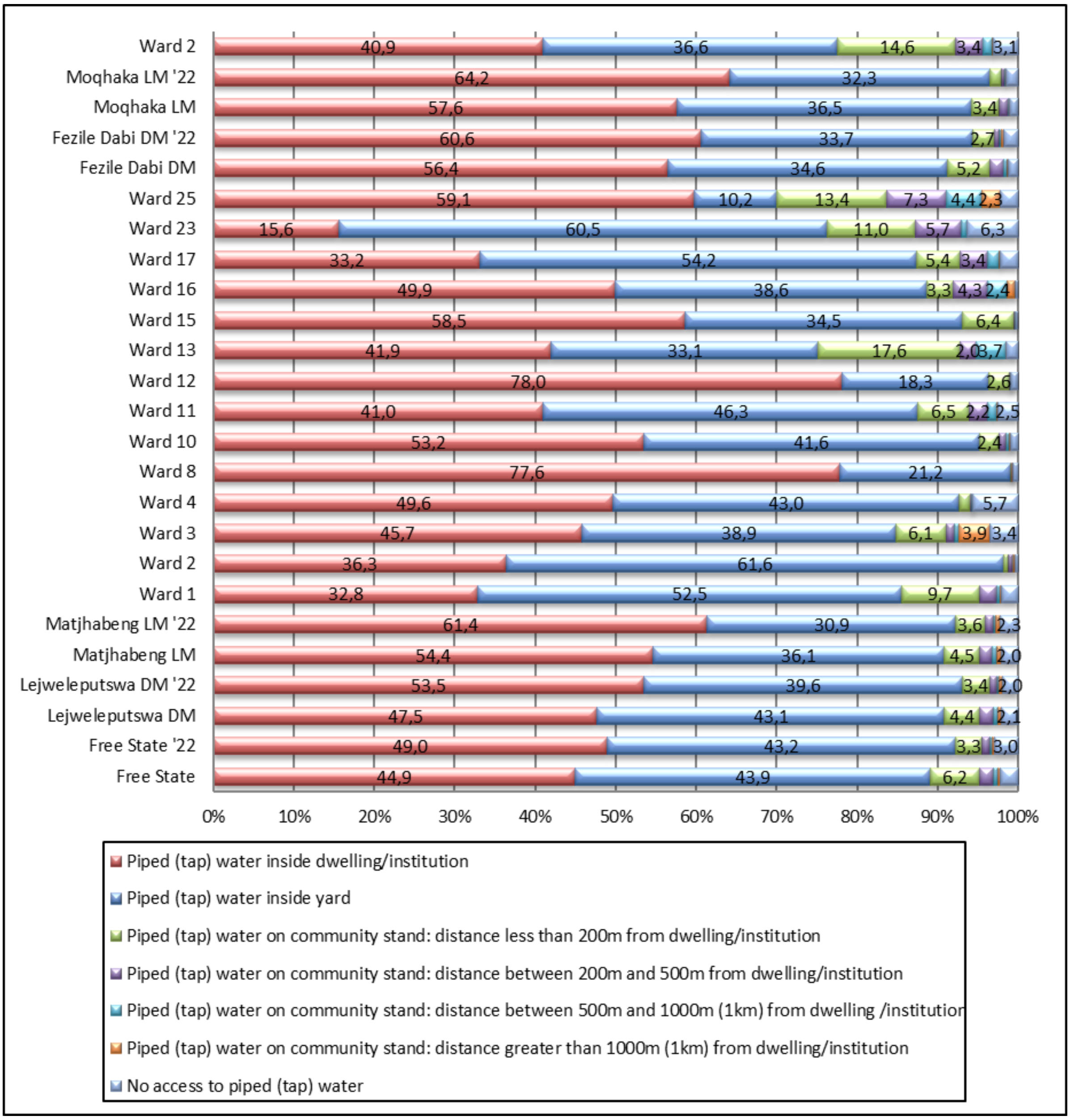


Figure 34: Piped water (shown in percentage, source: Census 2011, Census 2022).

The majority of households in Ward 23 have access to a pit toilet without ventilation (**Figure 35**). The level of access to flush toilets that are connected to a sewerage system varies between the wards.

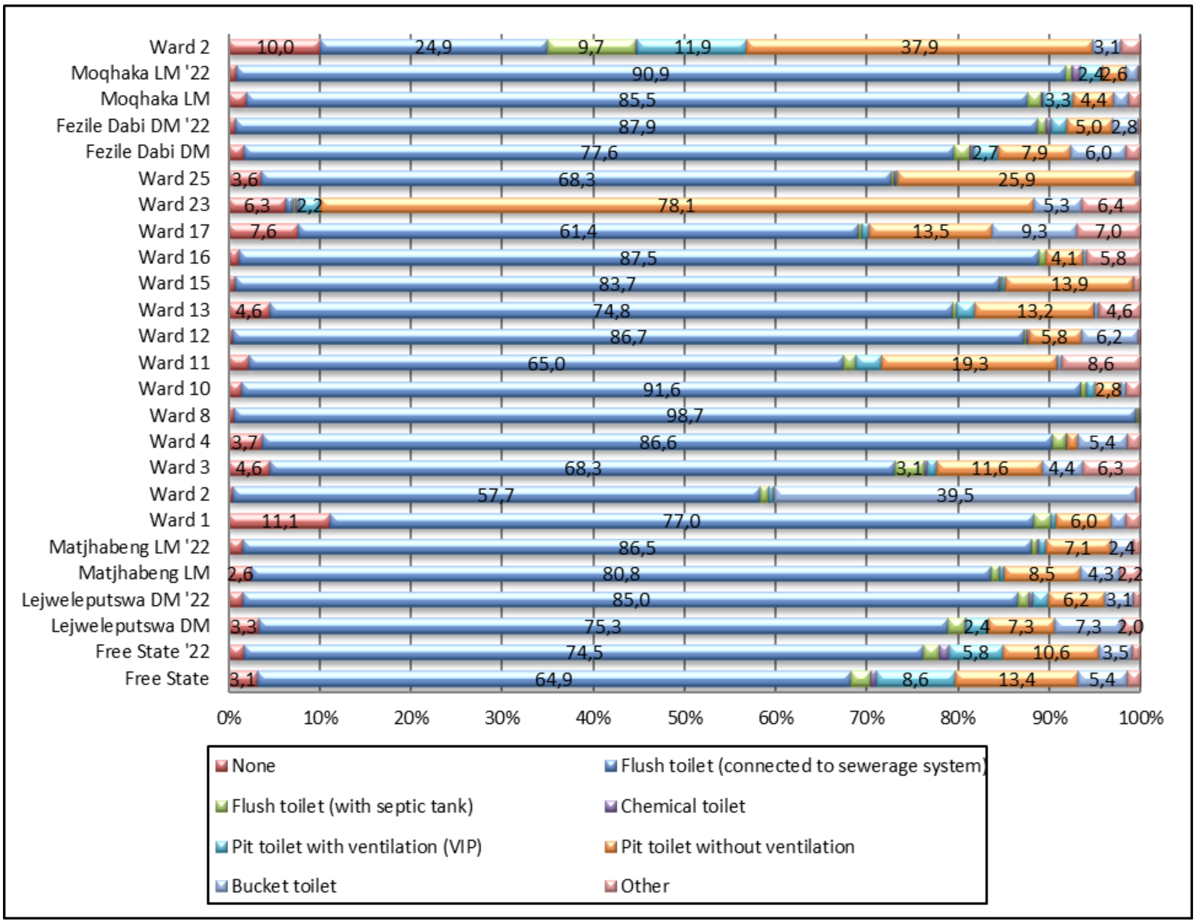


Figure 35: Sanitation (shown in percentage, source: Census 2011).

4.5.3.5 **ENERGY**

Electricity is seen as the preferred lighting source (Noble *et al.,* 2006) and the lack thereof should thus be considered a deprivation. Even though electricity as an energy source may be available, the choice of energy for cooking may be dependent on other factors such as cost. Wards 13, 23 and 25 of Matjhabeng LM and Ward 2 of the Moqhaka LM have the lowest proportion of households with access to electricity as energy source for lighting (**Figure 36**). It is evident from the energy source usage that gas is underutilized in the area although there is direct evidence includes gas-emitting boreholes, nearby commercial gas production, gas encountered during drilling and underground mining operations in the region.

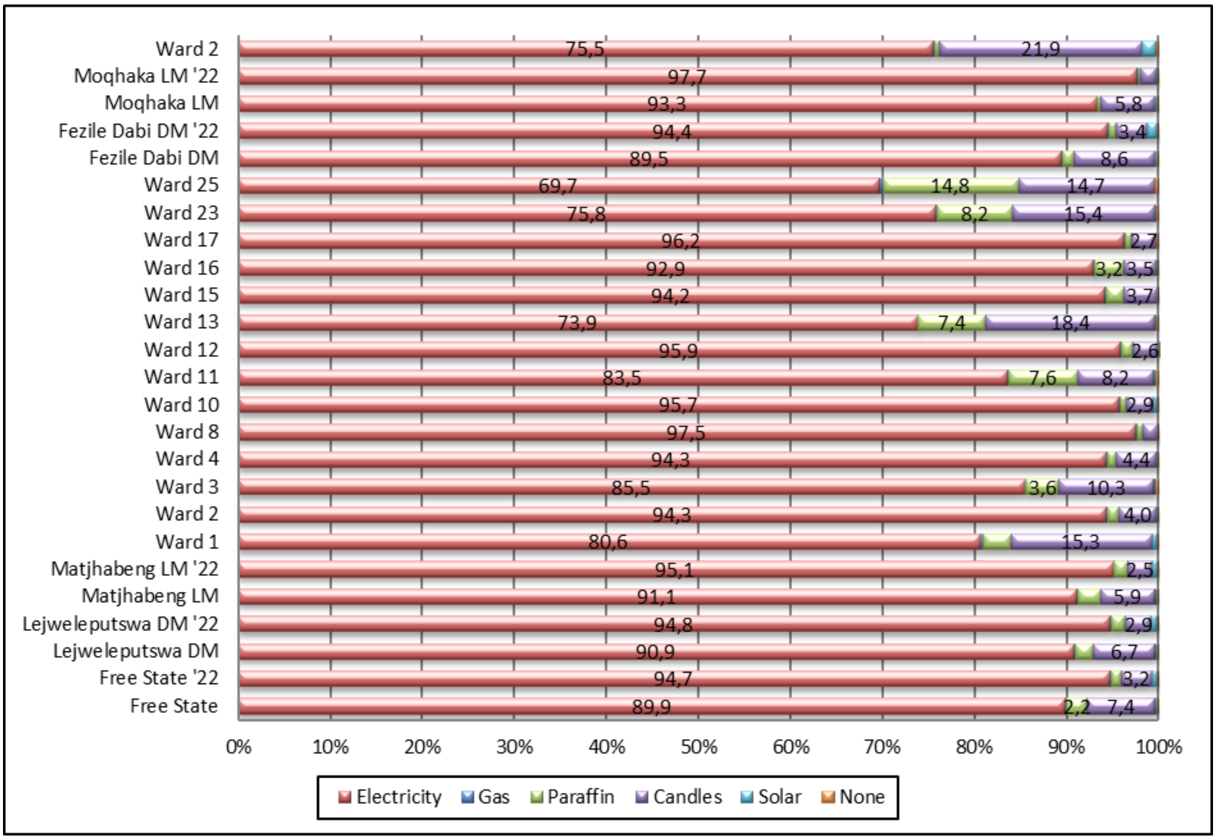


Figure 36: Energy source for lighting (shown in percentage, source: Census 2011, Census 2022).

4.6 CULTURAL HERITAGE RESOURCES

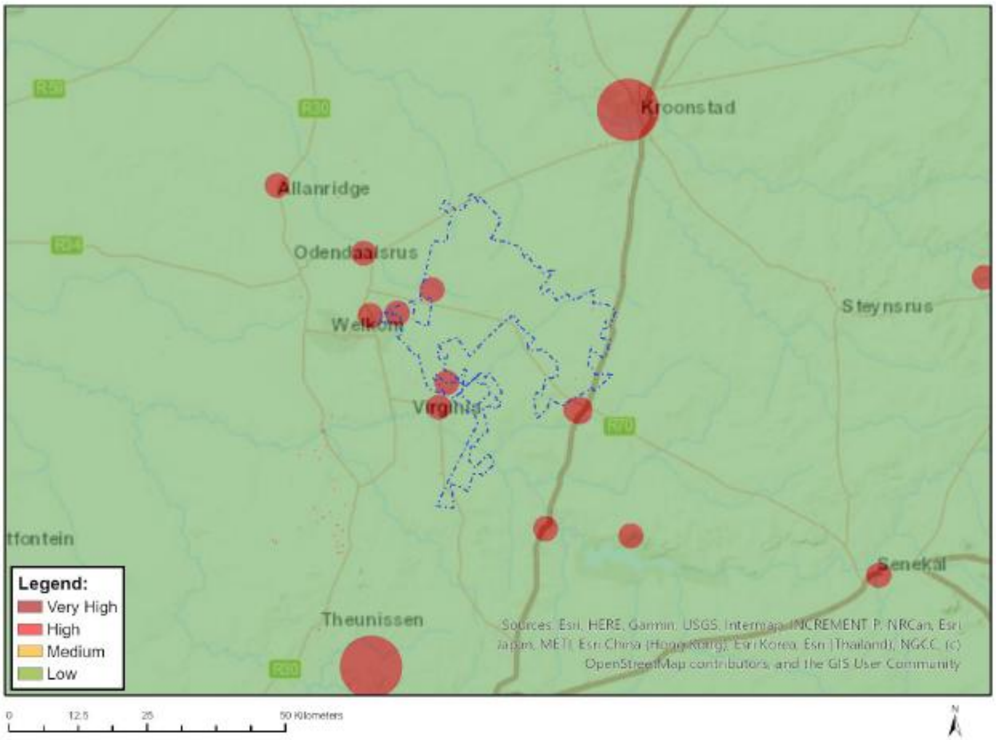
The objective of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) is to introduce an integrated system for the management of national heritage resources. The Act defines a 'heritage resource' as any place or object of cultural significance (aesthetic, architectural, historical, scientific, social, spiritual, linguistic, or technological value or significance). The identification, evaluation and assessment of any cultural heritage site, artefact or find in South Africa is required by this Act. This section of the report presents the heritage status of the proposed D3 Energy ER386 in Welkom.

According to the Heritage Impact Assessment Report undertaken by Dr Lucien James (EIMS, 2026), the Free State has a rich archaeological and historical history going back millions of years and includes significant aspects such as Later Stone Age rock art, Battlefields and Iron Age stonewalled enclosures. The general surroundings of the study area became a melting pot of contact and conflict as it represents one of many frontiers where San hunter-gatherers, Nguni and Sotho-Tswana agro-pastoralists, Dutch Voortrekkers and British Colonists all came together. The ravages of war also swept across these plains, and in particular the South African War (1899-1902) as well as the Boer Rebellion (1914-1915).

4.6.1 HERITAGE SCREENING

4.6.1.1 RELATIVE ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME SENSITIVITY

According to the DFFE Screening Tool Report, ER386 is located within an area of *low to very high* relative archaeological and cultural heritage theme sensitivity (see **Figure 37**). An assessment of the NHRA and project information revealed that the proposed development triggers Section 38(1) of the NHRA. Therefore, a Heritage Impact Assessment was required. The South African Heritage Resources Agency (SAHRA), the Free State Heritage Resources Authority (FSPHRA) and Association of Southern African Professional Archaeologists (ASAPA) are stakeholders in the project and were provided with a copy of the Scoping Report for review and comment. These stakeholders have also been provided with a copy of this EIA Report for review and comment. It must be noted that at the time of compilation of this report, no objections were received from the stakeholders.



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
High	Within 150m of a Grade IIIa Heritage site
High	Within 100m of a Grade IIIb Heritage site
High	Within 50m of a Grade IIIc Heritage site
Low	Low Sensitivity
Very High	Within 2km of a Grade II Heritage site
Very High	Within 100m of an Ungraded Heritage site

Figure 37: Map of relative archaeological and cultural heritage theme sensitivity (DFFE, 2025).

Based on the Heritage Impact Assessment Report (**Appendix F)**, the ER was assessed using Google Earth as well as available surveys and mapping resources via the CDNGI Geospatial Portal (http://www.cdngiportal.co.za/cdngiportal/). First Edition Topographic maps (2726DD, 2826BB, 2827AA, 2727CC) of the area were analysed. As the maps were drawn between 1945 and 1975, it would include information on observations within the footprint of the development. Altogether, 38 potential heritage features were identified, including, ruins, potential stone wall structures, old farm complexes, and graves or grave sites. The two Grade II provincial heritage features previously identified and discussed are further presented in terms of their location and proximity to proposed activities.

4.6.1.2 **2726DD**

The area covered by these topographic maps includes 5 target areas and associated seismic transects. Several observations were made considering topographic maps dated 1945 and 1954. A total of 17 potential heritage features were identified which may be affected by the **initially proposed activities**. **These activities have since changed, however, this report still considers features which were initially identified considering the initially proposed activities (which included additional target areas and seismic lines) as they are still located within ER386** Many of these features were identified as old structures, or current farm complexes with several ruins or old buildings recognisable through an assessment of Google Earth imagery. Given that these features would be older than 60 years, it is understood that they are protected by the NHRA. The area covered by the maps also includes one of the identified Grade II sites, that is, the grave of Itumeleng Caswell Mokobo, a political figure. The grave is located in the Phumulani Cemetery of Welkom. Although the further sections of the 2km buffer associated with the feature does intersect with proposed activities' area of interest, it is anticipated that the activities will in no way affect the grave. The feature is almost 1,9 kms from the closest seismic transect. This is further substantiated by the fact that the feature does not stand alone and is located in a cemetery which will not be affected by the proposed activities. Refer to **Figure 38** for one of the extracts of the maps indicating the approximate location of heritage features as identified through Google Earth.

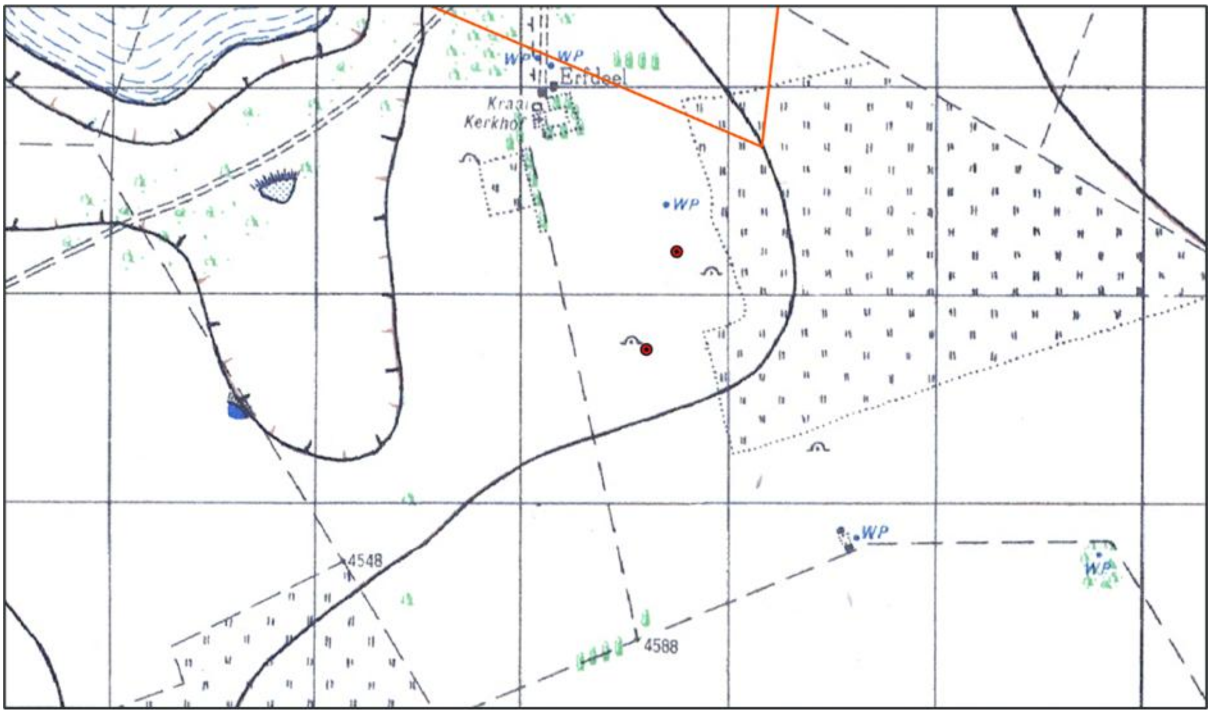


Figure 38: Extract of the 2726DD First Edition Topographic Map dated 1945. Map indicates the approximate location (determined through Google Earth) of potential heritage features (red points) within the ER area (orange boundary) at the western section of ER386 south of Harmony Masimong 5 Shaft. These features would have initially intersected with previously proposed transects and target areas.

4.6.1.3 **2826BB**

The area covered by these topographic maps includes 3 target areas and associated seismic transects. Several observations were made considering the first edition topographic map dated 1954. A total of 6 potential heritage features were identified which may be affected by the proposed activities. An additional 4 potential heritage features were identified within, and adjacent to the ER Area. While these features (MO003, MO004, MO005, MO006) will not be affected by the proposed activities, they have been identified providing context to the nature of heritage structures of the area. Many of these features were identified as old structures, or current farm complexes with several ruins or old buildings recognisable through an assessment of Google Earth imagery. A potential stone wall structure complex was also identified (MO030). A prospecting borehole was also identified (MO029). Given that these features would be older than 60 years, it is understood that they are protected by the NHRA. The area covered by the maps also includes one of the identified Grade II sites, that is, Ferreirasrust, a farmhouse which was nominated as a provincial heritage site. Similarly to the grave of Itumeleng Caswell Mokobo, the further reaches of the 2km buffer associated with Ferreirasrust intersects with the proposed seismic transects. Activities are expected to take place approximately 1,8 kms from the Grade II heritage feature but will not affect the feature or surrounding sense of place. Refer to **Figure 39** for one of the extracts of the maps indicating the approximate location of heritage features as identified through Google Earth.

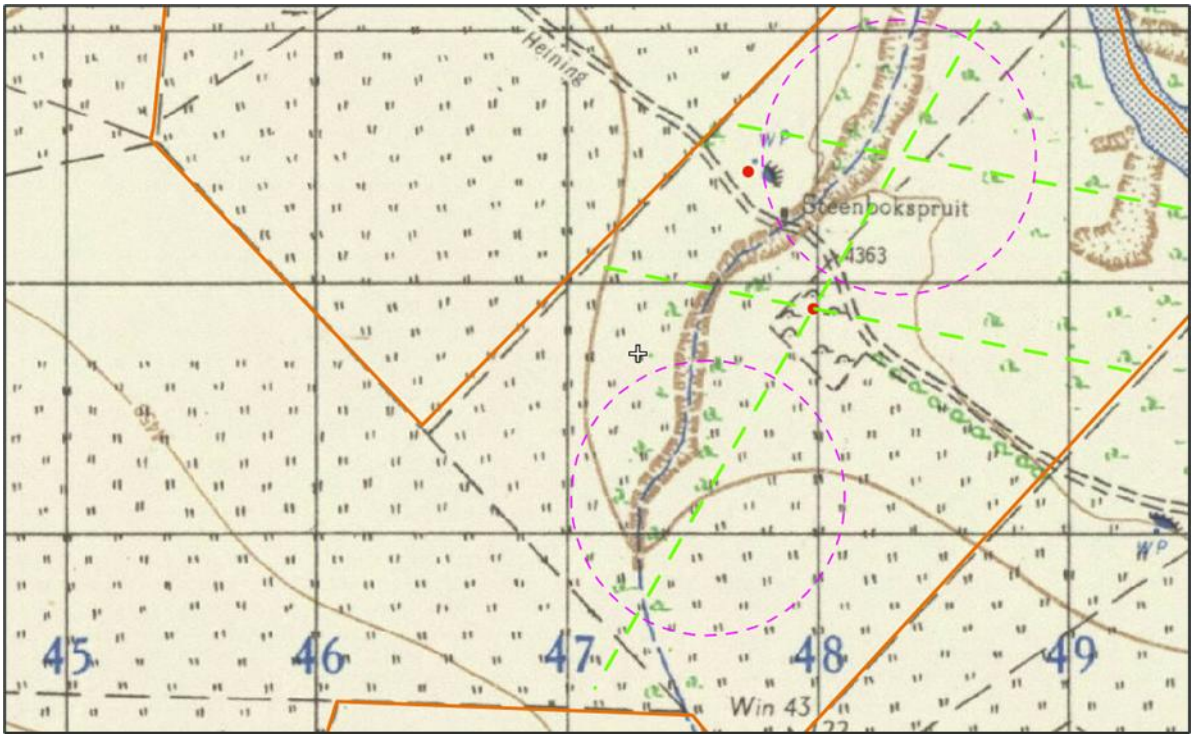


Figure 39: Extract of 2826BB First Edition Topographic Map dated 1954. The approximate location (determined through Google Earth) of features that still stand associated with farm complex "Steenbokspruit" such as a farm dam were plotted (red points) near Target Areas 1 and 2.

4.6.1.4 **2827AA**

The area covered by these topographic maps includes no target areas, but a short section of a seismic transect. Several observations were made considering the topographic maps dated 1951 and 1975. A total of 3 potential heritage features were identified which may be affected by the proposed activities. This included a feature marked on the maps as a “shed” (MO020) and a feature marked as a “native hut” (MO021). A grave (MO035) was also identified however, this feature is more than 500m away from the closest seismic transect. Refer to **Figure 40** for extracts of the map indicating the approximate location of heritage features as identified through Google Earth.

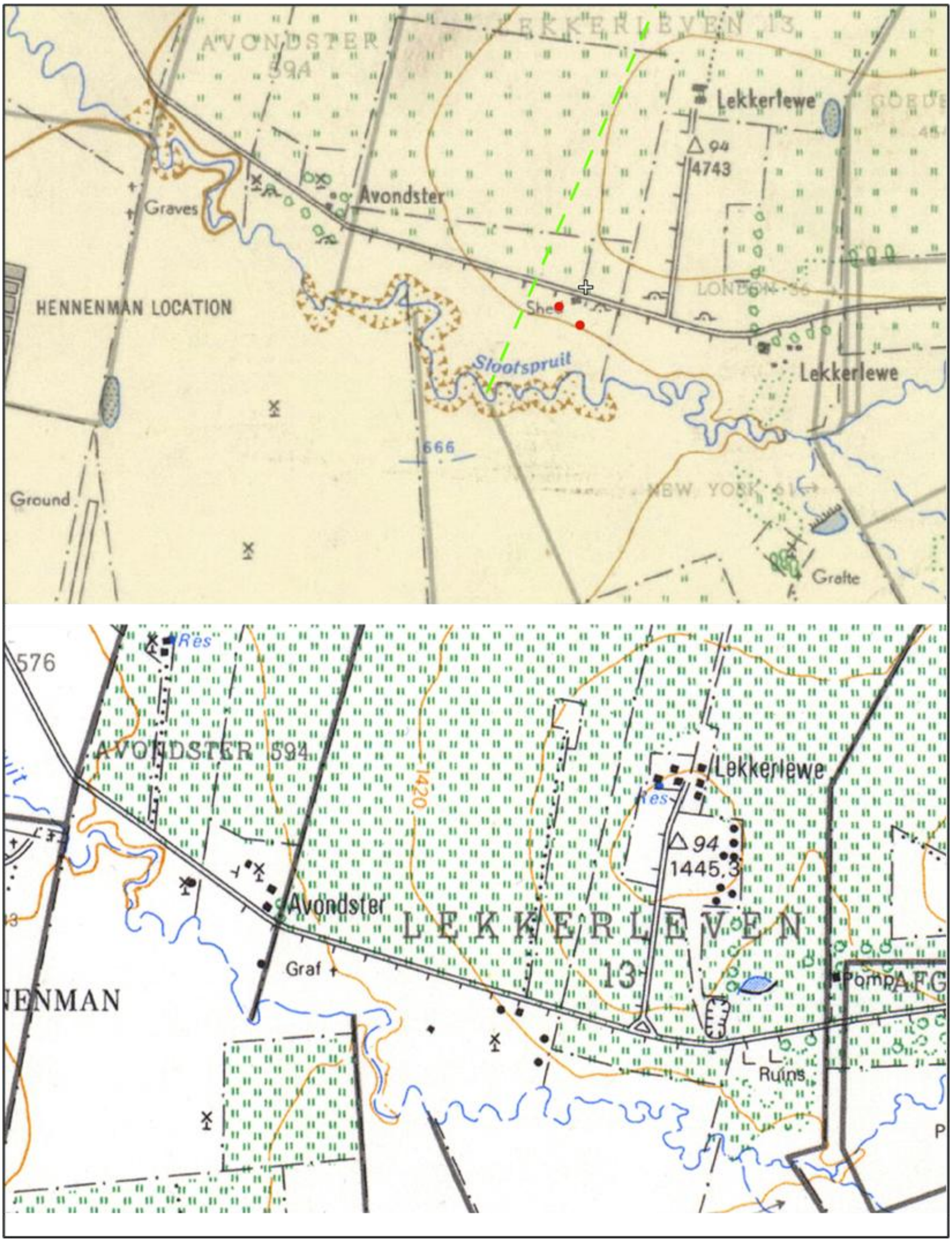


Figure 40: Extract of 2827AA First Edition Topographic Map dated 1951 (top) and a 1975 map (bottom). The approximate location (determined through Google Earth) of features (red points) labelled “Shed” and a nearby structure were identified as structures older than 60 years in proximity of a seismic transect (green dashed lines). A grave (labelled “Graf”) on the 1975 map was also identified near seismic transect HF1.

4.6.1.5 **2727CC**

The area covered by these topographic maps includes no target areas but does cover an area intersected by several proposed seismic transects. Several observations were made considering the topographic maps dated

1958. A total of 8 potential heritage features were identified which may be affected by the proposed activities. Many of these features were identified as old structures, or current farm complexes with several ruins or old buildings recognisable through an assessment of Google Earth imagery. Given that these features would be older than 60 years, it is understood that they are protected by the NHRA. Further, a cemetery was also identified (MO010), as well as a feature marked as "Graves" (MO023). Refer to **Figure 41** for extracts of the map indicating the approximate location of heritage features as identified through Google Earth.

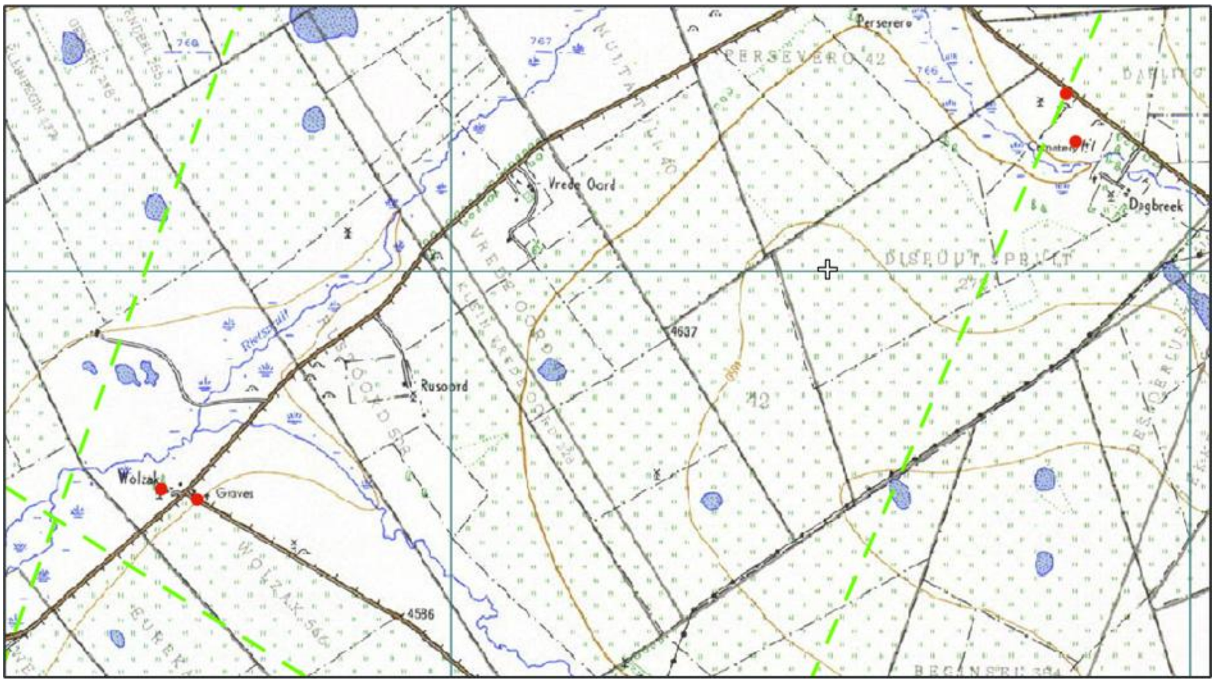


Figure 41: Extract of 2727CC First Edition Topographic Map dated 1958. The approximate location (determined through Google Earth) of graves (bottom left) and a cemetery (top right) along and in proximity to seismic transects (green dashed lines) were plotted (red points).

4.6.1.6 SUMMARY OF BASELINE HERITAGE FINDINGS

Altogether, besides for Grade II provincial heritage features identified, 31 structures, buildings, or complexes as well as three grave sites were identified as having or potentially having heritage significance. The graves in question are protected by the NHRA and have been provisionally graded as Grade III A or of High significance. All structures, buildings, complexes, or ruins thereof have been provisionally graded as Grade IV A or of Medium significance. This suggests that mitigation must take place should proposed activities have the potential to disturb these features. **Figure 42** present a visual summary of the main findings and their locations. Buffers of the Grade II features are illustrated on the maps. Buffers associated with other sites are too small to be illustrated on the maps. **Table 17** provides a summary of the different features identified, a description of the feature, as well as the coordinates of a relative central point associated with the find.

Table 17: Summary of different finds identified. Grade III A features highlighted in yellow. After site verification, some features were removed (highlighted in blue) (EIMS, 2026).

Feature No.	Description	Ratings and Significance	Coordinate
MO001	Huts or structures – Although no longer present, site may still hold remains dating 60 years or older. No surface features can be observed at the location as the area has been substantially disturbed.	None	28°9'50.73"S, 26°58'51.04"E
MO002	Farm dam – Structure dating 60 years or older. Additional features were noted in proximity including an associated windmill, and telephone junction box located between MO002, and MO037.	Grade IV A Medium	28°9'34.51"S, 26°58'42.32"E
MO003	Historical ruin – structure dating 60 years or older.	Grade IV A Medium	28°2'9.46"S, 26°57'23.46"E
MO004	Farm dam – Structure dating 60 years or older.	Grade IV A Medium	28°2'24.61"S, 26°57'12.05"E
MO005	Farm Complex – Structures dating 60 years or older.	Grade IV A Medium	28°2'41.14"S, 26°58'23.09"E
MO006	Ruins of a farm dam – foundation remains dating 60 years or older.	Grade IV A Medium	28°2'42.82"S, 26°58'13.19"E
MO007	Farm Complex – Welgegund. Farm complex may include structures dating 60 years or older.	Grade IV A Medium	28°1'30.53"S, 26°54'31.33"E
MO008	Farm Complex – Roemryk. Farm complex may include structures dating 60 years or older. Also includes a nearby hut.	Grade IV A Medium	27°58'14.81"S, 26°57'0.58"E
MO009	Historical ruins of a settlement area – structure dating 60 years or older.	Grade IV A Medium	27°56'21.84"S, 27°8'29.78"E
MO010	Cemetery – Graves may be 60 years or older.	Grade III A High	27°56'32.13"S, 27°8'32.11"E
MO011	Historical ruin – structure dating 60 years or older.	Grade IV A Medium	27°55'10.98"S, 27°5'29.68"E
MO012	Historical ruins of a settlement area – structure dating 60 years or older.	Grade IV A Medium	27°52'21.61"S, 26°59'12.08"E
MO013	Farm dam – Structure dating 60 years or older.	Grade IV A Medium	27°51'20.91"S, 26°58'37.08"E
MO014	Farm Complex – Bluegum Grove. Farm complex may include structures dating 60 years or older.	Grade IV A Medium	27°51'18.03"S, 26°58'39.63"E

Feature No.	Description	Ratings and Significance	Coordinate
MO015	Historical ruins of a settlement area – structures dating 60 years or older.	Grade IV A Medium	27°51'7.97"S, 26°58'35.34"E
MO016	Farm Complex – Graspan. Farm complex may include structures dating 60 years or older.	Grade IV A Medium	27°49'15.07"S, 26°58'20.42"E
MO017	Ruins of Farm Complex – Donkerhoek. Farm complex may include structures dating 60 years or older.	Grade IV A Medium	27°49'44.18"S, 26°58'9.80"E
MO018	Farm dam and Kraal area - structures dating 60 years or older.	Grade IV A Medium	27°54'8.61"S, 26°59'15.77"E
MO019	Huts or structures – Although no longer present, site may still hold remains dating 60 years or older.	Grade IV A Medium	27°52'26.02"S, 27°0'27.92"E
MO020	Historical ruin – foundation of structure dating 60 years or older.	Grade IV A Medium	28°0'54.37"S, 27°6'20.88"E
MO021	Historical ruins of a settlement area – structures dating 60 years or older.	Grade IV A Medium	28°0'57.06"S, 27°6'24.33"E
MO022	Location of demolished Farm Complex – Wolzak. Site may include heritage finds.	Grade IV A Medium	27°57'46.77"S, 27°4'49.38"E
MO023	Grave site - Graves may be 60 years or older.	Grade III A High	27°57'49.01"S, 27°4'58.16"E
MO024	Historical ruins of a settlement area – structures dating 60 years or older.	Grade IV A Medium	27°57'24.80"S, 26°54'47.82"E
MO025	Farm dam – Structure dating 60 years or older.	Grade IV A Medium	27°56'17.31"S, 26°54'5.26"E
MO026	Farm Complex – Dew Drop. Farm complex may include structures dating 60 years or older.	Grade IV A Medium	27°52'28.35"S, 27°1'40.77"E
MO027	Location of demolished Farm Complex – Uitzicht or Uitkyk. Site may include heritage finds.	Grade IV A Medium	27°50'12.63"S, 26°56'22.40"E
MO028	Location marked as ruins - Site may include heritage finds.	Grade IV A Medium	27°50'43.90"S, 26°55'35.43"E
MO029	Prospecting borehole – feature older than 60 years	Grade IV A Medium	28°0'34.41"S, 26°54'0.32"E
MO030	Potential Stone Walled Structure – removed from list as observations were not confirmed.	None	28°1'39.78"S, 26°54'16.19"E

Feature No.	Description	Ratings and Significance	Coordinate
MO031	Historical ruin – structure dating 60 years or older.	Grade IV A Medium	27°56'23.30"S, 26°54'11.65"E
MO032	Huts or structures – Although no longer present, site may still hold remains dating 60 years or older.	Grade IV A Medium	27°55'15.93"S, 27°8'58.63"E
MO033	Hut or structure – Site is densely vegetated but may still hold remains dating 60 years or older.	Grade IV A Medium	27°58'31.72"S, 26°53'3.69"E
MO034	Hut or structure – Site is densely vegetated but may still hold remains dating 60 years or older.	Grade IV A Medium	27°58'17.72"S, 26°53'8.61"E
MO035	Cemetery – Graves may be 60 years or older.	Grade III A High	28°0'48.61"S, 27° 5'54.48"E
MO036	Farm Complex – Bothasrus. Farm complex may include structures dating 60 years or older.	Grade IV A Medium	27°49'48.46"S, 26°58'27.12"E
MO037	Farm dam – The feature is related to the infrastructure identified as MO002. Feature is older than 60 years.	Grade IV A Medium	28°9'33.92"S, 26°58'44.90"E
MO038	Graveyard – The feature was noted along a dirt path close to ruined buildings of Donkerhoek (MO017)	Grade III A High	27°49'22.35"S, 26°58'5.32"E
MO039	Grave yard including at least 4 individual graves. Graves are marked with headstones. Only noted headstone with a date dated back to 2002.	Grade III A High	27°52'23.66"S, 26°58'58.84"E
MO040	Rotary hoe of the mid-20th Century – The feature is potentially older than 60 years.	Grade IV B Medium	27°59'1.68"S, 27°6'43.99"E
MO041	Graveyard including at least 30 individual graves. Graves are marked with headstones dating as early as 1949.	Grade III A High	27°58'54.02"S, 27° 6'40.10"E
MO042	Feeding trough made of a mid-20th Century tank – The feature is potentially older than 60 years.	Grade IV B Medium	28°9'40.03"S, 26°58'44.50"E

The exploration area is extensive, the site intersects, and is in proximity of several Grade III heritage sites, as well as several Grade II or nominated Provincial heritage sites. This highlighted sensitivity corresponds with Grade II sites, the farmhouse, Ferreirasrust (9/2/318/0001), and several graves of political figures located along the outskirts of Welkom. It was further ascertained that the Very High sensitivity attributed to the ER from the DFFE Screening Report is in relation to Ferreirasrust, and the graves nominated as Grade II provincial sites. Since the ER area is so extensive, sections of the area intersect with the applied buffers of 2km which surrounds these Grade II provincial heritage sites. It is understood that the proposed seismic transects may intersect with the 2km buffers associated with Ferreirasrust and a Grade II grave in Welkom, however, the proposed activities will have no impact on the Provincial heritage features highlighted given their distance from the TAs, and the nature of the proposed seismic survey activities (the impact of this survey is not expected to affect the sense of place which the buffer in place is meant to preserve). Further, the defined 500 m TAs do not fall within any of the buffers associated with these features.

4.6.2 SITE-SPECIFIC HERITAGE

The appointed Archaeologist surveyed the various areas which fall within the proposed development footprint over a two-day site visit in March 2026. The survey covered mainly the Target Areas as well as sections of the seismic transects of the ER with the intention to identify sensitivities in terms of heritage significance which may be affected by proposed activities. Various dirt paths, farmhouses, broken down infrastructure, ploughed agricultural land, overgrown agricultural land, and crop fields characterise the site. The heritage of the landscape has been altered over the years through the extensive farming activities which took place and has been taking place. Hennenman was noted as the most central urban space in proximity to the ER. Six (6) features of archaeological significance were identified in addition to the features identified through the desktop assessment. These features consisted of three (3) additional grave sites, as well as three (3) structures or in-situ features related to mid-20th Century farming activities discussed below.

4.6.2.1 FARMHOUSES AND FARM COMPLEXES

Features noted included abandoned farmhouses, windmills or windpumps, farm dams, whole farm complexes including several buildings of the mid-20th Century, as well as in-situ farming implements and devices. Some of the farm buildings identified through the desktop assessment were verified through the field survey. For instance, the extent of one of the largest abandoned farmhouses and associated complex, Donkerhoek (MO017) was surveyed (**Figure 43**). The main house itself was assessed and key features of the structure which stood out included its double-stack chimney which is an iconic feature of rural Free State houses of the early to mid-20th Century. The gable of the house presents an opportunity to date to house back to a period in South Africa associated with the Cape Dutch Revival. These features suggest that the house can be dated back to at least the 1920s. This period saw a surge in the construction of houses with this architectural style given that the style was seen as a moving away from Victorian architectural styles. Such structures are examples of early 20th Century post-war movements of the Afrikaans community against British colonialism.

The ruins of the main house of the Donkerhoek farm complex may be as much as 100 years old holding evidence of change throughout the 20th Century. Such farmhouses and farm complexes are characteristic of the ER area and must be considered as structures with heritage potential as they embody the rich history of the Free State. These features have been rated as Grade IV A, that is of High-Medium heritage significance.

4.6.2.2 FARMING IMPLEMENTS AND INFRASTRUCTURE

Associated with the farm complexes and activity of the area, several examples of farming implements and examples of farm infrastructure were expected and noted during the field survey. These included features which were not specifically noted as part of farm complexes including isolated farm dams and windmills or windpumps. In addition to these features, a telephone junction box, metal feeding trough, and rotary hoe were also identified.

Windmills and farm dams were noted throughout the study area. Some were noted through the desktop assessment which were then verified through the field survey such as MO002. In proximity to MO002, an associated windmill or windpump feature was identified, as well as a telephone junction box. These features allowed for a more refined dating of MO002 and MO037. The windmill (**Figure 44**) is an example of mid-20th Century farming technology. Time period markers of the remains of the windmill include the fact that the structure was riveted, and not electric arc welded. This suggests that the structure was fabricated at least pre-1940s. However, the structure may have been placed later.

A telephone junction box was found near the windmill structure (**Figure 45**). This feature provides an understanding of the change and continuity related to communication networks of the area between the mid and late 20th Century. The box would have connected several telephone lines allowing farmers in the rather rural area a communication channel. This feature, together with the windmill have been considered as features of site MO002. MO002 maintains its initial rating of Grade IV A, being of High-Medium heritage significance

MO037 was identified in a densely vegetated patch which would not have otherwise been able to be identified through the desktop assessment. While the site itself is close to MO002, it was marked as a separate heritage structure. MO037 is a farm dam which appeared to be constructed including the typical corrugated iron wall, as well as concrete rim (**Figure 46**). The feature would have been of the same period as the windmill or perhaps earlier suggesting it may have been built between the early and mid-20th Century. As with the other farm dams identified, MO037 was rated as Grade IV A, that is of High-Medium heritage significance.

During the field survey, a rotary hoe (MO040)(**Figure 47**) and feeding trough (MO042)(**Figure 48**) were also identified. The features would have been too small to be identified through the desktop assessment. Both features include riveted iron components suggesting that the manufacturing of these components predate electric arc welding. While both features do include electric arc welded parts (the overall structure of the rotary hoe and the anchoring poles of the trough), their exact date of placement at the locations found potentially point to a date between the 1950s and 1990s. Both features have been considered of heritage value as each provides an understanding of farming practices of the 20th Century. These features have been rated as Grade IV B, or of Medium heritage significance.

4.6.2.3 GRAVES / CEMETERIES

Three additional grave sites (MO038, MO039, and MO041) were identified during the field assessment. These features mainly graveyards including marked and dated graves (MO039 and MO041) as well as a graveyard enclosure within which no gravestones could be identified. The graveyard enclosure (MO038) was located several meters from the main house of the Donkerhoek farm complex (**Figure 49**). It is here suggested that this was the family graveyard of the estate. Key features noted which aided in concluding the description of the feature included the metalwork of the enclosure itself as well as the size and scale of the enclosure. Judging by its extent, the enclosure holds no more than six individual graves.

MO039 was located among crop fields. The feature has been deliberately avoided by farming activities and includes clearly marked headstones. A total of 4 individual graves were noted within a previously enclosed graveyard. Only one grave had legible dates on it. The date of death of the person interred was 2002. The other graves identified seemed to have been buried and broken as a result of soil movement around them.

MO041 was identified as the largest and best-preserved graveyard. Previously also enclosed, remains of the graveyard fence as well as the graveyard gate were noted. The graveyard was initially identified through the identification of the only headstone visible from far distances. Although 30 individual graves were noted, the graveyard may include unmarked graves. This is supported by the fact that some graves were only marked with corroded metal plaques. The oldest grave of the graveyard is dated 1949 (**Figure 50**). As with desktop observations, the three graveyards identified were rated as Grave III A features, or of High heritage sensitivity.

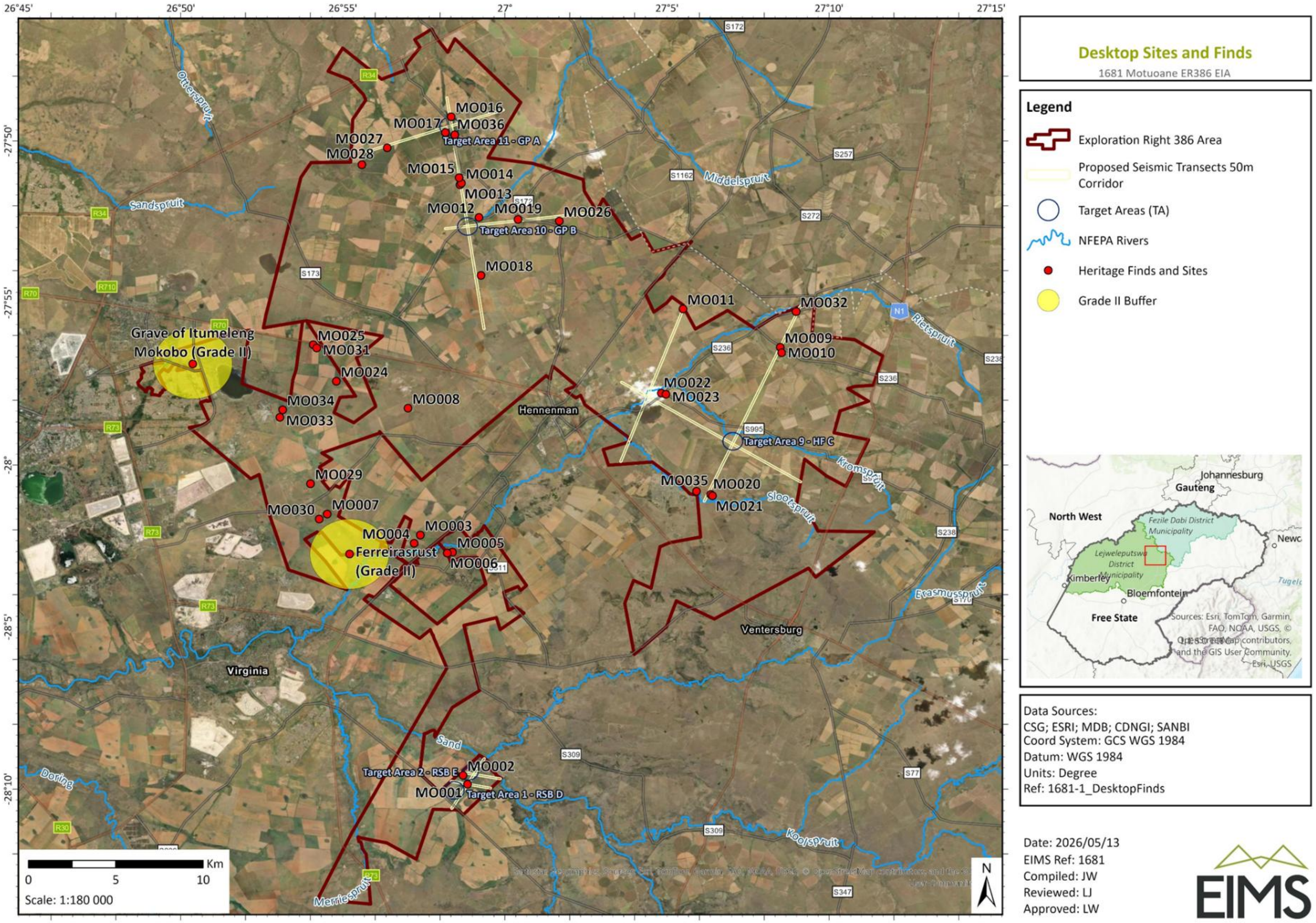


Figure 42: Map of potential heritage features across the ER Area including Grade II site 2km buffers.

Figure 43: Ruins of the main farmhouse of the Donkerhoek farm complex (MO017).

Figure 44: The remains of the windmill found near the farm dam, MO002

Figure 45: Telephone junction box found at MO002

Figure 46: MO037 Farm dam found near MO002

Figure 47: MO040 - Rotary hoe

Figure 48: MO042 - Feeding trough

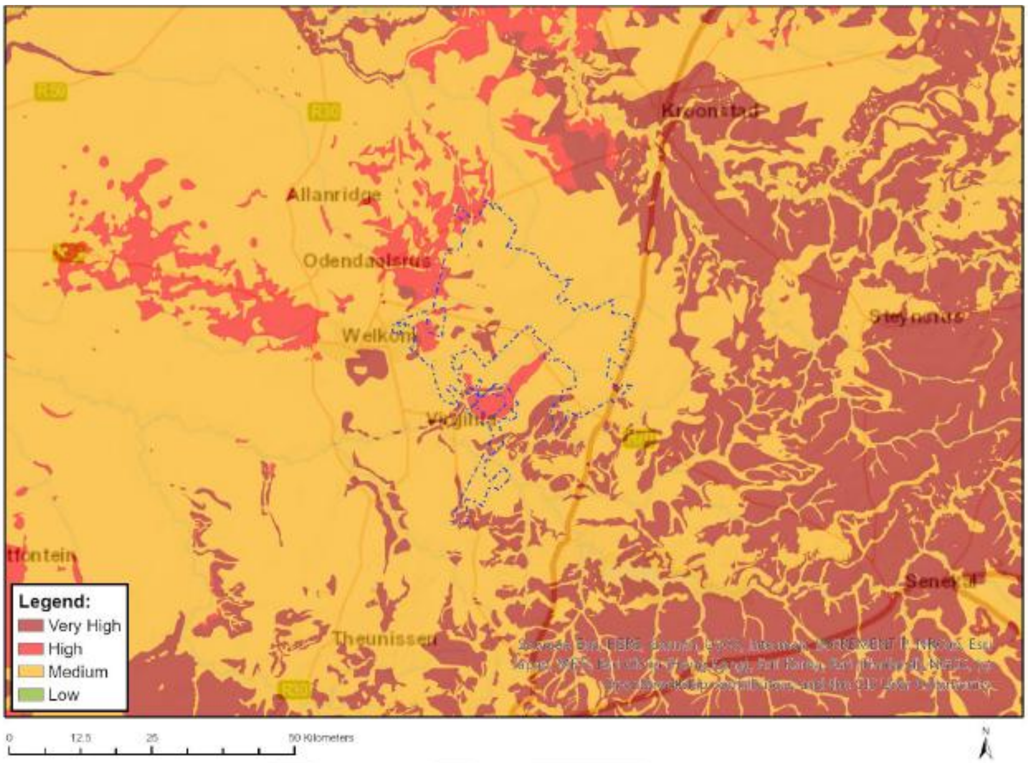
Figure 49: MO038 - Graveyard near Donkerhoek farm complex

Figure 50: MO041 - Oldest grave identified in the graveyard dated 1949

4.7 PALAEONTOLOGY

Cultural Heritage in South Africa, including all heritage resources, is protected by the National Heritage Resources Act (Act 25 of 1999) (NHRA). Heritage resources as defined in Section 3 of the Act include “all objects recovered from the soil or waters of South Africa, including archaeological and **palaeontological objects** and material, meteorites and rare geological specimens”. Palaeontological heritage is exceptional and non-renewable and is protected by the NHRA. Palaeontological resources and may not be unearthed, broken, moved, or destroyed by any development without prior assessment and without a permit from the relevant heritage resources authority as per section 35 of the NHRA.

Based on the 1:250 000 SAHRIS PalaeoMap and the National Web-Based Screening Tool Report, the study area is located within a *Very High* Palaeo-Sensitivity area (see **Figure 51**). The study area is located on an area which has largely been transformed but the proposed development entails deep excavations (650m boreholes). A Palaeontological Impact Assessment (PIA) will be undertaken for the project to confirm the preliminary findings and/or identify fossil resources and the potential impact by the proposed development as well as mitigation measures.



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
High	Features with a High paleontological sensitivity
Medium	Features with a Medium paleontological sensitivity
Very High	Features with a Very High paleontological sensitivity

Figure 51: Map of relative palaeontology theme sensitivity (DFFE, 2025).

According to the Palaeontological Impact Assessment Report for the ER (Fourie, 2025), the study area is underlain by Quaternary deposits, while the largest portion of the development is underlain by the Adelaide

Subgroup (Beaufort Group, Karoo Supergroup). The bulk of the site is underlain by the Karoo Supergroup Formations covered by vegetation, grass, trees, roads, and buildings. According to the Council for Geoscience (CGS) 1:250 000 geological maps (Geological Map Sheet 2726 Kroonstad and Geological Map Sheet 2826 Winburg), the surface geology of the study area is characterized by a variety of lithologies, formations, and intrusions. These include geologically recent Quaternary deposits; sediments of the Beaufort and Ecca Groups within the Karoo Supergroup; dolerite dykes, sheets, and sills associated with the Karoo Dolerite Suite; and post-Karoo kimberlite pipes and dykes. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of all Karoo Supergroup geological formations are ranked as VERY LOW to VERY HIGH, and here the impact is potentially VERY HIGH for the Beaufort Group, HIGH for Quaternary (Qs), MODERATE for Ecca rocks and the Qauternary (Qc). A wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. The Jurassic Dolerite does not contain fossils.

During the site visit in May 2025 by the Palaeontologist (refer to the Palaeontologic Assessment in **Appendix F**), no visible evidence of fossiliferous outcrops were found in within the target areas and seismic transects. An overall medium palaeontological significance is allocated for the project area.

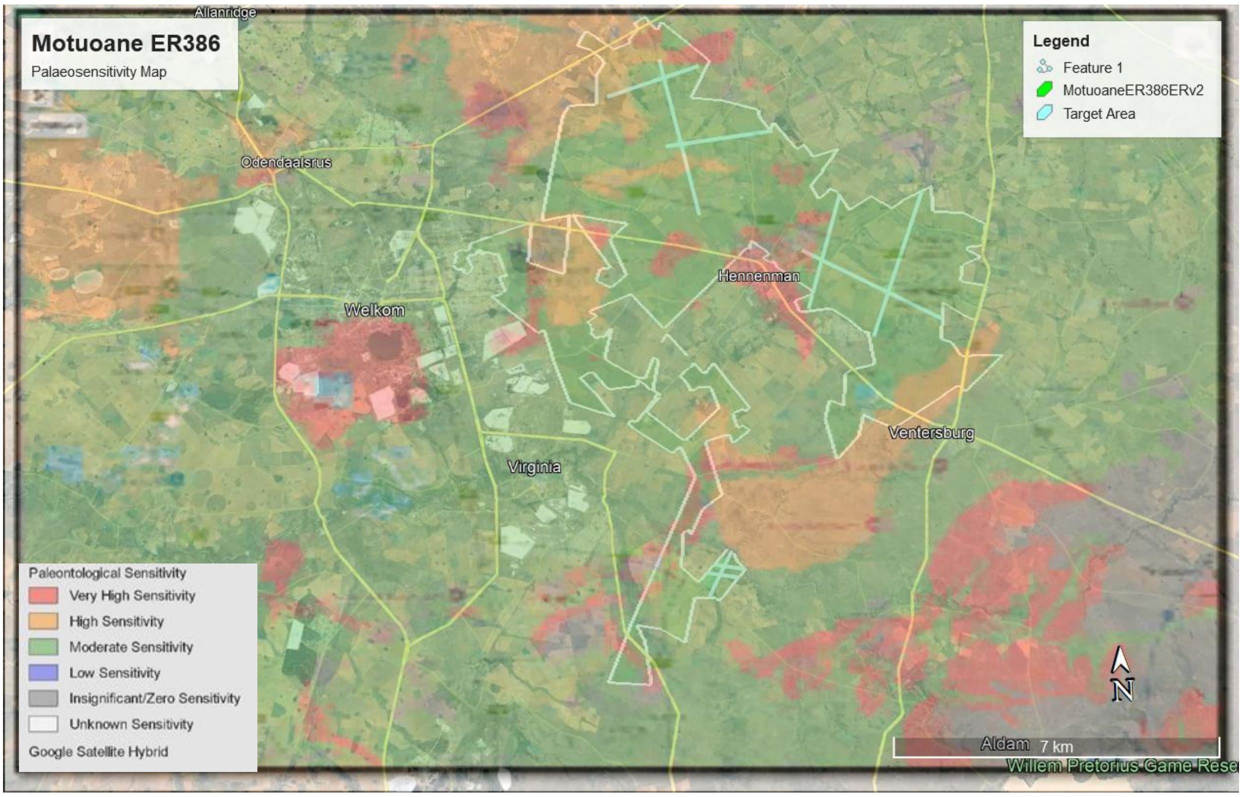


Figure 52: Extract of the SAHRIS PalaeoMap map (Dr Fourie, 2025).

4.8 SOILS AND AGRICULTURAL POTENTIAL

A Soils and Agriculture Assessment was undertaken by The Biodiversity Company (**Appendix F**). The baseline soil information was obtained using published South African Land Type Data. Land type data for the site was obtained from the Institute for Soil Climate and Water (ISCW) of the Agricultural Research Council (ARC) (Land Type Survey Staff, 1972 - 2006). The land type data is presented at a scale of 1:250 000 and comprises of the division of land into land types. In addition, a Digital Elevation Model (DEM) as well as the slope percentage of the area was calculated by means of the NASA Shuttle Radar Topography Mission Global 1 arc second digital elevation data by means of QGIS and SAGA software.

The land capability was determined by using the guidelines described in “The farming handbook” (Smith, 2006) which the DAFF land capabilities were further developed from. Accordingly, the identified soil forms associated with the ER are restricted to land capability 2 and 3, categorised between land capability 6-8 (Pinedene, Westleigh, Augrabies, Swartland and Glen soils) and land capability 8 (Witbank soil), categorised between land capability 1-5. The baseline soil land capability was compared to the National Land Capability data (DAFF, 2017). The land potential classes are further determined by combining the land capability results and the climate capability of a region.

4.8.1 SOIL FORMS

According to the land type database (Land Type Survey Staff, 1972 – 2006), the ER is characterized by the Bb1, Dc12, Dc8, Bd19, Bd21, Bd20, Ea40, Dc9 land types. Figure 53 illustrates the respective terrain units relative to the most prevalent land use type. The associated land capability ranges from Very Low-Low (02) to Moderate-High (10). Refer to **Figure 53** for the land types and land capabilities within the ER.

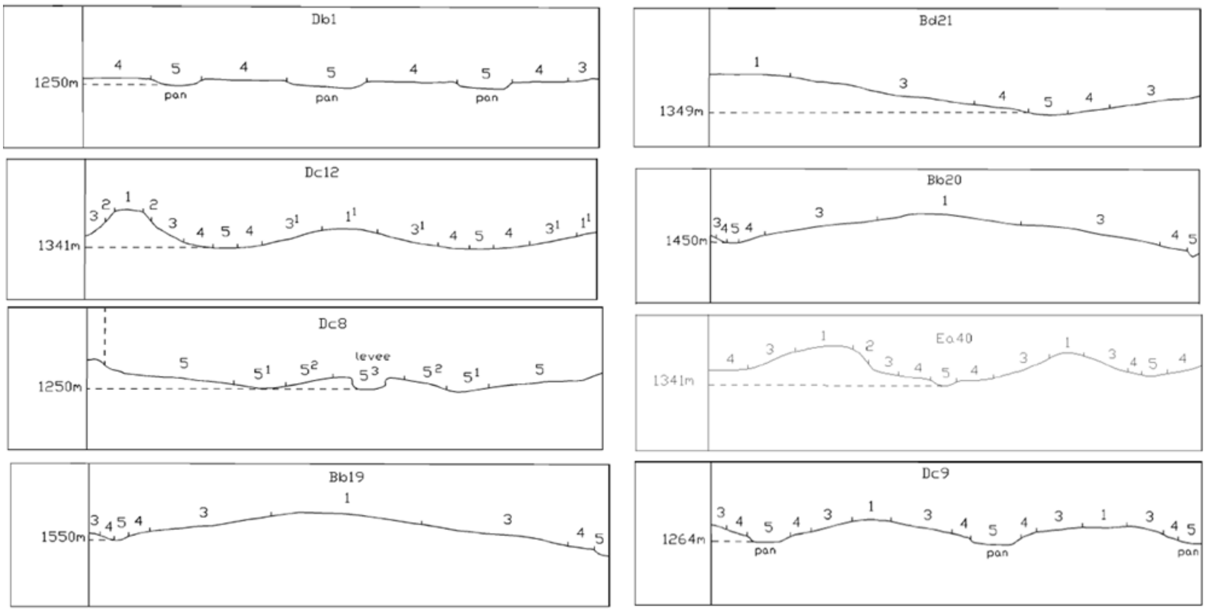


Figure 53: Illustration of Bb1, Dc12, Dc8, Bd19, Bd21, Bd20, Ea40, Dc9 and type terrain units (Land Type Survey Staff, 1972 – 2006) (The Biodiversity Company, 2026).

Fourteen (14) representative soil forms were identified in the proposed seismic survey drilling areas namely, Ermelo, Griffin, Hutton, Clovelly, Pinedene, Westleigh, Katspruit, Kroonstad, Rensburg, Sepane, Arcadia, Johannesburg, Stilfontein and Grabouw soil forms (**Figure 54**).

The most sensitive soil forms suitable for crop production identified within the seismic survey drilling areas includes the Ermelo, Griffin, Hutton and Clovelly soil forms. The Ermelo soil form consists of an orthic topsoil horizon on top of a thick yellow brown apedal horizon. The Griffin soil form consists of an orthic topsoil horizon on top of a yellow brown apedal horizon underlain with a red apedal horizon below. The Hutton soil form consist of an orthic topsoil horizon top of a thick red apedal horizon. The Clovelly soil form consists of an orthic topsoil horizon on top of a yellow brown apedal underlain with a lithic horizon below. These soils are usually used for crop farming due to their good drainage, aeration and nutrient and water holding capabilities. Furthermore, these soils are characterised with a high suitability for crop production due to the permeability of their underlying horizons that promotes water infiltration, root penetration and gas exchange.

The other soils identified within the proposed target areas include the Pinedene and Westleigh soil forms. The Pinedene soil form consists of an orthic topsoil horizon on top of a yellow brown apedal horizon underlain with a gleyic horizon below. The Westleigh soil form consists of an orthic topsoil horizon on top of a soft plinthic horizon underlain with a gleyic horizon below. These soil forms are usually used for crop farming due to their good nutrient and water holding capacity. However, these soils are characterised by period saturation of the subsurface horizons which may subject crops to waterlogging conditions.

Three (3) hydromorphic soils with signs of wetness identified within the proposed target areas includes the Katspruit, Kroonstad and Rensburg soil forms. The Katspruit soil form consist of an orthic topsoil horizon on top of a gley horizon. The Kroonstad soil form consists of an orthic topsoil horizon on top of an albic horizon underlain with a gley horizon below. The Rensburg soil form consists of a vertic topsoil horizon underlain with a gley horizon.

The less sensitive soil forms with low suitability for crop production identified within the proposed target areas includes the Sepane and Arcadia soil forms. The Sepane soil form consists of an orthic topsoil horizon on top of a pedocutanic horizon underlain with a gleyic horizon below. These soils are characterised by high clay content which may impede drainage, aeration, and root penetration.

Three (3) anthropogenic soils with transported material were also identified within the proposed target areas, namely Johannesburg, Stilfontein and Grabouw soil form. The Johannesburg urban Technosols is characterised as the land under graveyard or cemeteries. The Stilfontein hydric Technosols is characterised as anthropogenic material which is artificially saturated by natural quality water. The Grabouw physically disturbed Anthrosols is characterised as the land which is physically disturbed by anthropogenic actives for agricultural purposes. These soil forms are characterised by extremely severe limitation for crop production and are more suitable for wildlife practices.

The desktop assessment database (Land Type Survey Staff, 1972 – 2006) for the areas forming the entire seismic right area excluding the site verified proposed seismic survey drilling areas indicates that the areas are characterised with the Dundee, Avalon, Bainsvlei, Hutton, Clovelly, Oakleaf, Rensburg, Willowbrook, Valsrivier, Swartland, Sterkspruit, Glenrosa and Mispah soil forms. The Dundee, Avalon, Bainsvlei, Hutton, Clovelly and Oakleaf soil forms are mostly suitable for cropping practices. The Rensburg and Willowbrook are characterised by hydromorphic conditions associated with watercourse and wetlands areas. The Valsrivier, Swartland, Sterkspruit, and Glenrosa and Mispah soil forms have high clay contents and restricted depths which can limit most cropping practices, respectively. Some of the identified soil horizons within the proposed seismic survey drilling, as well as the current land uses are illustrated in **Figure 55** to **Figure 56** and **Figure 57**, respectively. Moreover, some of the current land uses within the 50 m buffer of the proposed project area are illustrated in **Figure 58**.

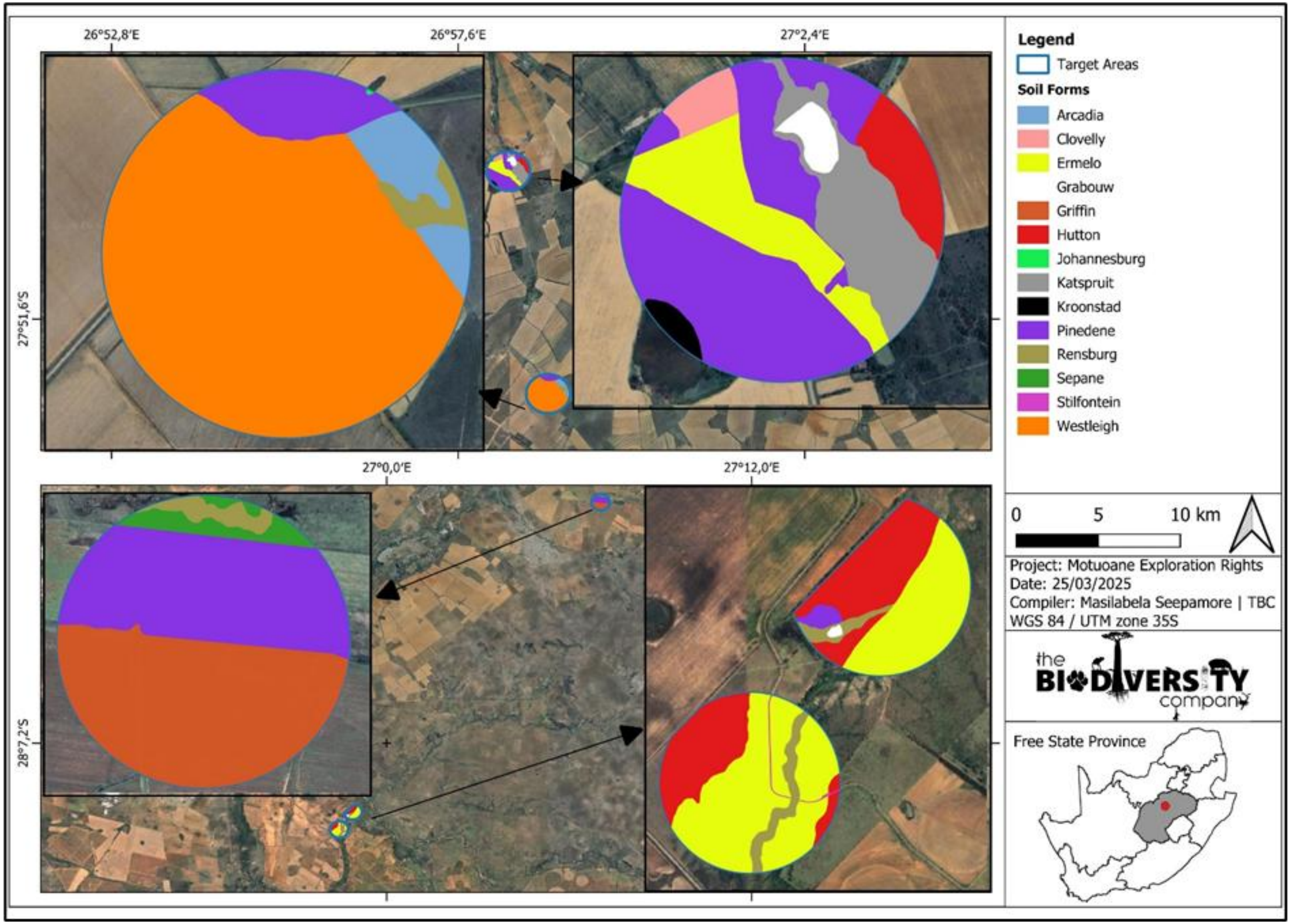


Figure 54: Soil forms found within the proposed project area (The Biodiversity Company, 2026).

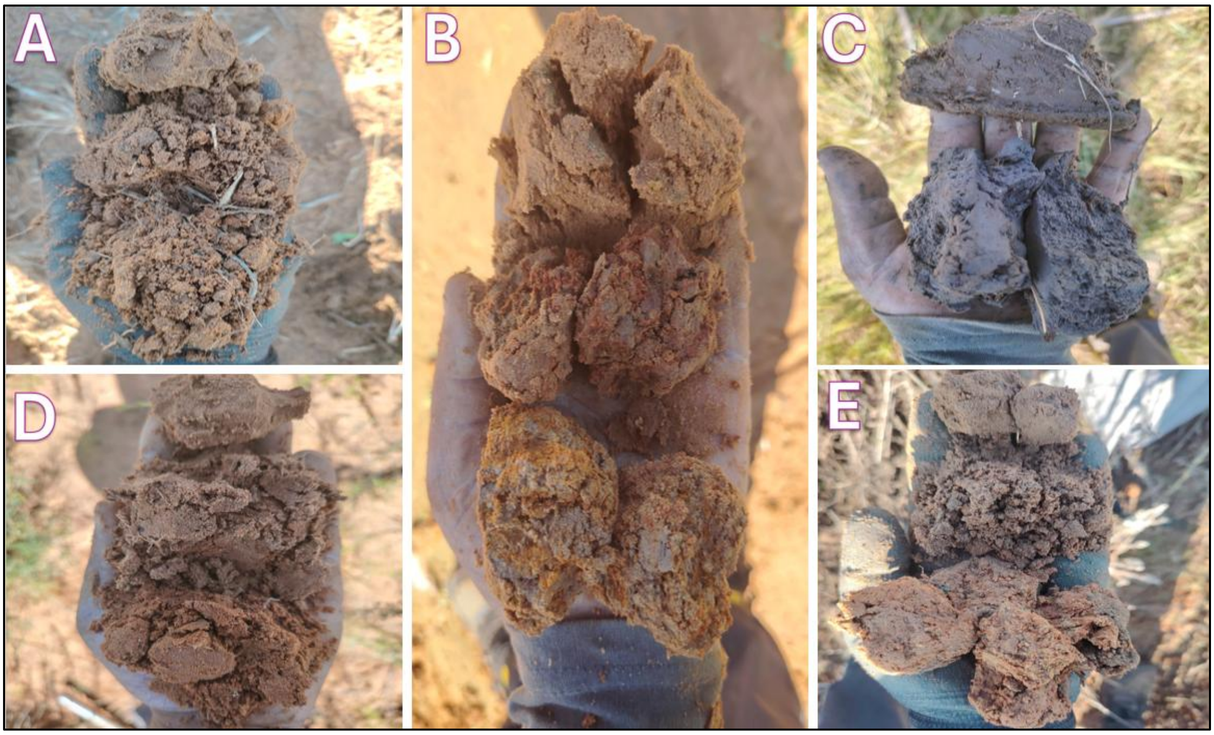


Figure 55: Diagnostic soil horizons identified on-site: A) Clovelly soil form; B) Westleigh soil form; C) Rensburg soil form; D) Griffin soil form; and E) Pinedene soil form (The Biodiversity Company, 2026).

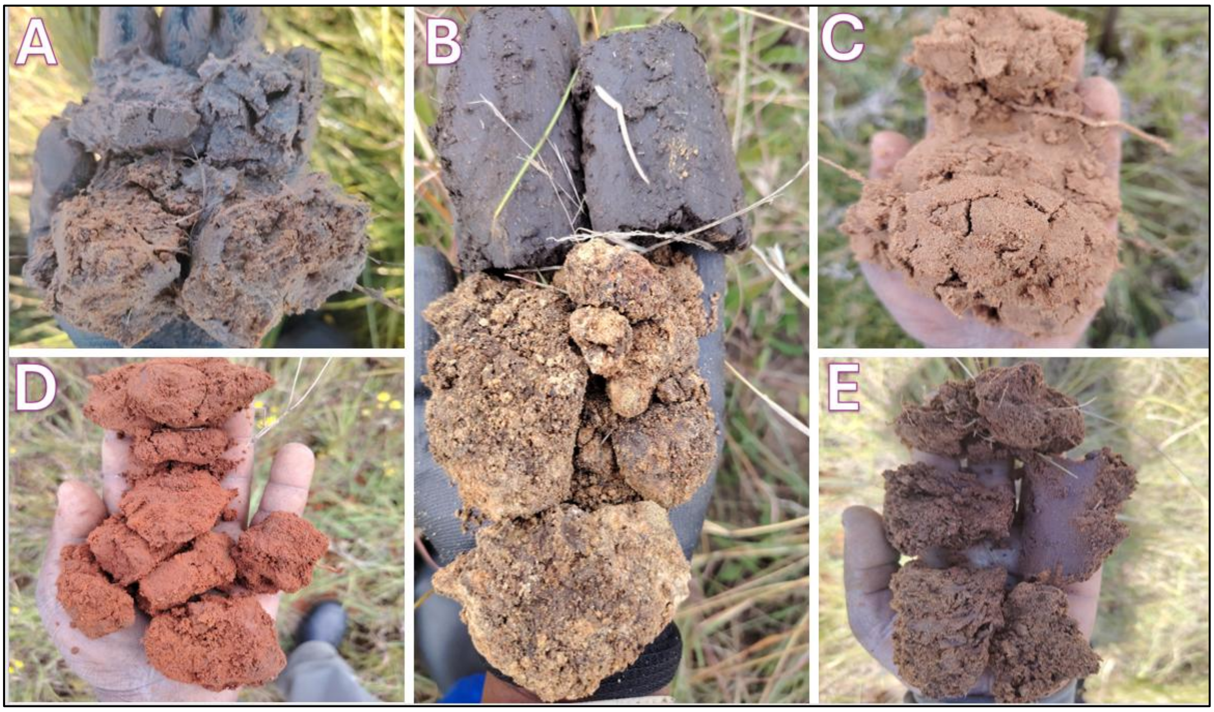


Figure 56: Diagnostic soil horizons identified on-site: A) Albic over gley subsurface horizons; B) Arcadia soil form; C) Ermelo soil form; D) Hutton soil form; and E) Sepane soil form (The Biodiversity Company, 2026).

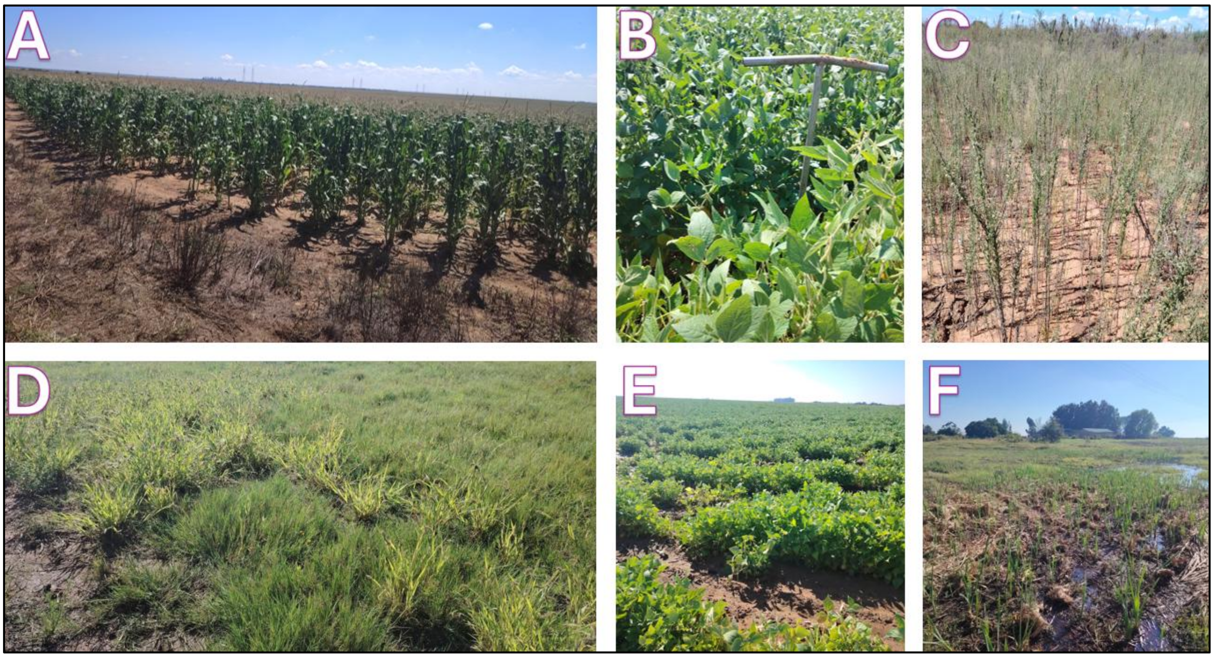


Figure 57: Current land use found within the proposed seismic survey drilling areas; A); B) & E) Active crop fields; C) historical crop fields; D) Common vegetation; and F) Wetland (The Biodiversity Company, 2026).

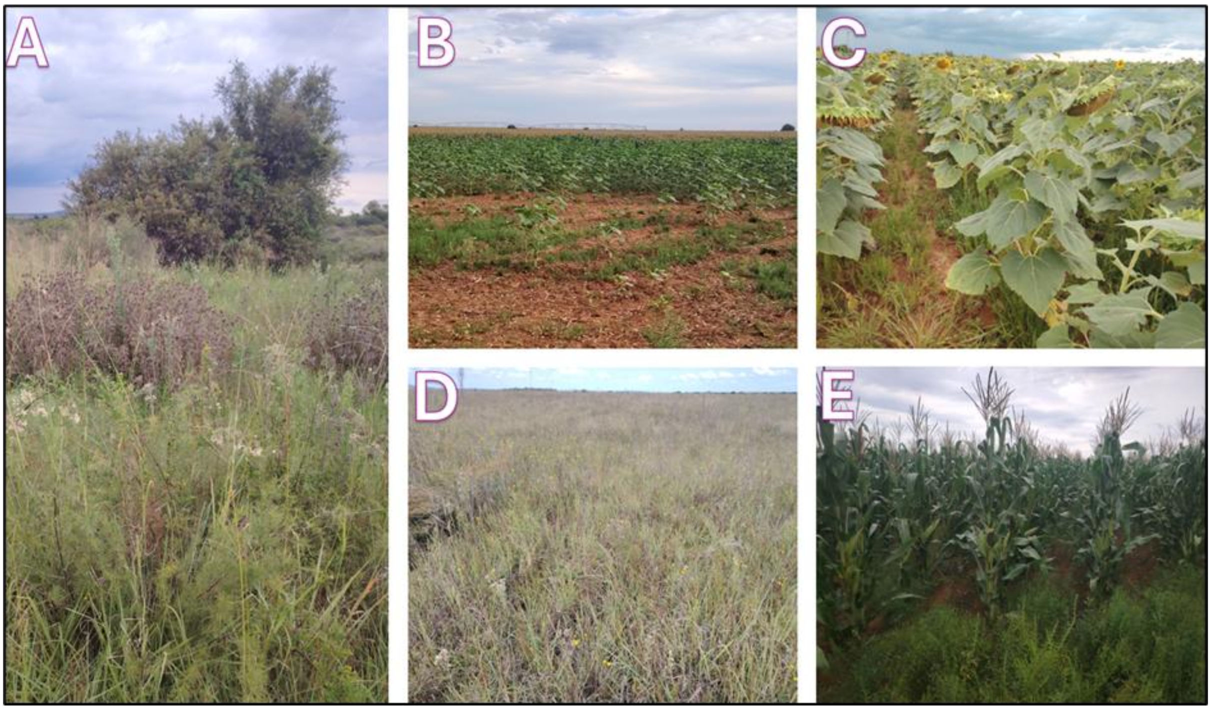


Figure 58: Current land use found within the proposed project area ; A); B) & E) Active crop fields; C) historical crop fields; D) Common vegetation; and F) Wetland (The Biodiversity Company, 2026).

4.8.2 AGRICULTURAL POTENTIAL

Agricultural potential is determined by a combination of soil, terrain, and climate features. Land capability classes reflect the most intensive long-term use of land under rain-fed conditions. The land capability is determined by the physical features of the landscape including the soils present. The land potential or agricultural potential is determined by combining the land capability results and the climate capability for the region.

The climatic capability has been determined by means of the Smith (2006) methodology, of which the first step includes determining the climate capability of the region by means of the Mean Annual Precipitation (MAP) and annual Class A pan (potential evaporation). According to Smith (2006), the climatic capability of a region is only refined past the first step if the climatic capability is determined to be between climatic capability 1 and 6. Given the fact that the climatic capability (i.e. Vaal-Vet Sandy Grassland and Windburg Grassy Shrubland , MAP 530 and 495 mm and MAPE of 2423 and 2273 mm with a MAP: A pan Class of 0.22, respectively. The Central Free State Sandy Grassland and Highveld Alluvial Vegetation, MAP 562 and 495 mm, MAPE od 2226 and 2507 mm, with a MAP: A pan Class of 0.25 and 0.20, respectively) has been determined to be "C8" for the project area.

The Land Capability (LC) was determined by using the guidelines described in "The farming handbook" (Smith, 2006). The delineated soil forms were clipped into the four different slope classes (0-5%, 5-10%,10-15% and 15-20%) to determine the land capability of each soil form. Accordingly, the most sensitive soil forms associated with the project area are restricted to land capability "I" (i.e. maize and soyabean cultivation), land capability "II" (i.e. Ermelo, Clovelly, Griffin, Hutton, Pinedene and Westleigh soil forms), land capability "III" (i.e. Sepane and Arcadia soil forms), land capability "V" (i.e. Katspruit, Kroonstad and Rensburg soil forms) and land capability "VIII" (i.e. Johannesburg, Stilfontein and Grabouw soil forms). Refer to **Table 18** for the LC for the soils within the project area. Following Smith, (2006) which the national DAFF, (2017) land capabilities protocols were further expanded from, the above-mentioned identified soil forms associated with active cropping is restricted to land capability class "I" (i.e. Maize and soyabeans) categorised by LC 8-10 (Moderate to Moderate-High), land capability classes "II" (i.e. Ermelo, Clovelly, Griffin, Hutton, Pinedene and Westleigh soil form) categorised by LC 6-7 (Low-Moderate); land capability "III" (i.e. Sepane and Arcadia soil forms) categorised by LC 1-5 (Very Low to Low), land capability "V" (i.e. Katspruit, Kroonstad and Rensburg soil forms) categorised by LC 6-7 (Low-Moderate), and land capability "VIII" (i.e. Johannesburg, Stilfontein and Grabouw soil forms) categorized by LC 1-5 (Very Low to Low). The soil land capability was aligned and - compared to the National Land Capability data (DAFF, 2017).

Table 18: Land capability for the soils within the project area (The Biodiversity Company, 2026).

LC Class	Definition	Conservation Need	Use-Suitability	LC Group	Sensitivity
I	No or few limitations. Very high arable potential. Very low erosion hazard.	Good agronomic practice.	Annual cropping.	Arable	High
II	Slight limitations. High arable potential. Low erosion hazard.	Adequate run-off control.	Annual cropping with special tillage or ley (25%).	Arable	Medium
III	Moderate limitations. Some erosion hazard.	Special conservation practices and tillage methods.	Rotation of crops and ley (50%)	Arable	Medium
IV	Severe limitations. Low arable potential. High erosion hazard.	Intensive conservation practice.	Long-term leys (75%)	Arable	Medium
V	Water course and land with wetness limitations.	Protection and control of water table.	Improved pastures, suitable for wildlife	Arable	Medium
VI	Limitations preclude cultivation. Suitable for perennial vegetation.	Protection measures for establishment, e.g., sod-seeding	Veld, pasture, and afforestation.	Non-Arable	Low

The land potential was determined to further verify the land capability to the National Land Capability data (DAFF, 2017). From the three land capability classes, the land potential levels have been determined by means of the Guy and Smith (1998) methodology. The land capability class “I” is equivalent to land potential 4, land capability “II” is equivalent to land potential 5, land capability class “III” were equivalent to a land potential level 6, land capability class V to Vlei, and land capability “VIII” to land potential 8 due to available climatic conditions. Areas under grain production are categorised with a land potential 4. Refer to **Figure 59** for the land potential within the ER.

Figure 59: Site land potential of the dominant soil forms identified in the proposed project area (The Biodiversity Company, 2026).

4.9 TERRESTRIAL BIODIVERSITY AND VEGETATION

Terrestrial biodiversity is the variety of life forms on the land surface of the Earth. High biodiversity is an indicator of a healthy ecosystem, which is directly linked to human health. Animals and plants are responsible for many vital services our lives depend on, including: oxygen production; water regulation; soil retaining; and providing flood protection.

Biodiversity is both a part of nature and affected by it. Some biodiversity loss is because of events such as seasonal changes or ecological disturbances (wildfires, floods, etc.), but these effects are usually temporary, and ecosystems have managed to adapt to these threats. Human-driven biodiversity loss, in contrast, tends to be more severe and long-lasting. The human-made climate crisis is leading to environmental destruction, habitat loss, and species extinction. Terrestrial biodiversity is decreasing rapidly through habitat loss: a process where a natural habitat becomes incapable of supporting its native species, which are consequently displaced or killed. In the recent past, there have Increased efforts implemented to prevent further loss of terrestrial biodiversity and the ecosystem services they provide. The characteristics and implications of the terrestrial biodiversity within the D3 Energy ER386 site are discussed below.

4.9.1 ECOLOGICALLY IMPORTANT LANDSCAPE FEATURES

The following features describe the general area and habitat; this assessment is based on spatial data that are provided by various sources such as the provincial environmental authority and the South African National Biodiversity Institute (SANBI).

Table 19: Summary of relevance of the proposed project to ecologically important landscape features (The Biodiversity Company, 2026).

Desktop Information Considered	Relevant/Irrelevant	Section in the Report
Ecosystem Threat Status (RLE 2021)	Relevant. Overlaps with 'Endangered (EN) and 'Least Concern (LC)' ecosystems.	**4.9.5.1**
Ecosystem Protection Level	Relevant. Overlaps with 'Not Protected (NP)' and 'Poorly Protected (PP)' ecosystems.	**4.9.5.2**
Provincial Conservation Plan	Relevant. Overlaps with Other Natural Areas (ONAs), Ecological Support Areas 1 & 2 (ESAs 1 & 2), Degraded Areas (DAs) as well as Critical Biodiversity Areas 1 & 2 (CBAs 1 & 2).	**3.2.3**
South Africa Protected Areas Database - SAPAD and South Africa Conservation Areas Database - SACAD	Relevant. Overlaps with the Thabong Game Range and falls within >5 km of Tara Wildlife Safaris, Newlands Game Ranch, De Rust Private Nature Reserve and Goliatskraal Private Nature Reserve.	**4.9.2**
National Protected Areas Expansion Strategy (NPAES)	Relevant. The ER overlaps with NPAES Priority Focus Areas.	**4.9.3**
Key Biodiversity Areas (KBA)	Irrelevant. The nearest KBA is situated over 30 km from the ER.	-
South African Inventory of Inland Aquatic Ecosystems (SAIIAE)	Relevant. The ER overlaps with 'Least Concern' (LC) and 'Critically Endangered' (CR) wetlands.	**4.10.2**
National Freshwater Priority Area	Relevant. The ER overlaps with non-priority and priority FEPA wetlands.	**4.10.3**
Mining and Biodiversity Guidelines	Relevant. The ER overlaps with an area of Highest Biodiversity Importance.	**3.1.11**
Strategic Water Source Areas (SWSA)	Irrelevant. The ER does not overlap with any SWSA.	-

4.9.2 PROTECTED AREAS

The DFFE maintains a spatial database on Protected Areas and Conservation Areas. Protected Areas and Conservation Areas (PACA) Database scheme that used for classifying protected areas (South Africa Protected Areas Database-SAPAD) and conservation areas (South Africa Conservation Areas Database-SACAD) into types and sub-types in South Africa. The ER overlaps with the Thabong Game Reserve and more than 5 km of Tara Wildlife Safaris, Newlands Game Ranch, De Rust Private Nature Reserve and Goliatskraal Private Nature Reserve (**Figure 60**). Although according to SAPAD, the ER overlaps with the Thabong Game Reserve, it must be noted that the Thabong Game Reserve remains a game reserve only on outdated GIS information. The area earmarked as Thabong Game Reserve is currently known as Harmony Cluster, it is used for mining, residential and grazing activities (refer to **Figure 16** to **Figure 19** in **Section 4.1**).

4.9.3 NATIONAL PROTECTED AREA EXPANSION STRATEGY

The National Protected Area Expansion Strategy 2010 (NPAES) was identified through a systematic biodiversity planning process. They present the best opportunities for meeting the ecosystem-specific protected area targets set in the NPAES and were designed with strong emphasis on climate change resilience and requirements for protecting freshwater ecosystems. These areas should not be seen as future boundaries of protected areas, as in many cases only a portion of a particular focus area would be required to meet the protected area targets set in the NPAES. They are also not a replacement for fine scale planning which may identify a range of different priority sites based on local requirements, constraints and opportunities (NPAES, 2010).

South Africa's protected area network currently falls far short of representing all ecosystems and maintaining healthy functioning ecological processes. In this context, the goal of the NPAES is to achieve cost effective protected area expansion, thus enabling better ecosystem representation, ecological sustainability, and resilience to climate change. A comprehensive set of priority areas was compiled based on the priorities identified by provincial and other agencies in their respective protected area expansion strategies. These focus areas are generally large, intact and unfragmented and are, therefore, of high importance for biodiversity, climate resilience and freshwater protection (DFFE, 2022b). Portions of the southern sections of the ER overlaps with NPAES Priority Focus Areas (**Figure 61**).

4.9.4 THE NATIONAL VEGETATION MAP 2018

The Vegetation Map of South Africa, Lesotho and Swaziland is a fundamental data set that is updated periodically. The National Biodiversity Assessment (NBA) 2018 process provided an opportunity for a more comprehensive revision of the NVM and better alignment between the terrestrial, marine and estuarine ecosystem maps. Based on the NVM, the ER is located within a Grassland Biome. Grassland Biome is centrally located in southern Africa, and adjoins all except the desert, fynbos, and succulent Karoo biomes (Mucina & Rutherford, 2006). Major macroclimatic traits that characterise the grassland biome include: Seasonal precipitation; and the minimum temperatures in winter (Mucina & Rutherford, 2006). The grassland biome is found chiefly on the high central plateau of South Africa, and the inland areas of KwaZulu-Natal and the Eastern Cape. The topography is mainly flat and rolling but includes the escarpment itself. Altitude varies from near sea level to 2 850 m above sea level. Grasslands are dominated by a single layer of grasses. The amount of cover depends on rainfall and the degree of grazing. The grassland biome experiences summer rainfall and dry winters with frost (and fire), which are unfavourable for tree growth. Thus, trees are typically absent, except in a few localized habitats. Geophytes (bulbs) are often abundant. Frosts, fire, and grazing maintain the grass dominance and prevent the establishment of trees. The ER overlaps with the Vaal-Vet Sandy Grassland, Central Free State Grassland, Highveld Alluvia Vegetation and the Winburg Grassy Shrubland vegetation types (**Figure 62**).

4.9.4.1 VAAL-VET SANDY GRASSLAND

The Vaal-Vet Sandy Grassland occurs in North-West and Free State Provinces from its northern distribution, in an area south of Lichtenburg and Ventersdorp, stretching to Klerksdorp, Leeudoringstad, Bothaville and Brandfort in the south. is situated in the summer rainfall region with a mean annual precipitation of 530 m, where summers are mild to hot and winters very cold with frequent frost. Aeolian and colluvial sand overlay sandstone, shale, and mudstone of the Karoo Supergroup (mostly Ecca Group) as well as older Ventersdorp Supergroup Andesite and basement gneiss in the north. Soil forms are mostly Avalon, Westleigh, and Clovelly (Mucina and Rutherford, 2010).

The landscape is dominated by plains with some scattered, slightly irregular undulating plains and hills. Low-tussock grasslands with strong karroid elements and the relative dominance of the grass species *Themeda triandra* are important features of Vaal-Vet Sandy Grassland. Dominant and other significantly occurring grasses are *Anthephora pubescens, Aristida congesta, Brachiaria serrata, Chloris virgata, Cymbopogon caesius, C. pospischilii, Cynodon dactylon, Digitaria argyrograpta, D. eriantha, Elionurus muticus, Eragrostis curvula, E. chloromelas, E. lehmanniana, E. plana, E. obtusa, E. racemosa, E. superba, E. trichophora, Heteropogon contortus, Panicum coloratum, P. gilvum, Pogonarthria squarrosa, Setaria sphacelata, Themeda triandra Trichoneura grandiglumis, Triraphis andropogonoides and Tragus berteronianus.* Dominant and characteristic herbs and low shrubs generally include *Anthospermum rigidum, Berkheya onopordifolia, Bulbine narcissifolia, Euphorbia inaequilatera, Felicia muricata, Geigeria aspera, Helichrysum caespititium, H. dregeanum, H. paronychioides, Hermannia depressa, Hibiscus pusillus, Ledebouria marginata, Monsonia burkeana, Pentzia globosa, Rhynchosia adenodes, Selago densiflora, Tripteris aghillana, Vernonia oligocephala and Ziziphus zeyheriana*.

This vegetation type is described as endangered because approximately 63% of it has been transformed for commercial crop cultivation and grazing pressure from cattle and sheep. Only 0.3% of this vegetation type is statutorily conserved in Bloemhof Dam, Schoonspruit, Sandveld, Faan Meintjies, Wolwespruit and Soetdoring Nature Reserves (Mucina and Rutherford, 2010). Vaal-Vet Sandy Grassland is comparable with Dry Cymbopogon-Themeda Veld (VT 50) (Acocks, 1953) and Dry Sandy Highveld Grassland (LR 37) (Low and Rebelo, 1996).

4.9.4.2 **CENTRAL FREE STATE GRASSLAND**

The Central Free State Grassland mostly occurs in the Free State Province and marginally into Gauteng Province in a broad zone from around Sasolburg in the north to Dewetsdorp in the south, also including towns such as Kroonstad, Ventersburg, Steynsrus, Lindley, Winburg and Edenvale in its distribution area. It is situated in the summer rainfall region of South Africa with a mean annual precipitation of 560 mm. Summers are generally mild and frost occurs frequently during winter months. The geology of this vegetation type is generally dominated by sedimentary mudstones and sandstone of the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) as well as those of the Ecca Group (Karoo Supergroup). These rock formations give rise to vertic, melanic and red soils, typically of the Arcadia, Bonheim, Kroonstad, Valsrivier and Rensburg soil forms (Mucina and Rutherford, 2010).

The landscape is charactersed by undulating plains supporting short grassland. Under natural conditions it is dominated by Themeda triandra but is dominated by *Eragrostis curvula* and *E. chloromelas* in disturbed habitats. Dwarf Karoo-shrubs establish in severely degraded clayey bottomlands, and overgrazed and trampled low-lying areas are prone to Vachellia karroo encroachment. Dominant and other characteristic plant species include the grasses *Aristida adscensionis, A. congesta, A. bipartite, A. canescens, Andropogon appendiculatus, Agrostis lachnantha, Cynodon dactylon, C. transvaalensis, Cymbopogon pospischilii, Digitaria argyrograpta, Eragrostis curvula, E. chloromelas, E. lehmanniana, E. micrantha, E. plana, E. obtusa, E. racemosa, E. trichophora, Elionurus muticus, Heteropogon contortus, Microchloa caffra, Panicum coloratum, Setaria sphacelata, S. incrassata, Sporobolus discosporus, Themeda triandra and Tragus koelerioides.* Also, the herbs and low shrubs *Anthospermum rigidum, Berkheya onopordifolia, Conyza pinnata, Crabbea acaulis, Euphorbia inaequilatera, Felicia muricata, Geigeria aspera, Helichrysum dregeanum, Hermannia depressa, Hibiscus pusillus, Melolobium candicans, Oxalis depressa, Pentzia globosa, Pseudognaphalium luteo-album, Raphionacme dyeri and Tripteris aghillana* (Mucina and Rutherford, 2010).

Central Free State Grassland is compared to Acocks' (1953) Dry Cymbopogon-Themeda Veld (VT 50) and also to Low and Rebelo's (1996) Dry Sandy Highveld Grassland (LR 37). From a conservation point of view, this unit is described as vulnerable due to almost a quarter of the area of it being transformed for crop cultivation and building of large dams such as Allemanskraal, Erfenis, Groothoek, Koppies, Weltevrede and Kroonstad Dams. Small portions are conserved in the Willem Pretorius, Rustfontein and Koppies Dam Nature Reserves as well as in some private nature reserves (Mucina and Rutherford, 2010).

4.9.4.3 **HIGHVELD ALLUVIAL VEGETATION**

The Highveld Alluvial Vegetation occurs in the Free State, North-West, Mpumalanga and Gauteng Provinces, and also in Lesotho and Swaziland and are associated with alluvial drainage lines and floodplains along rivers embedded in the Grassland Biome, and marginally along eastern Kalahari rivers in the Savanna Biome. Important rivers that fall in this unit are the Riet, Harts, Vals, Vet, Wilge, Mooi, Sand, middle and upper Vaal, upper Modder and upper Caledon Rivers as well as their many tributaries. Climatically this unit is situated in the summer rainfall region of southern Africa with MAP over the distribution range of the unit at about 500 mm. Summers are generally hot and winters are cold with frequent frost. Deep sandy to clayey alluvial soils, which developed over Quaternary alluvial sediments, with Oakleaf, Dundee, Shortlands, Glenrosa and Mispah soil forms, generally dominate this unit. The topography is generally flat and the river banks support riparian thickets accompanied by seasonally flooded grasslands and disturbed herblands, often dominated by alien flora. The rivers in this unit are perennial, often flooding in the high rainfall summer months and erosion of river banks and the deposition of fine soil on alluvium is a general phenomenon (Mucina and Rutherford, 2010).

Important plant species in riparian thickets are the trees and woody shrubs *Celtis africana, Diospyros lycioides, Ehretia rigida, Grewia flava, Gymnosporia buxifolia, Lycium hirsutum, Searsia lancea, S. pyroides, Salix* *mucronata, Vachellia karroo* and *Ziziphus mucronata*, the herbs and herbaceous shrubs *Asparagus laricinus, A. suaveolens, Clematis brachiata, Pollichia campestris and the grasses Panicum maximum* and *Setaria verticillata*. Reed beds are dominated by Phragmites australis and flooded herb- and grasslands by the graminoids *Agrostis lachnantha, Andropogon appendiculatus, A. eucomus, Brachiaria marlothii, Chloris virgata, Cynodon dactylon, Cyperus denudatus, C. longus, Echinochloa holubii, Eragrostis obtusa, E. plana, E. porosa, Fimbristylis ferruginea, Hemarthria altissima, Imperata cylindrica, Ischaemum fasciculatum, Miscanthus junceus, Panicum coloratum, Paspalum distichum, Pycreus mundii, Sporobolus africanus, S. fimbriatus, Themeda triandra* and *Urochloa panicoides*, as well as the herbs and herbaceous shrubs *Alternanthera sessilis, Barleria macrostegia, Corchorus asplenifolius, Crinum bulbispermum, Equisetum ramosissimum, Felicia muricata, Galium capense, Gomphocarpus fruticosus, Haplocarpha lyrata, Hibiscus pusillus, Lobelia angolensis, Myriophyllum spicatum, Nidorella residifolia, Persicaria amphibia, P. lapathifolia, P. hystricula, Pseudognaphalium oligandrum, Pulicaria scabra, Rorippa fluviatilis, Senecio inoratus, Stachys hyssopoides* and *Vahlia capensis* (Mucina and Rutherford, 2010).

From a conservation point of view Highveld Alluvial Vegetation is not threatened and about 10% of the unit is statutorily conserved in Baberspan (a Ramsar site), Bloemhof Dam, Christiana, Faan Meintjies, Soetdoring, Sandveld and Schoonspruit Nature Reserves. More than 25% has been transformed by crop cultivation and the building of the Bloemhof, Erfenis, Krugersdrif, Mockes and Vaalharts Dams (Mucina and Rutherford, 2010). The unit is prone to invasion by a number of alien weeds and invaders such as the trees and woody shrubs *Celtis sinensis, Melia azedarach, Morus alba, Salix babylonica, Schinus molle, Nicotiana glauca, N. longiflora* and *Populus x canescens*, and also the herbs *Argemone ochroleuca, Chenopodium strictum, Conyza canadensis, Datura stramonium, Melilotus alba, Oenothera indecora, Tagetes minuta, Verbena bonariensis, Xanthium strumarium, Zinnia peruviana, and the grasses Paspalum dilatatum , P. urvillei* and *Pennisetum clandestinum*.

4.9.4.4 **WINBURG GRASSY SHRUBLAND**

The Windburg Grassy Shrubland is located primarily in the Free State Province. There are a series of larger patches between Trompsburg through Bloemfontein and Winburg to Ventersburg. The altitude ranges from 1,300 to 1,660 meters, predominantly between 1,360 and 1,440 meters. The landscape features solitary hills, slopes and escarpments of mesas creating a mosaic of habitats ranging from open grassland to shrubland (Mucina & Rutherford, 2006).

Important Plant Taxa includes graminoids: *Aristida adscensionis (d), A. congesta (d), A. diffusa (d), Cymbopogon pospischilii (d), Cynodon dactylon (d), C. incompletus (d), Eragrostis chloromelas (d), E. lehmanniana (d), E. micrantha (d), E. obtusa (d), E. trichophora (d), Eustachys paspaloides (d), Heteropogon contortus (d), Panicum stapfianum (d), Setaria lindenbergiana (d), S. sphacelata (d), Sporobolus fimbriatus (d), Themeda triandra (d), Tragus koelerioides (d), Digitaria argyrograpta, Elionurus muticus, Enneapogon scoparius, Eragrostis plana, E. superba, Tragus berteronianus, T. racemosus, Triraphis andropogonoides.* Small Trees: *Vachellia karroo, Celtis africana, Cussonia paniculata, Pittosporum viridiflorum,Searsia lancea, Scolopia zeyheri, Ziziphus mucronata.* Tall Shrubs: *Buddleja saligna (d), Euclea crispa subsp. ovata (d), Gymnosporia polyacantha (d), Olea europaea subsp. africana (d), Rhus burchellii (d), R. erosa (d), Diospyros lycioides subsp. lycioides, Grewia occidentalis, Gymnosporia buxifolia, Tarchonanthus camphoratus.* Herbs: *Berkheya onopordifolia var. onopordifolia, Hermannia coccocarpa, Indigofera alternans, Mohria caffrorum, Pupalia lappacea, Salvia repens.* Low Shrubs: *Helichrysum dregeanum (d), Pentzia globosa (d), Anthospermum rigidum subsp. pumilum, Asparagus cooperi, A. laricinus, Berkheya annectens, Chrysocoma ciliata, Clutia pulchella, Euryops empetrifolius, Felicia filifolia subsp. filifolia, F. muricata, Nenax microphylla, Osyris lanceolata, Rosenia humilis, Selago saxatilis, Solanum tomentosum var. coccineum.*

From a conservation point of view, the Winburg Grassy Shrubland is classified as Least Threatened, with a national conservation target of 28%. A small extent is conserved in statutory areas such as the Willem Pretorius Nature Reserve. Around 10% of this vegetation type has been transformed due to urban expansion and cultivation (Mucina & Rutherford, 2006).

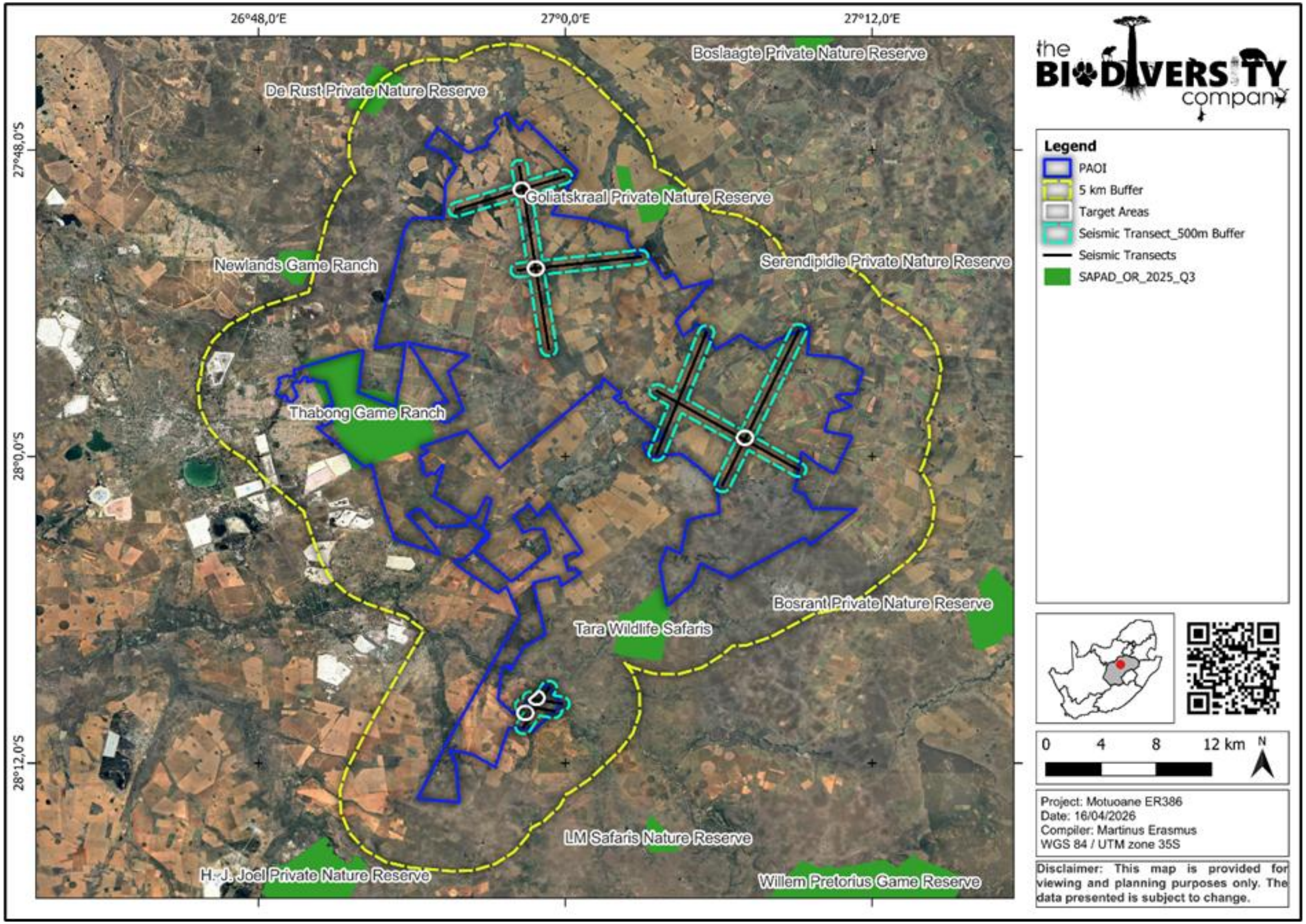


Figure 60: Map illustrating the ER in relation to the SAPAD areas (The Biodiversity Company, 2026).

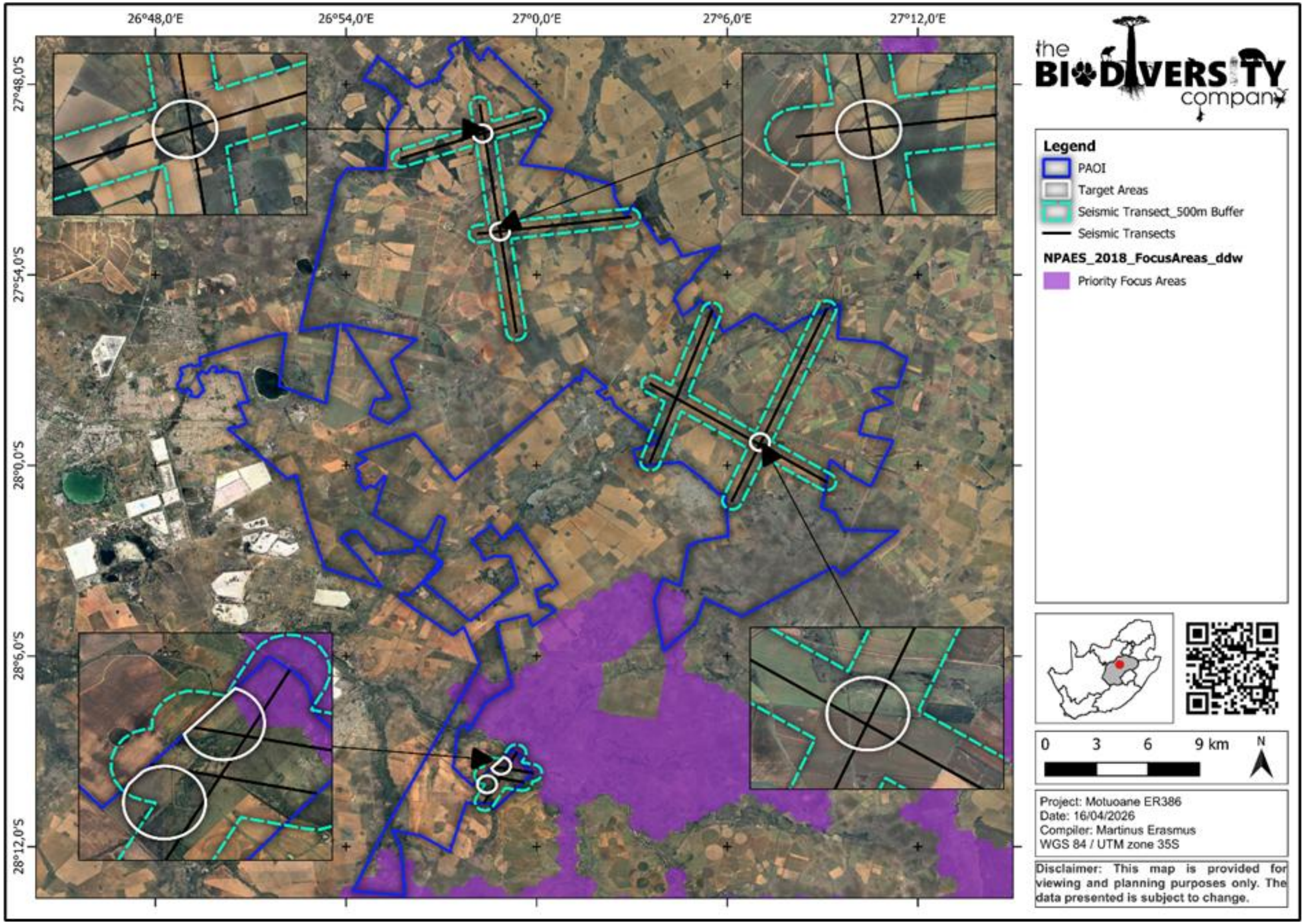


Figure 61: Map illustrating the ER in relation to the NPAES areas (The Biodiversity Company, 2026).

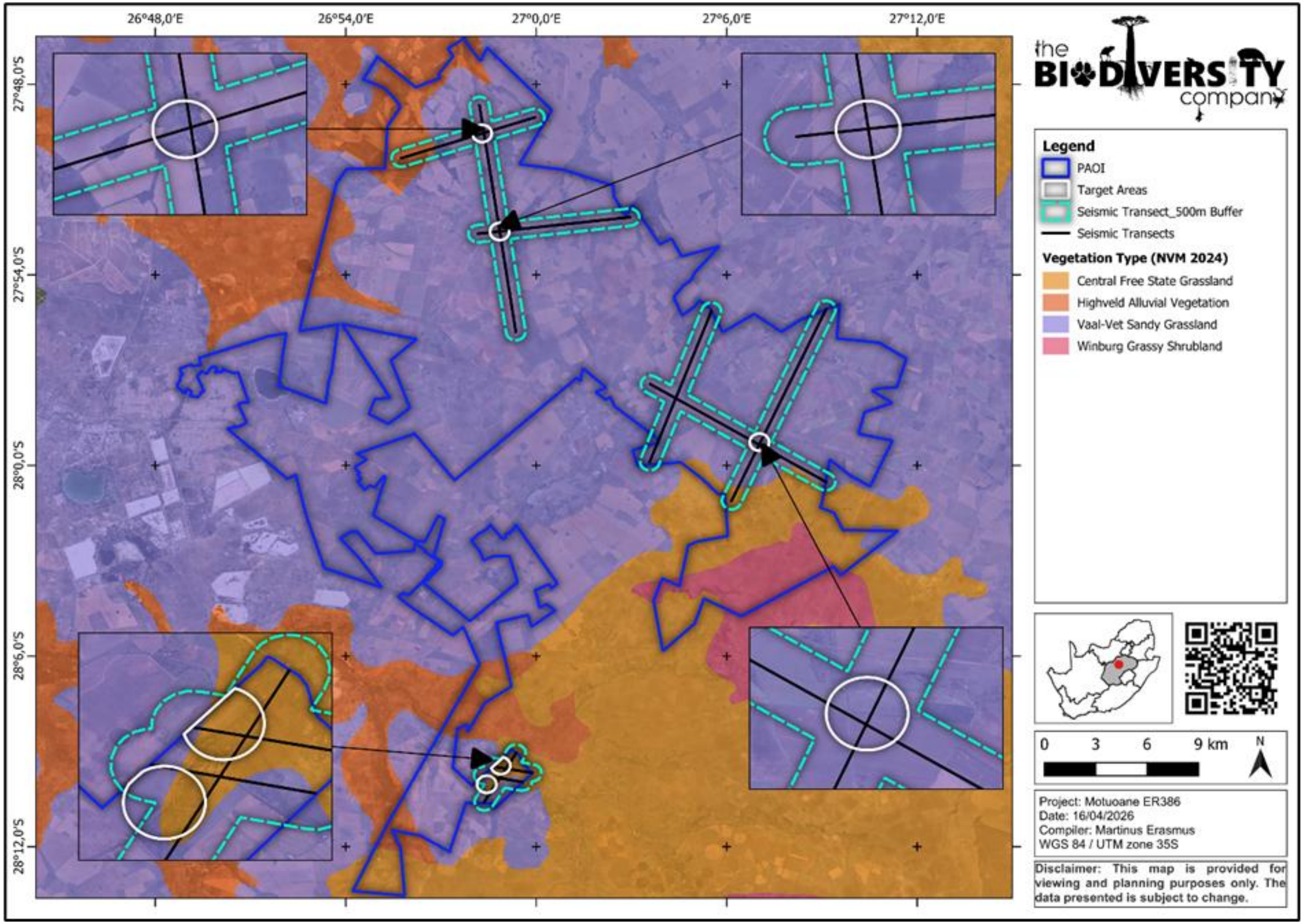


Figure 62: Vegetation types associated with the ER (The Biodiversity Company, 2026).

4.9.5 THE NATIONAL BIODIVERSITY ASSESSMENT

The National Biodiversity Assessment (NBA) was completed as a collaboration between the SANBI, the DFFE and other stakeholders, including scientists and biodiversity management experts throughout the country over a three-year period. The purpose of the NBA is to assess the state of South Africa's biodiversity with a view to understanding trends over time and informing policy and decision-making across a range of sectors.

The two headline indicators assessed in the NBA are Ecosystem Threat Status and Ecosystem Protection Level (Skowno *et al.,* 2019).

4.9.5.1 **ECOSYSTEM THREAT STATUS**

Ecosystem Threat Status (ETS) outlines the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function, and composition, on which their ability to provide ecosystem services ultimately depends. Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Least Concern (LC) or Protected, based on the proportion of each ecosystem type that remains in a good or healthy ecological condition (Skowno et al., 2019). CR, EN, VU or Protected ecosystem types are collectively referred to as threatened ecosystems. Critically Endangered (CR) ecosystems experiencing severe ecological degradation due to human intervention and facing an extremely high risk of irreversible transformation. Endangered (EN) ecosystems that have undergone degradation but are not critically endangered, meaning they have a high risk of further decline. Vulnerable (VU) ecosystems at a high risk of significant degradation, although not currently endangered or critically endangered. Protected ecosystems of high conservation value or national/provincial importance, regardless of whether they are critically endangered, endangered, or vulnerable. According to the spatial dataset, the ER overlaps with EN and LC ecosystems (**Figure 63**).

4.9.5.2 **ECOSYSTEM PROTECTION LEVEL**

Ecosystem Protection level (EPL) informs on whether ecosystems are adequately protected or under-protected. Ecosystem types are categorised as Not Protected (NP), Poorly Protected (PP), Moderately Protected (MP) or Well Protected (WP), based on the proportion of each ecosystem type that occurs within a protected area recognised in the Protected Areas Act (Skowno et al., 2019). NP, PP or MP ecosystem types are collectively referred to as under-protected ecosystems. In South Africa, approximately 33% of ecosystem types are considered well protected, while 59% are not protected. The country aims for at least 17% of terrestrial ecosystems to be conserved through protected areas, but currently only has 8.37%. Ecosystems like estuaries and wetlands are among the most threatened and least protected, and freshwater fish are the most threatened species group.

Ecosystem protection level based on the target achievement (%) of each vegetation type by type 1 protected areas. Well-protected (WP) ecosystems are defined as vegetation types with 100% of their target area conserved; similarly, MP ecosystems, PP, and NP ecosystems have at least 50%, 25%, and 5% of their target areas conserved, respectively. According to the National Vegetation Data (2018) obtained from SANBI, the ER overlaps with NP and PP ecosystems (**Figure 64**).

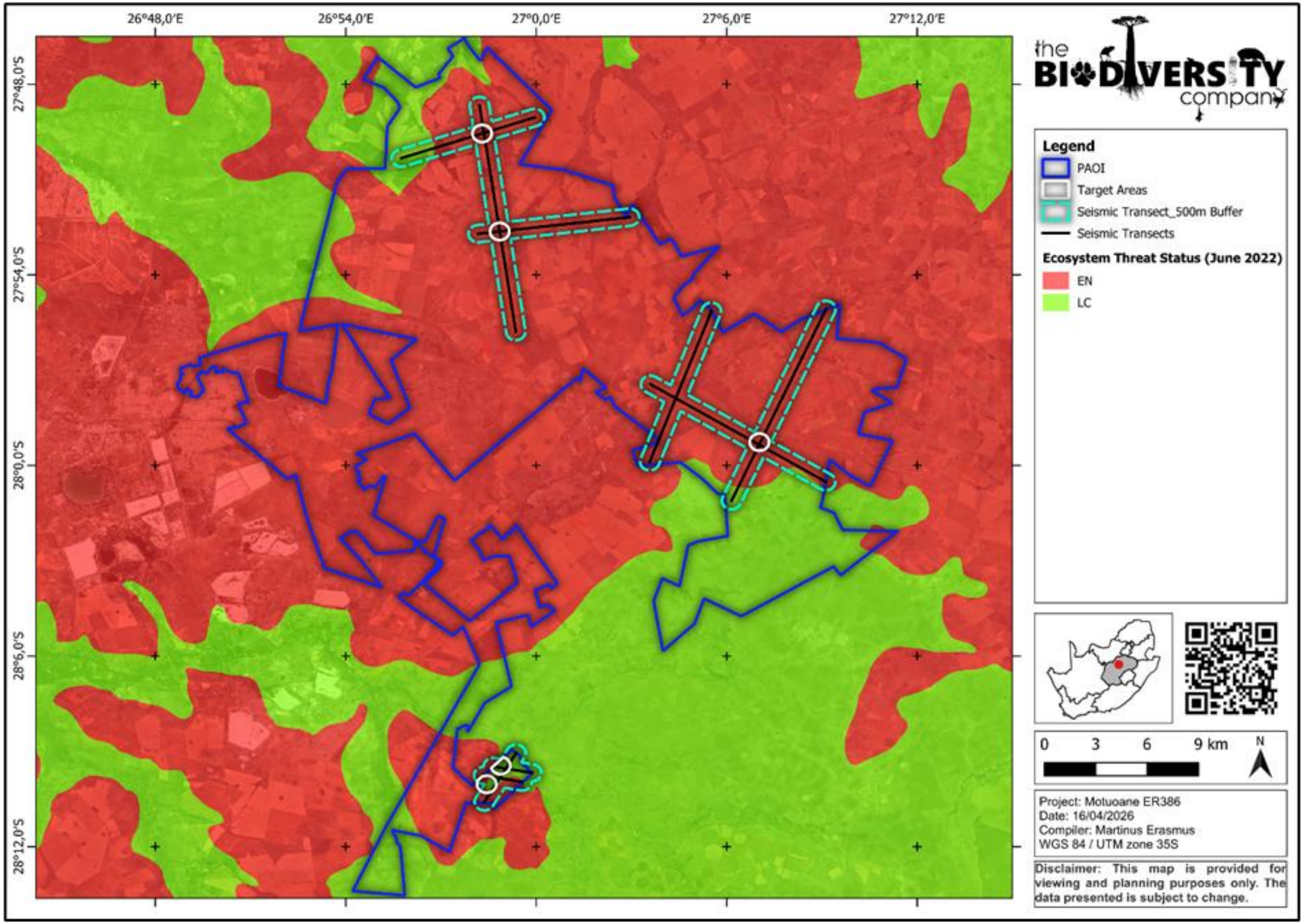


Figure 63: Map illustrating the ecosystem threat status associated with the ER (The Biodiversity Company, 2026).

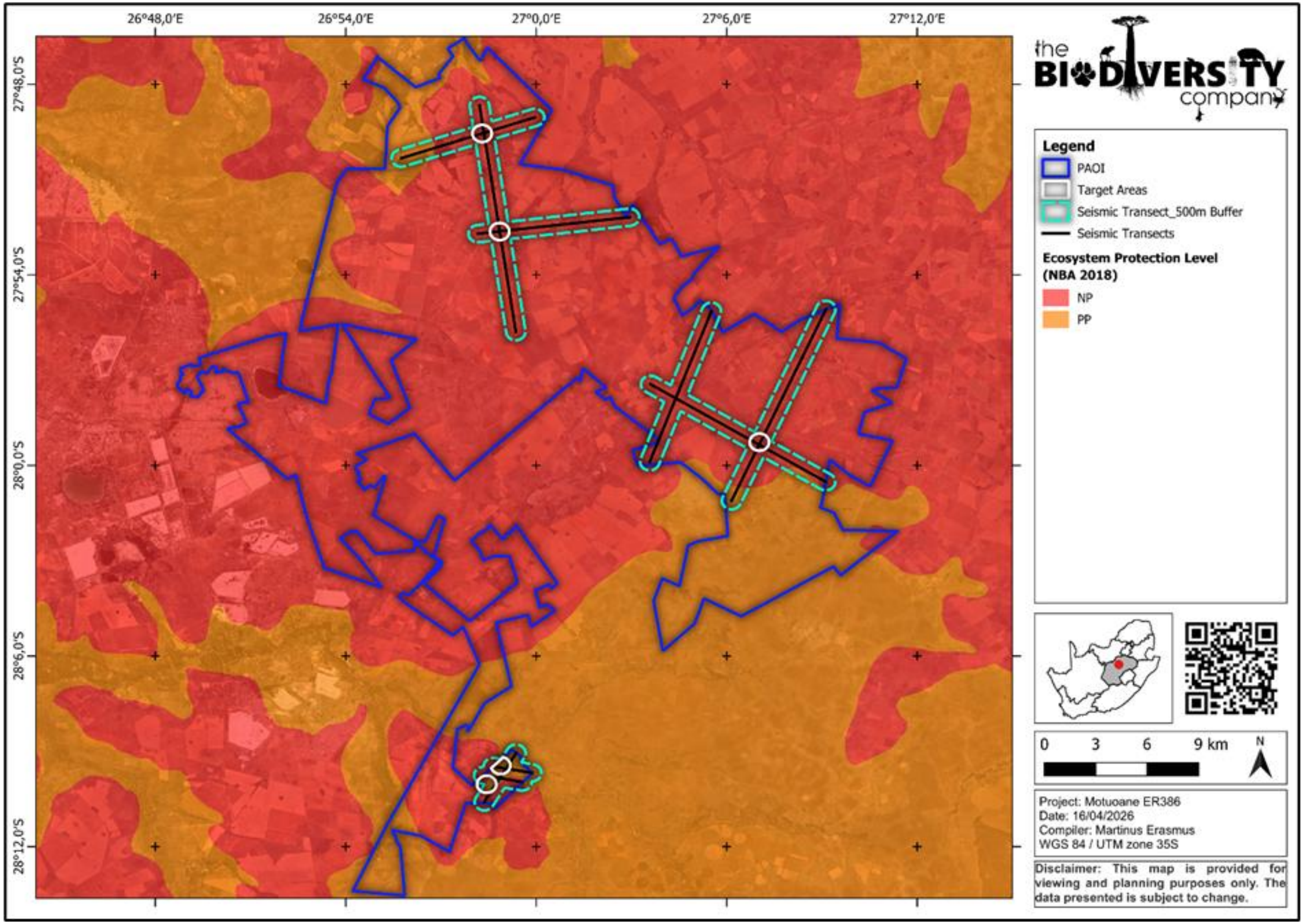


Figure 64: Map illustrating the ecosystem protection level associated with the ER (The Biodiversity Company, 2026).

4.9.6 SITE-SPECIFIC BIODIVERSITY

The following sections discuss the results from the field surveys that was conducted for the proposed project on the 19th of March 2026 by ecologists from The Biodiversity Company.

4.9.6.1 **HABITATS WITHIN THE EXPLORATION RIGHT**

The habitats observed are discussed below (**Table 20**). The fieldwork within the ER was focused within the Target Areas for Drilling Wells, and thus the findings pertain to those areas

Table 20: Summary of the habitat types delineated within the ER from north to south of the ER (The Biodiversity Company, 2026).

Target Area & *Habitats Present*	**Area description and condition**
Target Area 11 (GP A) *Secondary Vaal Vet Sandy Grassland* *Degraded Vaal Vet Sandy Grassland* *Disturbed Vaal Vet Sandy Grassland* *Dam & Artificial Drainage* *Water Resource* *Modified*	The target area contains the highest diversity of habitats compared to the other target areas. It comprises a water resource system associated with disturbed Vaal-Vet Sandy Grassland, interspersed with modified and secondary grassland areas. These grasslands have been affected by overgrazing and edge effects resulting from adjacent agricultural land uses. Overall, the target area is considered to have a Low to High Site Ecological Importance (SEI). No flora SCC are expected within this habitat unit. However, fauna SCC, particularly avifauna, are likely to make use of the water resource and the surrounding disturbed grassland habitats.

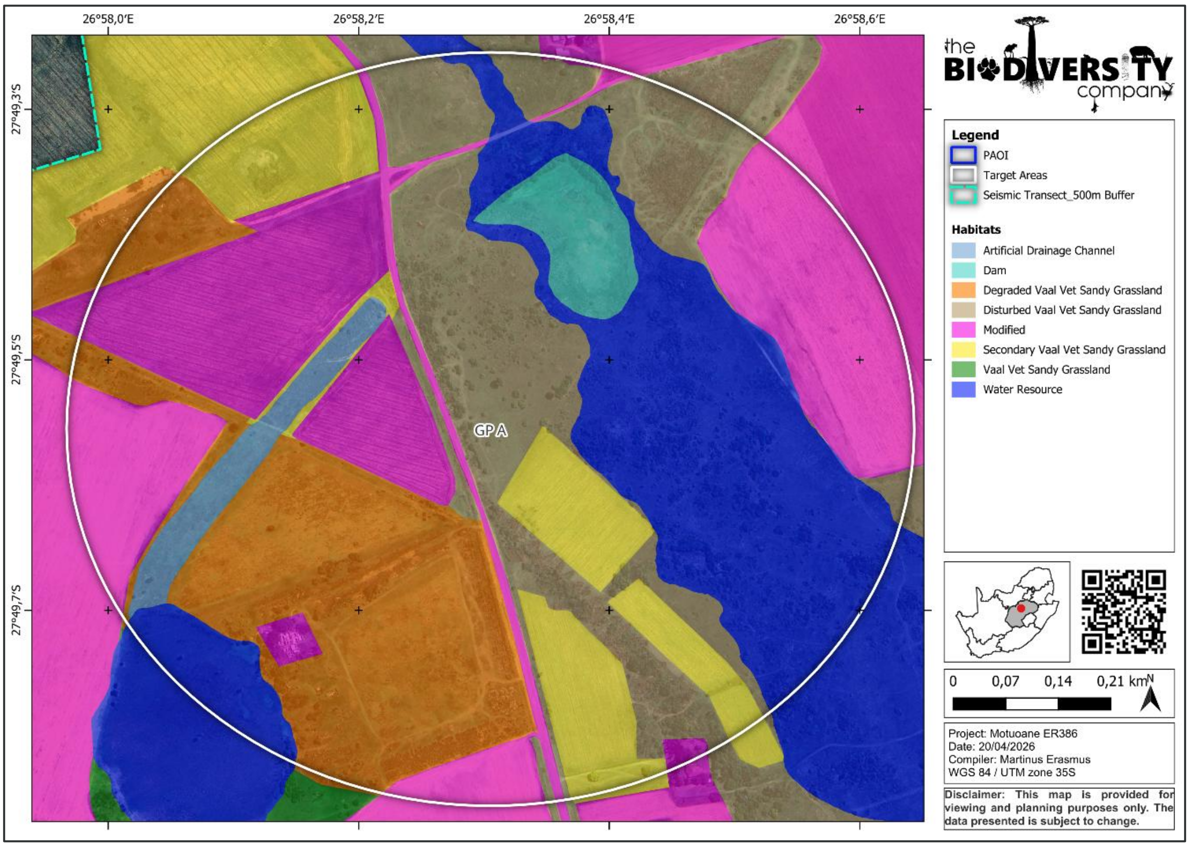


Figure 65: Map illustrating the habitats with Target Area 11 (The Biodiversity Company, 2026).

Figure 66: General site conditions of the habitats with Target Area 11 (The Biodiversity Company, 2026).

Target Are 10 (GP B) *Degraded Vaal Vet Sandy Grassland* *Disturbed Vaal Vet Sandy Grassland* *Water Resource* *Modified*	The target area is largely composed of modified areas in the form of agricultural land, with limited remnant natural habitat remaining. It includes a water resource system associated with disturbed Vaal-Vet Sandy Grassland, interspersed with degraded grassland areas. The grasslands within and adjacent to the target area have been affected by overgrazing and the edge effects of surrounding agricultural activities. Overall, the target area is considered to have a largely very Low SEI, with a portion to the west being Medium/High SEI. No flora SCC are expected within this habitat unit. However, fauna SCC, particularly avifauna, may utilise the water resource and the adjacent disturbed grassland habitats.

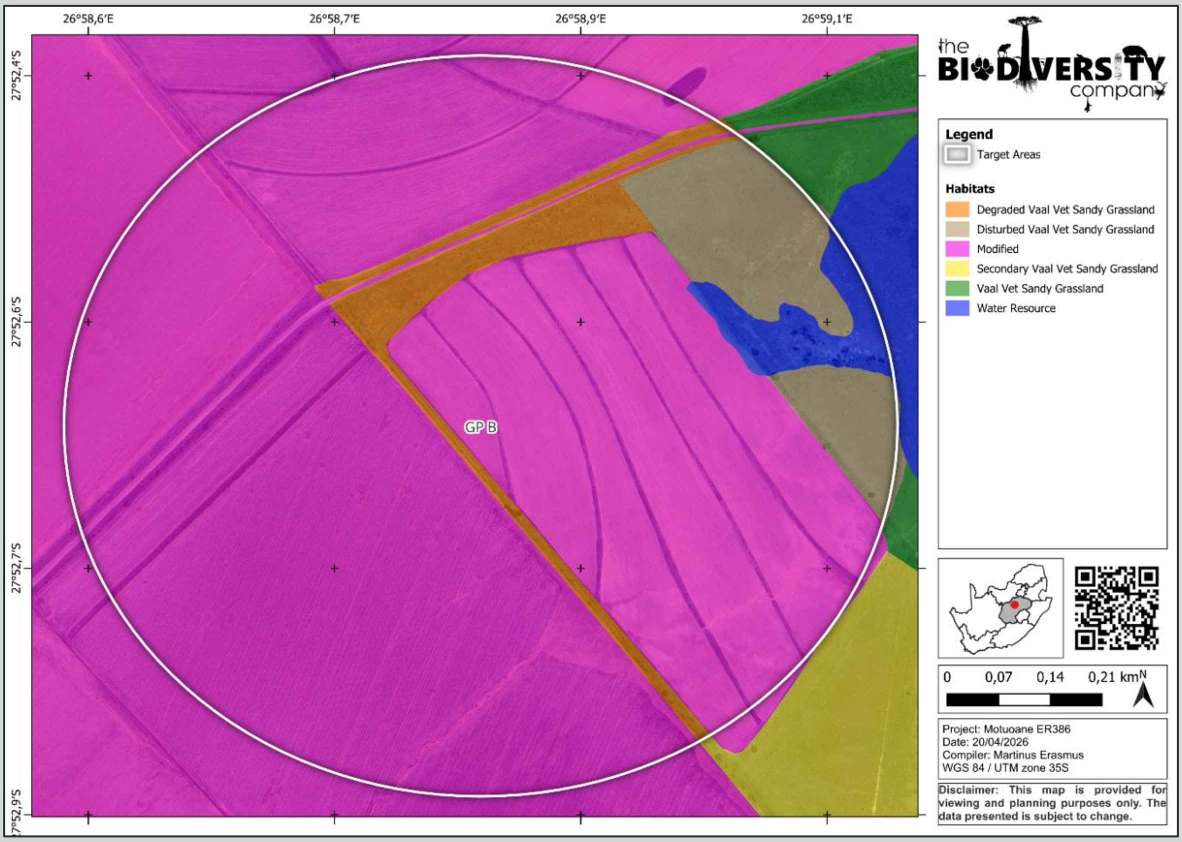


Figure 67: Map illustrating the habitats with Target Area 10 (The Biodiversity Company, 2026).

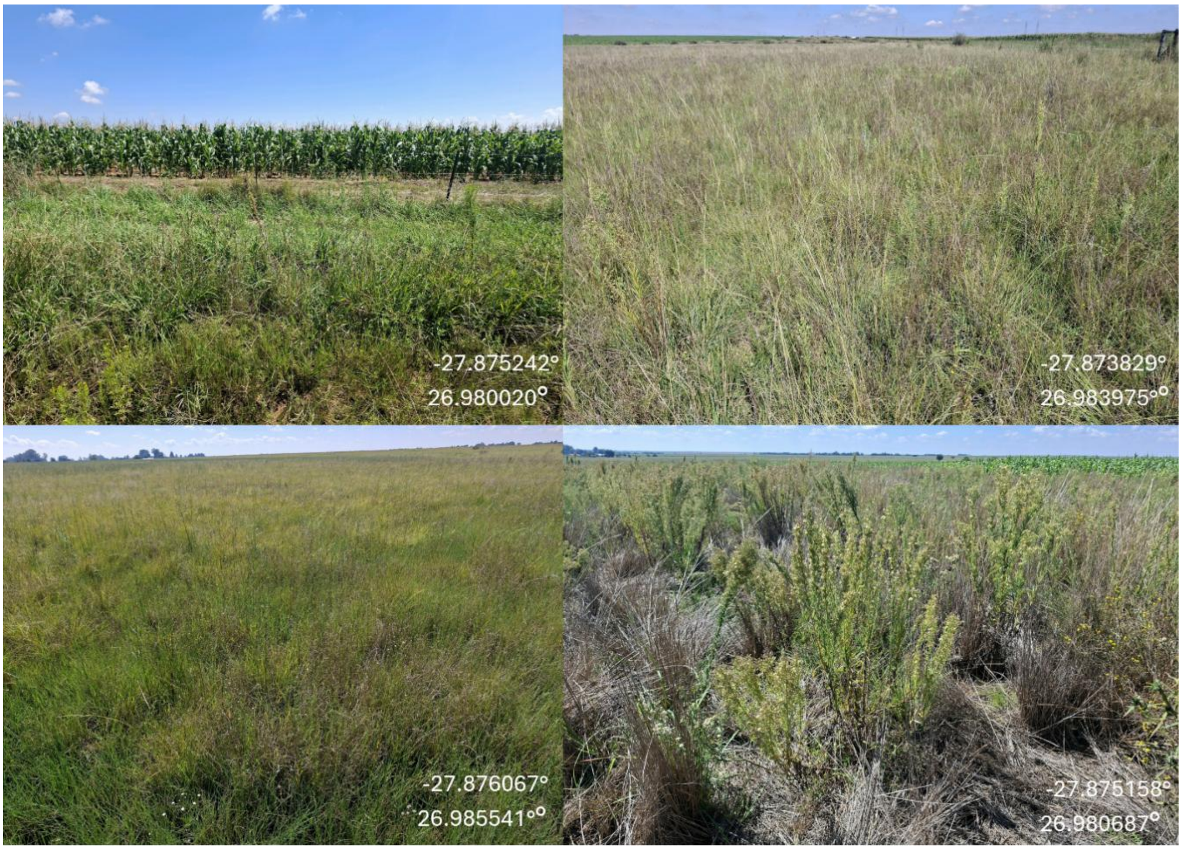


Figure 68: General site conditions of the habitats with Target Area 10 (The Biodiversity Company, 2026).

Target Area 9 (HFC) *Modified* *Degraded Vaal Vet Sandy Grassland* *Water Resource* *Vaal Vet Sandy Grassland*	The target area is largely composed of modified areas in the form of agricultural land, with limited remnant natural habitat remaining. It includes a water resource system associated with intact Vaal-Vet Sandy Grassland. The grasslands within and adjacent to the target area have been affected by overgrazing and the edge effects of surrounding agricultural activities. Overall, the target area is considered to have a largely very Low SEI, with a portion to the north being Medium/High SEI. No flora SCC are expected within this habitat unit. However, fauna SCC, particularly avifauna, may utilise the water resource and the adjacent disturbed grassland habitats.

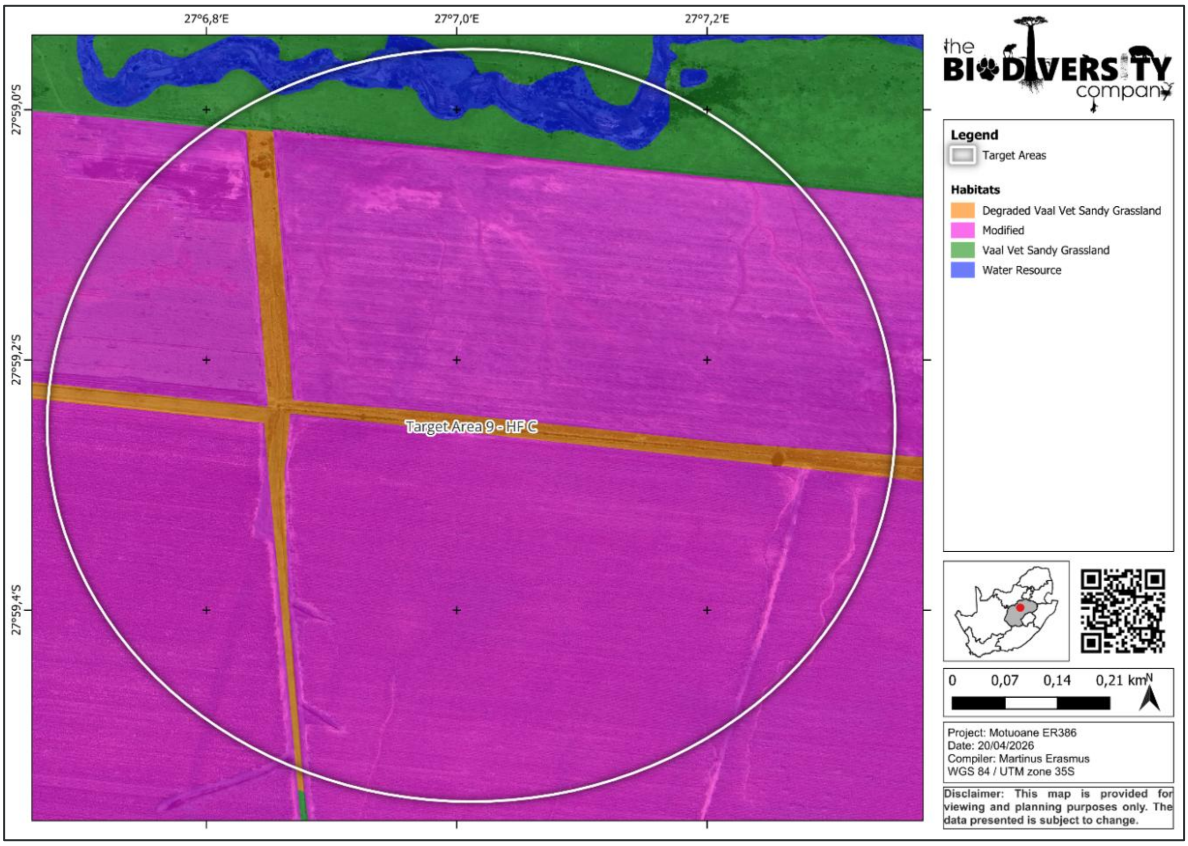


Figure 69: Map illustrating the habitats with Target Area 9 (The Biodiversity Company, 2026).

Figure 70: General site conditions of the habitats with Target Area 9 (The Biodiversity Company, 2026).

Target Area 2 (RSB E) *Secondary Vaal Vet Sandy Grassland* *Alluvial vegetation* *Water Resource* *Dam* *Modified*	The target area is predominantly characterised by alluvial vegetation, with some secondary grassland areas also occurring within the broader habitat unit. It includes a water resource system associated with the alluvial vegetation. The target area has been affected through overgrazing, as well as by edge effects resulting from adjacent agricultural land uses. Overall, the target area is considered to have a Low to High SEI. No flora SCC are expected within this habitat unit. However, fauna SCC, particularly avifauna, may utilise the water resource and the surrounding alluvial vegetation habitats.

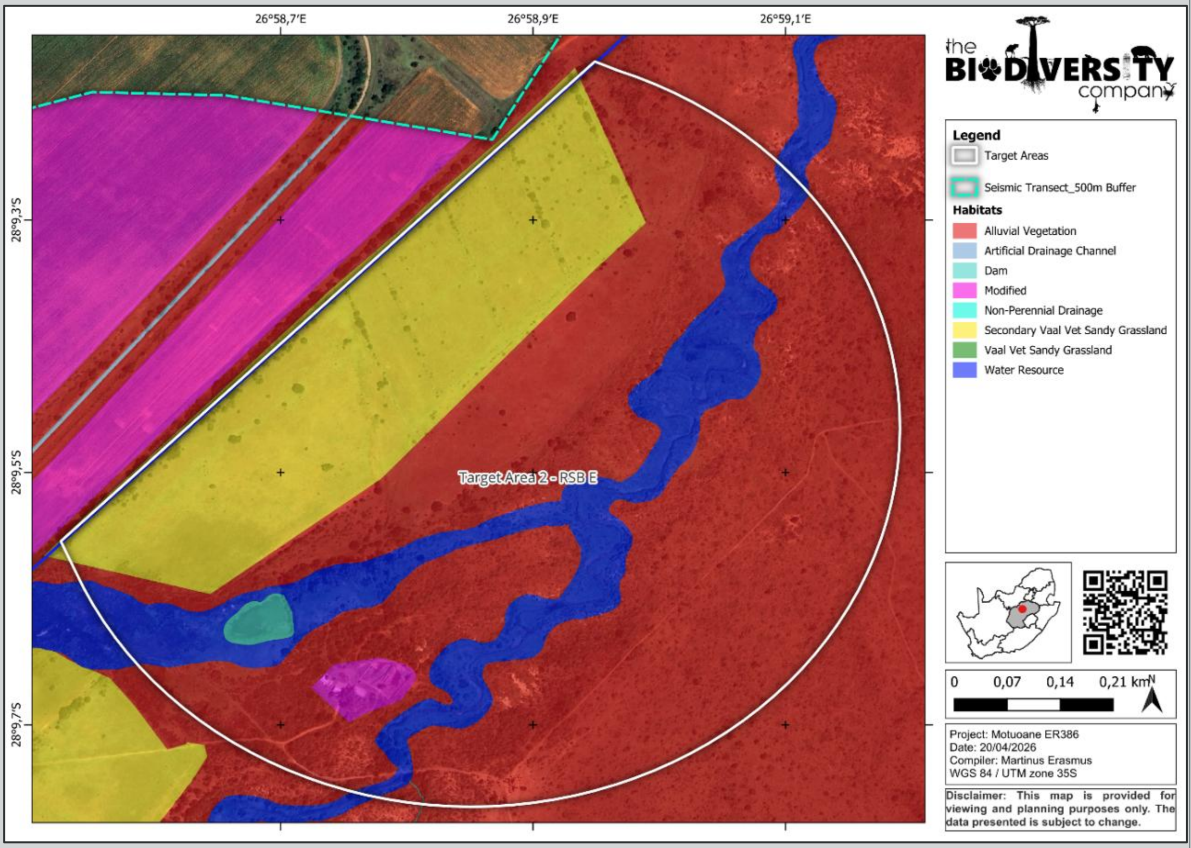


Figure 71: Map illustrating the habitats with Target Area 2 (The Biodiversity Company, 2026).

Figure 72: General site conditions of the habitats with Target Area 2 (The Biodiversity Company, 2026).

Target Area 1 (RSB D) *Degraded Vaal Vet Sandy Grassland* *Secondary Vaal Vet Sandy Grassland* *Alluvial vegetation* *Water Resource* *Artificial Drainage Channel*	The target area is largely composed of secondary grassland habitat. It includes a water resource system associated with alluvial vegetation, as well as degraded grassland areas. The grasslands within and surrounding the target area have been degraded by overgrazing, as well as by edge effects associated with adjacent agricultural land uses. Overall, the target area is considered to have a Low to High SEI. No flora SCC are expected within this habitat unit. However, fauna SCC, particularly avifauna, may utilise the water resource and the surrounding alluvial vegetation grassland habitats.

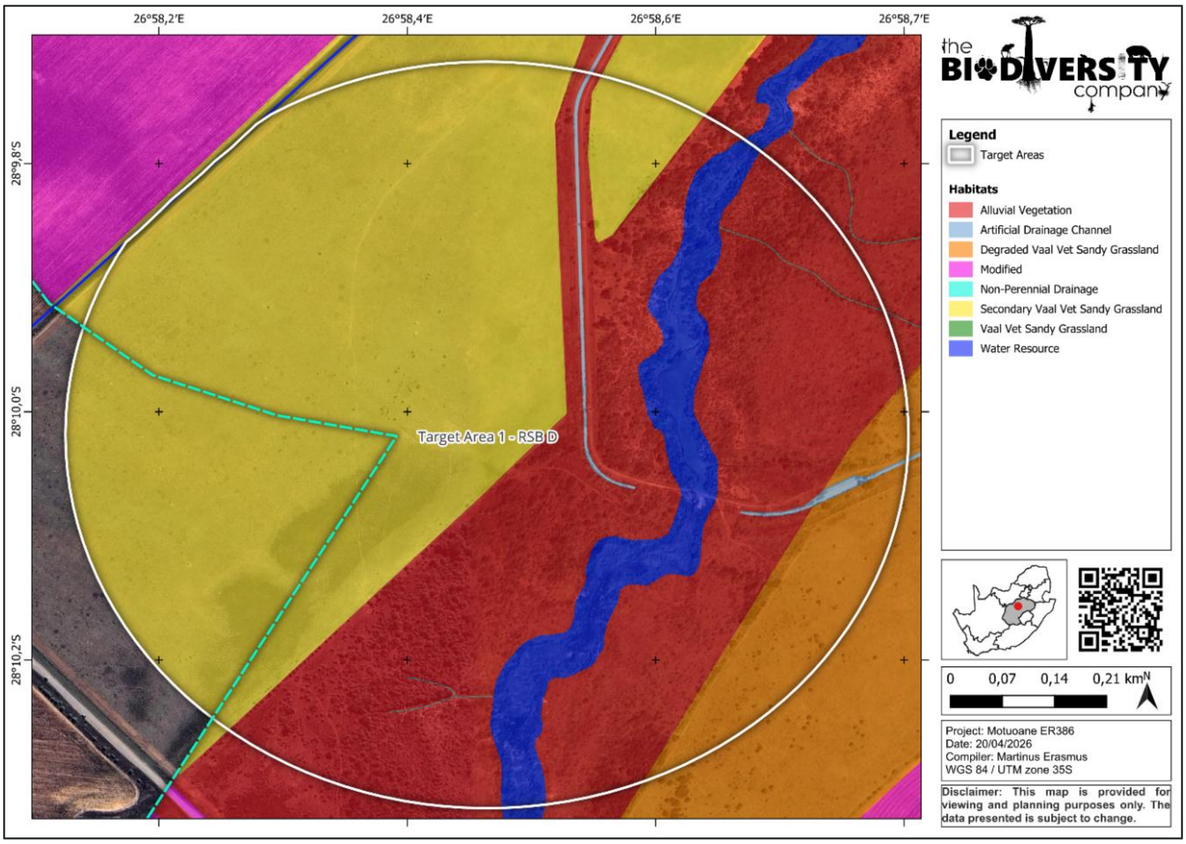


Figure 73: Map illustrating the habitats with Target Area 1 (The Biodiversity Company, 2026).

Figure 74: General site conditions of the habitats with Target Area 1 (The Biodiversity Company, 2026).

4.9.6.2 FLORA ASSESSMENT

The vegetation assessment was conducted throughout the extent of the target areas. The species composition within the assessment area aligns with what is typically found in the vegetation types, considering some impact. This is largely due to some disturbance, as the land is primarily used for livestock grazing. Within this vegetation type, distinct communities were identified and can be categorized which varied across the ER. The list of plant species recorded is not exhaustive (can be provided upon request), and additional surveys conducted during different phenological periods, those not yet covered, could potentially reveal up to 20% more flora species in the ER. Nevertheless, the floristic analysis completed thus far is considered a reliable representation of the local flora for the ER.

Two (2) species of provincially protected plant were recorded for the Target areas – *Ammocharis coranica* and *Helichrysum nudifolium*. These species occurred in close proximity to water resources and the associated grassland. As indicated in **Section 3.2.1**, they are protected under the Free State Nature Conservation Ordinance No. 8 of 1969. According to the list of protected species under the Schedule, if any individuals of these plant species are to be disturbed, permits must be obtained from the FSDESTEA. Due to suitable grassland habitat present on site, more protected species are expected for the ER.

Twelve (12) AIP species were recorded for the ER. These species are listed under the Alien and Invasive Species List 2020, Government Gazette No. GN1003. Nine (9) of these species are NEMBA category 1b AIP species that must be controlled by implementing an AIP Management Programme, in compliance with section 75 of NEMBA. Refer to **Section 3.1.10.2** for the list of AIP species and detailed discussion.

4.9.6.3 FAUNA ASSESSMENT

Mammal, herpetofauna and avifauna observations and recordings are discussed in this section.

4.9.6.3.1 MAMMALS

The mammal species recorded for the ER during the field survey are presented in **Table 21** below. Additional common mammal species are expected for the ER. One mammal SCC was recorded, namely *Leptailurus serval* (Serval). It should also be noted that Sensitive Species 15 may also occur within the ER.

Table 21: Mammal species recorded for the ER during the field survey. (The Biodiversity Company, 2026).

Scientific Name	Common Name	Conservation Status		Free State Nature Conservation Ordinance 8 of 1969
		SANBI	IUCN	
Cynictis penicillata	Yellow Mongoose	LC	LC	
Lepus saxatilis	Scrub Hare	LC	LC	Schedule 2
Raphicerus campestris	Steenbok	LC	LC	Schedule 2
Xerus inauris	Cape Ground Squirrel	LC	LC	
Leptailurus serval	Serval	NT	LC	

4.9.6.3.2 HERPETOFAUNA

No reptile or amphibian species were recorded for the ER. Common reptile and amphibian species are expected for the ER. It should also be noted that SCC *Pyxicephalus adspersus* (Giant Bull Frogs may also occur within the ER.

4.9.6.3.3 AVIFAUNA

Thirty (30) species of bird were recorded for the ER during the survey based on either direct observation, vocalisations, or the presence of visual tracks and signs (**Table 22**). Three species are SCC namely *Anas undulata* (Yellow-billed Duck), *Elanus caeruleus* (Black-winged Kite), and *Scopus umbrette* (Hamerkop). These species are likely to make use of the water resource and the surrounding grassland habitats.

Table 22: Avifauna species recorded for the ER during the field survey (The Biodiversity Company, 2026).

Species	Common Name	Conservation Status		FSNCO 8 of 1969[7]
		Regional	**IUCN**	
Acridotheres tristis	Myna, Common	Unlisted	LC	-
Afrotis afraoides	Korhaan, Northern Black	Unlisted	LC	Schedule 1
Alopochen aegyptiaca	Egyptian Goose	Unlisted	LC	Schedule 2
Anas undulata	Yellow-billed Duck	NT	LC	Schedule 2
Bostrychia hagedash	Ibis, Hadeda	Unlisted	LC	Schedule 1
Bubulcus ibis	Egret, Cattle	Unlisted	LC	Schedule 1
Cisticola tinniens	Levaillant's Cisticola	Unlisted	LC	Schedule 1
Corvus albus	Crow, Pied	Unlisted	LC	-

[7] FSNCO = Free State Nature Conservation Ordinance 8 of 1969

Species	Common Name	Conservation Status		FSNCO 8 of 1969[7]
		Regional	IUCN	
Dendrocygna viduata	White-faced Whistling Duck	Unlisted	LC	Schedule 1
Elanus caeruleus	Black-winged Kite	NT	LC	Schedule 1
Euplectes orix	Southern Red Bishop	Unlisted	LC	
Fulica cristata	Coot, Red-knobbed	LC	LC	Schedule 2
Gallinula chloropus	Common Moorhen	Unlisted	LC	Schedule 1
Lanius collaris	Southern Fiscal	Unlisted	LC	Schedule 1
Macronyx capensis	Cape Longclaw	Unlisted	LC	Schedule 1
Oena capensis	Namaqua Dove	Unlisted	LC	Schedule 1
Passer melanurus	Cape Sparrow	Unlisted	LC	
Phalacrocorax lucidus	White-breasted Cormorant	Unlisted	LC	
Plectropterus gambensis	Spur-winged Goose	Unlisted	LC	Schedule 2
Prinia flavicans	Black-chested Prinia	Unlisted	LC	Schedule 1
Pternistis swainsonii	Swainson's Spurfowl	Unlisted	LC	Schedule 2
Saxicola torquatus	African Stonechat	Unlisted	LC	Schedule 1
Scopus umbretta	Hamerkop	NT	LC	Schedule 1
Spilopelia senegalensis	Dove, Laughing	Unlisted	LC	-
Tachybaptus ruficollis	Little Grebe	Unlisted	LC	Schedule 1
Tricholaema leucomelas	Acacia Pied Barbet	Unlisted	LC	Schedule 1
Vanellus armatus	Lapwing, Blacksmith	Unlisted	LC	Schedule 1
Vanellus armatus	Blacksmith Lapwing	Unlisted	LC	Schedule 1
Vanellus coronatus	Lapwing, Crowned	Unlisted	LC	Schedule 1
Vidua chalybeata	Village Indigobird	Unlisted	LC	Schedule 1

4.10 FRESHWATER ECOLOGY - SURFACE WATER AND WETLAND

4.10.1 DRAINAGE AND CATCHMENT

This section provides an overview of the regional hydrological (surface water) environment across the extent of the project area. Information in this section has been sourced from the Geohydrological Assessment undertaken by Gradient Groundwater Consulting and the Aquatics and Wetlands Assessment undertaken by the Biodiversity Company (**Appendix F**).

South Africa is divided into nineteen (19) Water Management Areas (WMAs). The delegation of water resource management from central government to catchment level is achieved by establishing Catchment Management Agencies (CMAs) at WMA level. Each CMA progressively develops a Catchment Management Strategy (CMS) for the protection, use, development, conservation, management and control of water resources within its WMA. This is to ensure that on a regional scale, water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all persons. The main instrument that guides and governs the activities of a WMA is the CMS which, while conforming to relevant legislation and national strategies, provides detailed arrangements for the protection, use, development, conservation, management and control of the region's water resources. The greater study is situated in primary catchment (C) of the Vaal River drainage system which covers a total area of approximately 580.0km^2. The resource management falls under the Vaal Water Management Area (WMA5) (previously Middle Vaal WMA[8]) which spans portions of the North West Province, northern Free State as well northern sections of the Northern Cape. The study area encompasses several quaternary catchments of the Vaal WMA. These include Quaternary Catchments C25B, C42H, C42J and C60H. The main watercourses within the Middle Vaal WMA are the Mooi, Vet, and Vaal Rivers (WRC, 2016). The Vaal River is a major tributary of the Orange River, which generally drains in an eastern direction towards the Atlantic Ocean. The primary rivers in and around the study area include the Vals River towards the northeast of the study area, the Sand River in the central parts of the study area, and the Vet River towards the southwest of the study area (WRC, 2016).

The perennial Vals River, a major tributary of the Vaal River, flows across the northeastern extremity of the study area, where it is dammed by the Serfontein Dam, and drains in a northwestern direction. The Serfontein Dam has a surface area of approximately 1.09 km^2. Minor tributaries of the Vals River located within the study area include Blomspruit and Enslinspruit toward the northeast of the study area, Middelspruit and Otterspruit toward the north of the study area, and Sandspruit towards the northwest of the study area. Blomspruit, Middelspruit and Sand Spruit drain in a northwestern direction toward the Vals River, while Enslinspruit and Otterspruit drain toward the north.

The perennial Sand River, a tributary of the Vet River, flows across the central parts of the study area and drains in a western direction. The Sand River is dammed by the Allemanskraal Dam southeast of the study area. The Allemanskraal Dam has a surface area of approximately 28.64 km^2. Minor tributaries of the Sand River located within the study area include Koolspruit, Erasmusspruit, and Rietspruit north of the Sand River and Maselspruit, Merriespruit, and the Doring River south of the Sand River. Koolspruit, Erasmusspruit, and Rietspruit drain in a southwestern direction toward the Sand River, Maselspruit and Merriespruit drain in a northern direction toward the Sand River, and the Doring River drains in a northwest direction toward the Sand River.

The perennial Vet River, a major tributary of the Vaal River, is located towards the southwest of the study area and drains in a northwestern direction. The Vet River is dammed by the Erfenis Dam towards the south of the study area. The Erfenis Dam has a surface area of approximately 32.40 km^2. Minor tributaries of the Vet River located within the study area include Soutspruit and Kromspruit north of the Vet River. Soutspruit drains is a southern direction towards the Vet River, while Kromspruit drains towards the southwest. Surface water drainage overall occurs in a western to northwestern direction within the study area. The mean annual runoff (MAR) for the study area is estimated at approximately 13.16 Mm^3/a, based on MAR data obtained from WR2012 (WRC, 2016). **Table 23** provides a summary of relevant climatological and hydrogeological information for the relevant quaternary catchments. Refer to **Figure 75** for the hydrological conditions.

Table 23: Study Area Catchment and Hydrological Properties (Gradient Groundwater Consulting, 2026).

Quaternary Catchment	Area (km2)	% Covered by Study Area	MAP (mm/a)	MAE (mm/a)	MAR (Mm3/a)	Rainfall Zone	Evaporation Zone
C25B	1 887.67	1.91	509.21	1 750	7.23	C2H	9A

[8] It should be noted that the Department of Water Affairs (DWA), now the Department of Water and Sanitation (DWS), replaced the original 19 WMAs established in 2004 by 9 new WMAs as defined in Government Gazette No. 35517, July 2012. This resulted in the grouping of the Upper, Middle, and Lower Vaal WMAs into the single Vaal WMA.

C42H	445.00	9.83	540.00	1 590	10.16	C4C	19C
C42J	1 013.93	26.69	529.79	1 600	21.26	C4C	19C
C60H	1 232.02	19.39	512.75	1 650	2.64	C6B	11A

4.10.2 SOUTH AFRICAN INVENTORY OF INLAND AQUATIC ECOSYSTEMS

As per the Aquatics and Wetland Assessment, Several wetlands were identified within the ER by means of the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) dataset (**Figure 76**). These wetlands mainly consist of isolated depressions scattered throughout the ER, with few floodplain and valley-bottom wetlands coinciding with the major stream paths in the northeastern ER. Main rivers identified within the ER according to the dataset was the Merriespruit, Sand River, Erasmusspruit, Rietspruit, Kromspruit, Slootpsruit, and tributary to the Middelspruit.

The depression wetlands were classified as “Least Concern” and “Poorly Protected” with regard to Ecosystem Threat Status, and Ecosystem Protection Level, respectively. Furthermore, the valley-bottom and floodplain systems were classified as “Critically Endangered” and “Not Protected”. All identified rivers were classified as “Critically Endangered” and were dominantly “Not Protected” with a few systems being classified as “Poorly Protected”.

4.10.3 NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREA STATUS

To better conserve aquatic ecosystems, South Africa has categorised its river systems according to set ecological criteria (i.e., ecosystem representation, water yield, connectivity, unique features, and threatened taxa) to identify Freshwater Ecosystem Priority Areas (FEPAs) (Driver *et al.,* 2011). The FEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the NEM:BA biodiversity goals (Nel *et al.,* 2011).

As with the SAIIAE dataset, several wetlands were identified within the ER, consisting mainly of depression wetlands with few valley-bottom and floodplain systems located within the major stream paths (**Figure 76**). Furthermore, several rivers were identified which coincide with the identified features from the SAIIAE dataset. Only three wetlands were identified to be “Priority” ecosystems, and these features occur on the edges of ER and not within the Target Areas or 500 m Buffer of the Seismic transects. The remaining wetlands were classified as “Non-Priority” ecosystems. **Figure 77** shows that the ER overlaps with non-priority and priority FEPA wetlands.

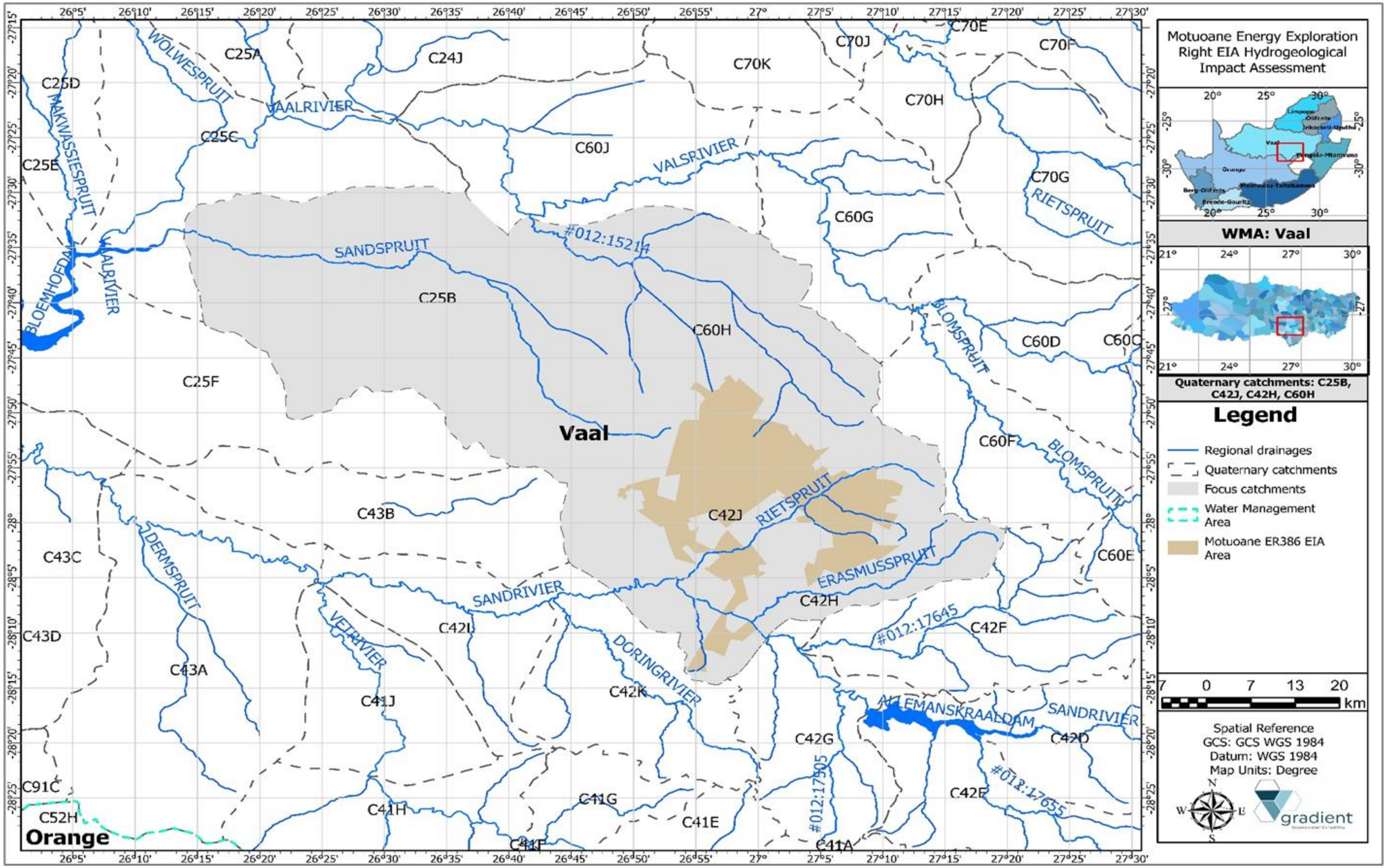


Figure 75: Quaternary catchments and water management area (Gradient Groundwater Consulting, 2026).

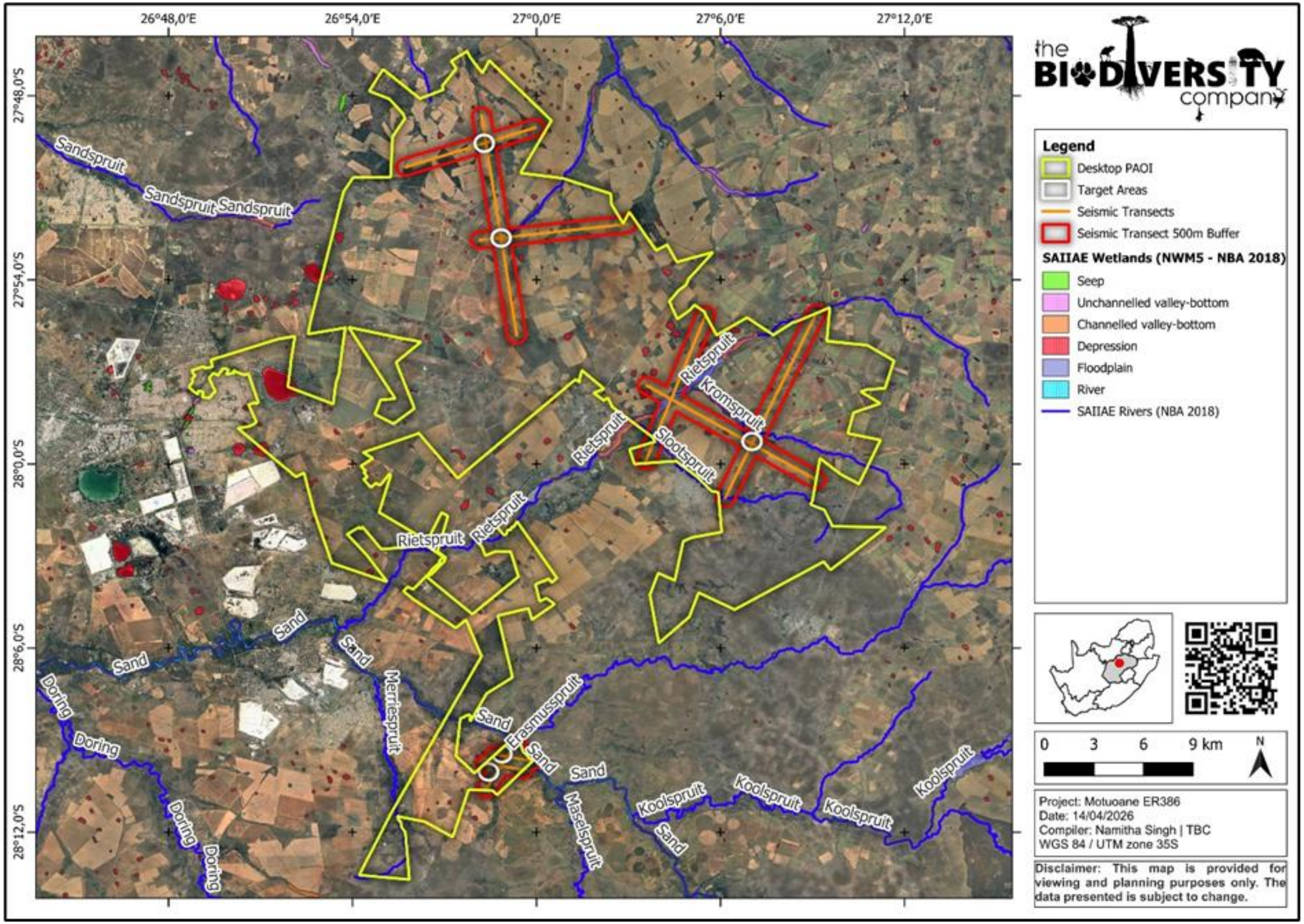


Figure 76: South African Inventory of Inland Aquatic Ecosystems with relevance to the project (The Biodiversity Company, 2026).

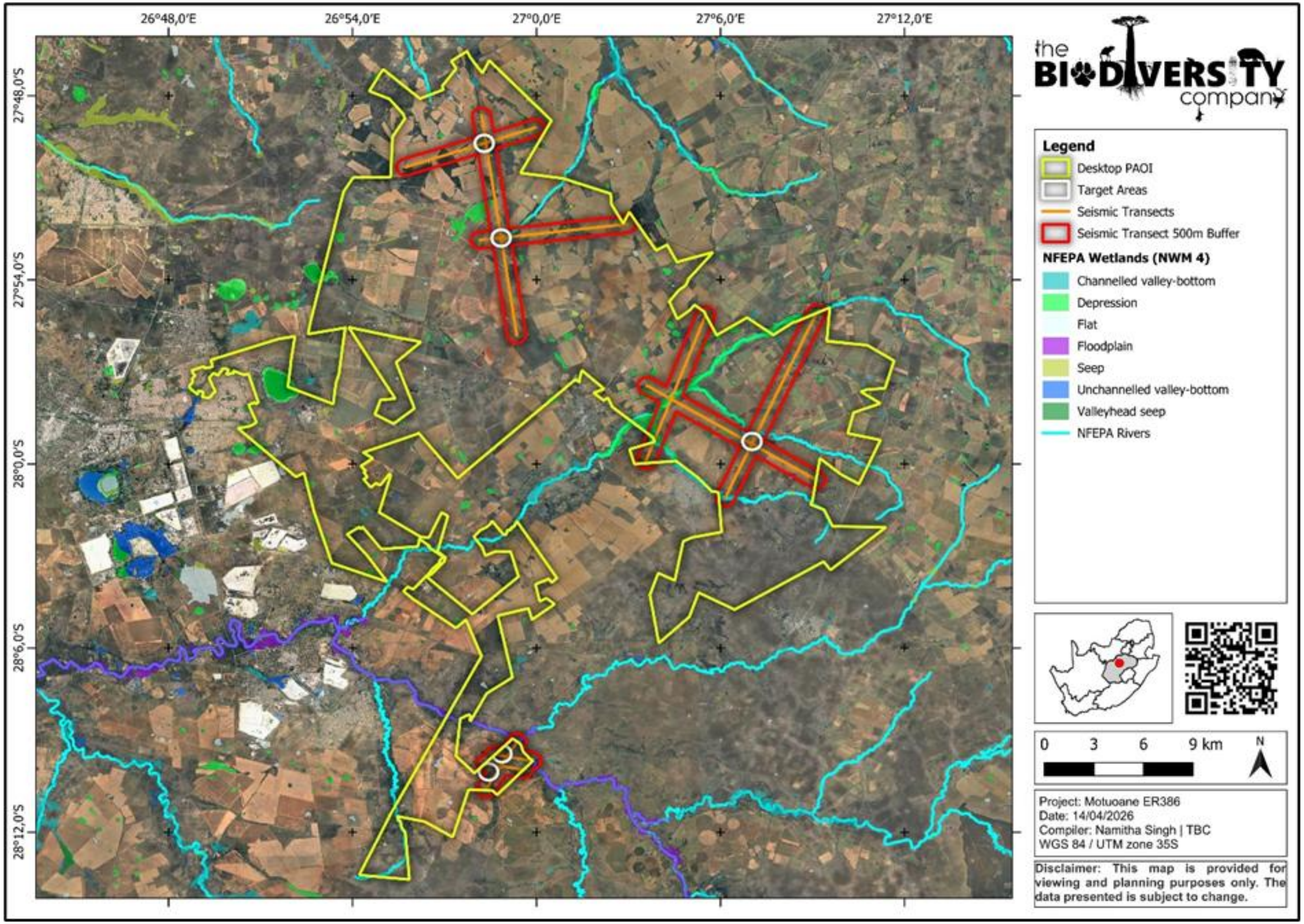


Figure 77: The ER in relation to the National Freshwater Ecosystem Priority Areas (The Biodiversity Company, 2026).

4.11 HYDROGEOLOGY - GROUNDWATER

This section summarises the regional and site-specific hydrogeology as obtained from the Geohydrological Assessment by Gradient Groundwater Consulting (referred to as Gradient Consulting) (2026) attached as **Appendix F**. The geohydrological setting and conceptual model of the study area is described according to the following criteria:

- Regional hydrogeology information;
- Local hydrostratigraphic units;
- Unsaturated zone;
- Groundwater-surface water interaction;
- Hydraulic parameters;
- Aquifer classification; and
- Hydrogeological conceptual model.

4.11.1 REGIONAL HYDROGEOLOGY INFORMATION

The Department have characterised South African aquifers based on host-rock formations in which it occurs together with its capacity to transmit water to boreholes drilled into relative formations. The water bearing properties of respective formations can be classified into four aquifer classes defined below. Each of these classes is further subdivided into groups relating to the capacity of an aquifer to transmit water to boreholes, typically measured in Litres per second (L/s). The groups therefore represent various ranges of borehole yields:

a. **Class A:** Intergranular Aquifers associated either with loose and unconsolidated formations such as sands and gravels or with rock that has weathered to only partially consolidated material.

b. **Class B:** Fractured Aquifers associated with hard and compact rock formations in which fractures, fissures and/or joints occur that are capable of both storing and transmitting water in useful quantities.

c. **Class C:** Karst Aquifers associated with carbonate rocks such as limestone and dolomite in which groundwater is predominantly stored in and transmitted through cavities that can develop in these rocks.

d. **Class D:** Intergranular and fractured Aquifers that represent a combination of Class A and B aquifer types. This is a common characteristic of South African aquifers. Substantial quantities of water are stored in the intergranular voids of weathered rock but can only be tapped via fractures penetrated by boreholes drilled into it.

According to the DWS Hydrogeological map (DWS Hydrogeological map series 2726 Kroonstad) the study area is predominantly underlain by a Class d2 intergranular and fractured aquifer (typically associated with median borehole yields ranging between 0.1 and 0.5 L/s), while small portions towards the northwest of the study area are underlain by a Class d3 intergranular and fractured aquifer (typically associated with median borehole yields ranging between 0.5 and 2.0 L/s). Both the Class d2 and Class d3 aquifers consist of primarily argillaceous (clay-containing) rocks, including shale, mudstone, and subordinate siltstone. Most hard-rock aquifers are secondary in nature with groundwater associated with fracturing, fault zones as well as contact zones of the dolerite intrusions. Aquifer hosts in the Beaufort Group comprise of mudstone and sandstone intruded by dolerite dykes and sheets, however, will not only be multi-layered, but also multi-porous with variable thicknesses. The contact plane between two different sedimentary layers will cause a discontinuity in the hydraulic properties of the composite aquifer. The Ecca Group aquifers consist mainly of shales and sandstones that are very dense with permeability usually very low due to poorly sorted matrices. Accordingly, it can be assumed that the aquifer has a low development potential, it should however be noted that higher yielding boreholes (>5.0l/s) may occur along intruding dyke contact zones and other structural features i.e., fault zones etc. (Barnard, 2000).

According to Vegter's groundwater regions delineated (2000) the study area can be classified as falling under the Northeastern Upper Karoo Region (Region 30) towards the central, eastern and southern areas whereas the northern and northwestern section forming part of the Northeastern Pan Belt Region (Region 33). Groundwater Region 33 comprises of mudstone and sandstone (with dolerite dyke and sill intrusions) of the Adelaide and Tarkastad Subgroups within the Beaufort Group of the Karoo Supergroup (WRC, 2016). The maximum aquifer thickness i.e., shallow, intergranular aquifer system within the Northeastern Pan Belt Region is <20m while the maximum aquifer thickness within the Northeastern Upper Karoo Region is slightly thicker at 20 – 30m with water stored mainly in decomposed/partly decomposed rock and water bearing fractures principally restricted to a shallow zone below the static groundwater level. The average groundwater level within Groundwater Region 33 is 14.90 mbgl, while the average saturated thickness of the weathered (shallow) and fractured (deeper) zones are 22.60 m and 75.00 m, respectively (WRC, 2016). Groundwater Region 30 comprises of compact, dominantly argillaceous strata of the Ecca Group within the Karoo Supergroup (WRC, 2016). The average groundwater level within Groundwater Region 30 is 18.20 mbgl, while the average saturated thickness of the weathered (shallow) and fractured (deeper) zones are 9.30 m and 185.00 m, respectively (WRC, 2016). Refer to **Figure 79** for a map illustrating the typical groundwater occurrence for the greater study area while **Figure 80** depicts the hydrogeological map of the greater study area.

4.11.2 LOCAL HYDROSTRATIGRAPHIC UNITS

For the purposes of this investigation, three main hydrostratigraphic units/aquifer systems can be inferred in the saturated zone[9]:

i. A **shallow Quaternary (perched and unconfined) aquifer**: These aquifers consist of recent types of sediments and are characteristically primary porosity aquifers, such that groundwater flow occurs in the pore spaces between soil and sediment particles. These aquifers are formed by alluvial material along the riparian zone of local drainages and are limited to a zone of variable width and depth. Clay lenses in the soil and unsaturated zones may cause local, perched water tables which occur above the regional water table.

ii. A **shallow, intergranular and fractured aquifer within the Beaufort Group**: These aquifers occur in the transitional soil and weathered bedrock formations underlain by more consolidated bedrock. Groundwater flow patterns usually follow the topography, discharging as natural springs at topographic low-lying areas. Usually, these aquifers can be classified as a secondary porosity aquifer and is generally unconfined with phreatic water levels. In secondary porosity aquifers, groundwater flow occurs along fractures, while water is stored within the rock matrix. Due to higher effective porosity (n) this aquifer is more susceptible to impacts from contaminant sources compared to confined aquifers.

iii. A **deeper, fractured aquifer within the Ecca Group and pre-Karoo rocks**: In fractured aquifers, pores are well-cemented and do not allow any significant flow of water. Groundwater flow is dictated by transmissive secondary porosity structures such as bedding planes fractures, faults and contact zones fracture zones that occur in the relatively competent host rock. Fractured mudstone, sandstone, shales sequences as well as dolerite dykes and sills are considered as fractured rock aquifers holding water in storage in both pore spaces and fractures. Groundwater yields, although more heterogeneous, can be expected to be higher than the weathered zone (shallow) aquifer. This aquifer system usually displays semi-confined or confined characteristics with potentiometric heads often significantly higher than the water-bearing fracture position.

4.11.3 UNSATURATED ZONE

The unsaturated (vadose) zone is defined as the subsurface zone between the ground surface and the main water table where pores are filled with both air and water as depicted in **Figure 78** (Fetter and Kreamer, 2023). According to WR2012 (WRC, 2016), the average thickness of the unsaturated zones of Groundwater Region 30 and 33 are 18.20 m and 14.90 m, respectively. According to the 1.0×1.0 km groundwater level grid obtained

[9] Refer to project assumptions and limitations, it should be noted that no site characterisation boreholes have been drilled to confirm this statement.

from WR2012 (WRC, 2016), the thickness of the unsaturated zone ranges between 15.98 to 56.82 m, with an average thickness of 29.48 m.

4.11.4 GROUNDWATER-SURFACE WATER INTERACTION

Groundwater and surface water interaction is an essential component of the hydrological cycle. The hyporheic zone (stream bed) is the zone of most interaction (Adams *et. al*.,2012). According to records documented by Van Tonder and Dennis (2003), under natural conditions this area exhibits certain regions where there is pronounced interaction between surface and groundwater. The two regimes are therefore well-linked and should be integrated to manage any water-related issues in these catchments. Regional drainages can be generally classified as influent or gaining stream systems as the groundwater head elevation of the water table in the vicinity of the stream is higher than the altitude of the stream bed and, accordingly, there definitely exists groundwater discharge as baseflow to local drainages. The alluvial associated with the floodplains within the greater study area forms a primary aquifer and may potentially be directly connected with surface water resources, especially during high flow conditions.

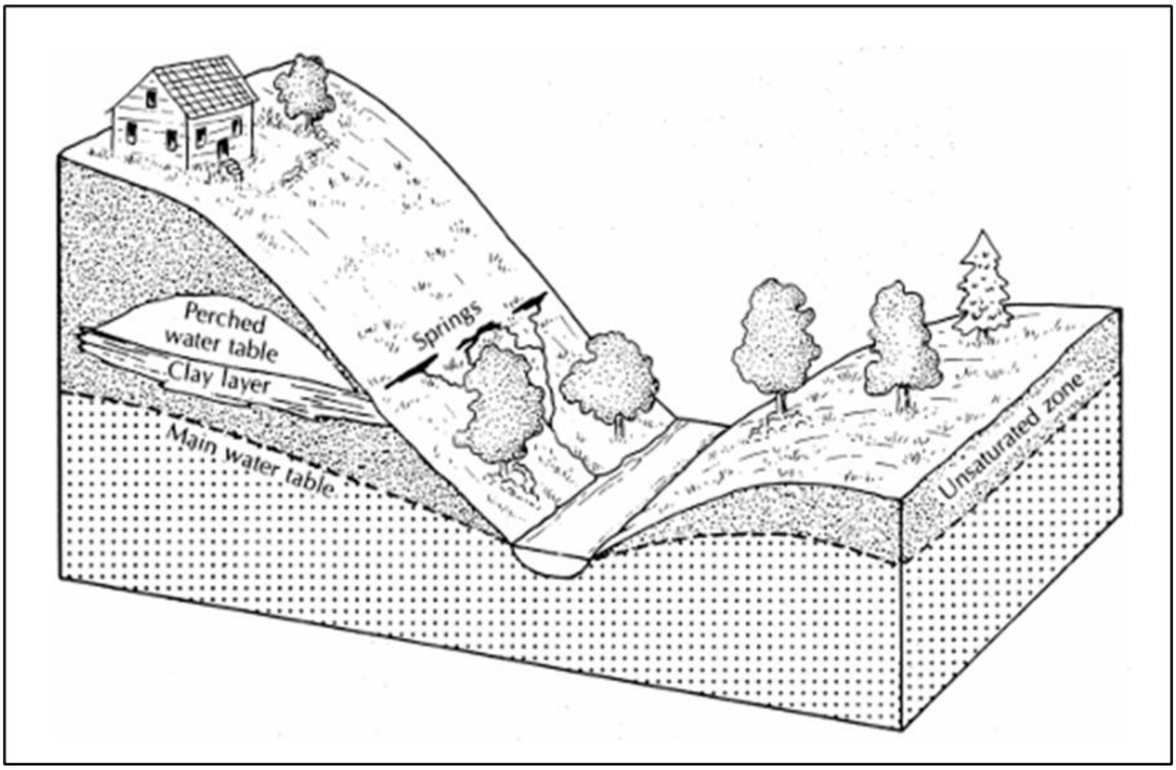


Figure 78: Illustration of the Unsaturated Zone (Fetter and Kreamer, 2023).

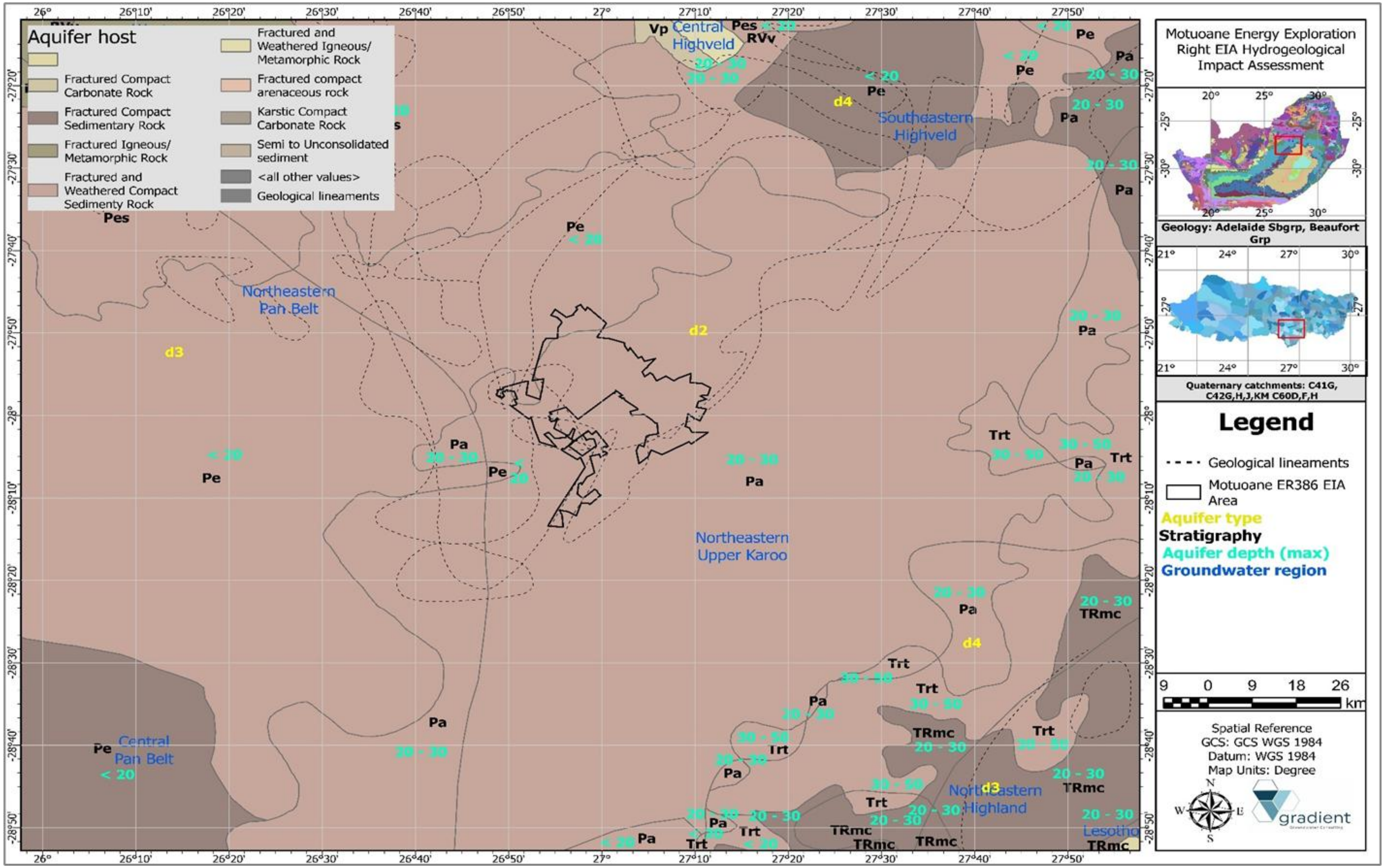


Figure 79: Typical aquifer hosts and groundwater occurrence for the study region (Gradient Consulting, 2026).

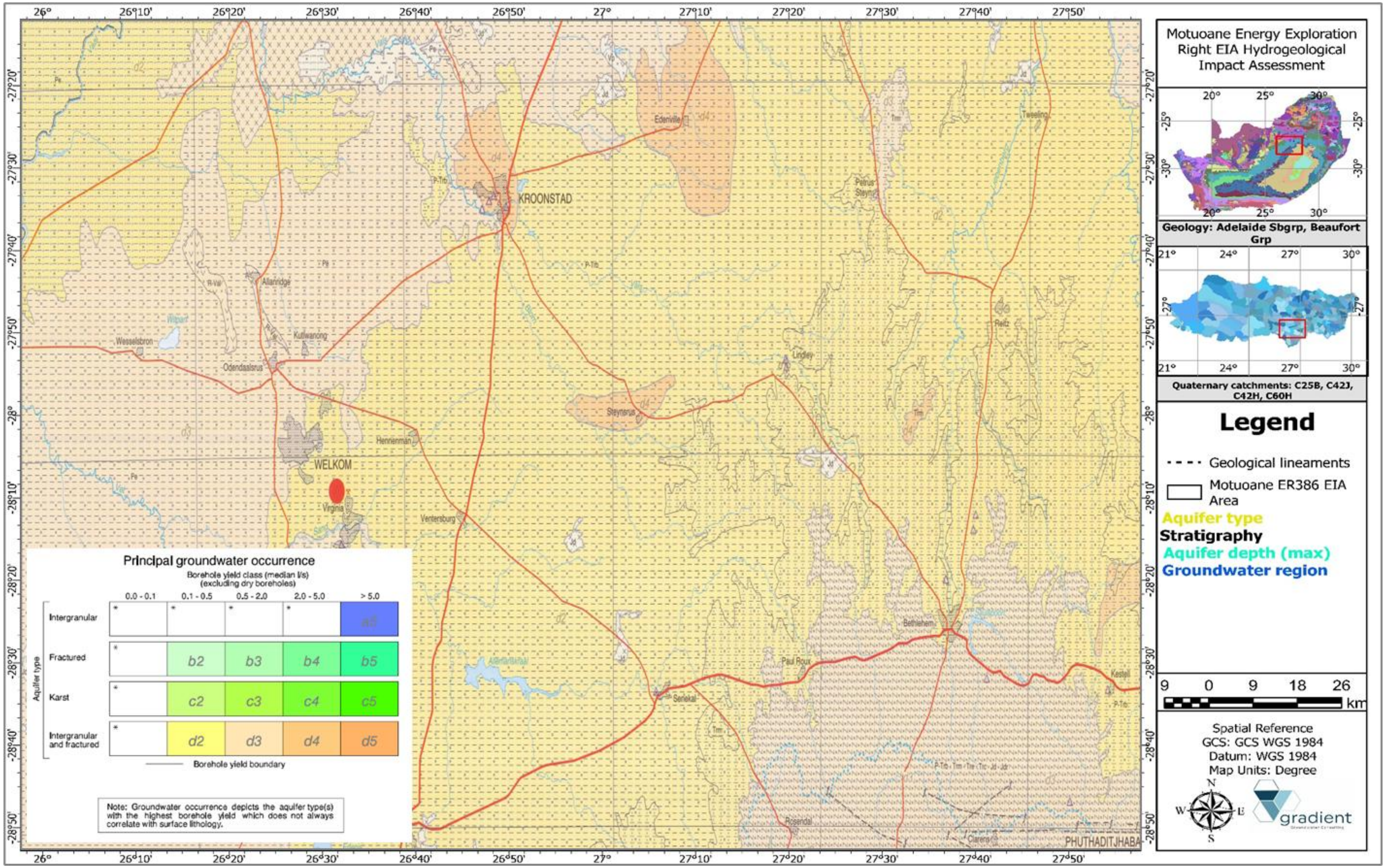


Figure 80: Hydrogeological map of the greater study region (Gradient Consulting, 2026).

4.11.5 HYDRAULIC PARAMETERS

This section provides a brief overview of aquifer hydraulic parameters based on published literature for similar hydrogeological conditions as well as historical reports.

4.11.5.1 HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY

Hydraulic conductivity is the constant of proportionality in Darcy's Law which states that the rate of flow through a porous medium is proportional to the loss of head, and inversely proportional to the length of the flow path as indicated in the following equation for Hydraulic Conductivity (Darcy's Law)**:**

$$\boldsymbol{K} = \frac{\boldsymbol{Q}}{\boldsymbol{A}\left(\frac{\boldsymbol{dh}}{\boldsymbol{dl}}\right)}$$

where:

K = Hydraulic Conductivity (m/d).

Q = Flow of water per unit of time (m^3/d).

dh/dl = Hydraulic gradient.

A = is the cross-sectional area, at a right angle to the flow direction, through which the flow occurs (m^2)

The hydraulic conductivity of sedimentary formations such as evident on site can range from $10E^{-6}$ – $10E^{-2}$ m/d. The hydraulic conductivity of fractured igneous rocks (i.e. dolerite) varies between $10E^{-6}$ – $10E^{-1}$ m/d, while conductivity values for un-fractured igneous rocks (i.e. fresh dolerite sill) ranges between $10E^{-9}$ – $10E^{-6}$ m/d. The hydraulic conductivity of quaternary deposits and alluvial pockets associated with the drainage system i.e., riverbed aquifers can be orders higher and can vary between $10E^{-2}$ – $10E^{1}$ m/d (Freeze and Cherry, 1979). Refer to **Figure 81** for the typical hydraulic conductivity values for on-site hydrostratigraphical units.

Transmissivity can be expressed as the product of the average hydraulic conductivity (K) and thickness (b) of the saturated portion of an aquifer and expressed by:

$$\boldsymbol{T} = \boldsymbol{Kb}$$

where:

T = Transmissivity (m^2/d).

K = Hydraulic Conductivity (m/d).

b = Saturated aquifer thickness.

According to the transmissivity GIS data provided by WR2012 (WRC, 2016), the entire study area is underlain by a Class d2 intergranular and fractured aquifer with an average transmissivity of 17.5 m^2/day (WRC, 2016)[10].

[10] It should be noted that no aquifer tests were conducted to support site representative hydraulic parameters.

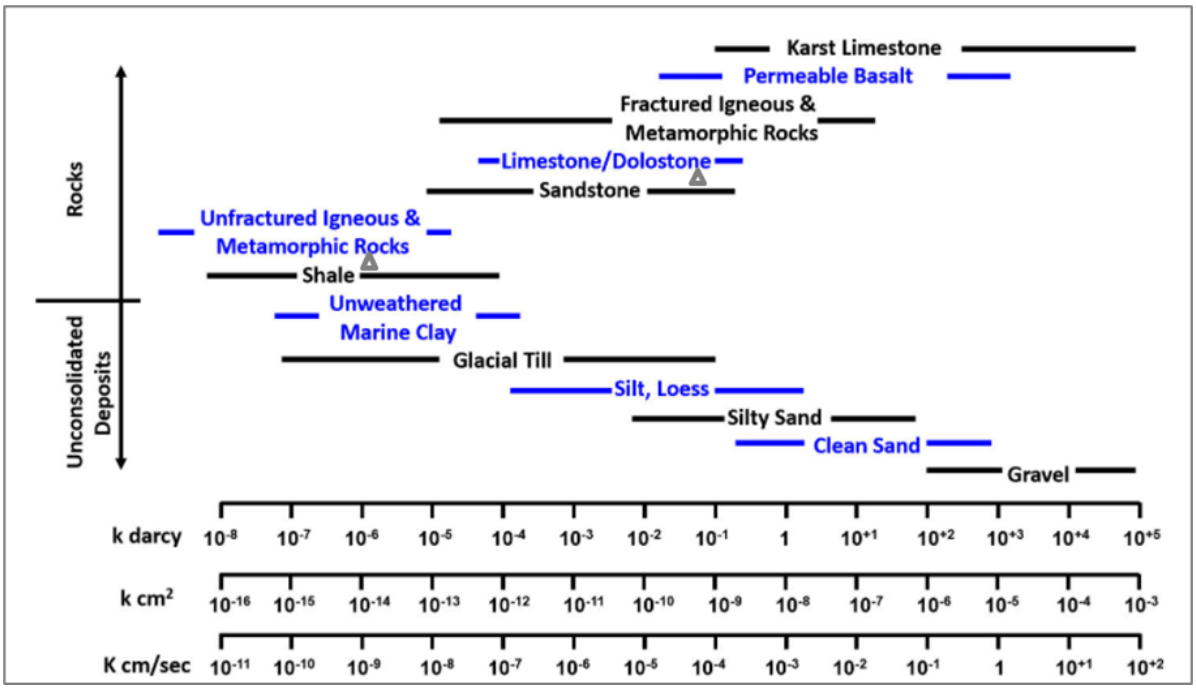


Figure 81: Typical hydraulic conductivity values for on-site hydrostratigraphical units (Gradient Groundwater Consulting, 2025).

4.11.5.2 STORATIVITY

Storativity refers to the volume of water per volume of aquifer released as a result of a change in head. For a confined aquifer, the storage coefficient is equal to the product of the specific storage and aquifer thickness. Typical storativity values for fractured rock systems is in the order of $10E^{-5}$ – $10E^{-3}$ (Freeze and Cherry, 1979). Storativity values of the shallow, weathered aquifer will be slightly higher i.e., $10E^{-2}$.

4.11.5.3 POROSITY

Porosity is an intrinsic value of seepage velocity and hence contamination migration. The porosity of fractured sedimentary formations ranges between 3% – 10%, while porosity of weathered formations can range between 10% to 15% depending on the nature and state of weathering. The intrinsic porosity of primary aquifers i.e., alluvial deposits can be as high as 20% depending on the nature of sorting (Freeze and Cherry, 1979).

4.11.5.4 RECHARGE

An approximation of recharge for the study area is estimated at ~3.50% of MAP i.e. ~19.48 mm/a as summarised in **Table 24**. According to the 1 × 1 km recharge grid obtained from WR2012, the average recharge in the greater study area ranges is approximately 9.11 mm/a (WRC, 2016). Groundwater recharge was calculated using the RECHARGE Program1 (van Tonder and Xu, 2000), which includes using qualified guesses as guided by various schematic maps. The following methods/sources were used to estimate the recharge: (i) Geology (ii) Vegter Groundwater Recharge Map (**Figure 82**) (iii) Harvest Potential (**Figure 83**) (iv) Baseflow as a minimum of recharge (v) Qualified opinion and, (vi) Literature review.

Table 24: Recharge estimation (after van Tonder and Xu, 2000) (Gradient Consulting, 2026).

Recharge method/ Reference	Recharge (mm/a)	Recharge (% of MAP)	Weighted Average (High = 5; Low = 1)
Geology	21.60	4.06	2.00
Vegter	25.00	4.70	1.00
Harvest Potential	20.00	3.76	2.00

Recharge method/ Reference	Recharge (mm/a)	Recharge (% of MAP)	Weighted Average (High = 5; Low = 1)
Baseflow	15.00	2.82	2.00
Qualified Opinion	17.50	3.29	4.00
Literature	17.80	3.35	4.00
Weighted average	**19.48**	**3.50**	**15.00**
Notes: Recharge per annum were calculated using a MAP of 532.0 mm/a.			

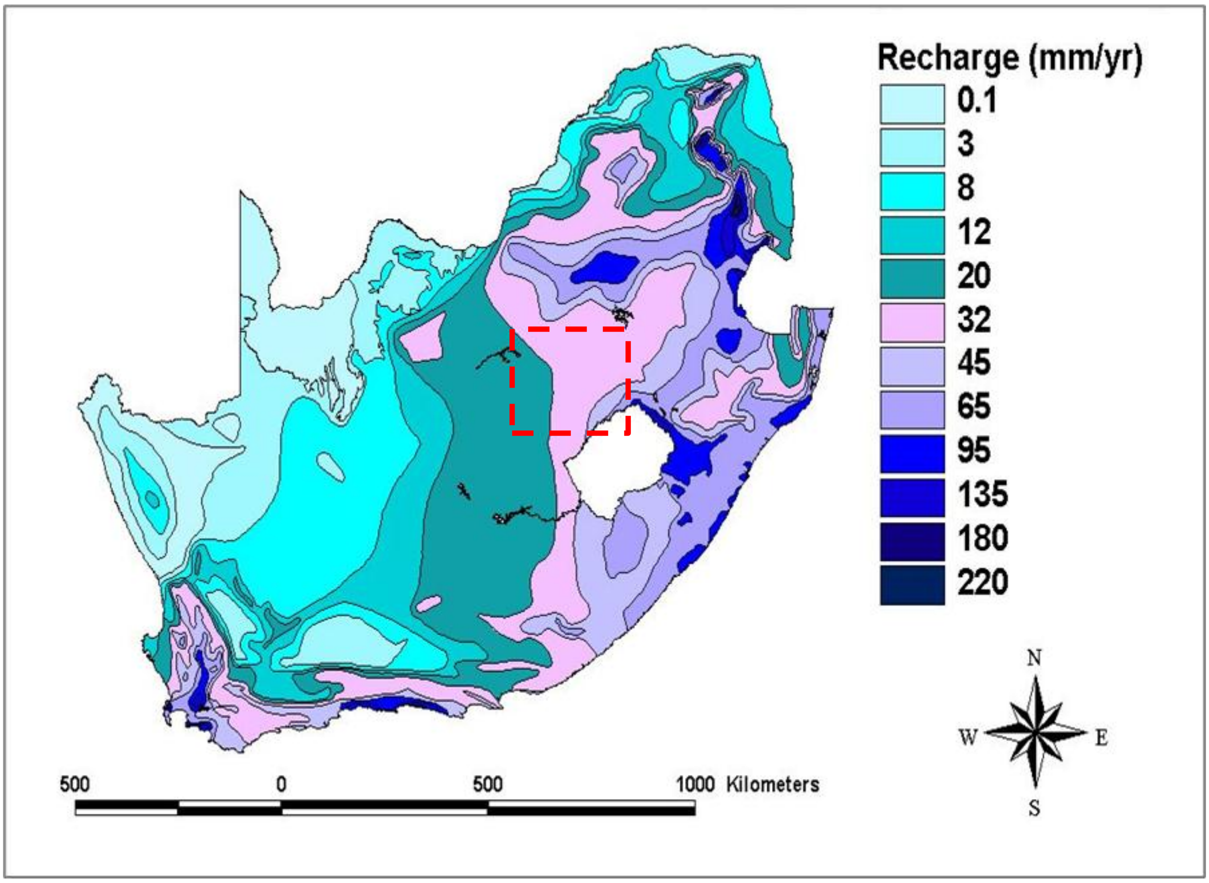


Figure 82: Groundwater recharge distribution in South Africa (After Vegter, 1995).

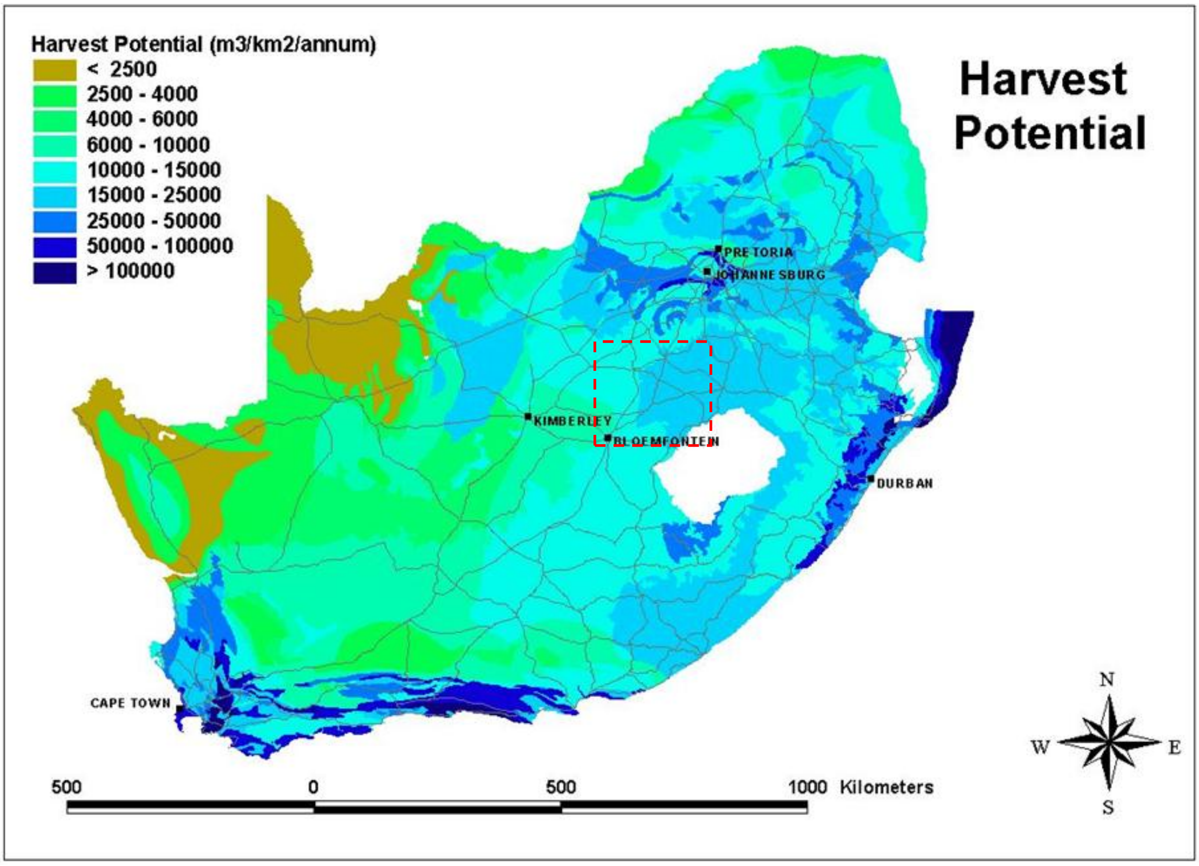


Figure 83: Harvest potential distribution in South Africa (DWS, 2013).

4.11.6 AQUIFER CLASSIFICATION AND GROUNDWATER MANAGEMENT INDEX

The most widely accepted definition of groundwater contamination is defined as the introduction into water of any substance in undesirable concentration not normally present in water e.g. microorganisms, chemicals, waste or sewerage, which renders the water unfit for its intended use (UNESCO, 1992). The objective is to formulate a risk-based framework from geological and hydrogeological information obtained as part of this investigation. Two approaches were followed in an estimation of the risk of groundwater contamination as discussed below. As part of the aquifer classification, a Groundwater Quality Management (GQM) Index is used to define the level of groundwater protection required. The GQM Index is obtained by multiplying the rating of the aquifer system management and the aquifer vulnerability. A **GQM Index = 4** was calculated for the local aquifer system and according to this estimate, a "**Medium**" level groundwater protection is required for this aquifer system.

$$\textbf{\textit{GQM Index}} = \boldsymbol{Aquifer\ system\ management\ x\ Aquifer\ vulnerability}$$

4.11.6.1 AQUIFER CLASSIFICATION

An aquifer classification system provides a framework and objective basis for identifying and setting appropriate levels of groundwater resource protection. This would facilitate the adoption of a policy of differentiated groundwater protection. The aquifer classification system used to classify the aquifers is the proposed National Aquifer Classification System of Parsons (1995). This system has a certain amount of flexibility and can be linked to second classifications such as a vulnerability or usage classification. Parsons suggests that aquifer classification forms a very useful planning tool that can be used to guide the management of groundwater issues. Parsons also suggests that some level of flexibility should be incorporated when using such a classification system.

The South African Aquifer System Management Classification is presented by five major classes:

- Sole Source Aquifer System;

- Major Aquifer System;
- Minor Aquifer System;
- Non-Aquifer System; and
- Special Aquifer System.

The following definitions apply to the aquifer classification system:

- Sole source aquifer system: "An aquifer that is used to supply 50 % or more of domestic water for a given area, and for which there are no reasonable alternative sources should the aquifer become depleted or impacted upon. Aquifer yields and natural water quality are immaterial".
- Major aquifer system: "Highly permeable formations, usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes. Water quality is generally very good".
- Minor aquifer system: "These can be fractured or potentially fractured rocks that do not have a high primary permeability, or other formations of variable permeability. Aquifer extent may be limited and water quality variable. Although this aquifer seldom produces large quantities of water, they are both important for local supplies and in supplying base flow for rivers".
- Non-aquifer system: "These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. Water quality may also be such that it renders the aquifer unusable. However, groundwater flow through such rocks does occur, although imperceptible, and needs to be considered when assessing risk associated with persistent pollutants".
- Special aquifer system: "An aquifer designated as such by the Minister of Water Affairs, after due process".

According to the aquifer classification map of South Africa the project area is underlain by a "**Minor aquifer**".

4.11.6.2 AQUIFER VULNERABILITY

Aquifer vulnerability can be defined as the tendency or likelihood for contamination to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer. According to the aquifer vulnerability map of South Africa the project area is underlain by an aquifer system with a "**Moderate**" vulnerability rating.

4.11.6.3 AQUIFER SUSCEPTIBILITY

Aquifer susceptibility is a qualitative measure of relative ease with which a groundwater body can be potentially contaminated by anthropogenic activities. According to the Aquifer susceptibility map of South Africa the project area is underlain by an aquifer system with a "Medium" susceptibility rating. Refer to **Table 25**.

Table 25: Groundwater Quality Management Index (Gradient Consulting, 2026).

Aquifer system Management qualification		Aquifer vulnerability Classification	
Class	**Points**	**Class**	**Points**
Sole Source Aquifer System	6	High	3
Major Aquifer System	4	**Moderate**	**2**
Minor Aquifer System	**2**	Low	1
Non-Aquifer System	0		
Special Aquifer System	0-6		
GQM INDEX	**Level of protection**		
<1	Limited Protection		

Aquifer system Management qualification		Aquifer vulnerability Classification
1 to 3	Low Level Protection	
3 to 6	Medium Level Protection	
6 to 10	High Level Protection	
>10	Strictly Non- Degradation	
	GQM Index:	4

4.11.7 HYDROGEOLOGICAL CONCEPTUAL MODEL

The hydrogeological conceptual model consists of a set of assumptions, which will aid in reducing the problem statement to a simplified and acceptable version. Data gathered during the desk study and site investigation has been incorporated to develop a conceptual understanding of the regional hydrogeological system. **Figure 84** depicts a generalised hydrogeological conceptual model for similar environments and illustrates the concept of primary porous media aquifers and secondary fractured rock media aquifers. In porous aquifers, flow occurs through voids between unconsolidated rock particles whereas in double porosity aquifers, the host rock is partially consolidated, and flow occurs through the pores as well as fractures in the rock. In secondary aquifers the host rock is consolidated, and porosity is generally restricted to fractures that have formed after consolidation of the rock.

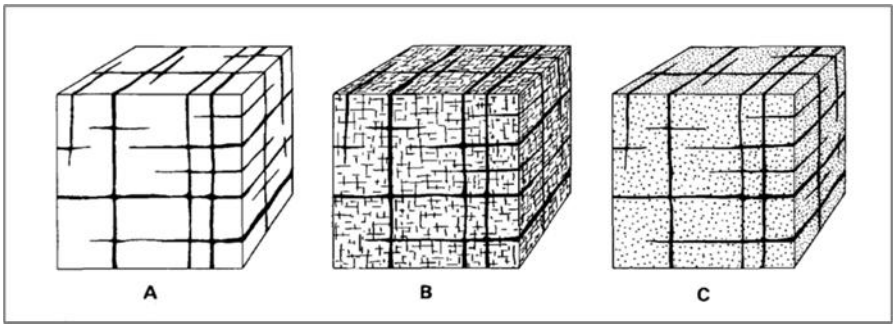


Figure 84: Generalised conceptual hydrogeological model (after Kruseman and de Ridder, 1994).

4.11.8 SITE INVESTIGATION

4.11.8.1 HYDROCENSUS USER SURVEY

A hydrocensus user survey within the greater study area was conducted during November and December 2025[11] where relevant hydrogeological baseline information was gathered. The aim of the hydrocensus survey is to determine the ambient and background groundwater conditions and applications and to identify potential sensitive environmental receptors, i.e., groundwater users in the direct vicinity of the proposed exploration activities. A total of 168 geosites were visited and recorded as part of the hydrocensus user survey which include surface water and groundwater receptors i.e., boreholes, artesian wells, wind pumps as well as surface water features and are largely applied for livestock watering and domestic water supply purposes. Refer to the Hydrogeological Impact Assessment (**Appendix F**) for the detailed hydrocensus information. **Figure 85** depicts a spatial distribution map of geosites visited as part of the hydrocensus user survey with **Figure 86** indicating the various groundwater status and applications.

4.11.8.1.1 GROUNDWATER STATUS

Of the boreholes recorded, the majority are in use (>77.58%) while ~22.42% are not currently being utilized. Refer to **Figure 86** for a summary of the groundwater status quo.

[11] It should be noted that relevant site information gathered will be representative of wet season contribution and conditions.

4.11.8.1.2 GROUNDWATER APPLICATION

Most boreholes recorded are being applied for livestock watering purposes (~33.33%) while water being applied for either domestic and household or domestic and livestock purposes account for >39.40%. A small number of boreholes are also being applied for domestic and gardening purposes (0.61%), wildlife watering (1.21%), irrigation (0.61%) or monitoring purposes (~2.42%). Boreholes which do not have an application and are not currently being utilized account to 22.42% of the total geosites visited. Refer to **Figure 87** for a summary of groundwater applications. According to the Middle Vaal ISP (DWAF, 2004), most boreholes are being applied for irrigation and small-town water supply.

4.11.8.1.3 BOREHOLE EQUIPMENT

Most boreholes visited are equipped with submersible pumps and account to 43.4%, while 35.20% of boreholes were fitted either with a wind pump or mono pump (0.63%). An average of 20.75% of boreholes are not equipped as indicated in **Figure 88**.

Figure 85: Spatial distribution map of the hydrocensus geosites surveyed (Gradient Consulting, 2026).

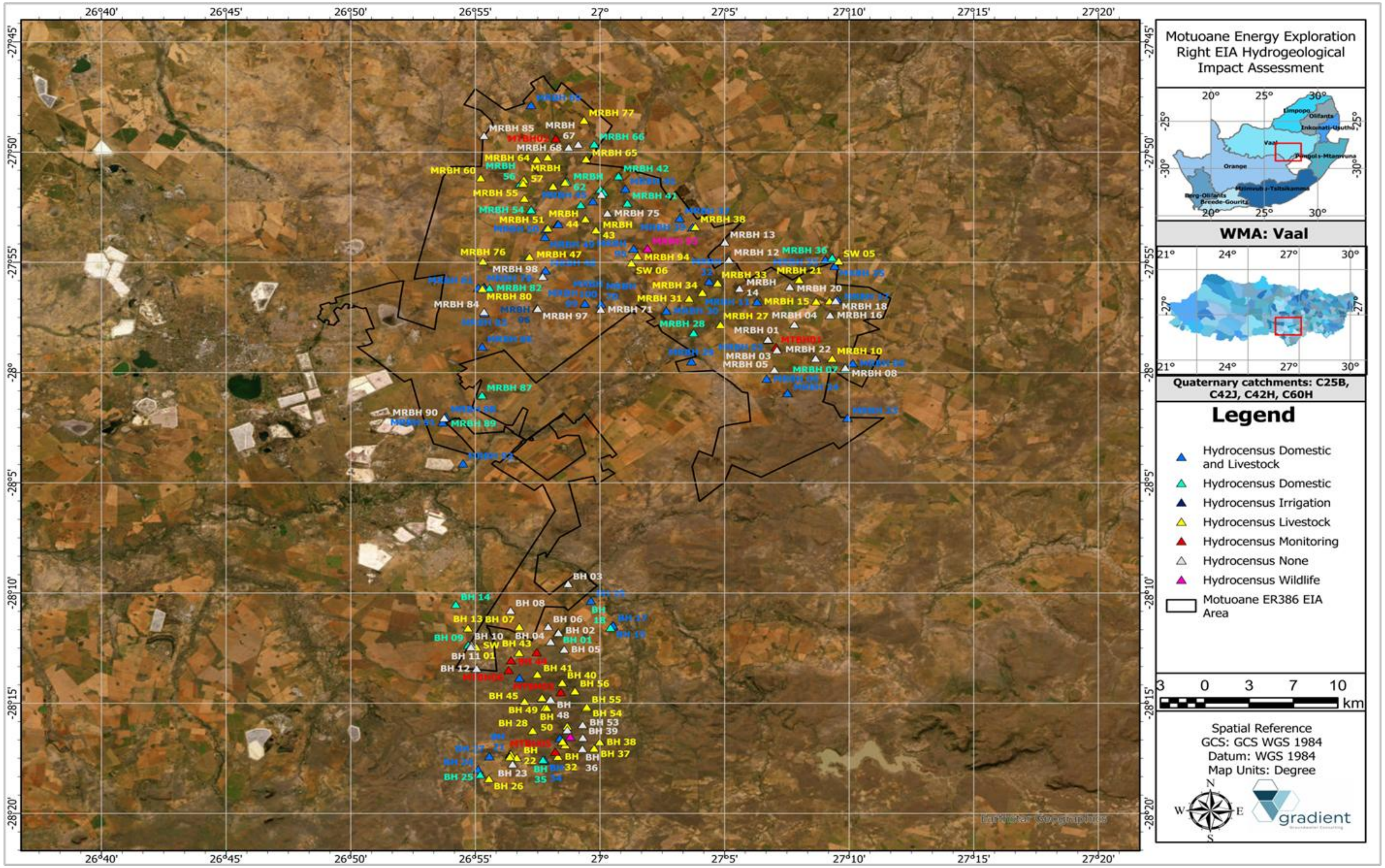


Figure 86: Spatial distribution map indicating groundwater status and application (Gradient Consulting, 2026).

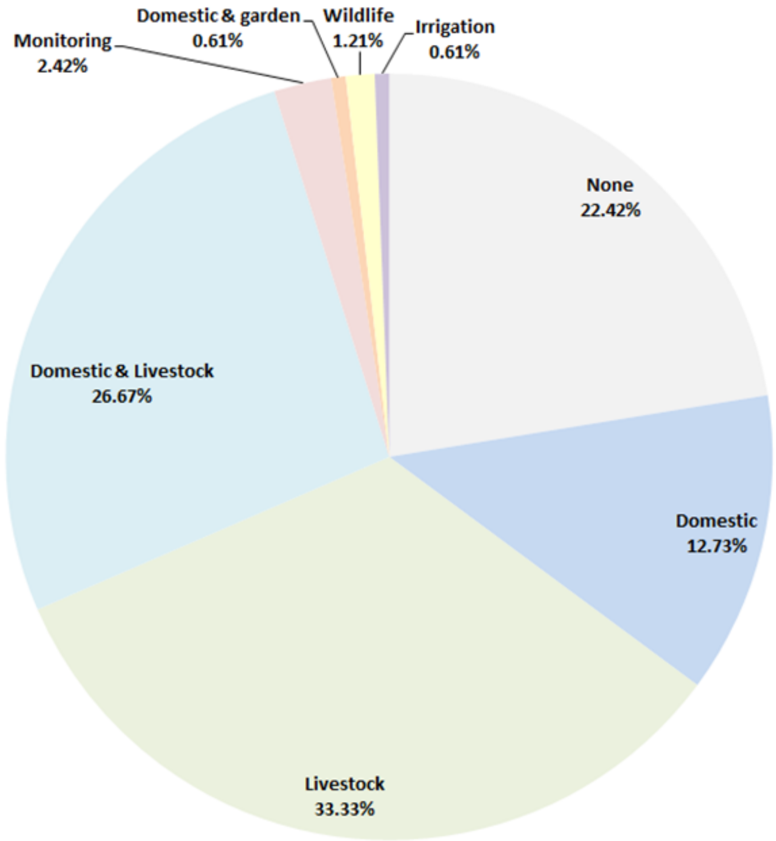


Figure 87: Hydrocensus user survey: Groundwater application (Gradient Consulting, 2026).

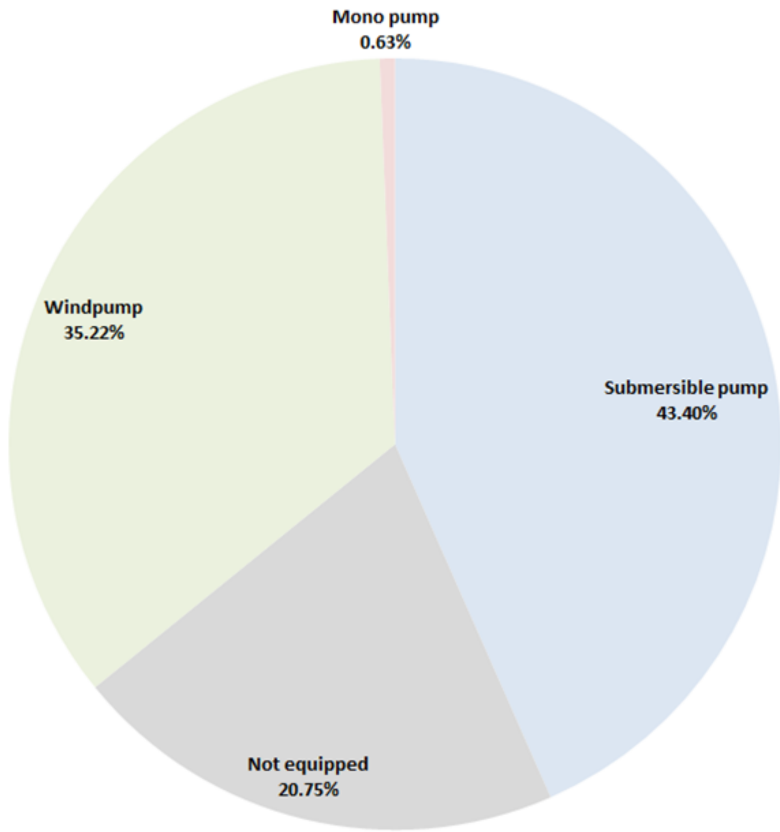


Figure 88: Hydrocensus user survey: Equipment type (Gradient Consulting, 2026).

4.11.8.2 GEOPHYSICAL SURVEY

A geophysical survey was conducted by the hydrogeologist in September 2025 wherein the sub-strata in the direct vicinity of the study area were investigated by applying the magnetic and electro-magnetic (EM) geophysical exploration techniques which were applied according to traverse array design for delineation of sub-surface lineaments and identification of potential preferential groundwater flow pathways to be targeted for site characterisation and monitoring boreholes. **Figure 89** shows a structural map of the greater study area with geological lineaments transecting the project site inferred. The latter was used in combination with structural geological interpretation to plan the geophysical survey and traverse layout. Refer to **Table 26** for a summary of geophysical traverse coordinates, traverse lengths, station spacings as well as approximate orientations and potential targets.
Figure 90 indicates the geophysical traverse array in relation to earmarked site characterisation gaps identified as week as existing geosites recorded as well as project boundary. To follow a brief description and interpretation of geophysical traverses at which drilling targets were executed. All geophysical survey graphs and interpretation including raw data and field-notes are summarised in Appendix B of the Hydrogeological Impact Assessment (**Appendix F**).

Table 26: Geophysical traverse summary (Gradient Consulting, 2026).

Traverse ID	Start		Approximate Length (m)	Potential target	Station spacing (m)	Drilling target	Approximate orientation
	Latitude	Longitude					
Traverse 01	-27.974865	27.128883	900.00	SW-NE striking lineament	10.00	MTBH01	W-E
Traverse 02	-27.971852	27.114019	650.00	W-E striking lineament	10.00	n/a	SW-NE
Traverse 02a	-27.974865	27.128883	600.00	W-E striking lineament	10.00	n/a	S-N
Traverse 03	-27.823385	26.968678	640.00	NW-SE striking lineament	10.00	MTBH02	SW-NE
Traverse 04	-27.821203	26.969845	600.00	NW-SE striking lineament	10.00	n/a	N-S
Traverse 05	-27.810811	26.966487	600.00	N-W striking lineament	10.00	n/a	SW-NE
Traverse 10	-28.207427	26.952012	800.00	NE-SW striking lineament	10.00	MTBH04	NW-SE
Traverse 11	-28.200461	26.941426	800.00	NE-SW striking lineament	10.00	n/a	NW-SE
Traverse 16	-28.229213	26.940949	1050.00	NE-SW striking lineament	10.00	n/a	NW-SE
Traverse 17	-28.246230	26.945356	480.00	NE-SW striking lineament	10.00	n/a	NW-SE
Traverse 18	-28.220336	26.936836	1000.00	NE-SW striking lineament	10.00	MTBH06	NW-SE

Figure 89: Map indicating potential reginal geological lineaments in relations to proposed infrastructure and activities (Gradient Consulting, 2026).

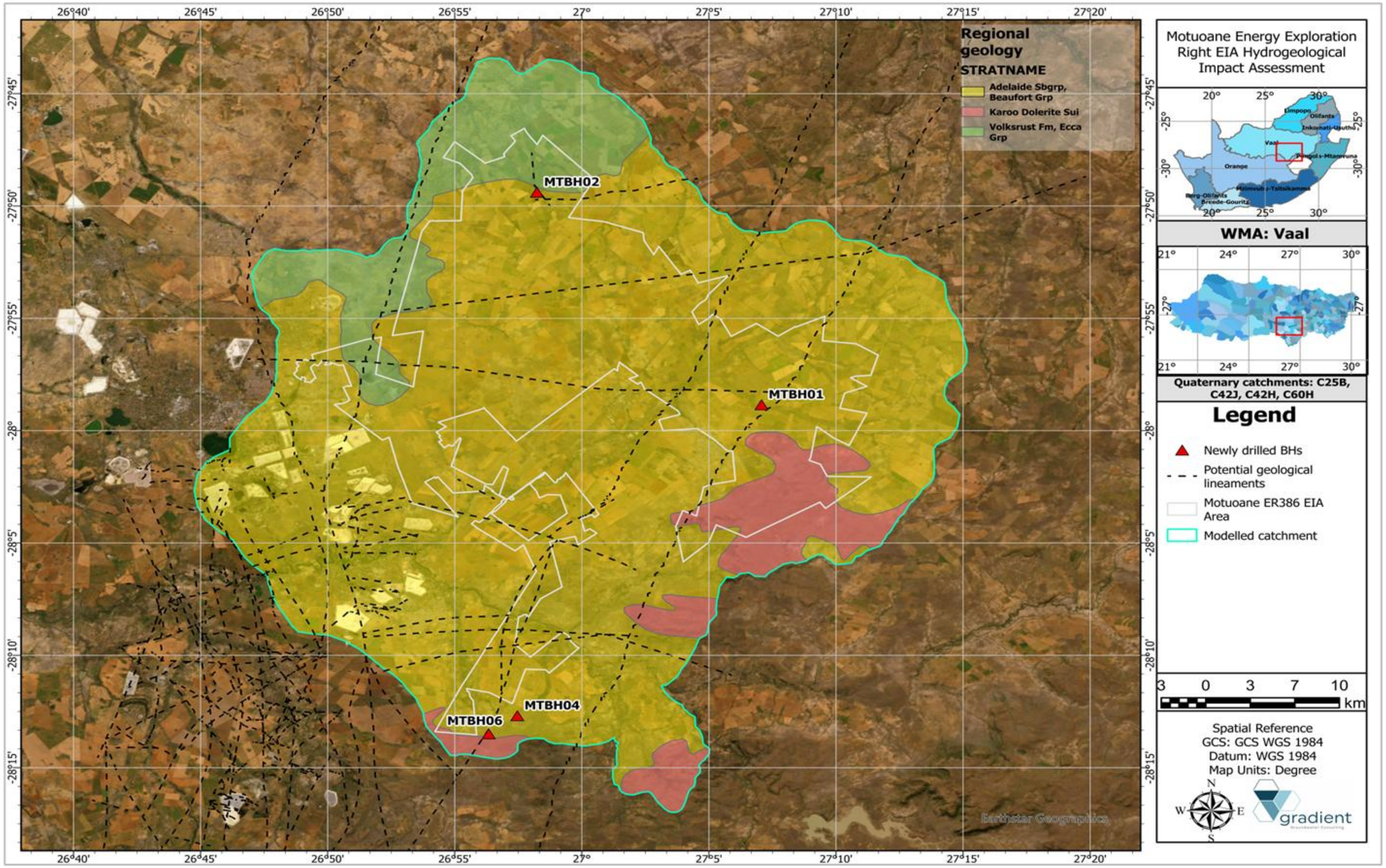


Figure 90: Geophysical traverse array and new drilled site characterisation borehole positions in relation to regional geology as well as potential geological lineaments (Gradient Consulting, 2026).

4.11.8.3 DRILLING

Following the geophysical survey, four drilling targets were identified and incorporated as part of the drilling program which was initiated during December 2025. The drilling technique applied is percussion drilling and the rationale for the placement and drilling of the new boreholes was based on the objectives of the study which include geological and hydrogeological site characterisation. Results from the geophysical survey and site accessibility for the drill rig were considered in the placement of the boreholes. Drilling objectives and placement is summarised in **Table 27** whereas borehole technical information is tabulated in **Table 28**. **Figure 90** shows the newly drilled borehole positions in relation to potential geological lineaments identified. Geological logs of the newly drilled boreholes as well as drilling field-notes are included in Appendix C of the Hydrogeological Impact Assessment (**Appendix F**).

Table 27: Drilling targets and objectives (Gradient Consulting, 2026).

BH ID	Latitude	Longitude	Aquifer target	Borehole purpose
MTBH01	-27.9803	27.11779	Fractured aquifer (confined)	Site characterisation and monitoring
MTBH02	-27.8227	26.97051	Fractured aquifer (confined)	Site characterisation and monitoring
MTBH04	-28.211	26.95767	Fractured aquifer (confined)	Site characterisation and monitoring
MTBH06	-28.2244	26.93892	Fractured aquifer (confined)	Site characterisation and monitoring

Table 28: Relevant borehole information summary (Gradient Consulting, 2026).

BH ID	BH depth (mbgl)	Static Water level (mbgl)	Borehole diameter (OD Ø)	Casing type	Casing diameter (OD Ø)	Collar height (mm)	Water strike (mbgl)	Blow yield (l/s)
MTBH01	120.00	1.42	219.0mm(0-18m); 165.0mm (18m-EOH)	Steel (starter = 18m) uPVC (EOH)	165.0mm (0-EOH)	200.00	60/96	0.55
MTBH02	120.00	1.65	250.0mm(0-18m); 165.0mm (18m-EOH)	Steel (starter = 18m) uPVC (EOH)	165.0mm (0-EOH)	200.00	Seepage (19)	None
MTBH04	120.00	12.88	219.0mm(0-6m); 165.0mm (6m-EOH)	Steel (starter = 6m) uPVC (EOH)	165.0mm (0-EOH)	200.00	Seepage (60)	0.33
MTBH06	120.00	13.09	219.0mm(0-6m); 165.0mm (6m-EOH)	Steel (starter = 6m) uPVC (EOH)	165.0mm (0-EOH)	200.00	16/30/60/102	0.33
Notes: EOH = End of Hole.								

4.11.8.4 AQUIFER TESTING

Following the drilling phase, the newly established site characterisation boreholes were subjected to hydraulic testing i.e., Constant Rate (CR) pump during January 2026 in order to supplement published aquifer parameter data that was available for the site conditions and setting. Important parameters that can be obtained from borehole test pumping include Hydraulic Conductivity (K), Transmissivity (T) and Storativity (S). These parameters are defined as follows (Krusemann and De Ridder, 1991):

i. Hydraulic Conductivity (K): This is the volume of water that will move through a porous medium in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. It is normally expressed in metres per day (m/d).

ii. Transmissivity (T): This is the rate of flow under a unit hydraulic gradient through a cross-section of unit width over the full, saturated thickness of the aquifer. Transmissivity is the product of the average hydraulic conductivity and the saturated thickness of the aquifer. Transmissivity is expressed in metres squared per day (m^2/d).

iii. Storativity (S): The storativity of a saturated confined aquifer is the volume of water released from storage per unit surface area of the aquifer per unit decline in the component of hydraulic head normal to that surface. Storativity is a dimensionless quantity.

Transmissivity can also be calculated by using the Cooper-Jacob (Cooper & Jacob, 1946) equation for drawdown in confined aquifers as given below:

Transmissivity (Cooper-Jacob).

$$T = \frac{2.3Q}{4\pi \Delta s}$$

where:

T = Transmissivity (m^2/d).

Q = Flow of water per unit of time (m^3/d).

Δs = Drawdown difference of one log cycle.

Refer to **Table 29** for a technical summary of hydraulic testing conducted while **Table 30** provides the aquifer hydraulic parameter estimations. Borehole specific drawdown and recovery data are included in Appendix D of the Hydrogeological Impact Assessment (**Appendix F**).

Table 29: Constant discharge aquifer tests summary (Gradient Consulting, 2026).

BH ID	Blow yield (ℓ/s)	Aquifer test type	Tested yield (ℓ/s)	CR duration (min.)	Water level (mbgl)	Pump depth inlet	Available Drawdown (m)	Drawdown reached (m)	% Drawdown used	Step1 yield (ℓ/s)	Step2 yield (ℓ/s)	Step3 yield (ℓ/s)	Step4 yield (ℓ/s)
MTBH01	0.55	CR	0.50	360.00	1.42	95.00	93.58	27.45	29.33	0.15	0.25	0.50	0.80
MTBH02	None	CR	0.20	360.00	1.65	95.00	93.35	17.67	18.93	0.15	0.20	0.30	0.50
MTBH04	0.33	CR	0.20	480.00	12.88	95.00	82.12	47.77	58.17	0.15			
MTBH06	0.33	CR	0.15	120.00	13.09	95.00	81.91	81.91	100.00	0.15	0.30	0.75	PI
Notes: CR = Constant Recharge Test.													
PI = Pump Inlet reached.													

Table 30: Aquifer tests: Hydraulic parameter estimation (Gradient Consulting, 2026).

BH ID	Potential hydrostratigraphical unit targeted	HYDROSOLV analysis		FC analysis		Average Values	
		Constant Rate Transmissivity (m^2/d)	Recovery Transmissivity (m^2/d)	Early Transmissivity (m^2/d)	Late Transmissivity (m^2/d)	Transmissivity (m^2/d)	Hydraulic conductivity (m/d)
MTBH01	Geological lineament	1.03	0.93	1.13	0.24	1.03	0.07
MTBH02	Volksrust formation	0.59	0.54	0.51	0.47	0.55	0.04
MTBH04	Beaufort Group formation	0.11	0.11	0.58	0.08	0.26	0.02
MTBH06	Karoo Dolerite Suite	0.03	0.03	0.05	0.04	0.04	0.00

4.11.9 NUMERICAL GROUNDWATER FLOW AND CONTAMINANT TRANSPORT MODEL

The purpose of a groundwater model is to serve as a tool to evaluate various water management options and scenarios. The typical workflow and modelling approach employed is summarised in **Figure 91** below and encompass a conceptualisation phase, calibration phase as well as a prediction phase.

It should be noted that modelling scenarios will be based on the worst-case approach to identify the most severe potential outcomes, ensuring preparedness for low-likelihood but high-impact events. A worst-case scenario is a concept in risk management wherein the modeller, considers the most severe possible outcome that can reasonably be projected to occur in a given situation and is a common form of strategic planning. The “worst case” scenario approach is applied to determine the maximum potential and in particular useful when the modelling is associated with high uncertainties (Matthias, K (2011); Haimes, Y (2008)).

Thus, although there is some evidence that the deeper, saline-water bearing aquifer, is depressurised, with gradient-driven solute transport unlikely, migration of saline groundwater, along with a poorly constructed and jeopardised well have been simulated to serve as a worst-case scenario in order to formulate adequate mitigation and management measures.

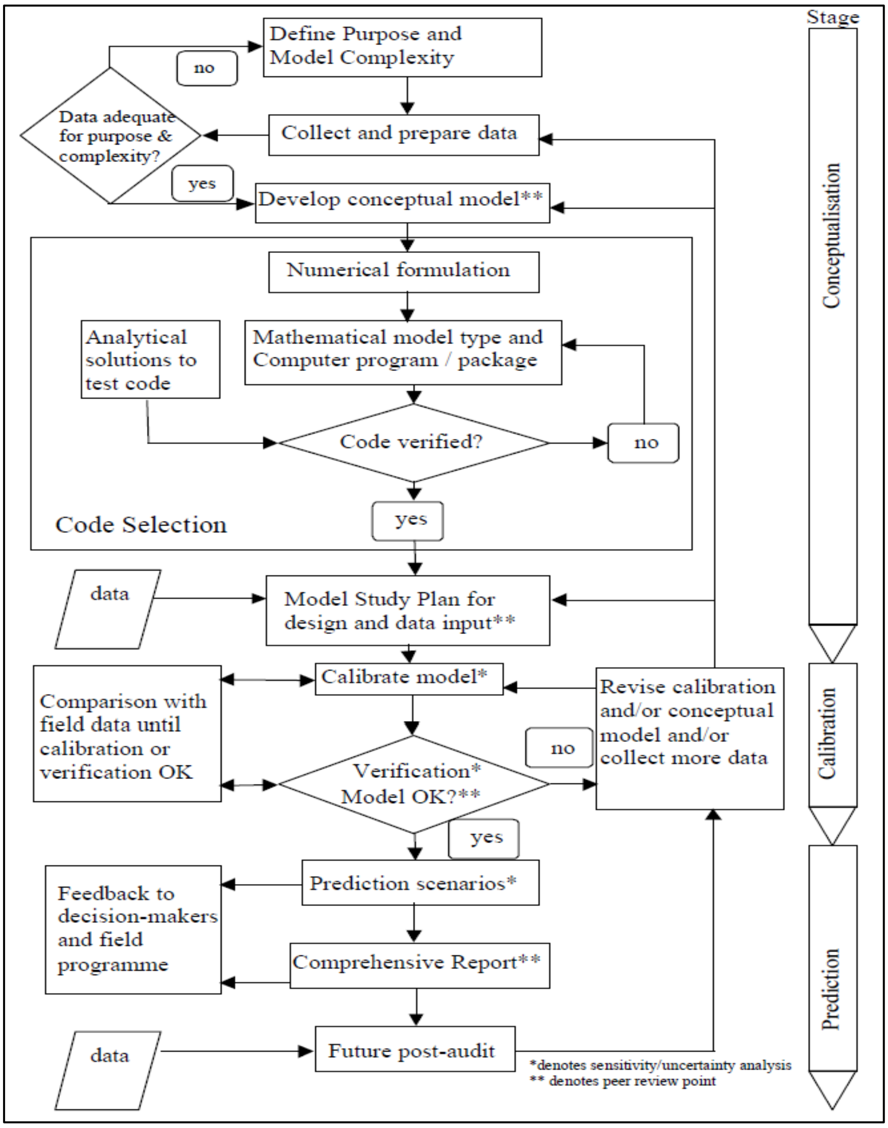


Figure 91: Workflow numerical groundwater flow model development (Groundwater Consulting, 2026).

A contaminant transport scenario was conducted simulating stray methane gas (CH4) from leaking gas proposed exploration boreholes. The explorational drilling of gas wells could result in the migration of stray gas from the deep-seated fracture zones to formations higher up in the geological sequence. This impact has been recorded in the US where hydraulic fracturing, dewatering or a combination of these has occurred (Jackson et al, 2013). It should be stated that the applicant does not intend to undertake hydraulic fracturing or any well stimulation and, as such, no dewatering will be required. Accordingly, the risk of stray gas migration is therefore expected to be low. It should be noted that this scenario is highly unlikely under natural conditions as the exploration zone(s) is separated from the shallow and potable Karoo aquifer by very low permeability shale formations which will act as an aquitard towards any groundwater and stray gas migration. This is however provided that well construction, including cementation and the installation of steel casing, is sound. As such, the impact assessment evaluated represents a worst-case scenario and simulates the eventual occurrence once stray gas does reach the shallow aquifer.

As methane gas reaches saturation in water at 28 milligrams per litre (mg/L) at atmospheric pressure (Eltschlager et al., 2001), this concentration was applied as source term for this scenario. According to the U.S. Environmental Protection Agency (EPA, 2011) as well as U.S. Department of the Interior, Office of Surface Mining (2011), methane concentrations below 10.0mg/L are generally considered safe.

Various management scenarios were modelled for the purposes of planning and decision making with stress periods listed in **Table 43**:

i. **Scenario 01:** Steady state water balance (∞).

ii. **Scenario 02:** Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the operational gas exploration phase.

iii. **Scenario 03:** Migration of stray methane (CH_4) gas emanating from the exploration zone to the overlying, potable aquifer(s) during the operations gas exploration phase.

iv. **Scenario 03:** Migration of stray methane (CH_4) gas emanating from the exploration zone to the overlying, potable aquifer(s) during the operations gas exploration phase.

v. **Scenario 04:** Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

vi. **Scenario 05:** Migration of stray methane (CH_4) gas emanating from the exploration zone to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

Table 31: Summary of model stress-periods (Gradient Consulting, 2026).

Stress period	Description
Year01 – Year9	Gas exploration operational phase
Year 10 – Year 60	50-years post closure
Year 61 – Year 111	100-years post closure

4.12 AIR QUALITY

The information presented in this section was obtained from the Air Quality Assessment Report undertaken by Airshed Planning Professionals (**Appendix F**). Air quality sensitive receptors (AQSRs) refer to places where humans reside. Ambient air quality guidelines and standards, as discussed under **Section 3.1.9**, have been developed to protect human health. Ambient air quality, in contrast to occupation exposure, pertains to areas outside of an industrial site or boundary where the public has access to and according to the Air Quality Act, excludes air regulated by the Occupational Health and Safety Act (Act No 85 of 1993). Potential sensitive receptors within the project area, include individual households and residential areas (i.e., Welkom, Hennenman, Virginia and Ventersburg).

4.12.1 CLIMATE AND ATMOSPHERIC DISPERSION POTENTIAL

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

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

Surface and profile weather data for the period 2023 to 2025 used for the assessment was obtained from the South African Weather Service (SAWS) station at Welkom.

4.12.2 LOCAL WIND FIELD

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

Period and diurnal wind roses drawn from the Welkom SAWS station shown in **Figure 92**. During the period 2023 to 2025, the wind field was dominated by winds from the northeastern sector. Calm conditions occurred for 2.5% of the time. Wind speeds decreased during night-time conditions with an increase in calms to 3.5%

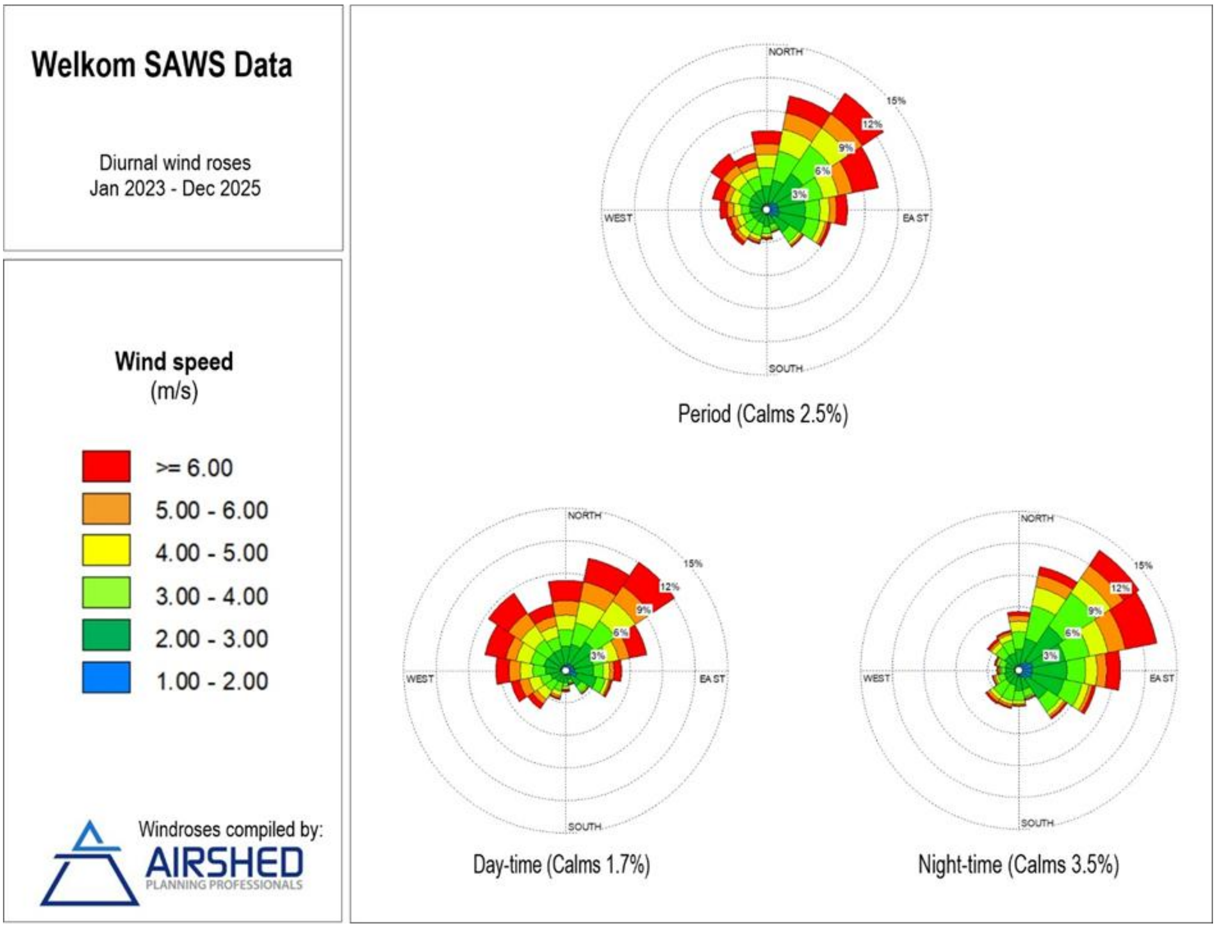


Figure 92: Period average, daytime and night-time wind roses (measured data; January 2023 to December 2025; SAWS Welkom monitoring station) (Airshed Planning Professionals, 2026)

4.12.3 ATMOSPHERIC STABILITY AND MIXING DEPTH

The new generation air dispersion models differ from the models traditionally used in a number of aspects, the most important of which are the description of atmospheric stability as a continuum rather than discrete classes. The atmospheric boundary layer properties are therefore described by two parameters: the boundary layer depth and the Monin-Obukhov length, rather than in terms of the single parameter Pasquill Class. The Monin-Obukhov length (LMo) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and less dilution potential. During windy and/or cloudy conditions, the atmosphere is normally neutral. For low level releases, the highest ground level concentrations would occur during weak wind speeds and stable (night-time) atmospheric conditions.

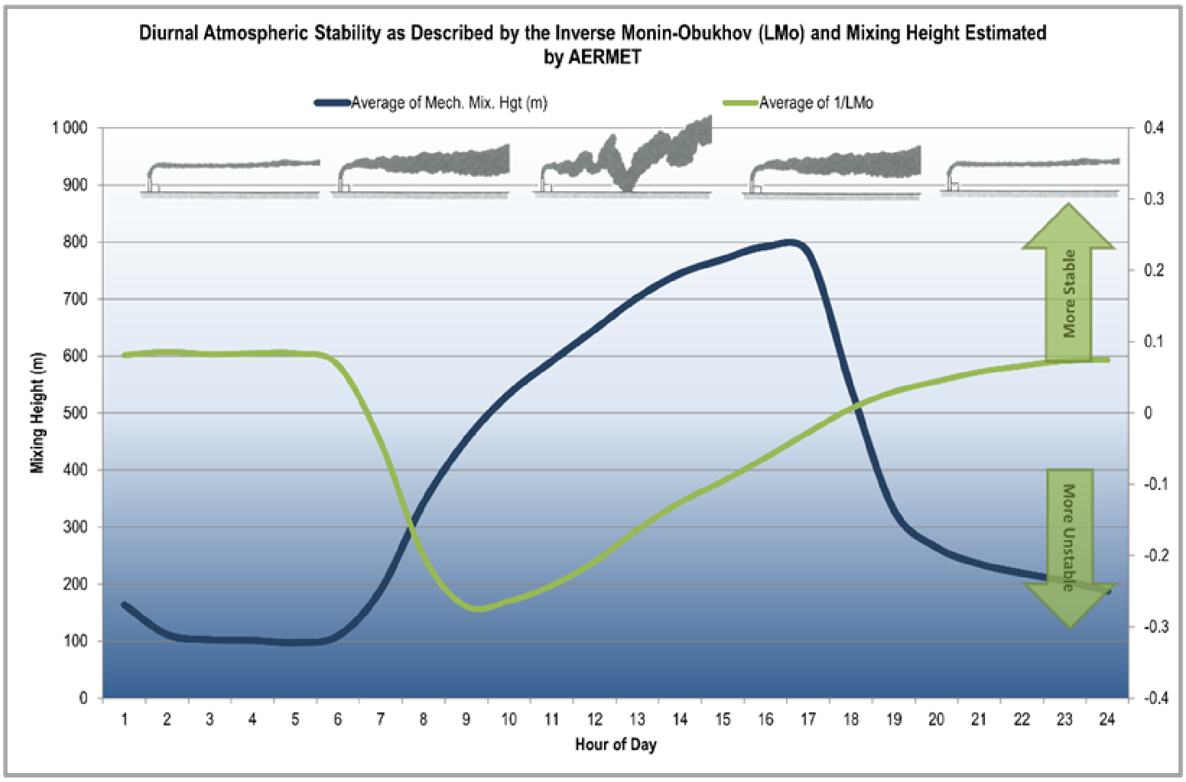


Figure 93: Diurnal atmospheric stability as described by the inverse of the measured Monin-Obukhov length (SAWS Welkom Data: 2023 to 2025)

4.12.4 AMBIENT AIR QUALITY WITHIN THE REGION

4.12.4.1 SOURCES OF POLLUTION IN THE REGION

Neighbouring land-use in the surrounding of the proposed project comprises predominantly of agriculture activities. These land-uses contribute to baseline pollutant concentrations via fugitive and process emissions, vehicle tailpipe emissions, household fuel combustion, biomass burning and windblown dust from exposed areas.

4.12.4.1.1 AGRICULTURE

Agriculture is a major land-use activity within and beyond the Project boundary. These activities include crop farming such as maize, and livestock farming. Particulate matter is the main pollutant of concern from agricultural activities as particulate emissions are derived from windblown dust, burning crop residue, and dust entrainment as a result of vehicles travelling along dirt roads. In addition, pollen grains, mould spores and plant and insect parts from agricultural activities all contribute to the particulate load. Should chemicals be used for crop spraying, they would typically result in odiferous emissions. Crop residue burning is also an additional source of particulate emissions and other toxins.

Livestock farms, especially cattle, are also significant sources of fugitive dust especially when feedlots are used and the cattle trample in confined areas. Pollutants associated with dairy production for instance include ammonia (NH_3), hydrogen sulfide (H_2S), methane (CH_4), carbon dioxide (CO_2), oxides of nitrogen (NOx) and odour related trace gasses. According to the US-EPA, cattle emit methane through a digestive process that is unique to ruminant animals called enteric fermentation. The calf-cow sector of the beef industry was found to be the largest emitter of methane emissions. Where animals are densely confined the main pollutants of concern include dust from the animal movements, their feed and their manure, NH_3 from the animal urine and manure, and H_2S from manure pits.

Organic dust includes dandruff, dried manure, urine, feed, mould, fungi, bacteria and endotoxins (produced by bacteria, and viruses). Inorganic dust is composed of numerous aerosols from building, materials and the environment. Since the dust is biological it may react with the defence system of the respiratory tract. Odours and VOCs associated with animal manure is also a concern when cattle are kept in feedlots. The main impact from methane is on the dietary energy due to the reduction of carbon from the rumen. Dust and gasses levels are higher in winter or whenever animals are fed, handled or moved.

4.12.4.1.2 MINING SOURCES

Particulates represent the main pollutant of concern at mining operations, whether it is underground or opencast. The amount of dust emitted by these activities depends on the physical characteristics of the material, the way in which the material is handled and the weather conditions (e.g. high wind speeds, rainfall, etc.). Mining of gold, including ore extraction, processing plants, waste rock dumps and tailings storage facilities are all commercial activities situated in the region of the project.

4.12.4.1.3 DOMESTIC FUEL COMBUSTION

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

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

4.12.4.1.4 BIOMASS BURNING

Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands. Within the project vicinity, crop-residue burning and wildfires (locally known as veld fires) may represent significant sources of combustion-related emissions. The frequency of wildfires in the grasslands varies between annual and triennial. Biomass burning is an incomplete combustion process (Cachier, 1992), with carbon monoxide, methane and nitrogen dioxide gases being emitted. Approximately 40% of the nitrogen in biomass is emitted as nitrogen, 10% is left in the ashes, and it may be assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds (Held, *et al.,* 1996). The visibility of the smoke plumes is attributed to the aerosol (particulate matter) content. In addition to the impact of biomass burning within the vicinity of the project activity, long-range transported emissions from this source can be expected to impact on the air quality between the months of August to October. It is impossible to control this source of atmospheric pollution loading; however, it should be noted as part of the background or baseline condition before considering the impacts of other local sources.

4.12.4.1.5 FUGITIVE DUST SOURCES

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

4.12.4.1.6 UNPAVED AND PAVED ROADS

Emissions from unpaved roads constitute a major source of emissions to the atmosphere in the South African context. When a vehicle travels on an unpaved road the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong turbulent air shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. Dust emissions from unpaved roads vary in relation to the vehicle traffic and the silt loading on the roads. Unpaved roads in the region are mainly haul and access roads.

Emissions from paved roads are significantly less than those originating from unpaved roads, however they do contribute to the particulate load of the atmosphere. Particulate emissions occur whenever vehicles travel over a paved surface. The fugitive dust emissions are due to the re-suspension of loose material on the road surface. Paved roads in the region include the N1, R70, R73 and the R34.

4.12.4.1.7 WIND EROSION OF OPEN AREAS

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, its erosion potential has to be restored; that is, the wind shear at the surface must exceed the gravitational and cohesive forces acting upon them, called the threshold friction velocity. Every time a surface is disturbed, its erosion potential is restored (US EPA, 2006). Erodible surfaces may occur as a result of agriculture and/or grazing activities.

4.12.4.1.8 VEHICLE EXHAUST EMISSIONS

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants form in the atmosphere as a result of chemical reactions. Significant primary pollutants emitted combustion engines include CO_2, carbon (C), SO_2, oxides of nitrogen (mainly NO), particulates and lead. Secondary pollutants include NO_2, photochemical oxidants such as ozone, sulfur acid, sulphates, nitric acid, and nitrate aerosols (particulate matter). Vehicle type (i.e. model-year, fuel delivery system), fuel (i.e. oxygen content), operating (i.e. vehicle speed, load) and environmental parameters (i.e. altitude, humidity) influence vehicle emission rates.

4.12.4.2 **AIR QUALITY SAMPLING RESULTS**

There are no publicly accessible ambient measurements in the vicinity of the project.

4.13 NOISE

This section provides details of the receiving acoustic environment which is described in terms of:

- Local Noise Sensitive Receptors (NSRs);
- The local environmental noise propagation and attenuation potential; and,
- Current noise levels and the existing acoustic climate

4.13.1 NOISE SENSITIVE RECEPTORS

NSRs generally include places of residence and areas where members of the public may be affected by noise generated by industrial activities. the impact of an intruding industrial noise on the environment rarely extends over more than 5 km from the source. Potential noise sensitive receptors within the study area include primarily homesteads and farmhouses surrounding the Target Areas and Seismic Transects, as shown in Figure 94. The closest NSRs to the operational areas were modelled as discreet receptors (labelled A to S on **Figure 94**, with more details provided in **Table 33**).

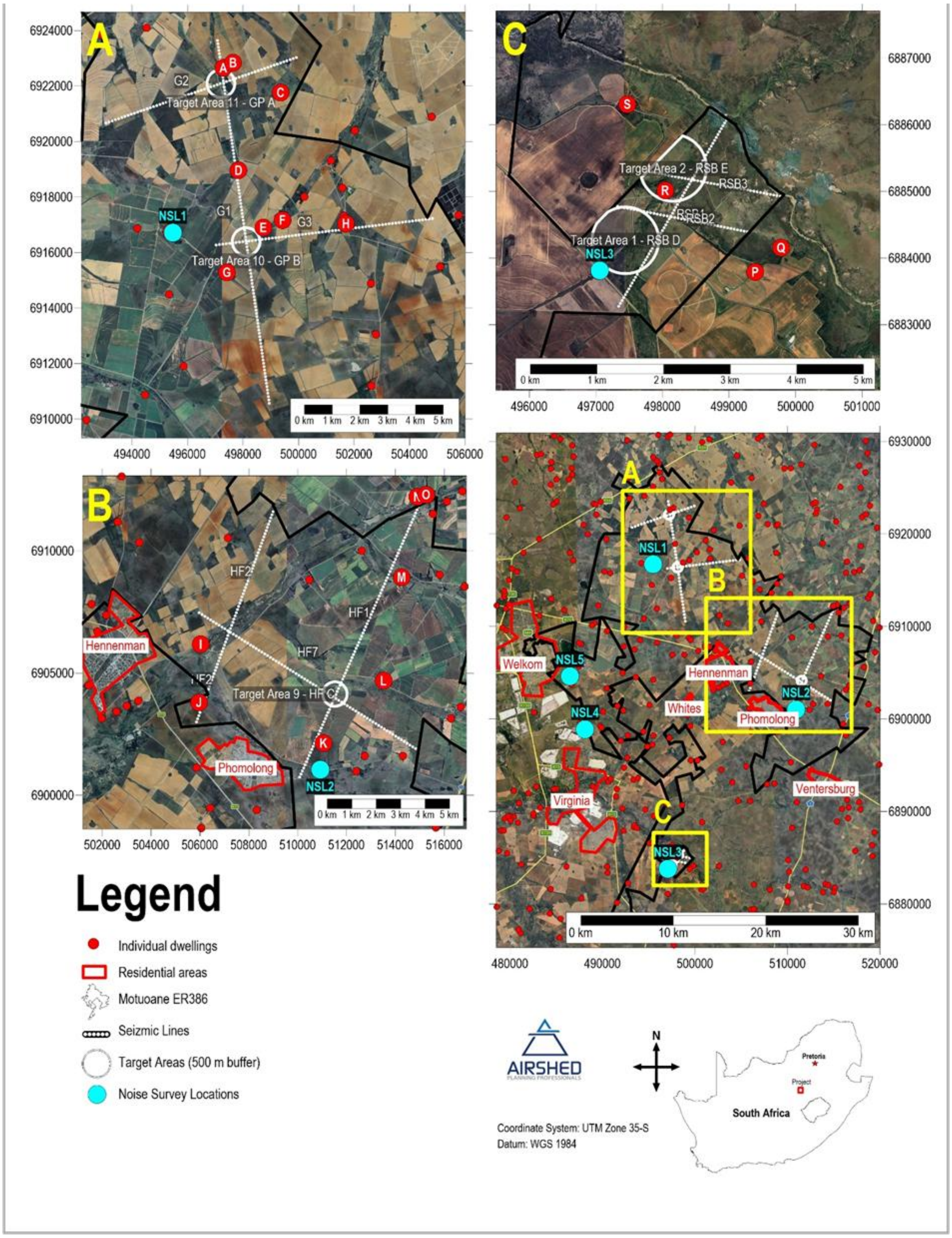


Figure 94: Sensitive receptors and noise survey sites (Airshed Planning Professionals, 2026).

4.13.2 ATMOSPHERIC ABSORPTION

The main meteorological parameters affecting the propagation of noise include wind speed, wind direction and temperature. These, along with other parameters such as relative humidity, air pressure, solar radiation and cloud cover affect the stability of the atmosphere and the ability of the atmosphere to absorb sound energy.

Wind speed increases with altitude. This results in the 'bending' of the path of sound to 'focus' it on the downwind side and creating a 'shadow' on the upwind side of the source. Depending on the wind speed, the downwind level may increase by a few dB but the upwind level can drop by more than 20 dB (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). It should be noted that at wind speeds of more than 5 m/s, ambient noise levels are mostly dominated by wind generated noise. The wind field of an area can be presented using wind roses. Wind roses represent wind frequencies for the 16 cardinal wind directions. Frequencies are indicated by the length of the shaft when compared to the circles drawn to represent a frequency of occurrence. Wind speed classes are assigned to illustrate the frequencies with high and low winds occurring for each wind vector. The frequencies of calms, defined as periods for which wind speeds are below 1 m/s, are also indicated.

Reference was made to meteorological data from the South African Weather Services (SAWS) operated station located in Welkom, for the period January 2015 to January 2022. The measured data set indicates wind flow primarily from the northeastern sector (**Figure 95**) during the day with winds also frequent from the northwestern and southwestern sectors. At night, the wind field is mostly from a northeastern sector (**Figure 95**). Calm conditions occur 2.96% of time during the day and 3.11% during the night. On average, noise impacts are expected to be slightly more notable to the southeast and southwest of the project activities during the day and to the southwest of the project activities during the night

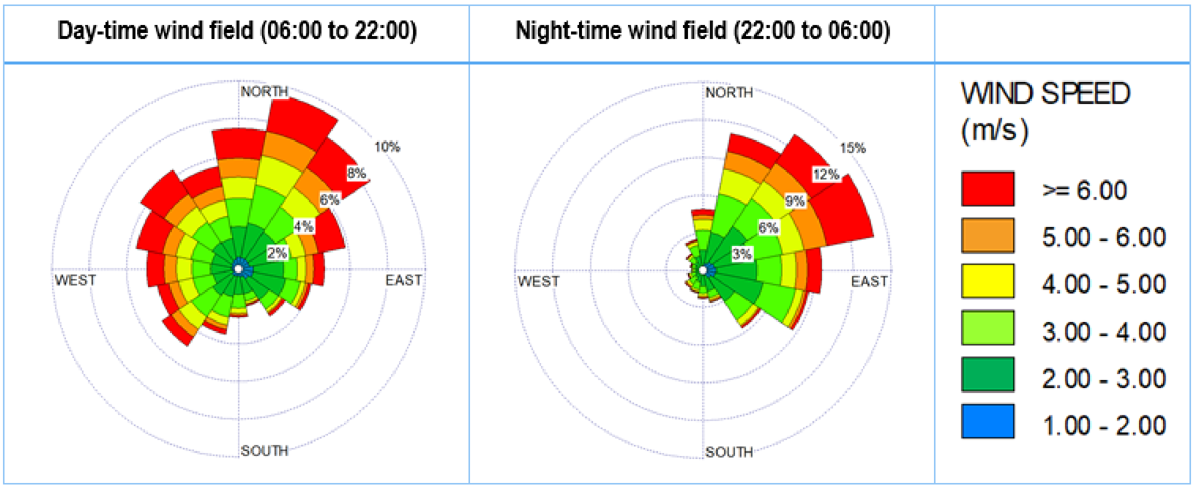


Figure 95: Wind rose for SAWS Welkom station, January 2015 to January 2022 (Airshed Planning Professionals, 2026).

Temperature gradients in the atmosphere create effects that are uniform in all directions from a source. On a sunny day with no wind, temperature decreases with altitude and creates a 'shadowing' effect for sounds. On a clear night, temperatures may increase with altitude thereby 'focusing' sound on the ground surface. Noise impacts are therefore generally more notable during the night. The average temperature for the site (as obtained from the SAWS data set for 2015 to 2022) was 15°C, while the average humidity was assumed as 50%.

4.13.3 TERRAIN, GROUND ABSORPTION AND REFLECTION

Noise reduction caused by a barrier (i.e. natural terrain, installed acoustic barrier, building) feature depends on two factors namely: the path difference of a sound wave as it travels over the barrier compared with direct transmission to the receiver and the frequency content of the noise (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). Sound reflected by the ground interferes with the directly propagated sound. The effect of the ground is different for acoustically hard (e.g., concrete or water), soft (e.g., grass, trees or vegetation) and mixed surfaces. Ground attenuation is often calculated in frequency bands to take into account the frequency content of the noise source and the type of ground between the source and the receiver (Brüel & Kjær Sound & Vibration Measurement A/S, 2000). The ground conditions were modelled as acoustically mixed.

4.13.4 BASELINE NOISE SURVEY AND RESULTS

Day- and night-time noise measurements were conducted from 2 to 4 June 2025 at five noise survey locations NSLs) representative of the acoustic climate in the exploration rights area (Figure 94). Noise monitoring was conducted by Airshed personnel and logged Sound Level Meter (SLM) output data, together with sampling log sheets, were recorded. Survey sites were selected taking into consideration the location of the proposed activities, nearby NSRs, accessibility and safety.

The locations of the sampling sites are shown in Figure 94, with coordinates provided in **Table 32**. Photographs of the sites are included in Appendix D and log sheets in Appendix F of the Noise Impact Assessment (**Appendix F**). Recorded time-series broadband sound pressure levels are shown in Appendix E of the Noise Impact Assessment (**Appendix F**).

Table 32: Location of the noise survey sites (Airshed Planning Professionals, 2026).

Site ID	Latitude	Longitude
NSL 1	-27.874321°S	26.953961°E
NSL 2	-28.015746°S	27.11111°E
NSL 3	-28.171378°S	26.970042°E
NSL 4	-28.035107°S	26.879039°E
NSL 5	-27.983465°S	26.862453°E

The daytime noise survey results are shown in **Figure 96**, while the night-time survey results are shown **Figure 97**. The recorded average (L_{Aeq}), maximum (L_{AFMax}) and background (L_{A90}) broadband sound pressure levels, together with the sampling dates, times, durations, noted noise sources, and general weather conditions are given in **Table 33** for the daytime and in **Table 34** for the night-time survey. At the survey sites closest to the proposed Target Areas and Seismic Transects (survey sites 1, 2 and 3), both daytime and night-time sound pressure levels were well below the typical rating levels for rural areas. At survey sites 4 and 5, which are located to the east of the town of Welkom and closer to nearby mining operations, significantly higher (but still fairly low) day- and night-time sound pressure levels were recorded. Because of low baseline sound pressure levels any intrusive noise sources, such as drilling, would be audible over large distances and could lead to significant disturbance at nearby NSRs, especially during the night-time.

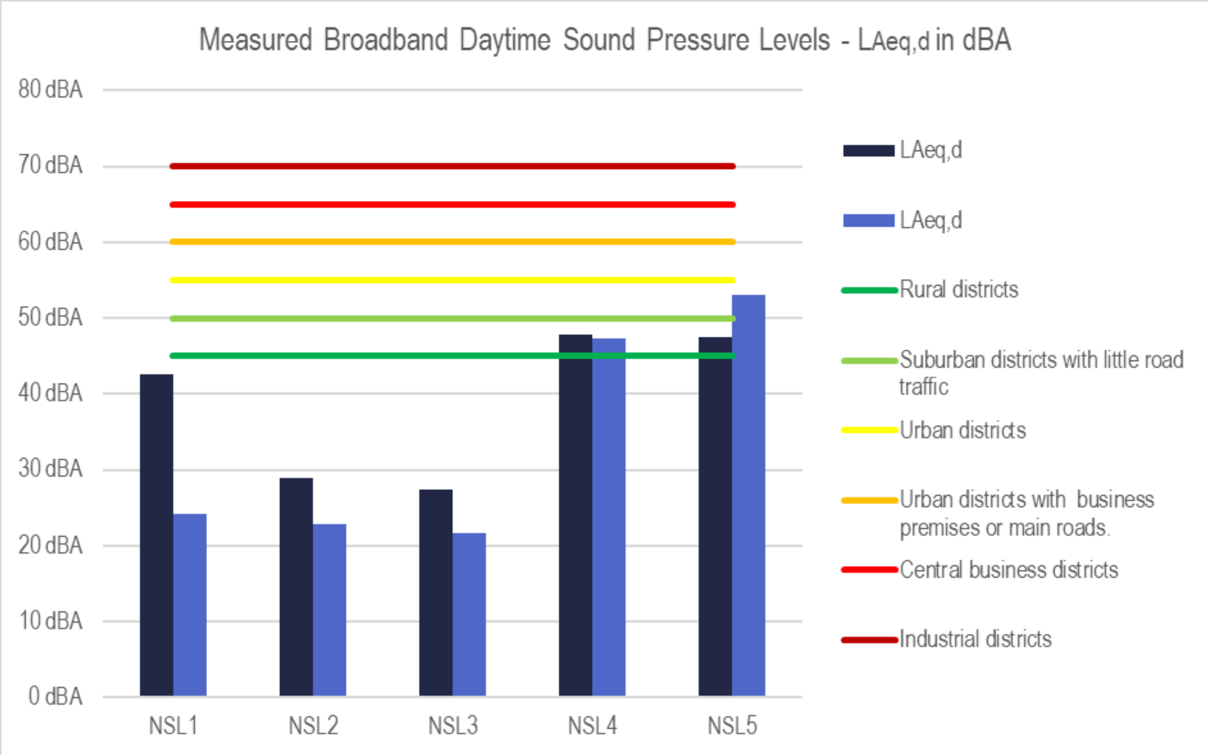


Figure 96: Broadband daytime survey results – June 2025 survey (Airshed Planning Professionals, 2026).

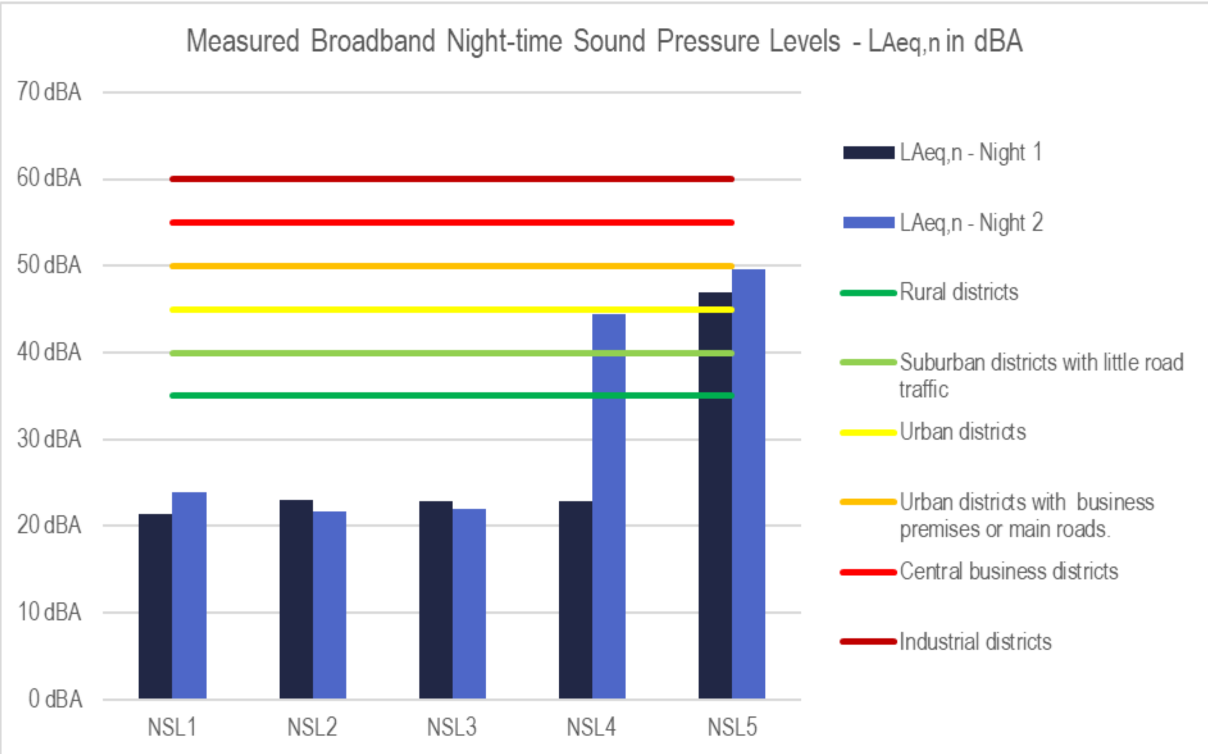


Figure 97: Broadband night-time survey results – June 2025 survey (Airshed Planning Professionals, 2026).

Table 33: Logged broadband results and observations at all sampling locations – daytime (Airshed Planning Professionals, 2026).

Site	Date	Time	Duration	L_{Aeq}	L_{Amax}	L_{Amin}	L_{A90}	L_{A90}	L_{Aeq}	Acoustic Climate	General Weather Conditions
1	2025/06/02	18:19	00:20	42.6	60.4	19.8	24.1	21.5	**33.4**	Near Ons Anker School. Noise sources include Cattle, dogs, people talking, occasional vehicles, birds, insects, faint music	Winds of 0.8 m/s from the S. Temp of 8.2°C, 60 % RH, 0% clouds
	2025/06/03	18:57	00:15	24.2	79.6	23.2	21.3			Near Ons Anker School. Noise sources include Insects, dogs, faint community, vehicles, music	Winds of 0.6 m/s from the S. Temp of 7.6°C, 56 % RH, 0% clouds
2	2025/06/02	19:23	00:15	28.9	58.0	20.7	23.2	21.7	**25.9**	Close to a farm road to the east of Phomolong. Noise sources include: Hum from Phomolong, birds, insects, faint community, music and vehicles	Winds of 0.8 m/s from the N. Temp of 11°C, 34 % RH, 0% clouds
	2025/06/03	19:56	00:15	22.8	79.4	22.6	21.5			Close to a farm road to the east of Phomolong. Noise sources include: Hum from Phomolong	Winds of 1.5 m/s from the N. Temp of 7.4°C, 51 % RH, 0% clouds
3	2025/06/02	20:35	00:15	27.4	56.9	17.4	20.4	19.3	**24.6**	Close to the road between Virginia and Aldam. Noise sources include: Birds, insects, rusting of grass	Winds of 0.5 m/s from the N. Temp of 6.4°C, 38 % RH, 0% clouds
	2025/06/03	21:04	00:15	21.7	82.5	21.1	19.8			Close to the road between Virginia and Aldam. Noise sources include: Birds, faint vehicles	Winds of 0.1 m/s from the N. Temp of 2.9°C, 65 % RH, 0% clouds
4	2025/06/02	21:25	00:15	47.8	71.1	27.1	29.2	25.6	**47.6**	East of Harmony Gold Saaiplaas. Noise sources include: Hum from Saaiplaas plant, cars, trucks, busses, insects	Winds of 0.7 m/s from the N. Temp of 9.4°C, 40 % RH, 0% clouds
	2025/06/04	18:00	00:20	47.3	84.0	24.0	23.7			East of Harmony Gold Saaiplaas. Noise sources include: Hum from Saaiplaas plant, cars, busses, birds, insects, air traffic	Winds of 0.4 m/s from the W. Temp of 14.2°C, 37 % RH, 0% clouds
5	2025/06/02	21:56	00:15	47.6	90.1	32.1	32.1	31.3	**50.3**	Between Goldfields Masimong 4 and 5. Noise sources include: Hum from Masimong 4 & 5, reverse alarms, cars, busses, dogs	Winds of 0.5 m/s from the N. Temp of 11°C, 40 % RH, 0% clouds
	2025/06/04	18:41	00:20	53.0	88.7	30.4	35.6			Between Goldfields Masimong 4 and 5. Noise sources include: Lots of vehicle traffic, cars and busses	Winds of 0.1 m/s from the NE. Temp of 11.2°C, 38 % RH, 0% clouds

Table 34: Logged broadband results and observations at all sampling locations – night-time (Airshed Planning Professionals, 2026).

Site	Date	Time	Duration	L_{Aeq}	L_{Amax}	L_{Amin}	L_{A90}	L_{A90}	L_{Aeq}	Acoustic Climate	General Weather Conditions
1	2025/06/03	00:23	00:10	21.4	81.4	20.0	18.0	20.5	**22.7**	Near Ons Anker School. Noise sources include Noise sources include Cattle, faint road and air traffic	Winds of 0.6 m/s from the S. Temp of 7.6°C, 56 % RH, 0% clouds
	2025/06/03	22:11	00:10	23.9	73.8	20.9	19.5			Near Ons Anker School. Noise sources include Birds, insects, dogs, community	Winds of 0.1 m/s from the S. Temp of 7.3°C, 33 % RH, 0% clouds
2	2025/06/03	01:18	00:10	23.0	82.4	20.9	19.6	21.0	**22.4**	Close to a farm road to the east of Phomolong. Insects, dogs	Winds of 1.5 m/s from the N. Temp of 7.4°C, 51 % RH, 0% clouds
	2025/06/03	23:00	00:10	21.7	80.3	21.1	19.1			Close to a farm road to the east of Phomolong. Birds, dogs, community	Winds of 0.5 m/s from the N. Temp of 8.4°C, 56 % RH, 0% clouds
3	2025/06/03	02:17	00:11	22.8	84.0	20.9	18.9	21.1	**22.4**	Close to the road between Virginia and Aldam. Noise sources include: Birds	Winds of 0.1 m/s from the N. Temp of 2.9°C, 65 % RH, 0% clouds
	2025/06/03	23:56	00:10	22.0	83.9	21.2	19.3			Close to the road between Virginia and Aldam. No notable noise sources were observed	Winds of 0.1 m/s from the N. Temp of 6.3°C, 68 % RH, 0% clouds
4	2025/06/03	02:17	00:11	22.8	84.0	20.9	18.9	26.9	**33.6**	East of Harmony Gold Saaiplaas. Noise sources include: Hum from plant, occasional vehicles	Winds of 0.5 m/s from the N. Temp of 3°C, 76 % RH, 0% clouds
	2025/06/04	22:05	00:15	44.5	86.3	32.9	33.0			East of Harmony Gold Saaiplaas. Noise sources include: Insects, cars	Winds of 3 m/s from the N. Temp of 10°C, 70 % RH, 0% clouds
5	2025/06/03	03:27	00:10	46.9	85.0	39.5	39.6	43.5	**48.3**	Between Goldfields Masimong 4 and 5. Hum from Masimong 4 and 5, vehicles	Winds of 0.1 m/s from the N. Temp of 5°C, 68 % RH, 0% clouds
	2025/06/04	22:34	00:15	49.6	87.5	47.5	47.9			Between Goldfields Masimong 4 and 5. Hum from Masimong 5 plant, vehicles, dogs	Winds of 3 m/s from the N. Temp of 10°C, 70 % RH, 0% clouds

5 PROJECT ALTERNATIVES

In terms of the EIA Regulations published in Government Notice (GN) R982 of 2014, as amended, feasible and reasonable alternatives must be identified and considered within the environmental assessment process. An alternative is defined as "…in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to the:

(a) property on which or location where it is proposed to undertake the activity;

(b) type of activity to be undertaken;

(c) design or layout of the activity;

(d) technology to be used in the activity;

(e) operational aspects of the activity; and

(f) Includes the option of not implementing the activity."

In terms of Section 24 of NEMA, the proponent is required to demonstrate that alternatives have been described and investigated in sufficient detail during the EIA process. It is important to highlight that alternatives must be practical, feasible, reasonable and viable to cater for an unbiased approach to the project and in turn to ensure environmental protection. In order to ensure full disclosure of alternative activities, it is important that various role players contribute to their identification and evaluation. Stakeholders have an important contribution to make during the EIA Process and each role is detailed as follows:

The role of the environmental assessment practitioner is to:

- encourage the proponent to consider all feasible alternatives;
- identify reasonable alternatives;
- provide opportunities for stakeholder input to the identification and evaluation of alternatives;
- document the process of identification and selection of alternatives;
- provide a comprehensive consideration of the impacts of each of the alternatives; and
- document the process of evaluation of alternatives.

The role of the proponent is to:

- assist in the identification of alternatives, particularly where these may be of a technical nature;
- disclose all information relevant to the identification and evaluation of alternatives;
- be open to the consideration of all reasonable alternatives; and
- be prepared for possible modifications to the project proposal before settling on a preferred option.

The role of the public is to:

- assist in the identification of alternatives, particularly where local knowledge is required;
- be open to the consideration of all reasonable alternatives; and
- recognise that there is rarely one favoured alternative that suits all stakeholders and that alternatives will be evaluated across a broad range of criteria, including environmental, social and economic aspects.

Table 35 outlines the various alternative types that must be considered for each development. The extent of the applicability of each of these is further presented. It must be highlighted that the alternatives presented in the table are derived from both the EIA Regulations (2014) as amended as well as the Department of Environmental Affairs and Tourism's (now Department of Environmental, Fisheries and Forestry) 2004 Integrated Environmental Information Series on the Criteria for determining alternatives in EIA. Where the alternative is applicable to the project, it will be further discussed in this EIA Report. The alternatives discussed further in this EIA Report are as follows:

- The No-Go Option;
- Location / property alternatives;
- Process alternatives;
- Scale alternatives; and
- Design alternatives.

Table 35: Project alternatives as per NEMA EIA Regulations, 2014 as amended.

Alternative	Comment / Motivation
No-go Option	The 'no-go' alternative is sometimes referred to as the 'no-action' alternative (Glasson *et al.,* 1999) and at other times the 'zero-alternative'. It assumes that the activity does not go ahead, implying a continuation of the current situation or the status quo. This alternative must be discussed on all projects as it allows for an assessment of impacts should the activity not be undertaken. It is the Department's requirement that this alternative be assessed for all EA applications. Subsequently, **this alternative is discussed in this report.**
Activity alternatives	These are sometimes referred to as project alternatives, although the term activity can be used in a broad sense to embrace policies, plans and programmes as well as projects. Consideration of such alternatives requires a change in the nature of the proposed activity. This would entail a process where a different project is proposed instead of the D3 Energy ER386. **Based on project information, D3 Energy only proposes to undertake exploration activities for hydrocarbons. Therefore, this alternative is not considered feasible and will not be discussed further.**
Location / property alternatives	Location alternatives could be considered for the entire proposal or for a component of a proposal, for example the location of a processing plant within the property boundary. The latter is sometimes considered under site layout alternatives. A distinction should also be drawn between alternative locations that are geographically quite separate, and alternative locations that are in proximity. In the case of the latter, alternative locations in the same geographic area are often referred to as alternative sites. There are up to five proposed drilling sites and nine seismic transects within the extended exploration right. Therefore, based on the project description, there are proposed exploration sites (target areas) and areas outside of the preliminary target areas. Subsequently, **the location/property alternatives are considered feasible and applicable to this project.**
Technology alternatives	Various terms are used for this category, including technological alternative and equipment alternative. The purpose of considering such alternatives is to include the option of achieving the same goal by using a different method or process. An industrial process could be changed, or an alternative technology could be used. These are also known as technological and equipment alternative and will be discussed as they are feasible and applicable to the D3 Energy ER386. **These will be discussed in this report.**
Demand alternatives	Demand alternatives arise when a demand for a certain product or service can be met by some alternative means. This is applicable to the demand for a product or service. An example of this would be where there is a need to provide housing units. Examples of alternatives can be

Alternative	Comment / Motivation
	through managing demand through various methods or providing additional housing through either single dwelling residential units or mixed-use developments. Specific to the proposed project, **alternatives regarding the demand are considered not feasible for the D3 Energy ER386 project and will not be discussed further.** As indicated in **Section 2.6**, ER386 project is justified partly by the growing and strategic demand for natural gas in South Africa. National policy frameworks—including the NDP (2012), Draft Integrated Energy Plan, and IRP 2025—highlight gas as a key future energy source, driven by the need to diversify the energy mix, reduce reliance on coal, and lower emissions. Gas demand is projected to grow significantly through 2050, second only to petroleum, particularly due to industrial expansion and its role in power generation and thermal applications. In addition, while the project also targets helium, gas remains important because helium is typically associated with natural gas deposits. The potential to produce both resources increases economic viability and reinforces the long-term demand-driven rationale for exploration.
Scheduling alternatives	These are sometimes known as sequencing or phasing alternatives. In this case an activity may comprise several components, which can be scheduled in a different order or at different times and as such produce different impacts. As indicated in Section 2, the proposed activities have to be undertaken in sequence, one phase (non-invasive exploration) informs the other phase (invasive exploration). First there are Non-Invasive Exploration activities which involve the seismic surveys to determine the areas of interest for the drilling team. Only once the seismics are completed, can a 2-D sub-surface geological network be generated and analysed to identify areas of interest for further exploration. The outcome of the seismic survey will be used to inform preferable drilling locations for the Invasive Exploration phase. Considering that the seismic activities will largely be undertaken on existing gravel roads, there will be minimal difference of impacts based on seasonal scheduling of the activities. Therefore, **scheduling alternatives are considered not feasible for the D3 Energy ER386 project and will not be discussed further.**
Input alternatives	By their nature, input alternatives are most applicable to industrial applications that may use different raw materials or energy sources in their processes. Considering that the proposed development is an exploration project which does not involve the conversion of raw materials into finished products, **input alternatives are considered not feasible for the D3 Energy ER386 project and will not be discussed further.**
Routing alternatives	Consideration of alternative routes generally applies to linear developments such as power lines, transport, and pipeline routes. Although the proposed D3 Energy ER386 exploration activities involve a linear aspect, seismic transect, routing alternatives are not feasible as seismic transects are strategic and follow a linear path because they facilitate the creation of clear, two-dimensional subsurface cross-sections, which are easier to interpret and analyse. **Therefore, routing alternatives are considered not feasible and will not be discussed further.**
Scale alternatives	In some cases, activities that can be broken down into smaller units can be undertaken on different scales. For example, a housing development within an overall mixed-used development could have the option of 1 000, 2 000 or 4 000 housing units. Each of these scale alternatives may have different impacts. Similarly, the exploration footprint is extensive and as such, there are two options, limiting exploration activities to a specific number (smaller scale) or undertaking unlimited exploration activities within the exploration right. **For this reason, scale alternatives will be discussed in this report.**
Design or Site layout alternatives	This entails the consideration of different site layouts or designs for aesthetic purposes or different construction materials to optimise local benefits and sustainability would constitute design alternatives. Site layout alternatives permit consideration of different spatial configurations of an activity on a particular site. This may include particular components of a proposed development or may include the entire activity. Generally, the design alternatives

Alternative	Comment / Motivation
	could be incorporated into the project proposal and so be part of the project description and need not be evaluated as separate alternatives. There are two options for containment sumps during the drilling phase, ground containment sumps (sump pit) or above ground steel or plastic sumps and location thereof which have different designs and different impacts. **Based on this, design or layout alternatives will be considered and discussed in this report**.
Operational alternatives	The Operational Alternative is where you can specify controls on the operational aspects of the project such as pressure pipes, pumps, as well as valves. In the case of the proposed ER386 activities, **feasible operational alternatives were not identified and are not discussed in this report.**

Feasible and/or reasonable alternatives that can be considered are described and motivated below.

5.1 LOCATION / PROPERTY ALTERNATIVES

The D3 Energy ER is situated towards the east of the de Bron fault. In the northern part of the ER, a major horst structure i.e. de Bron horst is present between the de Bron and Homestead faults, respectively. No gold bearing sediments occur in the horst. Detailed drilling defined the eastern limit of this horst structure along the Homestead fault. East of the Homestead fault, gold bearing sediments were intersected again. Two major fault systems, i.e. the Virginia and Ventersdorp faults, occur in the eastern part of the central region, often referred to as the "MELA" region. The displacement again was towards the west. Despite this major north-south striking structures several east-west faults are also present or could be extended into the ER. The east-west structures are the oldest structures in the Witwatersrand basin. Many kimberlite fissures and Karoo age dolerite dykes intruded into the younger strata along these structures. The east-west structures were right laterally displaced by north-south striking structures resulting in a very complex tectonic environment. The Importance of these structures is vested in the presence of methane gas occurrence associated in or in proximity of the structures. Hydrocarbons are believed to be derived from the crustal microbial methanogens in fractures within the Witwatersrand that has migrated through the Witwatersrand/Ventersdorp and into the Karoo Dwyka and Ecca Group Vryheid Formations. The anticipated geology and stratigraphy are based on the lithographic log in zero (0). The underlying geology through which D3 Energy No 1 Bloemskraal will be drilled will consist of sedimentary rocks of the Karoo Supergroup followed by the lavas of the Ventersdorp Supergroup.

The proposed exploration activities entail the undertaking of up to five (5) drilling sites and up to nine (9) seismic surveys within the exploration right footprint. For purposes of this report, location alternatives will be in reference to preliminary identified target exploration locations which are assessed in detail and preliminary general exploration footprint which is only assessed on desktop level. Detailed of the preliminary identified target exploration locations are indicated in **Section 2** (**Table 6**) while the preliminary identified target exploration locations and the general exploration footprint indicated in **Figure 1** and **Figure 2**.

5.1.1 EXPLORATION ACTIVITIES WITHIN PRELIMINARY IDENTIFIED TARGET EXPLORATION LOCATIONS

Undertaking the activities within preliminary identified target exploration locations would entail a process where these exploration activities are restricted to within 500m of preliminary well location and/or within 25m of the preliminary seismic transects. This would entail undertaking the exploration activities within areas assessed in detail, with known sensitivities to be avoided and processes in place to be followed to ensure activities are undertaken in an environmentally friendly and sustainable manner.

5.1.2 EXPLORATION ACTIVITIES OUTSIDE PRELIMINARY EXPLORATION TARGET AREAS

Undertaking the activities outside the preliminary assessed Target Areas and seismic transects areas would entail a process where the proposed exploration activities are undertaken outside of the assessed 500m of preliminary well location and/or outside of the 25m of the preliminary seismic transects. This would entail undertaking the exploration activities on areas only assessed in desktop level with little known site-specific environmental sensitivities.

5.1.3 EXPLORATION ACTIVITIES WITHIN PRELIMINARY IDENTIFIED TARGET EXPLORATION LOCATIONS EXCLUDING DIRECTLY AFFECTED RENEWABLE ENERGY PROJECTS

This alternative (**subject to alignment on co-existence arrangements to the extent that this is reasonably possible**) would entail undertaking the activities within preliminary identified target exploration locations but excluding the directly affected renewable energy developments. It would entail a process where these exploration activities are restricted to within 500m of preliminary well location and/or within 25m of the preliminary seismic transects but excluding land directly earmarked for renewable energy development where the exploration activities and the planned renewable energy development overlap. This would entail undertaking the exploration activities within areas assessed in detail, with known sensitivities to be avoided and avoidance of renewable energy developments. This process would reduce the exploration areas but would allow the renewable energy developments to proceed without interference.

5.1.4 ADVANTAGES AND DISADVANTAGES OF LOCATION ALTERNATIVES

Preliminary advantages and disadvantages of location alternatives are indicated in **Table 36**.

Table 36: Advantages and disadvantages of undertaking activities within different location alternatives.

ADVANTAGE	DISADVANTAGE
Undertaking the activities within preliminary identified target exploration locations	
Activities will be on known site-specific environmental sensitivities and controls in place.	Final drilling site/s may fall outside of the assessed area which would limit effective assessment of the gas resource.
Site-specific controls would be in place for the activities in these areas.	Additional specialist studies, applications or approvals may still be required depending on the final location.
Restricting exploration activities and subsequent disturbance / impacts to specific locations within the ER.	
Can be undertaken taken with the renewable energy developments through co-existence arrangements.	There may be reduced footprint and/or rescheduling of the of the renewable energy developments on the affected areas to allow for exploration which may affect capacity / timing of power generation.
Undertaking exploration activities within preliminary identified target exploration locations excluding directly affected renewable energy projects	
Activities will be on known site-specific environmental sensitivities and controls in place.	Final drilling site/s may fall outside of the assessed area which would limit effective assessment of the gas resource.
Site-specific controls would be in place for the activities in these areas.	Additional specialist studies, applications or approvals may still be required depending on the final location
Restricting exploration activities and subsequent disturbance / impacts to specific locations within the ER.	Reduced exploration activities on areas already assessed which may negatively affect the outcome of the exploration activities by impeding the detailed analysis of quantity and quality of gas reserves.
Allowance of renewable energy developments to proceed without interference	Depending on the final renewable energy facility layout and final drilling location, there is a positivity that the two projects do not interfere with each other. Therefore, there would be an unnecessary restriction to prevent potential valuable oil and gas information.
Undertaking the activities outside preliminary exploration target areas	
Final drilling site/s may fall outside of the assessed area based on the outcome of the seismic surveys. Strict	Activities will be located on areas with little knowledge of specific environmental sensitivities.

ADVANTAGE	DISADVANTAGE
measures to be included in the EMPr will allow activities to proceed in these areas. It must be noted that there may be a requirement to undertake additional site-specific environmental sensitivities and specify additional controls.	Minimal site-specific controls would be in place for the activities in these areas.
	This would open up the entire exploration footprint for exploration activities and potential disturbance / impacts.
	Additional specialist studies, applications or approvals may be required to allow for activities to be undertaken in these areas.

Based on the advantages and disadvantages indicated in **Table 36** above, it is recommended that the proposed activities be ideally undertaken within the preliminary identified target exploration locations through co-existence agreements (where applicable), should that not be successful, then the second preferred alternative would be the undertaking exploration activities within preliminary identified target exploration locations excluding directly affected renewable energy projects and the undertaking of the exploration activities outside preliminary exploration target is the least preferred alternative. However, the nature of the exploration activities is such that the target sites are somewhat adjustable. This provides the operator with flexibility to move the sites for on-the-ground- activities to avoid local sensitivities that must be avoided (e.g. residence, wetlands and watercourse, etc.) buffers where required provided that the relevant processes outlined in the EMPr (**Appendix H**). The specific locality of the exact drilling location can only be identified once the initial phases have been undertaken, environmental sensitivities identified and faults / fractures within the target rocks identified. **It is therefore recommended that, both areas inside the target areas and outside the target areas be considered for approval provided that relevant processes / measures are in place indicated in the EMPr (Appendix H) are adhered to.**

5.2 TECHNOLOGY OR PROCESS ALTERNATIVES

5.2.1 EXPLORATION DRILLING ALTERNATIVES

Drilling penetration into rock becomes more difficult with increasing hole diameters and rock compressive strength. In piling applications, hard rock formations have to be cut and excavated prior to the installation of the foundation piles and/or piled retaining walls. Commonly, conventional rotary drill tools are used for bored piles in medium to very high strength rocks. For harder rock formations different methods have to be adopted as much larger cutting energy and force input are normally required to break the material at the rock tool interface. Different drilling methods include rotary, percussion, rotary-percussion drilling and core drilling techniques, each utilizing distinct techniques to penetrate various soil and rock conditions, with rotary drilling using a rotating drill bit and percussion drilling using a hammering action.

5.2.1.1 **ROTARY DRILLING METHOD**

Rotary drilling uses a rotating drill bit to create boreholes by cutting or grinding through materials, and it is a versatile technique used in various applications, including well drilling, soil sampling, and geotechnical investigations. Rotary drilling is a method of creating boreholes in the ground using a spinning drill bit. This technique utilises a rotary drilling rig, which applies downward pressure and rotational force to the drill string, effectively cutting through soil and rock layers. As the drill bit advances, it grinds and chips away at the subsurface material, creating a cylindrical hole. The process uses a special fluid, often called drilling mud, which flows through the drill and out of small openings in the drill bit (refer to **Figure 98**). This fluid has several important jobs:

- Cooling the drill bit to prevent overheating;
- Lubricating the drilling components;
- Carrying cuttings from the borehole to the surface; and
- Stabilising the borehole walls to prevent collapse.

Rotary drilling rigs come in various sizes and configurations, including compact, rubber-tracked units designed for accessing confined spaces to large truck-mounted rigs capable of drilling deep boreholes in challenging conditions. Common uses of rotary drilling are deep water well drilling, geothermal wells, and oil & gas drilling.

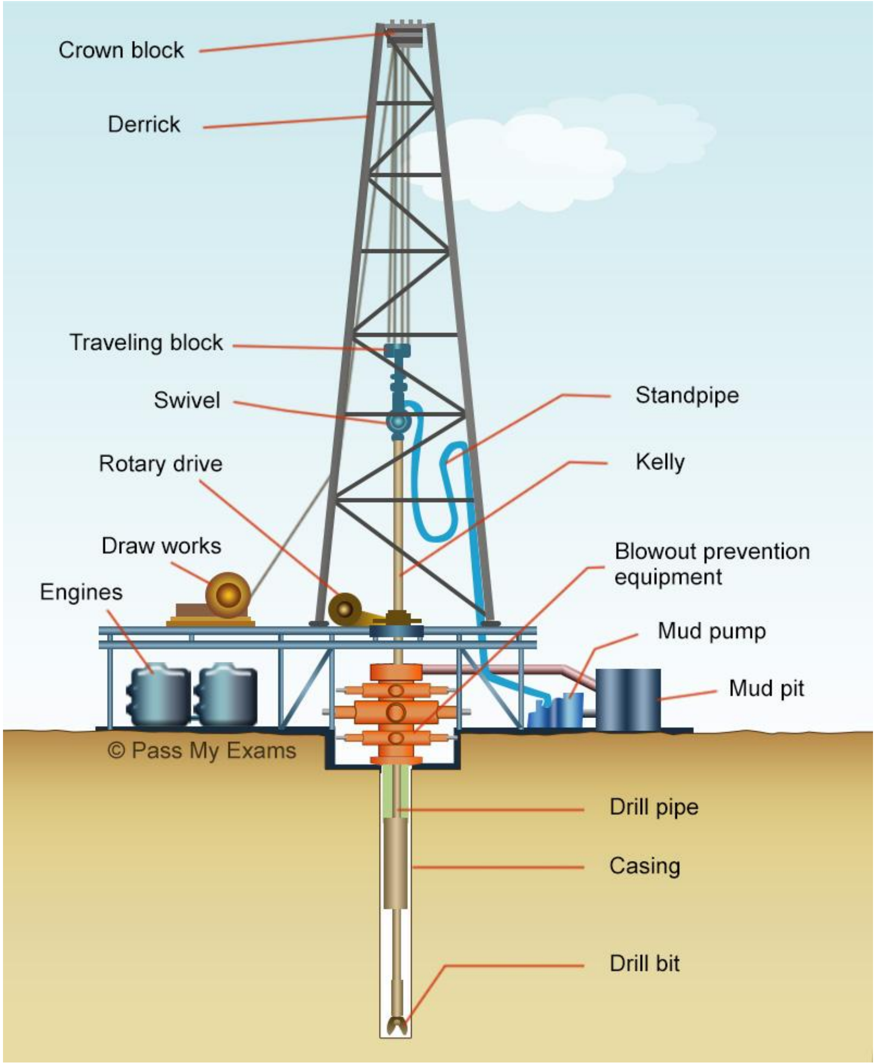


Figure 98: Fully cased drilling with rotary drive (https://www.passmyexams.co.uk/GCSE/chemistry/drilling-crude-oil-1.html).

5.2.1.2 PERCUSSION DRILLING METHOD

Percussion drilling is a technique where a hammering bit is attached to a long cable that is then lowered into a wide-open hole. As such, it is also called cable drilling, wherein the driller uses a tripod to support the tools. By going back and forth with the bit, the action loosens the soil in the borehole, which is then extracted with the help of a bailer. At intervals, the bit is removed while the cuttings are suspended in water, which is then removed by pumping to the surface. The percussion or churn drill digs a vertical hole. It employs the principle of freely falling chisel bit hung on a cable to which percussive motion is imparted by one of the various types of power units. The power units are manual lift and drop, compressed air, and electrically driven winches. The tungsten carbide bit fitted in a hammer is lifted few meters and allowed to drop (**Figure 99**) to hit the bottom of the hole. The process continues in succession. The churning motion of the bit crushes and scraps the ground, and so a hole is dug. The cutting of rocks thus produces mud or slurry by lowering water. The crushed material is removed from the bottom of the hole at a regular interval to make a sample. Churn drilling is suitable for soft and medium formation. In harder formation resharpening of cutting bit is required frequently resulting in lowering of progress. The capacity of the churn drill in its original form is limited to relatively short holes, under 40 m. Unless the formation is consolidated, a steel casing is necessary to prevent the collapse of the hole. Similarly, the casing may have to be cemented/isolated in order to protect the hole from contamination or prevent the hole from being a vehicle to bring various layers in communication (triggering environmental concerns). Only an uncemented casing can be used temporarily after permanent screen or casing is installed.

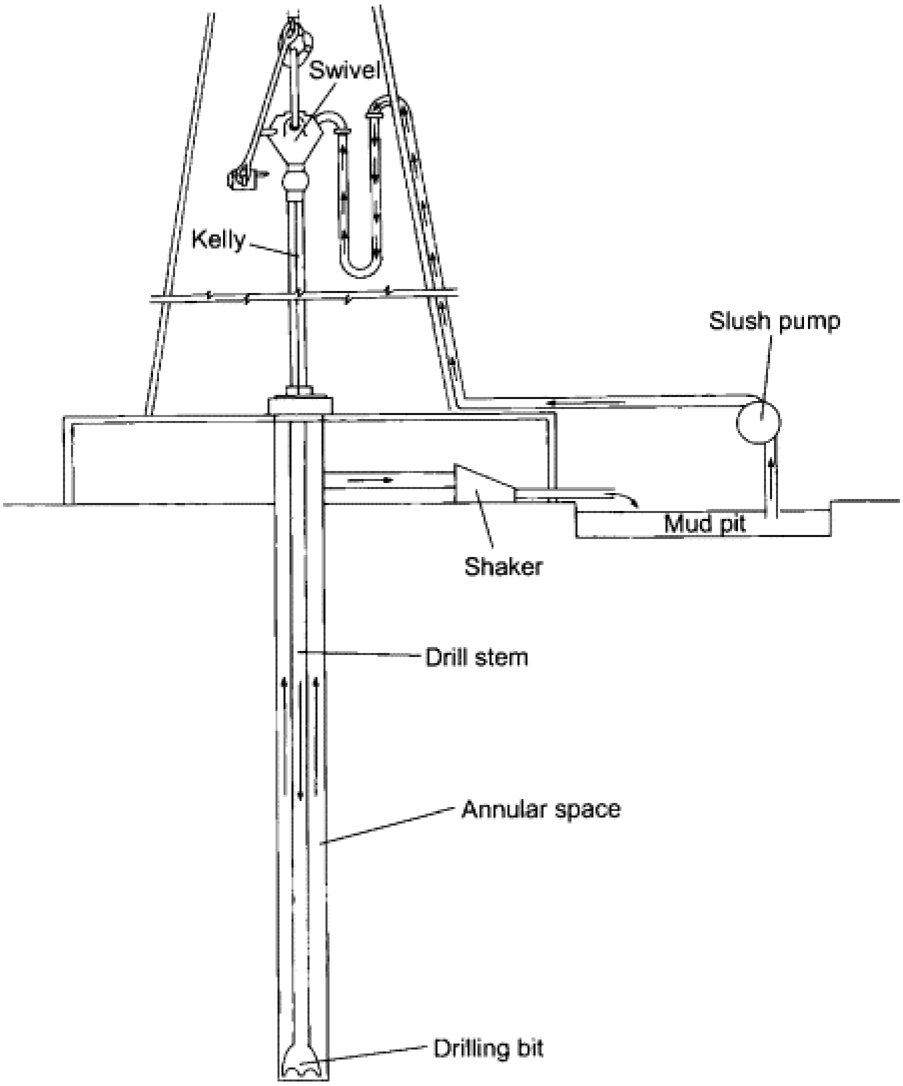


Figure 99: Typical example of percussion drilling technique (https://www.sciencedirect.com/topics/engineering/percussion-drilling).

5.2.1.3 ROTARY-PERCUSSION DRILLING METHOD

Rotary-percussion drilling, also known as down-the-hole hammer drilling, combines rotary and percussive drilling techniques to penetrate various soil and rock conditions efficiently, using a hammer tool to produce percussion while rotating the drill bit. A hammer drill (located directly in the borehole) delivers blows to a drill bit, breaking up the material. The drill pipes are rotated, and a flushing medium (like compressed air or water) is used to remove debris. The hammer drill is connected to the drill pipes, and the drill bit is forced through the drill pipes, hammer drill, and borehole. Refer to **Figure 100** for the excavation processes of the rotary-percussion composite excavation method: (**A**) excavating the shaft with rotary drilling; (**B**) completing the rotary drilling segment; (**C**) excavating the shaft with percussion drilling; (**D**) completing the percussion drilling segment

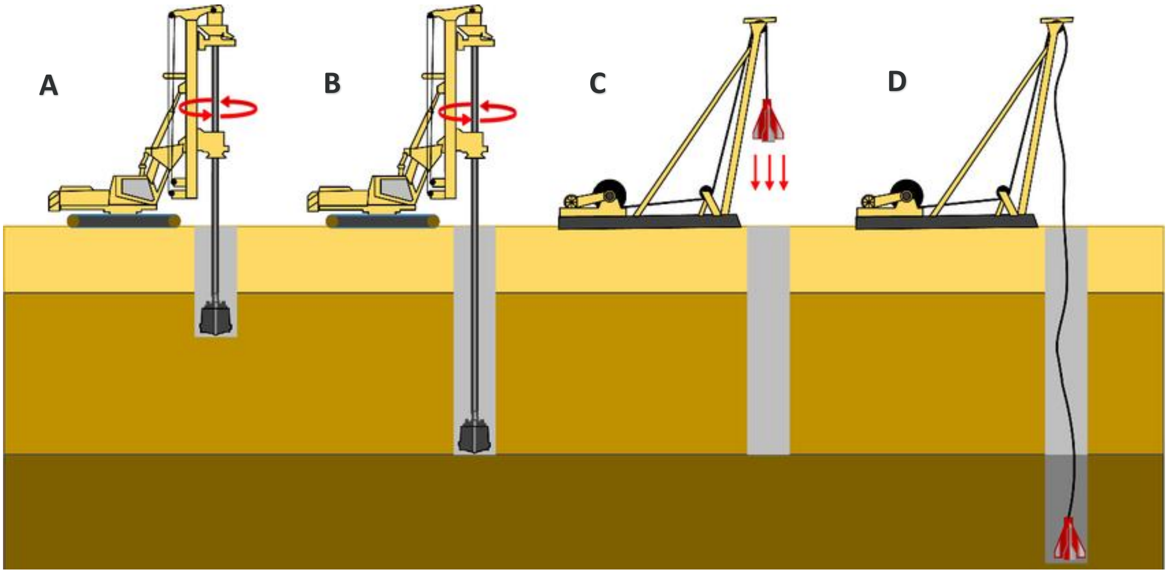


Figure 100: Typical example of rotary-percussion drilling technique (Hu *et al.,* 2023).

5.2.1.4 DIAMOND CORE DRILLING METHOD

Diamond drilling is a type of rotary drilling that uses a diamond studded drill bit (**Figure 101A**) to drill through and collect samples of sub-surface rock. The drill bit is attached to a core barrel which consists of an inner and outer barrel and a core lifter. The core barrel is then attached to a 6m drill rod (together called the "drill string") which is connected to a rotary / diamond drill rig (**Figure 101A**). During drilling, the inner barrel remains stationary while the outer barrel rotates with the drill bit. Water and other drilling fluids are injected into the drill string to prevent overheating. The drill bit cuts through the rock as it rotates and the opening at the end of the drill bit allows a solid column of rock (known as "drill core") to move up into the core barrel. When 6m has been drilled, a steel cable is used to latch the inner barrel and winch the drill core to the surface. The core lifter prevents the drill core from slipping out through the opening at the end of the drill bit while this is happening. Once at the surface, the drill core is removed from the inner barrel, washed, cracked into shorter lengths and placed in a core tray with markers inserted to track depth. Another 6m drill rod is attached to the top of the drill string and it is lowered back into the drill hole to continue drilling until the desired depth is reached. At least once a shift, core trays are transported to a separate core processing area to be marked up, photographed and logged by a qualified geologist. Once the geologist has finished with the drill core, it is cut in half longitudinally, so that half can be sent to a laboratory for analysis and half stored for future reference / use. Upon completion of drilling, it is a requirement that rehabilitation is undertaken to ensure that all areas impacted by drilling are restored to the condition that existed prior to undertaking the drilling, and no hazards are left behind that would impact the surrounding environment or land use.

A

B

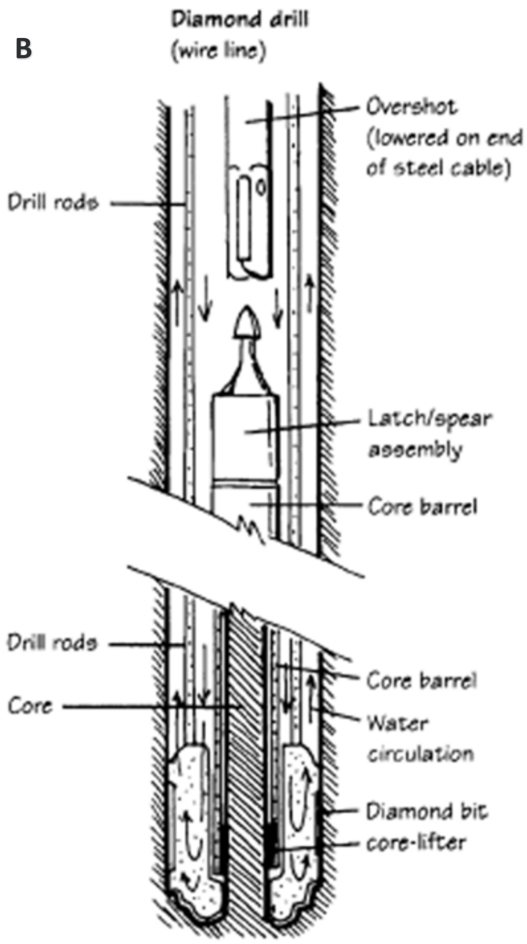


Figure 101: Diamon core drilling technique (Wai: https://www.precisiondrillingaustralia.com.au and Igo: ttps://www.igo.com.au)

5.2.1.5 ADVANTAGES AND DISADVANTAGES OF DIFFERENT EXPLORATION DRILLING METHODS

Table 37: Advantages and disadvantages of different exploration drilling alternatives.

Method	Advantage	Disadvantage
Rotary Drilling	Versatile, efficient, good for various formations	Rotary drilling equipment and operations can be more expensive than percussive drilling
	Faster drilling speeds due to continuous rotation	The machinery used in rotary drilling can generate significant noise and vibration, which can be disruptive, especially in residential areas.
	Enhanced safety as fewer manual connections are required	Can be slower and more challenging than percussive methods in extremely hard rock.
	Ideal for deep boreholes and oil & gas applications	Disposal of drilling waste, including large volumes of water if drilling below the water table, can be costly.
	Reduced risk of borehole collapse.	Can cause environmental impacts including noise and vibration pollution, air

Method	Advantage	Disadvantage
		pollution from exhaust emissions, and potential soil and water contamination from drilling fluids.
	High penetration rate in hard rock, durable	Expensive, requires specialized equipment
Percussion Drilling	In general, percussion drilling is relatively fast and efficient.	Percussion drilling cause noise pollution, potential for soil disturbance and contamination, and the need for proper waste disposal
	Percussion drilling is a cost-effective method.	Percussion drilling can cause significant damage to the rock formation being drilled, making it unsuitable for some geological projects.
	Can be used in a variety of geological formations, including hard rock, soft rock, and unconsolidated formations.	The equipment can be very heavy and relatively expensive.
	It is a straightforward method to operate and maintain, making it accessible for a range of projects and drilling environments.	Especially in harder rock, the method is slower than rotary-percussion and/or core methods.
Rotary-percussion Drilling	Can drill in consolidated or broken formations, as well as transitional hard or soft formation changes.	Generally slower than pure rotary drilling, especially in softer materials or for deep boreholes.
	Can increase rate of penetration (ROP) and drilled meters per shift.	Can be prone to hole deviation in certain conditions, especially in hard or unstable formations.
	Can be more cost-effective than other drilling methods, especially for deep drilling.	May require more specialized equipment and expertise compared to simpler drilling methods.
	Allows for the collection of continuous core samples, which is useful for detailed geological analysis.	Some rotary-percussion drilling techniques have limitations on the maximum drilling depth
	Causes less surface disruption compared to some other drilling methods, making it suitable for urban or residential areas.	Depending on the specific method and fluids used, there can be environmental concerns related to drilling fluids and waste disposal.
Diamond Core Drilling	Diamond core drilling is more precise than its offshoots of earth burying. Diamond core drilling produces clean, accurate holes with minimal vibration or damage to surrounding materials.	Diamond drilling can be noisy and create vibrations, which can be unpleasant for workers and nearby residents.
	Where the rotary and percussion drill mechanisms chip or crush the earth beneath tools, the core drill type is able to pull a slither of rock delicately from the earth.	Diamond drilling can lead to soil and water contamination if not managed properly. The drilling process can introduce harmful substances into the ground, affecting both soil quality and nearby water sources.

Method	Advantage	Disadvantage
	Has the drill to power through the hardest of rock materials.	Local ecosystems, including plants and animals, are often more disrupted by diamond drilling activities
	Diamond core drilling is important for geological analysis. By examining the extracted core a geologist can determine the relationship between the rock layers and examine the earth's condition in fault zones.	Diamond drilling equipment and diamond bits are expensive, and require regular maintenance, making the process costly.
	Diamond drilling is usually faster and more effective than conventional drilling methods.	Compared to other drilling methods, diamond core drilling can be slower, especially in hard rock formations.
	Diamond core drilling produces minimal dust and debris, which reduces cleanup time and environmental impact.	There's a risk of losing or damaging the core sample during the drilling process, which can hinder geological analysis.
	While the initial investment may be higher, diamond drills are durable and can last longer than other types of drills, which can lead to cost savings in the long run.	Diamond drilling equipment can be prone to failure, especially in harsh conditions, leading to downtime and increased costs.

In general, percussion drilling is a versatile and cost-effective method of geological exploration that is widely used in the exploration industry. While it has some drawbacks, such as its limited depth capabilities and potential for rock damage, it remains a popular choice for many exploration projects. As with any drilling method, it is important to weigh the pros and cons carefully before deciding whether to use percussion drilling for a specific geological exploration task. Based on the advantages and disadvantages indicated in **Table 37** above, each method has its own pros and cons, the seismic surveys will inform the type of drilling technique required but from an environmental point, percussion drilling has the least impacts while diamond core drilling has the most environmental impacts.

5.2.2 SEISMIC SURVEYS ALTERNATIVES

A seismic survey is a method used to investigate the subsurface structure, primarily for oil and gas exploration, by sending sound waves into the ground and analysing the reflected signals. Offshore surveys use airguns to create low-frequency sound waves that travel through the water and reflect off the seafloor, allowing geophysicists to map geological features and potential hydrocarbon deposits. While onshore seismic surveys are used to investigate the subsurface structure of land areas, commonly for exploring hydrocarbon reservoirs, mineral deposits, and natural gas, by using sound waves and the principles of reflection seismology. The proposed activities are onshore seismic surveys and thus, this report will only focus on onshore seismic surveys. Onshore seismic surveys utilize sound waves, which are generated and then reflected off subsurface layers. By analysing the reflected waves, geoscientists can create images of the subsurface structure. The design of a seismic survey depends on the specific objectives, the geological setting, and the availability of historical data. Factors to consider include the size of the survey area, the spacing of seismic lines, and the type of seismic acquisition techniques used. For purposes of this report, the types of seismic surveys techniques used will be based on three common methods used for oil and gas explorations namely, vibroseis technique, Accelerated Weight Drop (AWD) and Magnetotelluric Survey (MT) (refer to **Section 2.1.4** for detailed information).

5.2.2.1 **VIBROSEIS TECHNIQUE**

vibroseis seismic surveys use vehicles to generate artificial seismic waves through mechanical vibration, offering a low-impact method for gathering data to interpret geological features beneath the earth's surface, similar to how sound waves are used in an ultrasound. vibroseis trucks travel slowly, stopping at intervals to send seismic waves into the earth using vibrators mounted on the trucks. These waves travel through the earth and are reflected (echoed) off rock formations. Sensitive microphones on the surface, called geophones, record these reflected waves. Geoscientists analyse the recorded data to build knowledge of the underlying geology.

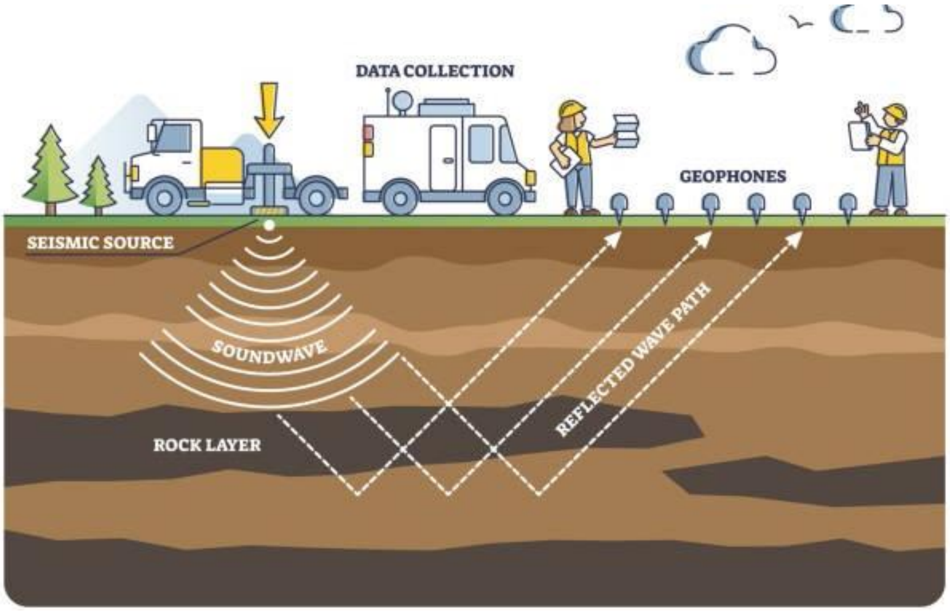


Figure 102: Illustration of vibroseis technique (Bhardwaj, 2024).

5.2.2.2 ACCELERATED WEIGHT DROP TECHNIQUE

An accelerated weight drop (AWD) seismic survey uses a heavy weight that is accelerated and dropped onto a base plate, generating seismic waves to image the subsurface. An AWD seismic source is a type of surface impact source that uses a weight striking a base plate coupled to the ground. The falling weight strikes the base plate, transmitting kinetic energy to the ground, which creates seismic waves that travel through the subsurface. These seismic waves are then recorded by geophones or other sensors, and the data is used to create images of the subsurface, which is useful for various applications, such as oil and gas exploration, groundwater studies, and engineering investigations (see **Figure 103**).

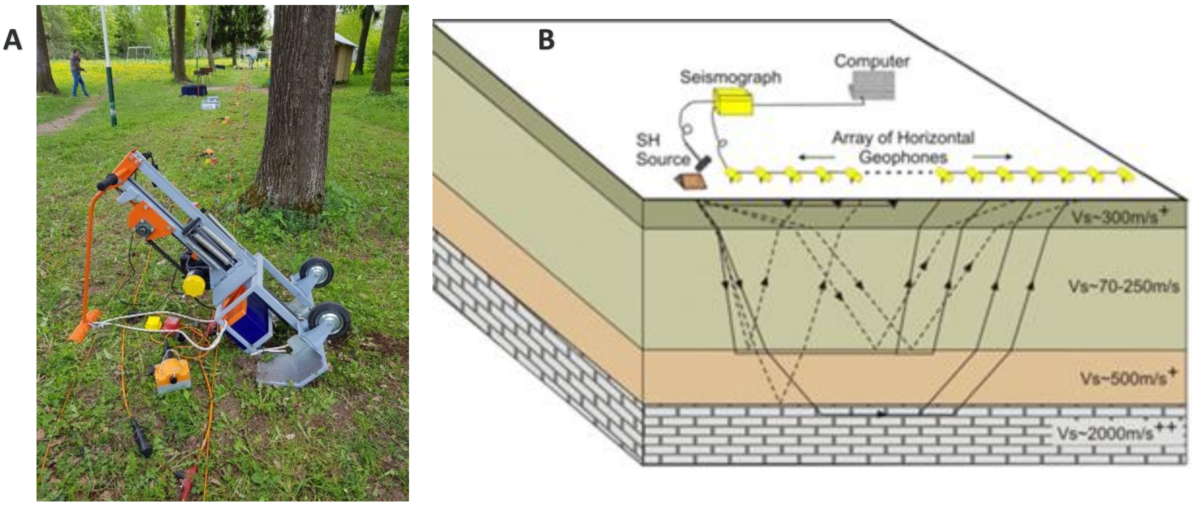


Figure 103: Illustration of AWD technique after Stephenson *et al.,* 2022. (A) AWD on site and (B) illustration of the process.

5.2.2.3 MAGNETOTELLURIC SURVEY

Magnetotellurics (MT) are electro-magnetic survey and imaging techniques that use naturally-occurring ionospheric current sheets and lightning storms — passive energy sources — to map geologic structures to depths of 500 meters or more. The MT geophysical survey method combines measurements of the earth's electric field and magnetic field over a wide band of frequencies. Low frequencies sample deep into the earth and high frequencies correspond to shallow samples. For hydrocarbon exploration, MT is mainly used as a complement to the primary technique of reflection seismology exploration. While seismic imaging is able to image subsurface structure, it cannot detect the changes in resistivity associated with hydrocarbons and hydrocarbon-bearing formations. MT does detect resistivity variations in subsurface structures, which can differentiate between structures bearing hydrocarbons and those that do not.

At a basic level of interpretation, resistivity is correlated with different rock types. High-velocity layers are typically highly resistive, whereas sediments – porous and permeable – are typically much less resistive. While high-velocity layers are an acoustic barrier and make seismic ineffective, their electrical resistivity means the magnetic signal passes through almost unimpeded. This allows MT to see deep beneath these acoustic barrier layers, complementing the seismic data and assisting interpretation.

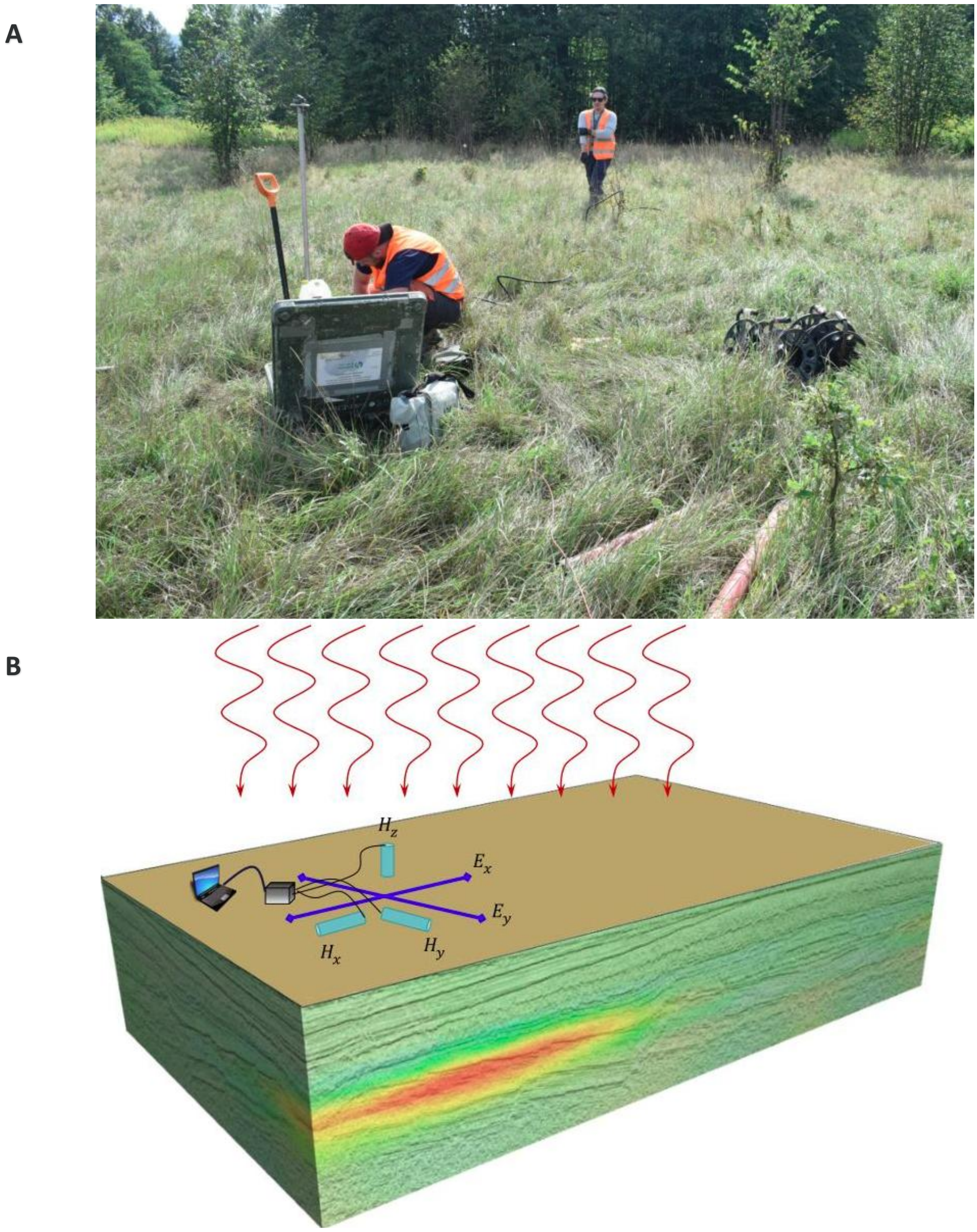


Figure 104: Illustration of MT survey (geopartner: https://geopartner.pl). (A) MT setup on site and (B) illustration of the MT process.

5.2.2.4 ADVANTAGES AND DISADVANTAGES OF DIFFERENT SEISMIC SURVEYS ALTERNATIVES

Preliminary advantages and disadvantages of different seismic survey techniques are indicated in **Table 38**.

Table 38: Advantages and disadvantages of different seismic survey alternatives.

Technique	Advantage	Disadvantage
vibroseis Survey	vibroseis allows for precise control over the frequencies and energy of the generated seismic waves, which is beneficial for tailoring the survey to specific geological targets.	Although vibroseis surveys are generally quicker, they can be affected by weather and terrain conditions resulting in longer survey periods.
	vibroseis sweeps can be repeated easily, allowing for high-quality data acquisition.	vibroseis trucks may have difficulty navigating rugged or steep terrain.
	vibroseis surveys are generally quicker.	Can be more expensive than some other geophysical methods
Accelerated Weight Drop Surveys	AWD surveys can be significantly faster than vibroseis surveys	Repeated thumping can cause soil disturbance, potentially leading to long-lasting effects
	AWD systems can be mounted on crawlers or other vehicles, allowing them to operate in more varied terrain.	Depending on local regulations, AWD surveys may require more permits than vibroseis surveys.
	AWD can produce more energy than vibroseis, potentially allowing for deeper penetration.	May not be as effective as other seismic methods in deeper areas
	AWD surveys can be used in areas where explosives or vibroseis are not practical or safe.	AWD methods are primarily designed for shallow subsurface investigations, making them less suitable for exploring deeper geological structures
Magnetotelluric Surveys	MT relies on naturally occurring electromagnetic fields, reducing the need for active sources and equipment, making it a cost-effective and environmentally friendly method.	Cannot provide the resolution of seismic surveys and may not be suitable for all geological environments.
	MT surveys can provide information about the subsurface at great depths and can be used in areas where seismic data collection is difficult or impractical.	MT surveys can be more complex and time-consuming than other geophysical methods.
	MT can map large areas and provide a regional perspective on subsurface resistivity variations.	MT surveys can be expensive, particularly for large-scale projects or surveys in challenging terrains.
	MT surveys do not require drilling or ground disturbance, minimizing environmental impact.	MT surveys may have limited resolution, particularly for shallow subsurface structures.

Based on the advantages and disadvantages indicated in **Table 38** above, it can be seen that the suitability for each is based on the nature of the exploration project and the environmental conditions. It can also be seen that where one technique lacks, the other can abounds. Therefore, it is **recommended that a multi-survey technique be used based on the environmental conditions of the final survey location.**

5.3 SCALE ALTERNATIVES

5.3.1 UNDERTAKING LIMITED DRILLING AND SEISMIC ACTIVITIES

In this alternative, the exploration activities within the ER would be limited to the proposed number of a maximum of five (5) drilling activities and nine (9) seismic transects. No additional exploration activities would be allowed through the current application. Should future additional exploration activities be required beyond the current proposed figures, then an amendment application with site specific specialist assessments (in new areas) or compliance studies (in current areas) would be required to support such an application.

5.3.2 UNDERTAKING EXTENSIVE DRILLING AND SEISMIC ACTIVITIES

In this alternative, it would entail a scenario where more than five (5) drilling activities and more than nine (9) seismic transects are undertaken, provided they are within the approved ER. Such additional exploration activities would only need to follow the process specified in the EMPr (**Appendix H**). Although this alternative would result in more in-depth understanding of the resource, this alternative would result in more negative environmental impacts and significant negative cumulative impacts in the area.

5.3.3 ADVANTAGES AND DISADVANTAGES OF DIFFERENT SCALE ALTERNATIVES

Preliminary advantages and disadvantages of undertaking limited / defined number compared to undertaking unlimited / undefined number of exploration activities within exploration area are indicated in **Table 39**.

Table 39: Advantages and disadvantages of different scale alternatives.

<table>
<tr><th>Advantage</th><th>Disadvantage</th></tr>
<tr><td colspan="2">Undertaking Limited Drilling and Seismic Activities within the ER</td></tr>
<tr><td>Limited allowance of exploration activities would result in lesser environmental impacts.</td><td rowspan="3">The specified number of exploration activities may possibly be not enough for effective resource quantity and quality analysis. Additional activities would then require assessments, authorisations / approvals which can be time consuming and expensive.</td></tr>
<tr><td>Limited allowance of exploration activities would ideally result in activities being undertaken primarily on the target areas which will be assessed in detail and will have adequate control measures in place.</td></tr>
<tr><td>There would be less or more control impacts on the surrounding land uses, thus less impacts on the economic activities of the area.</td></tr>
<tr><td colspan="2">Undertaking Extensive Drilling and Seismic Activities within the ER</td></tr>
<tr><td rowspan="3">The specified number of exploration activities may possibly be not enough for effective resource quantity and quality analysis. Additional activities would then be undertaken without additional authorisations / approvals which can save time and money.</td><td>This process would result in significant cumulative environmental impacts. Can lead to significant habitat loss, pollution, and resource depletion.</td></tr>
<tr><td>This could result in more exploration activities being undertaken outside of the target areas provided they are in less sensitive environments only based on desktop information which could be outdated information.</td></tr>
<tr><td>The area is known for agricultural and game farming as well as an area earmarked for renewable energy developments, unlimited exploration activities could significantly affect the land uses and the economic functions of the area.</td></tr>
</table>

Based on the advantages and disadvantages indicated in **Table 39** above, it is **recommended that the proposed activities ideally be limited to the proposed five (5) drilling activities and nine (9) seismic activities.**

5.4 DESIGN OR LAYOUT ALTERNATIVES

Design alternatives are the consideration of different designs for technical efficiency, aesthetic purposes or different construction materials in an attempt to optimise local benefits and sustainability. It must be noted that there are two types of drilling pit sumps, aboveground sumps and underground sumps. Underground sumps are used in underground mining operations to collect and pump water from working and therefore, not feasible nor applicable for the proposed exploration project. Subsequently, for purposes of this report, design or layout alternatives are based on the two options for aboveground drill sumps, namely the traditional plastic lined pond (sump pit) or above ground sumps with secondary steel or plastic containment.

In exploration drilling, a sump pit (or sump) is a contained area used to collect drill cuttings and manage drilling fluids, allowing for water recycling and efficient solids settling. Sumps are typically constructed as pits or basins, often made of steel or plastic tanks. They can be portable, allowing for easy transport and setup at different drill sites. Sumps are designed to prevent the escape of drilling fluids and cuttings into the environment. Ramps are often included in sump design to allow wildlife to escape if they enter the sump. Proper planning and construction of sumps are crucial for minimizing environmental impact and ensuring a safe drilling operation. It is important to note that the type of drilling method used will influence the size and design of the sump required.

5.4.1 TRADITIONAL LINED POND (DRILL SUMP PITS)

In this alternative, a sump pit is used to collect drill cuttings and manage cement mixing, allowing for water recycling and efficient solids settling. The drilling team will excavate a hole depending on the drilling method, then line the top portion (typically 0.5 meters) with materials and fenced to ensure joints are sealed for support and preventing water and animals from entering. The typical lining material used are high density polyethylene sheets (refer to **Figure 105**). After drilling operations are completed, the sump pit and the surrounding area must be rehabilitated to restore the site to its original condition. This may involve removing the accumulated solids, cleaning the pit, and restoring the vegetation.

Figure 105: Typical traditional sump pit used for one of the approved D3 Energy drilling sites in the region.

5.4.2 ABOVEGROUND SUMPS WITH SECONDARY CONTAINMENT

Above-ground sumps with secondary containment are designed to capture and contain spills or leaks from fuel tanks or other storage containers, acting as a secondary barrier to prevent environmental contamination. Secondary containment is a system designed to prevent the release of hazardous materials into the environment in case of a spill or leak from a primary storage container (like a tank). It is a crucial safety measure, especially for Above-Ground Storage Tanks (ASTs) that hold flammable or hazardous liquids. Common methods include containment sumps, bunds (earthen dykes), spill pallets, or double-walled tanks. Aboveground sumps are often made of materials that are impervious to the stored liquid, such as steel, concrete, asphalt, clay, or plastic. In exploration drilling, feasible material includes steel or plastic (**Figure 106**). The sumps are either emptied or disposed by a hazardous waste service provider at a hazardous waste facility.

Figure 106: Illustration of aboveground sumps with secondary containment (https://enduramaxx.co.uk/enduramaxx/chemical-storage-tanks-secondary-containment/)

5.4.3 ADVANTAGES AND DISADVANTAGES OF DIFFERENT DRILL CONTAINMENT SUMPS

Based on the analysis of the different feasible aboveground drill sumps proposed for the project, the advantages and disadvantages are provided in **Table 40**.

Table 40: Advantages and disadvantages different aboveground drill sumps.

Advantage	Disadvantage
Traditional lined pond (drill sump pits)	
Lined ponds prevent water seepage into the soil, conserving water resources, especially important in areas with intermittent water availability.	Requires dredging causing disturbance to soil.
For drilling activities, it is a cost-effective method compared to aboveground sumps with secondary containment	Waste material can settle and rot on the bottom, leading to ammonia buildup, which is toxic to aquatic life.
Liners prevent soil particles from dissolving into the water, maintaining water clarity and chemistry, which is beneficial for aquaculture and other water-based activities.	Requires constant monitoring to ensure there's no seepage.
Groundwater Safety: By collecting contaminated wastewater and accidental spills, sumps prevent these fluids from soaking into the soil and causing groundwater contamination.	Animals can easily be trapped by the fence and/or fall into the pit.
Trap chemicals, lubricants, and hydrocarbons, ensuring these hazardous substances do not mix with standard stormwater runoff or local waterways.	Lined ponds can suffer from leaks, liner damage, and require sump pumps. Punctures and tears are common, and repairs can be difficult and costly.

Advantage	Disadvantage
Sump pits act as primary containment zones for rig wash, cement returns, and excess cement slurry.	Damage to liner results in immediate contamination and may affect groundwater and/or nearby aquatic systems.
Appropriate liners for the specific activity and site are highly resistant to UV damage, chemicals, and punctures, ensuring long-term durability.	Requires backfilling and rehabilitation.
During well cementing, pits safely catch cement returns, equipment wash water, and cement slurry overflows	
Aboveground sumps with secondary containment	
Above-ground sumps are easier to install and are accessible for repairs and troubleshooting.	Secondary containment systems can be expensive to install and maintain and requires constant monitoring and maintenance.
Above-ground sumps can be designed to fit various spaces and needs, offering design flexibility.	Sediment can settle in the sump, reducing its capacity and requiring more frequent pumping.
Have a longer lifespan, leading to lower long-term costs.	Above-ground sumps can be unsightly and may not blend in with the surrounding landscape.
They are more effective in containing spills from primary container which can be easily identified and addressed compared to lined sumps.	Above-ground sumps can be expensive to install, especially if they are large or complex.
Above-ground sumps are prone to solids buildup and potential maintenance issues.	Secondary containment systems, like bunds or containment berms, require additional space around the primary tank or sump, increasing the overall area needed for storage
	Vehicles can back into them, vandals can deface or damage them, and trespassers can steal their contents. Exposure also increases the chance of leaks.
	Regular inspections and maintenance are crucial to ensure the integrity of both the primary and secondary containment systems.
	If the secondary containment fails, the spilled material can contaminate the surrounding soil and water.

Based on the advantages and disadvantages indicated in **Table 40** above, both sump pits and aboveground sumps have noticeable advantages and disadvantages. However, sump pits are compulsory in onshore oil and gas facilities primarily to prevent groundwater contamination, ensure site safety, and contain hazardous spills as they act as controlled, low-point collection basins that capture spilled hydrocarbons, contaminated wash water, and stormwater before they can seep into the surrounding environment. In addition, during well cementing, pits safely catch cement returns, equipment wash water, and cement slurry overflows. Furthermore, in addition to the small size of the pits (approximately 4m x 4m and 1.5m deep), air drilling is proposed for the drilling activities which uses compressed air, nitrogen, or gases instead of conventional liquids (like drilling mud) to cool the drill bit and lift rock cuttings out of the wellbore. Therefore, it is the **EAP's opinion that sump pits can be considered favourable for the exploration activities provided that the size and capacity is restricted to 4m x 4m and 1.5m deep per sump**. Additional containment if required (i.e., for emergency situations) should be aboveground sumps with secondary containment.

5.5 NO GO ALTERNATIVE

The no go alternative would imply that the explorations activities do not proceed. This would result in the status quo of the environment remaining in its current condition. Potential impacts such as some direct / indirect loss of habitats, direct / indirect mortalities, and displacement of fauna including SCC and Protected species would not occur. There would also be no potential for contamination of water resources (including surface water resources) associated with the exploration activities. In addition, the clearing of vegetation for the proposed activities which could expose, disturb and displace archaeological sites / material would be avoided. However, the approval of the proposed activities would allow the applicant to improve the accuracy of their exploration for an economically viable resource (natural gas including Helium) available in the area. It is important to note that the exploration right will not provide the required authorisation for production activities to be undertaken. As such, any future intention to undertake production of hydrocarbons within the exploration right area would require a further application, investigation and public consultation process.

Exploration for additional domestic hydrocarbon reserves is considered important, and any discoveries would be well received by the local market. ER386 exploration project is justified partly by the growing and strategic demand for natural gas in South Africa. National policy frameworks—including the National Development Plan (2012), Draft Integrated Energy Plan, and IRP 2025—highlight gas as a key future energy source, driven by the need to diversify the energy mix, reduce reliance on coal, and lower emissions. Gas demand is projected to grow significantly through 2050, second only to petroleum, particularly due to industrial expansion and its role in power generation and thermal applications.

South Africa's declining domestic gas reserves and heavy reliance on imported oil further strengthen the need for new gas discoveries to ensure energy security and stability in the gas-to-liquids industry. Exploration initiatives like D3 Energy are therefore considered essential to identify new domestic supplies that can meet this rising demand. In addition, while the project also targets helium, gas remains important because helium is typically associated with natural gas deposits. The potential to produce both resources increases economic viability and reinforces the long-term demand-driven rationale for exploration. Overall, the project aligns with national priorities to expand gas supply, meet rising demand, reduce import dependence, and support economic growth, even though current activities are limited to exploration and not production.

In addition, as indicated in **Section 10.3**, the findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Despite the negative impacts caused by the project, it must be considered that there are positive impacts as well, mostly based on the employment opportunities (although minimal). Based on the nature and extent of the proposed and the predicted impacts as a result of the construction, operation and closure of the facility, the findings of the EIA, and the understanding of the mostly low - moderate post-mitigation significance level of potential environmental impacts, it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed D3 Energy ER386 activities can be mitigated to an acceptable level and the project should be authorized. Furthermore, there are known mitigation measure to avoid and/or reduce potential impacts mentioned above as per the various specialist studies and knowledge from past exploration activities.

Considering the above, and that the proposed actives are short term and the footprint is very small and adaptable and can therefore be undertaken in parallel with other land uses **the no go alternative is <u>not</u> considered feasible or reasonable for this application**, also refer to the detailed need and desirability of the project indicated in **Section 2.6**.

6 STAKEHOLDER ENGAGEMENT

The Public Participation Process (PPP) is a requirement of several pieces of South African legislation and aims to ensure that all relevant Interested and Affected Parties (I&APs) are consulted, involved and their comments are considered, and a record included in the reports submitted to the Authorities. The process ensures that all stakeholders are provided this opportunity as part of a transparent process which allows for a robust and comprehensive environmental study. The PPP for the proposed project needs to be managed sensitively and according to best practises to ensure and promote:

- Compliance with international best practice options;
- Compliance with national legislation;
- Establishment and management of relationships with key stakeholder groups; and
- Involvement and participation in the environmental study and authorisation/approval process.

As such, the purpose of the PPP and stakeholder engagement process is to:

- Introduce the proposed project;
- Explain the authorisations required;
- Explain the environmental studies already completed and yet to be undertaken (where applicable);
- Solicit and record any issues, concerns, suggestions, and objections to the project;
- Provide opportunity for input and gathering of local knowledge;
- Establish and formalise lines of communication between the I&APs and the project team;
- Identify all significant issues for the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent negative environmental impacts and maximize and/or promote positive environmental impacts associated with the project.

6.1 LEGAL COMPLIANCE

The PPP must comply with several important sets of legislation that require public participation as part of an application for authorisation or approval, namely:

- The Mineral and Petroleum Resources Development Act (Act No. 28 of 2002 – MPRDA); and
- The National Environmental Management Act (Act No. 107 of 1998 – NEMA).

Adherence to the requirements of the above-mentioned Acts will allow for an Integrated PPP to be conducted, and in so doing, satisfy the requirement for public participation referenced in the Acts. The details of the Integrated PPP followed for the project are provided below.

6.2 PRE-CONSULTATION WITH THE COMPETENT AUTHORITY

A pre-application meeting with the Petroleum Agency of South Africa (PASA) was held on the 29th of January 2025. The objective of the meeting was to present the project, confirm identified triggered and applicable listed activities and the applicable application process to be followed as well as the identified applicable specialist studies. The pre-application meeting was also used to confirm the current application form and submission methods.

6.3 GENERAL APPROACH TO SCOPING AND PUBLIC PARTICIPATION

The PPP for the proposed project has been undertaken in accordance with the requirements of the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA) and National Environmental Management Act

(NEMA) Environmental Impact Assessment (EIA) Regulations (2014), and in line with the principles of Integrated Environmental Management (IEM). IEM implies an open and transparent participatory process, whereby stakeholders and other I&APs are afforded an opportunity to comment on the project and have their views considered and included as part of project planning.

6.3.1 IDENTIFICATION OF INTERESTED AND AFFECTED PARTIES

An initial I&AP database has been compiled based on known key I&AP's, Windeed searches, and stakeholders as well as trust information obtained from the regional deeds office (Bloemfontein Justice Department). The I&AP database includes amongst others, landowners, communities, farming groups, regulatory authorities and other special interest groups. Additional I&APs have been identified during the public review and comment period of the Scoping Report. The I&APs database will continuously be updated throughout the duration of the application process. A full list of I&APs is attached in **Appendix C**.

6.3.2 LIST OF PRE-IDENTIFIED ORGANS OF STATE/ KEY STAKEHOLDERS IDENTIFIED AND NOTIFIED

Government Authorities were notified of the proposed project and include:

Table 41: List of key organs of state and I&APs identified and notified.

Organs Of State	Key I&APs
• Council for Scientific and Industrial Research (CSIR) • Department of Mineral Resources and Energy: Free State • Fezile Dabi District Municipality • Free State Department of Agriculture & Rural Development • Free State Department of Cooperative Governance and Traditional Affairs • Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs • Free State Department of Mineral Resources and Energy • Free State Department of Police, Roads and Transport • Free State Department of Public Works and Infrastructure • Free State Department of Water and Sanitation • Free State Development Corporation • Free State Heritage Resources Authority • Free State Provincial Shared Services Centre (PSSC) Offices • Lejweleputswa Development Agency • Lejweleputswa District Municipality • Matjhabeng Local Municipality • National Department of Agriculture, Land Reform and Rural Development (DALRRD)	• African Conservation Trust • African Carbon Energy • AfriForum • Agri Free State • Agri South Africa • Air Traffic and Navigation Services (ATNS) • Birdlife South Africa • Botanical Society • Centre for Environmental Rights • Conservation South Africa (CSA) • Council of Geoscience • Earth Life Africa • Endangered Wildlife Trust • Federation for a Sustainable Environment • FrackFree South Africa • Free State Wetland Forum • GroundWork SA • GUBICO • Harmony Gold • Hennenman Farming Forum • Lebone Solar Farm (PTY) LTD • Matjhabeng Ratepayers Association • Mining and Environmental Justice Community Network of South Africa (MEJCON-SA)

• National Department of Forestry, Fisheries and Environment (DFFE) • National Department of Transport • National Department of Water and Sanitation (DWS) • National Energy Regulator of South Africa (NERSA) • National House of Traditional Leaders • Petroleum Agency SA • PetroSA • Sedibeng Water • South African Civil Aviation Authority (SACAA) • South African Defence Force (SANDF) • South African Heritage Resources Agency (SAHRA) • South African National Biodiversity Institute • South African National Roads Agency Ltd (SANRAL) • South African Radio Astronomy Observatory • Telkom SA SOC LTD • Transnet SOC LTD • Vaal Central Water • Irene Lengau on behalf of Concerned Women • Affected Landowners • Mining Affected Communities United in Action (MACUA)	• Mulilo Renewable Project Developments (Pty) Ltd ○ Middlepunt Solar PV (Pty) Ltd; ○ Erfdeel BESS (Pty) Ltd; ○ Aluwani Solar PV (Pty) Ltd; ○ Litha Solar PV (Pty) Ltd; ○ Masana Solar PV (Pty) Ltd; ○ Meru Solar PV (Pty) Ltd; ○ Nepal Solar PV (Pty) Ltd; ○ Anker Solar PV (Pty) Ltd; and ○ Phemelo Solar PV (Pty) Ltd. • Natural Justice • Pelegreen Energy • RICHARD SUMMERS INC. • Savannah Environmental (PTY) LTD • Seritigreen • Tara Wildlife SA • Vaal Environmental Justice Alliance (VEJA) • Vrystaat Landbou/ Free State Agriculture • Warburtons Attorneys • Webber Wentzel • WESSA • WILD TRUST

6.3.3 PROJECT NOTIFICATION AND REQUEST FOR INITIAL COMMENTS

The PPP commenced on the 14th of March 2024 with an initial notification and call to register. The notification was given in the following manner:

6.3.3.1 REGISTERED LETTERS, FAXES AND EMAILS

Notification letters in English, Afrikaans and Sesotho, faxes, and emails were distributed to all pre-identified key I&APs including government organisations, NGOs, relevant municipalities, ward councillors, landowners and other organisations that might be affected. Background Information Document in English, Afrikaans and Sesotho was compiled and uploaded to the EIMS website.

The notification letters included the following information to I&APs:

- The purpose of the proposed project;
- High level list of anticipated activities to be authorised;
- Scale and extent of activities to be authorised;
- Information on the intended exploration activities to enable I&APs to assess/surmise what impact the activities will have on them or on the use of their land;
- Map showing affected properties;
- Summary of the relevant legislation pertaining to the application process;

- Initial registration period timeframes; and
- Contact details of the EAP.

6.3.3.2 NEWSPAPER ADVERTISEMENTS / GOVERNMENT GAZETTE

Advertisements describing the proposed project and EIA process were placed in the local newspaper with circulation in the vicinity of the study area. The initial advertisement was placed in the Vista Newspaper (in English, Afrikaans and Sesotho) on the 20th of March 2025. Gazette Notice was published in the National Gazette on the 11th of April 2025. The newspaper advert and the Gazette included the following information:

- Project name;
- Applicant name;
- Project location;
- Nature of the activity and application;
- Availability of Scoping Report; and
- Relevant EIMS contact person for the project.

6.3.3.3 SITE NOTICE PLACEMENT

A1 correx site notices in English, Afrikaans and Sesotho were placed at 99 locations within the local project area between the 17th and 20th of March 2025. Fifty (50) A1 correx board site notices were replaced with the revised version of the map (smaller footprint) at 50 locations within the proposed project study area The on-site notices included the following information:

- Project name;
- Applicant name;
- Project location;
- Map of proposed project area;
- Project description;
- Legislative requirements; and
- Relevant EIMS contact person for the project.

Proof of revised site notices have been provided in this EIA Report which has been made available to I&APs.

6.3.3.4 POSTER PLACEMENT

Eight (8) A3 posters in English, Afrikaans and Sesotho were placed at local public gathering places in Virginia, Welkom, Thabong, Bronville and Saaiplaas.

The notices and written notification afforded all pre-identified I&APs the opportunity to register for the project as well as to submit their comments of the Scoping Report and indicate the contact details of any other potential I&APs that they feel should be contacted. The contact person at EIMS, contact number, email and faxes were stated on the posters. Comments/concerns and queries were encouraged to be submitted in either of the following manners:

- Electronically (fax, email);
- Telephonically; and/or
- Written letters.

6.3.4 SCOPING PHASE PUBLIC PARTICIPATION

6.3.4.1 **PUBLIC REVIEW AND COMMENT OF SCOPING REPORT**

Notification regarding the availability of this Scoping Report for public review was given in one or more of the following manner to all registered I&APs (which includes key stakeholders and landowners):

- Facsimile notifications with information similar to that in the registered letter described above;
- Email notifications with a letter attachment containing the information;
- SMS notifications with the relevant information; and/or
- Registered letters (only where no other communication method could be established with the I&AP).

The scoping report was made available for public review and comment from the **15th of May 2025 to the 18th of June 2025** for a period of 30 days.

6.3.4.2 **SCOPING PHASE PUBLIC / FOCUS GROUP MEETING**

Notification regarding the scoping phase public meeting was given in the following manner to all registered I&APs (which includes key stakeholders and landowners):

- Email notifications with a letter attachment containing the information; and/or
- Facsimile notifications; and/or
- SMS notifications with the relevant information; and/or
- Registered letters (only where no other communication method could be established with the I&AP).

The Scoping Phase Public Meeting was held at Harmonie Primary School, 2 Vondeling Road, Glen Harmony Virginia, on the 28th of May 2025 from 16:00 to 18:00. All registered I&APs were notified of the public meeting during the notification of the availability of the Scoping Report for public review and comment on the 25th of May 2025. A reminder of the Public Meeting was sent to all registered I&APs on the 26th of May. All attendees were asked to sign the attendance register upon entering the facility and were encouraged to fill in the comment sheet or provide comments to the project email address should they have any comments/queries regarding the project. All attendees were informed that the presentation and meeting would be recorded to ensure an accurate record for the meeting minutes. EIMS facilitated a formal presentation, followed by a Question-and-Answer session where attendees could raise any questions, concerns, or comments about the project. Please refer to Appendix 5 for the notification letters and Appendix 6.1 for the Public Meeting Document of the Public Participation Report (**Appendix C**).

A Focus Group Meeting was scheduled with representatives from Harmony on the 6th of June 2025. The aim of the meeting was to engage Harmony representatives as part of the public participation process for the D3 Energy ER386 EIA. Specifically, the session aimed at discussing the Scoping Report, clarifying the project's consultation and Scoping Report commenting timelines, and addressing the need for land access to conduct baseline environmental studies. Please refer to Appendix 6.2 of the Public Participation Report (**Appendix C**) for the meeting minutes.

6.4 REVIEW AND DECISION OF THE SCOPING REPORT BY COMPETENT AUTHORITIES

It must be noted that PASA is the Administrative Authority (assessor) of the petroleum related applications but is not the decision maker. The Competent Authority for making the final decision is still the Department of Mineral and Petroleum Resources (DMPR), previously the Department of Mineral Resources and Energy (DMRE). Both PASA as the assessor and DMPR as the Competent Authority were provided with a copy of this Scoping Report for review and commenting as well as the application form. Comments received from PASA have been captured and responded to on the Table of Correspondence for the project which will be made available in the

EIA Phase. The authorities will also be afforded another opportunity to review and comment on the EIA Report during the EIA Phase.

DMPR as the competent Authority for the listed activity must, within 43 days of receipt of the Final Scoping Report that has been subjected to 30 days of public review as a Draft Report, accept the Final Scoping Report and Plan of Study for EIA in writing should no amendments be required, or shortcomings be identified therein. Upon acceptance of the Scoping Report, the Environmental Assessment Practitioner (EAP) may then proceed with the tasks contemplated in the Plan of Study for EIA.

The authority can also reject the Scoping Report for not following legislative procedure if any of the required steps were not undertaken. In terms of Regulation 22 (b) of Government Notice R. 982, the Scoping Report may be amended and resubmitted by the EAP should it be rejected. On receipt of the amended Scoping Report and Plan of Study for EIA, the Competent Authority will then reconsider the application. Should the Scoping Report be approved, the amended Scoping Report will then be made available for public review and comment prior to submission to the Competent Authority. The authority may also advise the EAP of matters that may hinder the success of the EIA application or matters that may prejudice the success of the application. **The Scoping Report and EIA Plan of study was accepted by the PASA on the 13th of August 2025**.

6.5 EIA PHASE PUBLIC PARTICIPATION

6.5.1 NOTIFICATION OF SUSPENSION OF APPLICATION AND PUBLIC PARTICIPATION PROCESS

On the 4th of December 2025, registered I&APs were notified that the EA Application (12/3/386) submitted by D3 Energy Pty Ltd to PASA on 15th May 2025 effectively lapsed on 1st December 2025. A Final Scoping Report which was subjected to the 30-day legislated public review and comment period was submitted to PASA for consideration on 30th June 2025 and accepted on 13th August 2025. According to NEMA EIA Regulation 23 (1), 2014 as amended, and as indicated in Scoping Acceptance Letter, an EIA Report which is required to be subjected to a minimum of 30-day legislated public review and comment period was required to be submitted to PASA within 106 days from date of Acceptance of the Scoping Report (i.e., by 1st December 2025). Due to delays in finalizing access agreements for specialist studies with one of the key landowners, the NEMA EIA Regulation 23 (1), 2014 as amended could not be met. As a result, the EA 12/3/386 Application lapsed and could not be considered further by the relevant authorities. Subsequently, all public participation processes and/or opportunities associated with the application were suspended until further notice.

6.5.2 NOTIFICATION OF THE INTENTION TO RESUBMIT D3 ENERGY ER386 EA APPLICATION

On the 13th of April 2026, registered I&APs were notified that the Applicant (D3 Energy) intends to resubmit an Amended EA Application for the same activities (seismics and drilling wells for all saleable gases including but not limited to Methane, Carbon Dioxide, Helium, and Nitrogen), within the same approximate 58 000ha footprint (Exploration Right 386). Registered I&APs were advised that although the application area remains the same footprint (i.e., 58 000ha), the revised exploration activities were reduced from 11 drilling wells and 16 seismic transects to 5 drilling wells and 9 seismic transects respectively.

Registered I&APs were also advised that in line with NEMA EIA Regulation 21 (2), 2014 as amended, once the Amended EA Application has been resubmitted, the legislated process will proceed into the EIA Phase. The Public Participation Process for the Application will therefore proceed into the EIA Phase. In addition, registered I&APs were advised that they will be notified accordingly of opportunities to participate in the application which will include public review and commenting period of the EIA Report as well as Public and Focus Group Meeting Opportunities.

6.5.3 PUBLIC REVIEW AND COMMENT OF EIA REPORT

Notification regarding the availability of this EIA Report for public review was given in the following manner to all registered I&APs (which includes key stakeholders and landowners) in line with the accepted plan study:

- Registered letters (only where no other communication method could be established with the I&AP) with details on where the EIA Report can be obtained and/or reviewed, public meeting date and time, EIMS contact details as well as the public review comment period; and/or
- Facsimile notifications with information described above; and/or
- Email notifications with a letter attachment containing the information described above.

The hardcopies of the report have been placed at Welkom Public Library (Corner Reinet & Tulbagh Str, Welkom), Virginia Public Library (Corner Civic Ave & Virginia Gardens, Virginia), and Phomolong Public Library (Phomolong, Hennenman) while a softcopy version has been placed on the EIMS website (https://www.eims.co.za/2025/05/14/1681-motuoane-er386-eia-2/). Comments / concerns should be submitted to EIMS the by no later than **13th July 2026**. The comments / concerns should be directed to EIMS at:

Contact Person: Mbali Tshabalala

EIMS Reference Number: 1681

Postal Address: P.O. Box 2083; Pinegowrie; 2123

Telephone: (011) 789 7170

Fax: (086) 571 9047

E-mail: motuoane386@eims.co.za

Comments raised during the EIA Report public review will be addressed in a transparent manner and will be included in the Final EIA Report to be submitted to both the Administrative and the Competent Authority.

6.5.4 EIA PHASE PUBLIC / FOCUS GROUP MEETINGS

Notification regarding the EIA phase public meeting was given in the following manner to all registered I&APs (which includes key stakeholders and landowners):

- Email notifications with a letter attachment containing the information; and/or
- Facsimile notifications; and/or
- SMS notifications with the relevant information; and/or
- Registered letters (only where no other communication method could be established with the I&AP).

The EIA Phase Public Meetings are scheduled as indicated in **Table 42**. **Any changes to the public meeting venue/s, date/s and/or time/s will be communicated to registered I&APs**.

Table 42: EIA Phase planned public meetings

No.	Venue	Date	Time
1	**Virginia / Meloding / Saaiplaas** **Meloding Multi-Purpose Centre** Meloding Zone 13, Virginia	25 June 2026	11H00 – 13H00
2	**Welkom / Thabong / Bronville / Hani Park / Riebeeckstad** **Thabong Methodist Church** 8159 Thelingoane Weg, Thabong	25 June 2026	15H00 – 17H00

No.	Venue	Date	Time
3	**Hennenman / Whites / Phomolong** Kheleng Secondary School 2051 First Street, Phomolong	26 June 2026	15H00 – 17H00
4	**Virtual Meeting / Focus Group** Motuoane ER386 EA 12/3/386 Public Meeting Meeting ID: 386 885 275 800 764 Passcode: Ag9WZ2jw	29 June 2026	13H00 – 15H00

All attendees will be asked to sign the attendance register upon entering the facility and will be encouraged to fill in the comment sheet or provide comments to the project email address should they have any comments/queries regarding the project. All attendees will be informed that the presentation and meeting would be recorded to ensure an accurate record for the meeting minutes. EIMS will facilitate a formal presentation, followed by a Question-and-Answer session where attendees may raise any questions, concerns, or comments about the project. All comments and responses will be formally recorded while the attendance registers and meeting minutes will also be attached to the Public Participation Report which will be provided to PASA as part of the Final EIA to review and decision.

It should be noted that a Focus Group Meeting and/or a virtual meeting may be scheduled if requested by I&APs. Similarly to the physical public meeting, should a Focus Group Meeting and/or virtual meeting be requested, all comments and responses will be formally recorded while the attendance registers and meeting minutes will also be attached to the Public Participation Report which will be provided to PASA as part of the Final EIA to review and decision.

6.6 UPDATED I&AP COMMENTS AND/OR CONCERNS

Issues raised have been addressed in a transparent manner and the full details (such as the comment received, the name of the I&AP who commented, the issue raised and the main aspect of the raised issue, as well as the response provided to the I&AP) included in the Public Participation Report (**Appendix C**). The Public Participation Report and the comments and responses have continuously been updated throughout the public participation phase as and when new comments were received. A summary of comments received is as follows:

- South African Heritage Resources Agency request for an application to made.
- AgriSA request to redirect the initial notification to the relevant person.
- I&APs requesting to register for the project.
- South African National Roads Agency (SANRAL) request to redirect the initial notification to the relevant region/department.
- I&APs requesting to register for the project.
- I&APs requesting to register for the project.
- Request for shapefiles, maps, and KMZ files for the proposed project.
- Transnet wayleave application outcome - Transnet Pipelines not affected by the proposed project.
- Request for information on the impact of the proposed project on specific farm portions.
- Goldfields Community Forum request to engage directly with D3 Energy Community Liaison Officer.

- Moolman, Nel & Pienaar request to be removed from the I&AP database.
- South African Civil Aviation Authority (SACAA) request to redirect the initial notification to the relevant region/department
- Objections submitted by Centre for Environmental Rights (CER), on behalf of Mining Affected Communities United in Action (MACUA), Mining and Environmental Justice Community Network of South Africa (MEJCON-SA), and Natural Justice. Here are the key points raised in the document:
    - CER noted that the Scoping Report makes premature claims that emissions will be minimal without properly quantifying greenhouse gas (GHG) emissions. They indicated that the Scoping Report lacks detailed methodologies and fails to assess the full climate impact, including Scope 3 emissions and tools.
    - The report overlooks many pollution sources (e.g. diesel engines, dust, flaring). No adequate baseline air monitoring exists, especially in nearby communities such as Welkom, making any air quality assessment incomplete and potentially misleading. CER indicated that the deterioration of air quality will have detrimental impacts on the health and wellbeing of affected communities and the nation at large.
    - CER highlighted that hydrogeological investigation and Groundwater Impact Assessment lacks site-specific data. It does not include adequate borehole testing, tracer analysis, or risk modelling for contamination, well failure, or groundwater drawdown—critical in a water-scarce country like South Africa.
    - CER pointed out that the rationale for gas exploration is weak. The report does not consider renewable energy alternatives or the long-term economic and environmental risks of fossil fuel dependence, which contradict global energy trends and climate goals.
    - CER commented that the public engagement process was flawed with limited access to information, inaccessible venues, low attendance, poor notification, and communication barriers (use of English only), all undermining meaningful community involvement.
    - The report only accounts for formal landowners and ignores people with informal/customary rights. This violates the Interim Protection of Informal Land Rights Act (IPILRA), which requires their consent before any development.
    - CER raised a concern about the exploration activities, that it may contaminate land and water, threatening agriculture and local food systems, particularly impacting small-scale and subsistence farmers who rely on the land for survival.
    - CER highlighted that, South Africa lacks capacity to enforce environmental compliance in the oil and gas sector, no dedicated inspectors (EMRIs) for oil and gas, and only one PASA office nationally, which undermines oversight.
    - The submission concludes that due to all the above issues, the environmental assessment and public participation process must be revisited and improved to meet legal and ethical standards.
- Wesboerdery (Pty) Ltd request for information with regards to proposed project and how their farms may be impacted.
- Webber Wentzel submission on behalf of Mulilo Renewable Project Developments (Pty) Ltd. Key points raised in the Webber Wentzel submission on behalf of Mulilo Renewable Project Developments (Pty) Ltd and its subsidiaries, objecting to EA application (ER386) due to direct overlaps with their already approved renewable energy projects, which include solar PV and battery storage facilities in the Free State. Here are the key points raised in the document:

- Webber Wentzel notes that Scoping Report (SR) lists the wrong Mulilo entity and omits several of its project companies as Interested & Affected Parties (I&APs). Mulilo requests corrections.
- Webber Wentzel notes that eight Mulilo renewable energy projects already have environmental approvals and grid infrastructure planned or under development in the exact same area covered by D3 Energy's application.
- Webber Wentzel highlighted that although the SR suggests coexistence is possible, D3 Energy has not engaged meaningfully with Mulilo. Early communication from D3 Energy indicated that coexistence may not be viable due to critical gas zones overlapping with Mulilo's project sites.
- The SR fails to assess the impact of D3 Energy's exploration on Mulilo's authorised projects and does not address climate impacts, ignoring legal precedent that such assessments are required.
- They commented that do not consider excluding overlapping areas or a proper "no-go" alternative. It also overstates the benefits of possible gas finds without comparing them to the real and immediate benefits of the renewable projects.
- Mulilo asks the authority to refuse the EA application outright. Alternatively, it asks that overlapping areas be excluded or that exploration only proceed with strict measures to protect its projects.

- The Department of Water and Sanitation (DWS) indicated that no exploration activities must be located within 100-meter distance from the edge of a water course or within 1:100 year flood-line of any watercourse and within 500m radius from the delineated boundary (extent) of any wetland unless a Water Use Authorisation is obtained from DWS before commencing with exploration activities.
- DWS request to be informed in the event of any leakages or spillages of hydrocarbons and immediate clean up must be conducted as stipulated in section 19 of National Water Act (Act 36 of 1998).
- DWS request D3 Energy to perform the responsibility of identifying any sources or potential sources of pollution and take the necessary measures to prevent any pollution of the environment.
- DWS request the applicant to ensure that all hazardous and domestic waste generated is disposed of at licensed landfill site.
- Landowners and Trusts with properties identified for the exploration phase expressed concern that the exploration area proposed by D3 Energy overlaps with the land designated for the solar project. They noted that that D3 Energy has not consulted them regarding the exploration application. The landowners and Trusts have taken a stance to either:
  - Object to the inclusion of their properties in the exploration application, or
  - Request proper consultation and negotiation of a co-existence agreement to ensure the solar project is not disrupted.
- Richards Summers Inc submission on behalf of:
  - Red Rocket Energy (Pty) Ltd
  - Piscis Energy (Pty) Ltd;
  - Lupus Energy (Pty) Ltd;
  - URSA Energy (RF) (Pty) Ltd;
  - Norma Energy (Pty) Ltd;
  - Fornax Energy (Pty) Ltd;

- Volans Energy (Pty) Ltd; and
- K2022579146 (South Africa) (Pty) Ltd.
- Key points raised in the Richards Summers submission:
  - The multiple energy companies requested to be registered as I&APs in the EIA processes.
  - Request for essential information including ER315 EA (12/3/315), EA12/3/315 Amended EA, locations of proposed boreholes, and a copy of the appeal against EA12/3/315 (appeal has since been dismissed by the Minister).
  - Concern over overlapping land use and competing developments which may affect the renewable energy developer's rights and interests.
  - Inability to assess environmental and operational risks due to missing information (requested information has since been provided).

- Requirements for the EIA as part of the Scoping Report acceptance by PASA:
  - In undertaking the EIA process, the EAP is required to consider the following:
    - Adequate public meetings and stakeholder engagements must be scheduled to ensure that interested and affected parties (I&APs) are given a fair and reasonable opportunity to participate or be represented. The EAP must provide I&APs with timely and sufficient notice of all scheduled meeting date(s) and ensure that the meeting times are convenient and accessible, without prejudicing or disadvantaging any stakeholders who wish to be involved.
    - Planned focus group meetings must be extended to the affected stakeholders such as renewable energy companies, property-owning trusts (e.g., SGB Boerdery Trust) and non-governmental and community-based organisations (e.g., the Centre for Environmental Rights and Natural Justice).
    - Direct engagement with affected renewable energy companies is essential to understand the potential interactions and impacts between ongoing/proposed renewable energy operations and the proposed exploration project. These engagements will inform a robust environmental impact assessment, including cumulative impact assessment and the development of mitigation measures.
    - All objections, comments and concerns must be thoroughly considered and appropriately addressed as part of the EIA process.
    - All potential impacts associated with vibration-related activities such as those resulting from the use of vibroseis technique must be comprehensively identified and assessed during the EIA process. This includes, but is not limited to:

      (a) detailed evaluation of noise and ground vibration effects on fauna;

      (b) assessment of habitat disturbance and potential ecological displacement;

      (c) Assessment of risks of soil compaction and erosion;

      (d) consideration of socio-economic implications for the surrounding communities.

All comments that have been received throughout the application process have been captured and responded to through a Table of Correspondence that is included in **Appendix C**. All I&APs registered on the Project database were informed of the availability of the Scoping Report for public review. I&APs have been provided with another opportunity to submit their comments during the public review and comment of this EIA Report. Refer to see **Appendix C** for all Public Participation related documents.

6.7 REVIEW AND DECISION OF THE EIA REPORT BY COMPETENT AUTHORITIES

In line with Regulation 24 of the NEMA EIA Regulations, 2014 as amended, the DMPR as the competent Authority for the listed activity:

1. must within 107 days of receipt of the environmental impact assessment report and EMPr, in writing, -
    a. grant environmental authorisation in respect of all or part of the activity applied for; or
    b. refuse environmental authorisation.
2. to the extent that authorisation is granted for an alternative, such alternative must for the purposes of sub-regulation (1) be regarded as having been applied for, consulted on and its impacts investigated

6.8 APPEAL PERIOD

After a decision has been reached by DMPR, Chapter 2 of the National Appeal Regulations 2025 makes provision for any affected person to appeal against the decision. Within 20 calendar days from the date that the decision is sent by the decision-maker, or, where applicable, by the applicant to registered interested and affected parties; or within 30 calendar days from the date that the decision is received, where the appeal is submitted in terms of section 43(8) of the Act, the appellant must submit the appeal to the appeal administrator. The applicant, where applicable, the decision-maker and any other person contemplated in regulation 4 of the National Appeal Regulations may, within 20 calendar days from the date of receipt of the appeal, submit, in the form obtainable from the website of the relevant appeal authority a statement responding to an appeal, to the appeal administrator and to the appellant. The appeal administrator may request additional information from any person or affected organ of state for purposes of the appeal. An appeal panel may be appointed at the discretion of the delegated or organ of state to handle the case and it would then submit its recommendations to that organ of state for a final decision on the appeal to be reached. The appeal authority must decide an appeal, and notify the appellant, applicant, and, where applicable, any registered interested and affected party and affected organs of state of the decision within 50 calendar days of the expiry of the time period in regulation 5 of the National Appeals Regulations.

EIMS will communicate the decision of the Competent Authority and the way appeals should be submitted to the Minister and to all I&APs as soon as reasonably possible after the final decision has been received.

7 ENVIRONMENTAL IMPACT ASSESSMENT

This section aims to identify and do a preliminary assessment on the potential environmental impacts associated with the proposed D3 Energy ER386. This impact assessment will be used to guide the identification and selection of preferred alternatives, and management and mitigation measures, applicable to the proposed activities.

7.1 IMPACT ASSESSMENT METHODOLOGY

The impact significance rating methodology, as presented herein and utilised for all EIMS Impact Assessment Projects, is guided by the requirements of the NEMA EIA Regulations 2014 (as amended). The approach may be altered or substituted on a case by case basis if the specific aspect being assessed requires such- such instances require prior EIMS Project Manager approval. The broad approach to the significance rating methodology is to determine the significance (S) of an environmental risk or impact by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relating this to the probability/ likelihood (P) of the impact occurring. The S is determined for the pre- and post-mitigation scenario. In addition, other factors, including cumulative impacts and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the S to determine the overall final significance rating (FS). The impact assessment will be applied to all identified alternatives.

7.1.1 DETERMINATION OF SIGNIFICANCE

The final significance (FS) of an impact or risk is determined by applying a prioritisation factor (PF) to the post-mitigation environmental significance. The significance is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and Reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$\boldsymbol{C = \frac{(E + D + M + R) * N}{4}}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in **Table 43** below.

Table 43: Criteria for Determining Impact Consequence.

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. Highly localised, limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property or site boundary, or the area within a few hundred meters of the site)
	3	Local (i.e. beyond the site boundary within the Local administrative boundary (e.g. Local Municipality) or within consistent local geographical features, or the area within 5 km of the site)
	4	Regional (i.e. Far beyond the site boundary, beyond the Local administrative boundaries within the Regional administrative boundaries (e.g. District Municipality), or extends into different distinct geographical features, or extends between 5 and 50 km from the site).
	5	Provincial / National / International (i.e. extends into numerous distinct geographical features, or extends beyond 50 km from the site).

Aspect	Score	Definition
Duration	1	Immediate (<1 year, quickly reversible)
	2	Short term (1-5 years, less than project lifespan)
	3	Medium term (6-15 years)
	4	Long term (15-65 years, the impact will cease after the operational life span of the project)
	5	Permanent (>65 years, no mitigation measure of natural process will reduce the impact after construction/ operation/ decommissioning).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected)
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected, or affected environmental components are already degraded)
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; moderate improvement for +ve impacts; or where change affects area of potential conservation or other value, or use of resources).
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease; high improvement for +ve impacts; or where change affects high conservation value areas or species of conservation concern)
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease, substantial improvement for +ve impacts; or disturbance to pristine areas of critical conservation value or critically endangered species)
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring very high time and cost.
	5	Irreversible Impact.

Once the C has been determined, the significance is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/ scored as per **Table 44**.

It is noted that both environmental risks as well as environmental impacts should be identified and assessed. Environmental Risk can be regarded as the potential for something harmful to happen to the environment, and in many instances is not regarded as something that is expected to occur during normal operations or events (e.g. unplanned fuel or oil spills at a construction site). Probability and likelihood are key determinants or variables of environmental risk. Environmental Impact can be regarded as the actual effect or change that happens to the environment because of an activity and is typically an effect that is expected from normal operations or events (e.g. vegetation clearance from site development results in loss of species of concern). Typically, the probability of an unmitigated environmental impact is regarded as highly likely or certain (management and mitigation measures would ideally aim to reduce this likelihood where possible). In summary, environmental risk is about what could happen, while environmental impact is about what does happen.

Table 44: Probability/ Likelihood Scoring

Probability	1	**Improbable (Rare, the event may occur only in exceptional circumstances, the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <5% chance).**
	2	Low probability (Unlikely, impact could occur but not realistically expected; >5% and <20% chance).
	3	Medium probability (Possible, the impact may occur; >20% and <50% chance).
	4	High probability (Likely, it is most probable that the impact will occur- > 50 and <90% chance).
	5	Definite (Almost certain, the impact is expected to, or will, occur, >90% chance).

The result is a qualitative representation of relative significance associated with the impact. Significance is therefore calculated as follows:

$$S = C \, x \, P$$

Table 45: Determination of Significance

Consequence	5- Very High[12]	5	10	15	20	25
	4- High	4	8	12	16	20
	3- Medium	3	6	9	12	15
	2- Low	2	4	6	8	10
	1- Very low	1	2	3	4	5
		1- Improbable	2- Low	3- Medium/ Possible	4- High/ Probable	5- Highly likely/ Definite
	Probability					

The outcome of the significance assessment will result in a range of scores, ranging from 1 through to 25. These significance scores are then grouped into respective classes as described in **Table 46**.

Table 46: Significance Scores

S Score	Description
≤4.25	Low (i.e. where this impact is unlikely to be a significant environmental risk/ reward).
>4,25, ≤8.5	Low-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>8.5, ≤13.75	High-Medium (i.e. where the impact could have a significant environmental risk/ reward).
>13.75	High (i.e. where the impact will have a significant environmental risk/ reward).

The impact significance will be determined for each impact without relevant management and mitigation measures (pre-mitigation significance), as well as post implementation of relevant management and mitigation

[12] In the event that an impact or risk has very high or catastrophic consequences, but the likelihood/ probability is low, then the resultant significance would be Low-medium. This does in certain instances detract from the relative important of this impact or risk and must consequently be flagged for further specific consideration, management, mitigation, or contingency planning.

measures (post-mitigation significance). This allows for a prediction in the degree to which the impact can be managed/mitigated.

7.1.2 IMPACT PRIORITIZATION

Further to the assessment criteria presented in the section above, it is necessary to consider each potentially significant impact in terms of:

1. Cumulative impacts; and

2. The degree to which the impact may cause irreplaceable loss of resources.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impacts' post-mitigation significance (post-mitigation). This prioritisation factor does not aim to detract from the significance ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the post-mitigation significance based on the assumption that relevant suggested management/mitigation impacts are implemented.

Table 47: Criteria for Determining Prioritisation

Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/ definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable Loss of Resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in **Table 48**. The impact priority is therefore determined as follows:

$$\boldsymbol{Priority = CI + LR}$$

The result is a priority score which ranges from 2 to 6 and a consequent PF ranging from 1 to 1.5 (Refer to **Table 48**).

Table 48: Determination of Prioritisation Factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25

Priority	Prioritisation Factor
5	1.375
6	1.5

In order to determine the final impact significance (FS), the PF is multiplied by the post-mitigation significance scoring. The ultimate aim of the PF is an attempt to increase the post mitigation environmental risk rating by a factor of 0.5, if all the priority attributes are high (i.e. if an impact comes out with a high medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a higher significance).

Table 49: Final Environmental Significance Rating

Significance Rating	Description
<-25	**Very High (Impacts in this class are extremely significant and pose a very high environmental risk. In certain instances these may represent a fatal flaw. They are likely to have a major influence on the decision and may be difficult or impossible to mitigate. Offset's may be necessary.**
<-13.75 to -25	High negative (These impacts are significant and must be carefully considered in the decision-making process. They have a high environmental risk or impact and require extensive mitigation measures).
-8.5 to -13.75	Medium-High negative (i.e. Impacts in this class are more substantial and could have a significant environmental risk. They may influence the decision to develop in the area and require more robust mitigation measures).
<-4.25 to <-8.5	Medium- Low negative (i.e. These impacts are slightly more significant than low impacts but still do not pose a major environmental risk. They might require some mitigation measures but are generally manageable).
-1 to -4.25	Low negative (i.e. Impacts in this class are minor and unlikely to have a significant environmental risk. They do not influence the decision to develop in the area and are typically easily mitigated.
0	No impact
1 to 4.25	Low positive
>4.25 to <8.5	Medium-Low positive
8.5 to 13.75	Medium-High positive
>13.75	High positive

The significance ratings and additional considerations applied to each impact will be used to provide a quantitative comparative assessment of the alternatives being considered. In addition, professional expertise and opinion of the specialists and the environmental consultants will be applied to provide a qualitative comparison of the alternatives under consideration. This process will identify the best alternative for the proposed project.

7.2 IMPACTS IDENTIFIED

This Section presents the potential impacts that have been identified during the EIA. It should be noted that the Scoping Report was made available to I&AP's for review and comment and their comments and concerns were addressed in the final Scoping report submitted to the CA for adjudication. The results of the public consultation was used to update the identified potential impacts during this EIA Phase. It should be further noted that this EIA Report has been made available to I&APs for review and comments, all comments and/or recommendations to assess other potential impacts not currently identified by the EAP and specialists will be considered by the EAP and specialists for the Final EIA Report to be submitted to the Competent Authority.

Table 50 provides the list of potential impacts identified while **Table 51** provides the type of impact and the anticipated phase of the impact. Without proper mitigation measures and continual environmental management, most of the identified impacts may potentially become cumulative, affecting areas outside of their originally identified zone of impact. The potential cumulative impacts have been identified, evaluated, and mitigation measures suggested.

Without proper mitigation measures and continual environmental management, most of the identified impacts may potentially become cumulative, affecting areas outside of their originally identified zone of impact. The potential cumulative impacts have been identified, evaluated, and mitigation measures suggested.

When considering cumulative impacts, it is important to bear in mind the scale at which different impacts occur. There is potential for a cumulative effect at a broad scale, such as regional deterioration of air quality, as well as finer scale effects occurring in the area surrounding the activity. The main impacts which have a cumulative effect on a regional scale are related to the transportation vectors that they act upon. For example, air movement patterns result in localised air quality impacts having a cumulative effect on air quality in the region. Similarly, water acts as a vector for distribution of impacts such as contamination across a much wider area than the localised extent of the impacts source. At a finer scale, there are also impacts that have the potential to result in a cumulative effect, although due to the smaller scale at which these operate, the significance of the cumulative impact is lower in the broader context.

Table 50: Identified environmental impacts.

Main Activity / Action / Process	Ancillary Activity	Geo-physical (geology, topography, air, water)	Biological	Socio-economic	Heritage and cultural
Site preparation (Planning: pre-construction)	Removing vegetation, trees, and shrubs to create a clear drilling / exploration area Ensuring access to power and water sources if needed Installing warning signs and fencing to protect the area and prevent unauthorized access		○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Loss of floral species. ○ Displacement of faunal species	○ Visual impact and impact on sense of place ○ Perceptions and expectations Employment opportunities	○ Disturbance of archaeological sites or historic structures (if any)
Human resources management (Planning: pre-construction	Employment/recruitment I&AP consultations Integration with Municipalities' strategic long-term planning Comprehensive safety and environmental awareness training for all personnel Developing emergency plans to address potential accidents or incidents, such as drilling equipment failures or spills Establishing and maintaining effective communication/grievance systems between the exploration crew, landowners and community members			○ Employment opportunities. ○ Improving the knowledge of local team through training and awareness.	
Earthworks (Construction)	Stripping and stockpiling of soils Levelling, grubbing and bulldozing Removing vegetation, trees, and shrubs to create a clear drilling / exploration area Preparing trenches and foundations Establishment of drilling pads to provide a stable base for the drill rig Constructing or improving roads to allow for the transportation of	○ Erosion due to storm water runoff ○ Impact due to topsoil stripping ○ Surface water contamination ○ Loss of fertility ○ Loss of flow paths ○ Emissions and dust ○ Impacts on wetlands	○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Nuisance and impacts on game farming ○ Displacement of faunal species	○ Visual impact and impact on sense of place ○ Nuisance and impact on sense of place (i.e., noise, dust, etc.). ○ Safety and security (i.e., access to properties, theft, fire hazards, etc.). ○ Impact on existing infrastructure (i.e., roads, fences, etc.) ○ Perceptions and expectations	○ Disturbance/ destruction of archaeological sites or historic structures ○ Disturbance/ destruction of fossils

Main Activity / Action / Process	Ancillary Activity	Geo-physical (geology, topography, air, water)	Biological	Socio-economic	Heritage and cultural
	equipment and personnel to the drilling site			○ Employment opportunities	
	Setting up site camps for drilling and seismic team and vehicles				
	Setting up systems for managing drilling fluids, which may include containment sumps				
Exploration (Construction)	Drilling and seismic surveys	○ Erosion due to storm water runoff ○ Impact due to topsoil stripping ○ Surface water contamination (contaminant transport); ○ Surface water, quantity (baseflow contributions) ○ Groundwater contamination, ○ Loss of fertility ○ Loss of flow paths ○ Emissions and dust ○ Impacts on wetlands	○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Displacement of faunal species ○ Nuisance and impacts on game farming	○ Visual impact and impact on sense of place ○ Nuisance and impact on sense of place (i.e., noise, dust, etc.). ○ Safety and security (i.e., access to properties, theft, fire hazards, etc.). ○ Impact on existing infrastructure (i.e., roads, fences, etc.) ○ Perceptions and expectations of employment opportunities	○ Disturbance/ destruction of archaeological sites or historic structures ○ Disturbance/ destruction of fossils
	Collecting, storing, and transporting drill core samples				
	Collecting, storing, and disposing of drilling waste, including cuttings, fluids, and debris				
	Surface and groundwater water management				
Post Construction Rehabilitation (Decommissioning of drilling and seismic surveys)	Revegetation	○ Emissions and dust	○ Alien and invasive species	○ Safety and security (i.e., access to properties, theft, fire hazards, etc.). ○ Perceptions and expectations ○ Visual and dust	
	Soil / slope stabilisation				
	Backfilling (if necessary)				
	Erosion control				
Gas Analysis and Maintenance (Post construction)	Continuous analysis of gas quantity and quality	○ Surface and groundwater quality ○ Accidental damage of blower resulting in air quality & climate change impacts	○ Alien and invasive species	○ Visual ○ Site security and access control	
	Initiate maintenance and aftercare program				
	Environmental aspect monitoring				
Final Rehabilitation, Decommissioning and Closure	Plugging of boreholes	○ Emissions and dust	○ Alien and invasive species		
	Revegetation				
	Soil / slope stabilisation				

Main Activity / Action / Process	Ancillary Activity	Geo-physical (geology, topography, air, water)	Biological	Socio-economic	Heritage and cultural
	Backfilling (if necessary) Erosion control			○ Safety and security (i.e., access to properties, theft, fire hazards, etc.). ○ Perceptions and expectations ○ Visual and dust	
Monitoring, Maintenance and Relinquishment	Groundwater monitoring Floral monitoring Gas emissions monitoring	○ Emissions ○ Emissions and dust	○ Alien and invasive species	○ Safety and security (i.e., access to properties, theft, fire hazards, etc.) ○ Perceptions and expectations	

Table 51: Impact identification matrix

Phase	Activity	Environmental Component (- = negative impact; + = positive impact)													
		Air Quality (AQ)	Geology (G)	Hydrology (H)	Groundwater (GW)	Surface water/ wetlands (W)	Noise (N)	Soils (S)	Visual / Landscape (V)	Flora (FL)	Fauna (FA)	Health and safety (H&S)	Socio-economic (SE)	Palaeontology (P)	Cultural Heritage (C)
Construction	Site establishment	-			-	-	-	-	-	-	-		+	-	-
	Establishment of necessary infrastructure	-	-	-	-	-	-	-	-	-	-			-	-
Operation	Exploration drilling	-		-	-		-		-			-	-		
	Seismic Surveys	-		-	-		-		-			-	-		
	Maintenance and management of infrastructure				-	-		-		-	-				
	Clean and Dirty water management			-	-	-		-				+	+		
Closure and Rehabilitation	Revegetation	+				+		+	+	+	+	+	+		
	Erosion control			+	+	+		+		+	+	+	+		
Post Closure	Initiate maintenance and monitoring programmes				+	+		+		+	+	+	-		
	Environmental aspect monitoring and remediation	+		+	+	+		+	+	+	+	+	-		

7.3 DESCRIPTION AND ASSESSMENT OF POTENTIAL IMPACTS

The potential impacts were identified during the assessment and were assessed in terms of nature, significance, consequence, extent, duration and probability. Mitigation / management measures to minimise potential negative impacts or enhance potential benefits are put forward in this EIA Report. Refer to **Appendix G** for the detailed impact assessment matrix.

7.3.1 INTERFERENCE WITH EXISTING LAND USES / ACTIVITIES

This section presents the identified potential impacts on existing land uses / activities as per site sensitivity verification undertaken by the EAP and various specialist studies.

7.3.1.1 DESCRIPTION OF IMPACT

As indicated in **Section 4.1,** the study area can be subdivided into four sections namely, the northern section, southern section, western section, and the eastern section (refer to **Figure 1** for the site locality). The northern section consists almost entirely of cultivated land with several natural and artificial watercourses. The eastern is primarily dominated by cultivated land, open areas and minor game farms. There are distinctive watercourses within this area including the Kromspruit which is immediately to the north of the sole proposed drilling site, Target Area 9 (HF C) 500m assessment area within this section. The tip of the southern section is approximately 8.5km south of southern Virginia (Meloding) while the two target areas, Target Area 1 (RSB D) and Target Area 2 (RSB E) are approximately 7km east of southern Virginia. Similarly to the northern and eastern sections, the southern section is primarily dominated by cultivated land, open areas and minor game farms, several natural and artificial watercourses. Although there are two target areas within this section, two of the three seismic transects intersect the Sandrivier. There is also a canal that separated the two target areas. The western section is the section where majority of the exploration activities were previously proposed but have since been removed from the current application. This section is within a mining area and adjacent to mining towns. The edges of the residential areas of Saaiplaas, Bronville and Thabong form part of the eastern boundary of this section and ER386. Although this section also consists largely of cultivated land, open areas and minor game farms, several natural and artificial watercourses, it is the most transformed section within the ER comprising of mining activities, residential areas, road and electrical infrastructure. This section also comprises of several farms earmarked for renewable energy developments.

Existing land uses may be affected by the proposed drilling and seismic activities through movement of machinery and vehicles, clearance of vegetation for drilling pads and site establishment. The drill rig and supporting machinery may require new access roads and the establishment of drilling pads within largely farming areas which may cause an interference with the existing land uses. In addition, although exploration drilling plays a crucial role in the mining industry as it helps identify and assess potential mineral deposits. However, it can also come with its own set of challenges on existing mining operations. The drilling activity can penetrate a mine shaft destabilizing the shaft and/or affect mining operations. The impact ratings associated with the proposed drilling activities related to interference with existing land uses are indicated in **Table 52**.

The vibroseis truck may need access across boundary fences used for grazing or game which may be affected if access gates are left open. The seismic transects may also overlap with farming grounds which may result in temporary loss and/impact on agricultural fields and production. The impact ratings associated with the proposed seismic activities related to interference with existing land uses are indicated in **Table 52**.

7.3.1.2 IMPACT RATING

Table 52: Summary of impacts related to interference with existing land uses.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics and Drilling)	Negative	Medium to Low	Low	Low

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Construction / Exploration **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low
Decommissioning / Rehabilitation **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low

7.3.1.3 CUMULATIVE IMPACT

The proposed activities are not intensive in nature and do not require a large footprint and are of short duration. The seismic surveys are expected to last for a couple of weeks and the drilling activities to be completed within months, therefore the period of activities is also reduced. It must also be noted that in the event that a vibroseis truck is used, it will be equipped with very wide, low-pressure tires and will not leave ruts. There is also a chance of using an alternative method of a portable weight drop method, which is much smaller than the vibroseis truck and has lesser impacts. In addition, the activities are largely located on low-laying grassland. Although there were no identified surface mining activities or evidence of underground mining in the study area, it does not indicate the lack of active unground mining. However, it is unlikely that the drilling activities will intercept a mine shaft and therefore pose low risks to mining activities. Therefore, the cumulative impact of proposed activities on existing land uses is low

7.3.1.4 PROPOSED MITIGATIONS

The proposed mitigation measures to avoid adverse impacts on existing land uses due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix H**):

- Prior to accessing any portion of land, the Applicant must enter into formal written agreements with the affected landowner. This formal agreement should additionally stipulate landowners special conditions which would form a binding agreement.
- Landowners must be notified beforehand of the activities to be undertaken on their properties and requested to indicate the type and location of services within their properties.
- There must be a formal procedure in place on how to report incidents to ensure records of all grievances are kept, and responses are given within a certain time.
- Before the project commences, an asset and services baseline of services that may be affected within 50 m of the activities must be compiled. A copy of the baseline records should be given to each landowner/ service provider, and a master document kept by the applicant.
- Underground mining companies (if any) within the identified drilling locations must be engaged during the planning phase to ensure the drilling activities do not interfere with underground mining activities.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- None.

7.3.2 IMPACT ON EXISTING SERVICES / INFRASTRUCTURE

This section presents the identified potential impacts on existing services and/or infrastructure as per site sensitivity verification undertaken by the EAP and various specialist studies.

7.3.2.1 DESCRIPTION OF IMPACT

As indicated in **Section 4.1**, some of the infrastructure within the ER include surfaced and gravel roads. The conditions of the roads vary from good, maintained roads to roads which have been severely deteriorated roads in poor condition. There are railway lines within the ER which appear to be still operational in the western section. Eskom infrastructure including high voltage powerlines were also noted in the western section of the ER.

Drilling operations have the potential to disrupt or damage services such as water supply or sewage collection pipes if not situated correctly within the study area. Activities associated with drilling may also impact on existing infrastructure such as increased traffic on the adjacent road network, damage to fences and other local infrastructure from the drilling machinery and movement from one drill site to the other. The impact ratings associated with the proposed drilling activities related to existing services and/or infrastructure are indicated in **Table 53**.

Activities associated with seismic survey may also impact on existing infrastructure such as increased traffic on the adjacent road network, damage to fences and other local infrastructure from the surveying machinery and movement from one transect site to the other. The impact ratings associated with the proposed seismic survey activities related to existing services and/or infrastructure are indicated in **Table 53**

7.3.2.2 IMPACT RATING

Table 53: Summary of impacts related to existing services and/or infrastructure.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low
Construction / Exploration **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low
Decommissioning / Rehabilitation **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low

7.3.2.3 CUMULATIVE IMPACT

The study area is generally a rural area in nature with minimal existing services and infrastructure noted during the site visit. The properties are fenced using galvanized wire with a few farmhouses forming part of the buildings in the area. Boreholes were noted to be the main potable water source while there were noticeable high voltage and low voltage Eskom powerlines proving electricity as some of the observed services and infrastructure. There is overall low presence of infrastructure and services in the area and the proposed activities are less likely to impact on the services and infrastructure provided mitigation measures are implemented.

7.3.2.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on existing services / infrastructure due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix H**):

- If any damage occurs to services / infrastructure, the applicant will be liable to fix it to its original state.
- The Developer shall inform all landowners of the commencement of construction activities at least 30 days before commencement. Landowners must be requested to indicate the type and location of services within their properties.

- Before the project commences, an asset and services baseline of services that may be affected within 10m of the centreline of the seismic transect and 10m from the edge of drilling point must be compiled. A copy of the baseline records should be given to each landowner/ service provider, and a master document kept by the applicant.
- A services impact and interruption plan must be developed for sites which intersect existing services in order to minimise and manage potential interruptions should they occur due to an incident. Notice of planned service interruptions (if any) must be given at least 2 days before the interruption takes place and must be as short as reasonably possible – an SMS or e-mail system can be used for this purpose

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- None.

7.3.3 IMPACTS ON TEMPORARY DISPLACEMENT OF LANDOWNERS AND LIVESTOCK

This section presents the identified potential impacts on temporary displacement of landowner and/or livestock as per site sensitivity verification undertaken by the EAP and various specialist studies.

7.3.3.1 DESCRIPTION OF IMPACT

As indicated in **Section 4.1**, grazing activities were noted within the western section while the central area of the ER consists of low-lying grass within thick vegetation (further north) and some of the game within the area. Whereas the eastern section consists primarily of agricultural and grazing activities. Small dairy farming activities were noted close to Target Area 9 (HF C). Furthermore, the main land use of the northern section is cultivated land and grazing.

The proposed activities are located across various farms owned by different landowners. There may be a need to temporary displace the current landowners and/or their livestock so that the proposed drilling activities may be undertaken. The impact ratings associated with the proposed drilling activities related to landownership and displacement of livestock are indicated in **Table 54**.

The proposed activities are located across various farms owned by different landowners. There may be a need to temporary displace the current landowners and/or their livestock so that the proposed seismic activities may be undertaken. The impact ratings associated with the proposed seismic activities related to landownership and displacement of livestock are indicated in **Table 54**.

7.3.3.2 IMPACT RATING

Table 54: Summary of impacts related to landownership and displacement of livestock.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low
Construction / Exploration **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low
Decommissioning / Rehabilitation **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low

7.3.3.3 CUMULATIVE IMPACT

The temporary displacement of the current landowners and/or their livestock so that the proposed exploration activities may be undertaken would result in more agricultural land lost and reduce the livestock and the farming community's enablement to sustain themselves. However, at present this impact is not anticipated and is considered improbable. Negotiations with affected landowners have previously been undertaken and are currently ongoing with the current authorised exploration activities and these will continue for the amendment activities. Therefore, this impact is considered low negative overall.

7.3.3.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on landownership and displacement of livestock due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix H**):

- Ensure that all affected landowners are identified, and relevant information is provided to the landowners during the application phase.
- Prior to accessing any portion of land, the Applicant must enter into formal written agreements with the affected landowner. This formal agreement should additionally stipulate landowner's special conditions which would form a legally binding agreement.
- Negotiations with affected landowners must be undertaken and any loss of revenue caused by the exploration works must be reasonably compensated.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- None

7.3.4 NUISANCE AND IMPACT ON SENSE OF PLACE

This section presents the identified potential impacts on nuisance and sense of place as per site sensitivity verification undertaken by the EAP and various specialist studies.

7.3.4.1 DESCRIPTION OF IMPACT

As indicated in **Section 4.1**, the ER consists of various land uses consisting of residential, businesses, industrial, mining, agriculture, etc. The proposed drilling activities will impact on the established sense of place of a particular property. The character of the area would change due to the drilling activities being undertaken on that particular place. Additional vehicles, increased noise and dust, the removal of vegetation for drilling well site/s, and potential influx of workers will all contribute to the alteration of the sense of place. The impact ratings associated with the proposed drilling activities related to nuisance on sense of place are indicated in **Table 55**.

The proposed seismic activities will impact on the established sense of place of a particular property. The character of the area would change due to the seismic activities being undertaken on that particular place. Additional vehicles including vibroseis truck, increased noise and dust, the potential removal of vegetation along the seismic transect, and potential influx of workers will all contribute to the alteration of the sense of place. The impact ratings associated with the proposed seismic survey activities related to nuisance on sense of place are indicated in **Table 55**.

7.3.4.2 IMPACT RATING

Table 55: Summary of impacts related to nuisance on sense of place.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics and Drilling)	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics and Drilling)	Negative	Medium to Low	Low	Low

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Decommissioning / Rehabilitation **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low

7.3.4.3 CUMULATIVE IMPACT

The study area is generally a rural area in nature. It can be described as an open swath of land that has few homes or other buildings, and not very many people with very low population density. The area consists of minimal activities that are nuisance and have an impact on sense place. With the proposed exploration activities, minimal changes to the current sense of place is anticipated and low cumulative impact is expected.

7.3.4.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on sense of place due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix H**):

- Rehabilitation of the disturbed areas must be made a priority. Any disturbed area must be re-habilitated to its pre-disturbed state. Any disturbed area must be re-habilitated to its pre-disturbed state as defined in the pre-drill survey. Disturbed areas must be rehabilitated to support its post-closure land use, and this must be undertaken within six (6) months post drilling activities.
- All construction/operational and access must make use of the existing roads.
- Noise producing activities should be limited to daytime after 07h00 and 17h00 on weekdays.
- Adequate dust suppression measures should be utilized to minimize dust production.
- The duration of the construction should be minimized to as short term as possible, to reduce the period of disturbance on the area.
- Areas outside the direct project footprint, should under no circumstances be disturbed.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- All residents within 2 km of drilling activities and 1 km of seismic surveys should be informed regarding the exploration activities. Scheduling of activities should be communicated and coordinated with adjacent residents (where applicable).
- Signage indicating the channels for logging grievances should be posted at the closest public road boundary and at the site entrance.
- A noise complaints register must be kept. If complaints are received, noise sampling should be undertaken at the NSRs and source of noise should be investigated. Channels for logging of complaints should be communicated to all residents within 2 km of the drilling site and 1km of the seismic transects.
- Should noise become a nuisance (complaints), adequate / viable noise suppression measures must be implemented.
- All equipment should be kept in line with manufacturers specifications. This should particularly include the regular inspection and, if necessary, replacement of rotary equipment. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.

7.3.5 NOISE IMPACTS

This section presents the identified potential noise impacts as per the Noise Impact Assessment undertaken by Airshed Planning Professionals (**Appendix F**).

7.3.5.1 DESCRIPTION OF IMPACT

In terms of noise generating sources that form part of the exploration activities, the main sources will include drill rigs, seismic vibrators, trucks for equipment transport, vibroseis trucks, recording trucks and light vehicles. Sound power levels for all equipment were calculated using the Sound Power Level Predictions for Industrial Machinery as given in the Handbook of Acoustics (Crocker et al, 1998).

Because of very low baseline noise levels in the study area, exploration activities, particularly drilling activities, could be audible up to 5 km away from operational areas, while vehicle movements and seismic surveys could be audible up to 2.5 km away from the seismic transects (Figure 94). Based on noise attenuation modelling results, noise levels could be disturbing (>7 dBA increase from baseline) to residents up to 2 km from drilling activities and 1 km from seismic surveys.

Drilling and other exploration activities could be disturbing (albeit for relatively short periods) to the residents of the homesteads in or near the target areas, especially at:

- The homesteads just to the northeast of the Target Area 11- GP A 500 m buffer (NSRs A & B in **Table 56** and **Figure 107**);
- The homesteads to the northeast of Target Area 10- GP B (NSR E in **Table 56** and **Figure 107**);
- The homesteads to the west (~300 m) of Seismic Transect HF2 (in the south, NSR J in **Table 56** and **Figure 107**);
- The homestead to the east of Target Area 1 – RSB D and southeast of Target Area 2 – RSB E (NSR P in **Table 56** and **Figure 107**); and,
- The homestead inside Target Area 2 – RSB E (NSR R in **Table 56** and **Figure 107**).

The exploration activities could be audible and might be disturbing at several of the other identified noise receptors, including at NSRs B, G, H, I, K, L, M and Q. Construction activities and traffic during the drilling phase are anticipated to produce minimal noise. The onsite drilling activities will pose the potential for noisy conditions due to machinery and vehicles. The impact ratings associated with the proposed drilling activities related to noise are indicated in **Table 57**. Construction activities and traffic during the seismic survey phase are anticipated to produce minimal noise. The onsite seismic activities will pose the potential for noisy conditions due to vibroseis truck, machinery and supporting vehicles. The impact ratings associated with the proposed seismic activities related to noise are indicated in **Table 58**.

Table 56: Summary of simulated noise levels (provided as dBA) for proposed exploration activities at noise survey locations and identified nearby noise sensitive receptors (Airshed Planning Professionals, 2026).

NSR ID	Closest Operational Area	Direction from Site	Coordinates (WGS84 UTM 35S)		Measured Baseline Day-time Sound Pressure Level (L_{Aeq} in dBA)	Simulated Cumulative Daytime Sound Pressure Level (L_{Aeq} in dBA)	Simulated Increase Levels (ΔL_{Aeq} in dBA)$^{(e)}$
NSL1	TA10 - GP B	WNW	495414	6916734	33.4	33.5	0.1
NSL2	TA9 - HF C	S	510926	6901074	25.9	26.3	0.4
NSL3	TA1 - RSB D	SW	497050	6883805	24.7	**55.8**$^{(d)}$	31.1

NSR ID	Closest Operational Area	Direction from Site	Coordinates (WGS84 UTM 35S)		Measured Baseline Day-time Sound Pressure Level (L_{Aeq} in dBA)	Simulated Cumulative Daytime Sound Pressure Level (L_{Aeq} in dBA)	Simulated Increase Levels (ΔL_{Aeq} in dBA)[e]
A	TA11 - GP A	N	497291	6922653	33.4[a]	**56.9[d]**	23.5
B	TA11 - GP A	NE	497640	6922838	33.4[a]	42.6	9.2
C	Transect - G2	S	499356	6921765	33.4[a]	35.4	2.0
D	Transect - G1	E	497836	6918961	33.4[a]	36.7	3.3
E	TA10 - GP B	NE	498729	6916900	33.4[a]	**45.1[d]**	11.7
F	TA10 - GP B	ENE	499419	6917171	33.4[a]	38.1	4.7
G	TA10 - GP B	SW	497420	6915287	33.4[a]	38.9	5.5
H	Transect - G3	N	501709	6917043	33.4[a]	41.8	8.4
I	Transect - HF7	S	506034	6906183	25.9[b]	30.9	5.0
J	Transect - HF2	W	505960	6903805	25.9[b]	43.1	17.2
K	Transect - HF1	E	511056	6902136	25.9[b]	32.6	6.7
L	TA9 - HF C	NE	513516	6904689	25.9[b]	31.9	6.0
M	Transect - HF1	E	514255	6908923	25.9[b]	32.5	6.6
N	Transect - HF1	N	514901	6912220	25.9[b]	28.8	2.9
O	Transect - HF1	N	515263	6912308	25.9[b]	27.4	1.5
P	Transect - RSB2	E	499392	6883791	24.7[c]	35.2	10.5
Q	Transect - RSB2	SE	499781	6884155	24.7[c]	33.9	9.2
R	TA2 - RSB E		498041	6885015	24.7[c]	**73.8[d]**	49.1
S	TA2 - RSB E	NW	497472	6886310	24.7[c]	37.3	12.6

Notes:

(a) Based on baseline sound pressure levels at NSL1, NLS2 & NSL3.

(b) Exceedance of daytime Draft Environmental Noise Standards for rural is provided in bold.

(c) Likely community response in accordance with the SANS 10103

<3 dBA	*< 5 dBA*	*< 10 dBA*	*< 15 dBA*	*< 20 dBA*

NSR ID	Closest Operational Area	Direction from Site	Coordinates (WGS84 UTM 35S)	Measured Baseline Day-time Sound Pressure Level (L_{Aeq} in dBA)	Simulated Cumulative Daytime Sound Pressure Level (L_{Aeq} in dBA)	Simulated Increase Levels (ΔL_{Aeq} in dBA)[e]
Change imperceptible	*No reaction*	*'Little' reaction with sporadic complaints*	*'Medium' reaction with widespread complaints*	*'Strong' to 'very strong' reaction with threats of community action or vigorous community action.*		

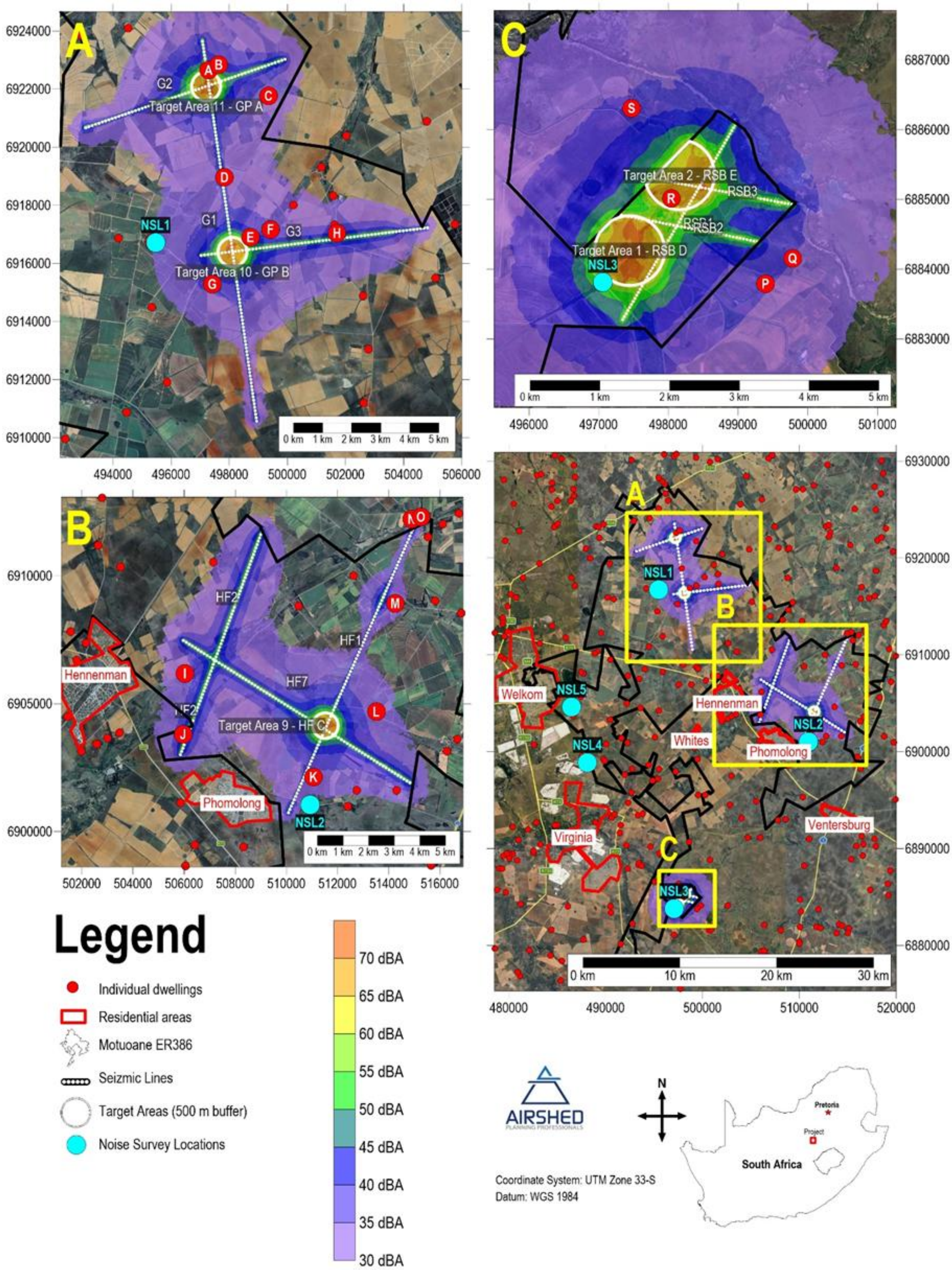


Figure 107: Simulated incremental day-time rating levels ($L_{Aeq,d}$) (Airshed Planning Professionals, 2026).

7.3.5.2 IMPACT RATING

Table 57: Summary of impacts related to noise from drilling activities (Airshed Planning Professionals, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction	Increase in noise levels (daytime)	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration		Negative	Medium to High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation		Negative	Medium to Low	Medium to Low	Medium to Low

Table 58: Summary of impacts related to noise from seismic activities (Airshed Planning Professionals, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction	Increase in noise levels (daytime)	Negative	Medium to Low	Medium to Low	Medium to Low
Construction / Exploration		Negative	Medium to Low	Medium to Low	Medium to Low
Decommissioning / Rehabilitation		Negative	Medium to Low	Medium to Low	Medium to Low

7.3.5.3 CUMULATIVE IMPACT

The noise associated with the proposed activities are not expected to be excessive in nature relative to the surrounding agricultural / rural area extent. The location of the activities is relatively far away from residential and businesses which are high noise pollution receptors. The small number of vehicles and temporary exploration works are anticipated to general minimal noise. Excessive noise impacts (if any) will be limited to the site and the area, generally has low noise generators such as industries. Therefore, the cumulative impact on noise pollution due to the proposed activity is medium to low post mitigation.

7.3.5.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse noise impacts due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix H**):

- The working hours stipulated in the Construction permit, where applicable, must be adhered to. Where this is not applicable, the following working hours must be adhered to: Monday to Friday from sunrise to sunset and where applicable on a Saturday which must be agreed upon between the affected parties and the Contractor.
- The contractor must attempt to restrict noisy activities as far as possible to times and locations whereby the potential for noise nuisance is reduced.

- All construction plant and other equipment must be in a good working order to reduce possible noise pollution.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- All residents within 2 km of drilling activities and 1 km of seismic surveys should be informed regarding the exploration activities. Scheduling of activities should be communicated and coordinated with adjacent residents (where applicable).
- Signage indicating the channels for logging grievances should be posted at the closest public road boundary and at the site entrance.
- A noise complaints register must be kept. If complaints are received, noise sampling should be undertaken at the NSRs and source of noise should be investigated. Channels for logging of complaints should be communicated to all residents within 2 km of the drilling site and 1km of the seismic transects.
- Should noise become a nuisance (complaints), adequate / viable noise suppression measures must be implemented.
- All equipment should be kept in line with manufacturers specifications. This should particularly include the regular inspection and, if necessary, replacement of rotary equipment. Any change in the noise emission characteristics of equipment should serve as trigger for withdrawing it for maintenance.

7.3.6 IMPACTS ON AIR QUALITY

This section presents the identified potential air quality impacts as per the Air Quality Impact Assessment undertaken by Airshed Planning Professionals (**Appendix F**).

7.3.6.1 DESCRIPTION OF IMPACT

The establishment of a comprehensive emission inventory formed the basis for the assessment of the air quality impacts from the project on the receiving environment. The project activities will consist of the exploration phase only. Emissions are quantified for pollutants associated with exploration activities and can be divided into two categories, namely, fugitive emissions and point source emissions. 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 point source emissions (IFC, 2007).

Different types of gases can be encountered while drilling, depending on the type and depth of the well being drilled. Some common gases encountered during drilling operations include Hydrocarbons Gases, Oil and condensate gases, Carbon dioxide (CO_2), Helium (He), etc. The impact ratings associated with the proposed drilling activities related to air quality are indicated in **Table 60**.

Hydrocarbon exploration and production activities, including seismic operations, emit greenhouse gases. However, GHG emission from seismic surveys are mainly offshore seismics from the large vessel and supporting vessel operations over a period of several months. While onshore seismic surveys have a short duration (weeks) and GHG are limited to the operation of the vibroseis truck. Therefore, the potential short-term releases of greenhouse gasses are not anticipated to significantly impact on the regional or global greenhouse gas emissions and as such this impact is rated to have a low negative significance with mitigation. The impact ratings associated with the proposed seismic activities related to air quality and greenhouse gas emissions are indicated in **Table 60**.

Gaseous pollutants released from the exploration of the wells is the main source of GHGs from the project. The release of GHG includes mainly CO_2, CH_4 and N_2O. GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour H_2O, CO_2, N_2O, CH_4 and O_3 are the primary GHG in the Earth's atmosphere. The effect of climate change is related to changing atmospheric GHG concentrations, increased temperatures, changing weather patterns and sea level rise (indirect negative impact).

7.3.6.1.1 NORMAL OPERATIONS

Pollutants with the potential to result in human health impacts which are assessed in this study include PM_{10}, $PM_{2.5}$, CO, SO_2, NO_2 and VOC. Dispersion simulations were undertaken using the AERMOD dispersion model and results are presented in as profile graphs. The maximum ground level concentrations are conservatively screened against the NAAQS and VOC comfort levels. Due to the short duration of activities, only short-term ground level concentrations were assessed

a) Testing Well Construction Activities

The exact location of the testing wells will only be determined during the exploration phase as more data becomes available to guide the positioning of further wells. The construction site for the testing wells was provided to be 50 m x 50 m for equipment movement and setup. Daily PM_{10} NAAQ limits are exceeded up to 35 m from the testing well construction site.

b) Light Vehicle Activities

It is assumed that light vehicles will be present in the target areas as well as the seismic transects. No exceedances of NAAQS are expected due to light vehicle activity.

c) Truck Activities

It is assumed that trucks would be in the target areas and the seismic transects (i.e. truck for the seismic vibrator). The daily PM2.5 NAAQ limits are exceeded up to a distance of 30 m from source and hourly NO2 NAAQ limit is exceeded up to 260 m from source.

d) Well Drilling

As the exact location of the testing wells are not known, the ground level concentrations due to exhaust releases from drills are provided as a function of distance. The daily PM_{10} and $PM_{2.5}$ NAAQ limits are exceeded up to 50 m and 60 m from the source respectively and hourly NO_2 NAAQ limit is exceeded up to 520 m from source. When comparing the daily maximum VOC concentrations to the comfort level of 200 $\mu g/m^3$, the distance of exceedance is 25 m from the source.

e) Testing Well Gaseous Release

The simulated daily NMVOC ground level concentrations due to testing well releases is provided as a function of distance. When conservatively comparing the daily maximum NMVOC concentrations to the comfort level of 200 $\mu g/m^3$, the distance of exceedance is 150 m from the source.

A summary of the exceedance of the assessment criteria as a distance from the project activities is provided in **Table 59**. The potential sensitive receptors that may be impacted by the project activities is summarised in **Table 596** with the receptors referenced in **Figure 108**.

7.3.6.1.2 ABNORMAL OR UNPLANNED EVENTS

Abnormal operations during gas exploration refer to deviations from standard drilling protocols, such as well-pressure spikes, equipment failures, or uncontrolled releases. These incidents significantly escalate safety and environmental risks, potentially triggering methane venting, groundwater contamination, or catastrophic blowouts.

a) Primary Causes of Abnormalities

i. Abnormally Pressured Formations

Drilling into highly permeable or deeply buried reservoirs can lead to sudden, uncontrolled pressure spikes. If unmanaged by drilling muds, this can cause formation fluids and gases to erupt into the wellbore.

ii. Non-Routine Operations

Actions like well testing, cementing, tripping pipes, or non-routine maintenance (such as startups and shutdowns) are the most frequent triggers for gas leaks and exposure incidents.

iii. *Geological Hazards*

Fault activities, salt domes, and shifts in underground stress can cause sudden, aggressive releases of trapped gas.

b) *Immediate Hazards and Risks*

i. *Blowouts & Explosions:*

Failure to seal a well experiencing an abnormal pressure spike can cause a blowout. This uncontrolled release of gas—when mixed with an ignition source—can lead to severe explosions and fires.

ii. *Methane Venting & Exposure:*

Unplanned flaring or venting of natural gas releases toxic volatile organic compounds (e.g., benzene) and heavy metals into the atmosphere.

iii. *Aquifer Contamination:*

The failure of well casings allows stray gas or toxic drilling fluids to migrate into shallow, potable groundwater sources

Although when they do occur, they carry high-risk consequences, primarily driven by equipment failure, poor cement sealing, and human error, it is important to note that abnormal operations in onshore gas exploration such as associated with air quality impacts are statistically rare:

a) Well Blowouts

The statistical likelihood of a major loss of well control (blowout) during modern onshore drilling is very low, with reported frequencies typically in the order of **10^{-4} to 10^{-3} per well drilled (approximately 1 event per 1,000–10,000 wells)**, based on industry and regulatory datasets (U.S. Environmental Protection Agency & The International Association of Oil & Gas Producers). This low probability is largely attributable to modern well control measures, including the use of blowout diverters / preventer systems and layered safety barriers.

b) Methane Venting/Migration

Uncontrolled subsurface migration of stray gas from abandoned or improperly decommissioned wells is a well-documented and persistent risk. Studies have shown that legacy wells can act as conduits for gas migration due to degradation of casing and cement barriers over time. Furthermore, older wells are associated with higher leakage probabilities than modern, regulated wells, owing to historical construction standards and weaker long-term integrity (Kang et al., 2014; Ingraffea et al., 2014; Watson & Bachu, 2009.

From an Air Quality aspect, abnormal operations in gas exploration - such as well blowouts, pipeline ruptures, equipment malfunctions, and emergency flaring – may cause severe, acute spikes in air pollution. These events release concentrated plumes of hazardous air pollutants (HAPs), VOCs, and particulate matter, creating localized public health and environmental crises. The localized nature of these abnormal operations means that nearby communities and workers face intense exposure. The Short-term exposure to these concentrated plumes causes acute respiratory irritation, headaches, nausea, dizziness, eye irritation, and exacerbation of asthma. While extended or repeated abnormal events increase the long-term risk of developing cardiovascular diseases, central nervous system damage, and certain cancers.

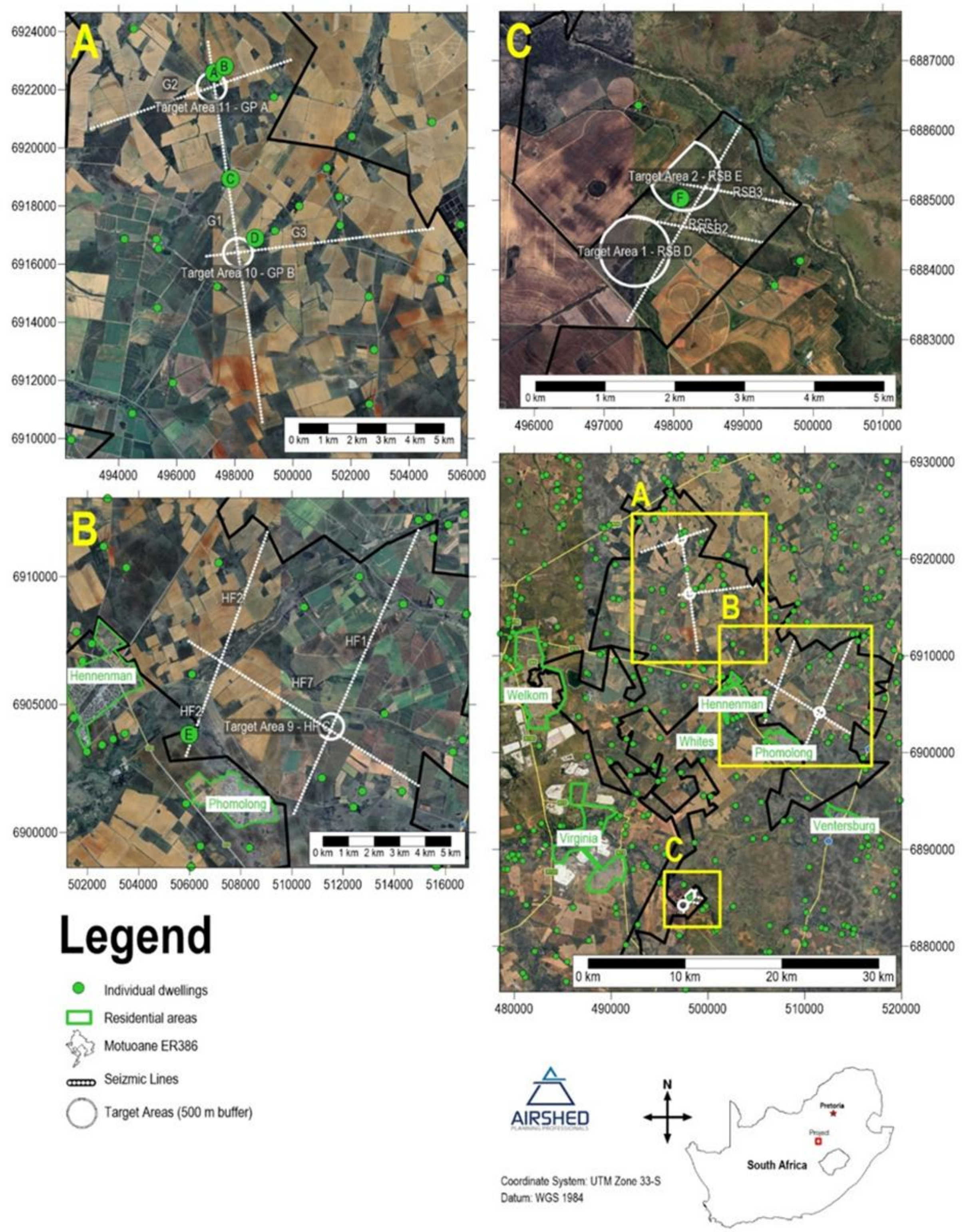


Figure 108: Potential sensitive receptors that may be impacted due to project activities (Airshed Planning Professionals, 2026).

Table 59: Summary of the exceedances of the assessment criteria as a distance from the project activities (Airshed Planning Professionals, 2026).

Project Area	Project phase	Source	Pollutant	Averaging period	NAAQS/ screening criteria (µg/m³)	Exceedance of NAAQS/ screening criteria as a distance from the source (m)	Potential sensitive receptors that may be impacted due to project activities	Distance of source from target areas (TA) or transects
Target Areas	Construction	Construction of site (land clearing)	PM_{10}	Daily	75	35	A	Within TA11 (Map A)
		Truck (engine exhaust releases)	$PM_{2.5}$	Daily	40	30	A	Within TA11 (Map A)
							F	Within TA2 (Map C)
			NO_2	Hourly	200	260	A	Within TA11 (Map A)
							C	100 m from G1 (Map A)
							E	120 m from HF2 (Map B)
							F	Within TA2 (Map C)
		Drill (exhaust releases)	PM_{10}	Daily	75	50	A	Within TA11 (Map A)
							F	Within TA2 (Map C)
			$PM_{2.5}$	Daily	40	60	A	Within TA11 (Map A)
							F	Within TA2 (Map C)
			VOC	Daily	200	25	A	Within TA11 (Map A)
							F	Within TA2 (Map C)
			NO_2	Hourly	200	520	A	Within TA11 (Map A)
							B	300 m from TA11 (Map A)
							D	280 m from TA10 (Map A)
							F	Within TA2 (Map C)

Project Area	Project phase	Source	Pollutant	Averaging period	NAAQS/ screening criteria (µg/m³)	Exceedance of NAAQS/ screening criteria as a distance from the source (m)	Potential sensitive receptors that may be impacted due to project activities	Distance of source from target areas (TA) or transects
	Operation	Testing well gaseous releases	NMVOC	Daily	200	150	A	Within TA11 (Map A)
							F	Within TA2 (Map C)
	Closure	Rehabilitation with topsoil[(a)]	PM_{10}	Daily	75	35	A	Within TA11 (Map A)
Seismic Transects	Construction	No construction activity required						
	Operation	Truck (engine exhaust releases)	$PM_{2.5}$	Daily	40	30	A	Within TA11 (Map A)
							F	Within TA2 (Map C)
			NO_2	Hourly	200	260	A	Within TA11 (Map A)
							C	100 m from G1 (Map A)
							E	120 m from HF2 (Map B)
							F	Within TA2 (Map C)
	Closure	No closure activity required						

7.3.6.2 IMPACT RATING

The project is expected to have the following significance rating (**Table 60**):

Table 60: Summary of impacts related to air quality and greenhouse gas emissions (Airshed Planning Professionals, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction	Ambient air quality at target areas (Normal Operations)	Negative	Medium to Low	Medium to Low	Medium to Low
Construction / Exploration		Negative	Medium to Low	Low	Low
Decommissioning / Rehabilitation		Negative	Medium to Low	Low	Low
Construction / Exploration (Drilling)	Ambient air quality at target areas (Abnormal Operations)	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration	Ambient air quality at seismic transects	Negative	Medium to Low	Low	Low

7.3.6.3 CUMULATIVE IMPACT

The area is known to have good hydrocarbon reserves which the current project aims to identify and quantify. There are also several existing gas emitting wells in the area which the proposed activities increase the number substantially. Collectively, these stations would increase gas emissions if they were leaking, however they are sealed with concrete and have pressure readings to identify potential leaks. Therefore, the addition of the 5 drilling wells will have minimal (low) negative cumulative impact on air quality and greenhouse gas emissions considered that the mitigation measures are implemented as the drilling and testing of the 5 wells would not occur in parallel but sequentially therefore there would at any one time only be one source point.

7.3.6.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on air quality / greenhouse gas due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- Limit air emissions as far as practically possible.
- Reduce to nuisance factor of dust to neighbouring residents.
- All drilling sites must be properly sealed to trap all gases from escaping.
- Implement dust suppression measures in all areas that will be affected by construction activities and where dust will be generated. Dust suppression must also be undertaken during windy and dry weather conditions.
- Speed restriction of no more than 20 km/h must be implemented for all construction vehicles within the construction site

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- The Emergency Response Plan must be updated to contain measures to prevent and react to abnormal events including but not limited to:
  - Blowout Diverters / Preventers
  - Shut-In Procedures to trigger the Blowout Diverters / Preventers system to physically seal the well and stop the flow of fluids
  - Emergency Shutdown Systems (ESD) to isolate valves and shuts rig power to prevent escalation into a major incident
  - High-Efficiency Flare Systems for flaring of excess gas to destroy toxic Volatile Organic Compounds (VOCs) and prevent dangerous emissions
  - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
  - A 500-meter danger zone is immediately enforced around the wellhead
  - Active Spill Prevention, Control, and Countermeasure
  - Emergency contact numbers of nearby response team with sufficient containment materials and berms to be used to prevent leaked fluids from entering local waterways or soil
- Reducing methane releases during well testing. Methane emissions must be monitored during well testing to assist with the greenhouse gas quantification. Options for gas capture and reuse/flaring should be investigated and implemented if reasonably practical.
- In order to ensure lower exhaust emissions from vehicles and machinery, equipment suppliers or contractors should be required to ensure compliance with appropriate emission standards. Also, maintenance and repair of diesel engines should be carried out as prescribed by manufacturer in order to maximise combustion and reduce gaseous emissions.
- All residents within 600 m of the target areas and 300 m of the seismic transects should be notified before commencement of activities.
- The Grievance Mechanism must be established and maintained throughout the project activities to indicate air quality complaints and responses. Channels for logging of complaints should be communicated to all residents within 600 m of the target areas and 300 m of the seismic transects. If complaints are received, they must be promptly investigated, recorded and addressed.
- Robust Leak Detection and Repair (LDAR) Programs:
  - Advanced LDAR programs can include visual checks, utilising infrared cameras (optical gas imaging), drones, satellites, and sensors to detect, locate, and quantify methane leaks from wells.
  - Leading practices recommend frequent (quarterly or even continuous) inspection, particularly for high-emitting components.
  - Upon detection, leaks must be repaired promptly to minimise fugitive emissions
- Proper plugging and abandonment
  - To prevent leaks from abandoned or inactive wells, wells must be plugged in accordance with international best practice and aligned with the approved FRDCP.
  - Regular monitoring of plugged wells is necessary to identify and remediate leakage from degraded cement or casing, which is a major source of methane seepage.

7.3.7 IMPACTS ON CLIMATE CHANGE & GHG EMMISSIONS

This section presents the identified potential climate change impacts as per the Climate Change Impact Assessment undertaken by Airshed Planning Professionals (**Appendix F**).

7.3.7.1 **DESCRIPTION OF IMPACT**

Gaseous pollutants released from the exploration of the wells is the main source of GHGs from the project. The release of GHG includes mainly CO_2, CH_4 and N_2O. GHGs are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour H_2O, CO_2, N_2O, CH_4 and O_3 are the primary GHG in the Earth's atmosphere. The effect of climate change is related to changing atmospheric GHG concentrations, increased temperatures, changing weather patterns and sea level rise (indirect negative impact).

7.3.7.1.1 NORMAL OPERATIONS

Different types of gases can be encountered while drilling, depending on the type and depth of the well being drilled. Some common gases encountered during drilling operations include Hydrocarbons Gases, Oil and condensate gases, CO_2, Helium (He), etc. Although the oil and gas industry may release large amounts of methane, a potent greenhouse gas, either by accident or design which may affect climate change. Equipment and operational techniques can be applied across production chains to significantly reduce these emissions, and because methane (natural gas) is a valuable commodity, this can often be done at no cost or even at a profit. In addition, the release of methane is mainly during the production phase, while the current project is only exploration. Onshore seismic surveys have a short duration (weeks) and GHG are limited to the operation of the vibroseis truck. Therefore, the potential short-term releases of greenhouse gasses which may result in climate change from drilling activities arising from the drill rig, support machinery and vehicles are not anticipated to significantly impact on the regional or global climate. Subsequently, climate change impacts are anticipated to be low negative post mitigation. The impact ratings associated with the proposed exploration activities related to climate change are indicated in **Table 61**.

The calculated CO_2e emissions from the project operations for Scope 1 is summarised in **Section 4.12**, estimating a total of 21 236 t CO_2e over a 9-year period (2 360 t CO_2e per annum). The project Scope 1 emissions would contribute approximately 0.0007% of the remaining carbon budget per year for 2030 and 2035 and represent a contribution of 0.0005% to the 2022 National GHG inventory total.

The climate change significance rating was as follows:

- Climate change manifestations on the project: **low**;
- Impact of the project on climate change adaptation or resilience: **low**;
- Impact of project on GHG emissions: **low**

7.3.7.1.2 ABNORMAL OR UNPLANNED EVENT

Abnormal operations during gas exploration refer to deviations from standard drilling protocols, such as well-pressure spikes, equipment failures, or uncontrolled releases. These incidents significantly escalate safety and environmental risks, potentially triggering methane venting, groundwater contamination, or catastrophic blowouts. Although when they do occur, they carry high-risk consequences, primarily driven by equipment failure, poor cement sealing, and human error, it is important to note that abnormal operations in onshore gas exploration such as associated with air quality impacts are statistically rare:

a) Well Blowouts

The statistical likelihood of a major loss of well control (blowout) during modern onshore drilling is very low, with reported frequencies typically in the order of **10^{-4} to 10^{-3} per well drilled (approximately 1 event per 1,000–10,000 wells)**, based on industry and regulatory datasets (U.S. Environmental Protection Agency & The International Association of Oil & Gas Producers). This low probability is largely attributable to modern well control measures, including the use of blowout diverter / preventer systems and layered safety barriers.

b) Methane Venting/Migration

Uncontrolled subsurface migration of stray gas from abandoned or improperly decommissioned wells is a well-documented and persistent risk. Studies have shown that legacy wells can act as conduits for gas migration due to degradation of casing and cement barriers over time. Furthermore, older wells are associated with higher leakage probabilities than modern, regulated wells, owing to historical construction standards and weaker long-term integrity (Kang et al., 2014; Ingraffea et al., 2014; Watson & Bachu, 2009.

From a Climate Change aspect, Abnormal (non-routine) events during onshore gas exploration—such as well blowouts, equipment failures, pipeline ruptures, venting, flaring malfunctions, and fugitive methane leaks ("super-emitter events") - can significantly amplify greenhouse gas (GHG) emissions and accelerate climate change. Abnormal events during onshore gas exploration represent a significant and often underestimated source of greenhouse gas emissions, particularly methane. These events contribute to climate change through direct emissions, secondary atmospheric processes, and feedback mechanisms. Their disproportionate impact—driven by high-intensity, short-duration releases—makes them critical targets for mitigation. Effective strategies must include enhanced monitoring, rapid response systems, and improved regulatory frameworks to reduce the climate risks associated with these events. The impact ratings associated with the proposed exploration activities related to climate change are indicated in **Table 61**.

7.3.7.2 **IMPACT RATING**

Table 61: Summary of impacts related to climate change emanating from the proposed activities (Airshed Planning Professionals, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics & Drilling)	Increased heat extremes may result in occupational health and operational risks on the project. These risks are driven by higher ambient temperatures which can lead to heat-related illnesses (i.e. heatstroke and exhaustion) in workers and reduced labour productivity.	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Low
Pre-Construction (Seismics & Drilling)	The impact of the project on the resources is limited to some clearing of land for the exploration areas.	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Low
Pre-Construction (Seismics & Drilling)	The project would release GHG emissions into the atmosphere during the exploration activities.	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Low
Construction / Exploration (Drilling)	Abnormal operations: amplified greenhouse gas (GHG) emissions and accelerate climate change	Negative	Medium to High	Medium to Low	Medium to Low

7.3.7.3 **CUMULATIVE IMPACT**

Similarly to air quality and GHG emissions, the area is known to have good hydrocarbon reserves which the current project aims to identify and quantify. There are also several existing hydrocarbon stations in the area which the proposed activities increase the number substantially. Collectively, these stations would increase gas emissions if they were leaking, however they are sealed with cement and have pressure readings to identify potential leaks. Therefore, the addition of the 5 drilling wells will have minimal (low) negative cumulative impact on air quality and greenhouse gas emissions considered that the mitigation measures are implemented. Subsequently, the short-term exploration activities and implementation of mitigation measures is anticipated to have an overall low negative cumulative impact on climate change.

7.3.7.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on climate change due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- The duration of the construction should be minimized to as short term as possible.
- Limit air emissions as far as practically possible.
- All drilling sites must be properly sealed to trap all gases from escaping.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Ensure all onsite employees receive annual extreme heat training, maintain updated risk assessments, and monitor heat-related incidents with defined performance targets and corrective action timelines.
- Reducing methane releases during well testing. Methane emissions must be monitored during well testing to assist with the greenhouse gas quantification. Options for gas capture and reuse/flaring should be investigated and implemented if reasonably practical.
- In order to ensure lower exhaust emissions from vehicles and machinery, equipment suppliers or contractors should be required to ensure compliance with appropriate emission standards. Also, maintenance and repair of diesel engines should be carried out as prescribed by manufacturer in order to maximise combustion and reduce gaseous emissions.
- All residents within 600 m of the target areas and 300 m of the seismic transects should be notified before commencement of activities.
- The Emergency Response Plan must be updated to contain measures to prevent and react to abnormal events including but not limited to:
  - Blowout Diverters / Preventers
  - Shut-In Procedures to trigger the Blowout Diverters / Preventers system to physically seal the well and stop the flow of fluids
  - Emergency Shutdown Systems (ESD) to isolate valves and shuts rig power to prevent escalation into a major incident
  - High-Efficiency Flare Systems for flaring of excess gas to destroy toxic Volatile Organic Compounds (VOCs) and prevent dangerous emissions
  - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
  - A 500-meter danger zone is immediately enforced around the wellhead
  - Active Spill Prevention, Control, and Countermeasure
  - Emergency contact numbers of nearby response team with sufficient containment materials and berms to be used to prevent leaked fluids from entering local waterways or soil
- Robust Leak Detection and Repair (LDAR) Programs:
  - Advanced LDAR programs can include visual checks, utilising infrared cameras (optical gas imaging), drones, satellites, and sensors to detect, locate, and quantify methane leaks from wells.
  - Leading practices recommend frequent (quarterly or even continuous) inspection, particularly for high-emitting components.
  - Upon detection, leaks must be repaired promptly to minimise fugitive emissions
- Proper plugging and abandonment

- To prevent leaks from abandoned or inactive wells, wells must be plugged in accordance with international best practice and aligned with the approved FRDCP.
- Regular monitoring of plugged wells is necessary to identify and remediate leakage from degraded cement or casing, which is a major source of methane seepage.

7.3.8 GROUNDWATER (HYDROGEOLOGICAL) IMPACTS

This section presents the identified potential hydrogeological impacts as per the Hydrogeological Impact Assessment undertaken by Gradient Consulting (**Appendix F**).

7.3.8.1 DESCRIPTION OF IMPACT

A concern previously raised by the I&APs during other applications for similar activities in the area is the potential for the exploratory drilling to have an adverse impact on groundwater quality and quantities. Existing stressors that affect ground water condition include application of pesticides and fertilizers to the land, waste from livestock and other animals, landfills, mining operations, and unintentional releases such as chemical spills or leaks from hydrocarbon tanks. There is always a risk of spills occurring during the construction / exploration. The spill can then infiltrate into the groundwater and contaminate the water resource. In order to evaluate the risk of groundwater contamination, potential sources of contamination should be identified, as well as potential pathways and receptors. The pollution linkage concept relies on the identification of a potential pollutant (i.e. source) on-site which is likely to have the potential to cause harm to a receptor by means of a pathway by which the receptor may be exposed to the contaminant (**Figure 109**).

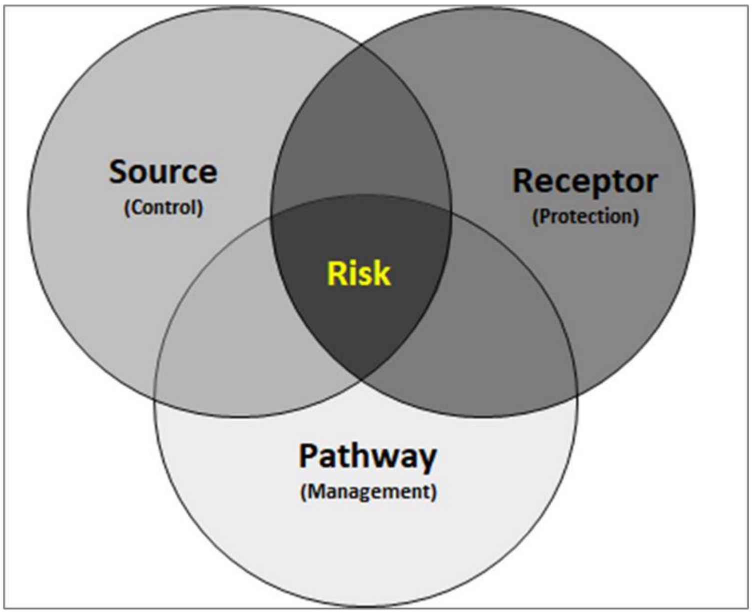


Figure 109: Source pathway receptor principle (Gradient Groundwater Consulting, 2026).

7.3.8.1.1 POTENTIAL SOURCES

The following potential sources have been identified:

i. Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase.
ii. Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase.
iii. Drilling fluids and additives, lubricants, oils, fuels, and grease from machinery, cement and grouting materials, surface runoff carrying sediments or chemicals, contaminated drilling water used during circulation.

iv. Mobilisation and maintenance of heavy vehicles and machinery on-site may cause hydrocarbon contamination of groundwater resources.

7.3.8.1.2 POTENTIAL PATHWAYS

The following aquifer pathways have been identified:

i. Vertical flow through the unsaturated/vadose zone as well as saturated zone to the underlying intergranular and fractured rock aquifers. The rate at which seepage will take place is governed by the permeability of sub-surface soil layers and host-rock formations.

ii. Preferential flow-paths include the contact between the depth of weathering and fresh un-weathered rock, fractures, faults, joints and bedding planes. Secondary fractures may also potentially act as transport mechanisms.

iii. If not adequately sealed and suitably mitigated, gas exploration and exploration wells will form preferential flow paths and serve as a direct connection between the deeper, fractured aquifer and shallow, potable aquifer unit(s).

7.3.8.1.3 POTENTIAL RECEPTORS

The following receptors were identified:

i. Shallow, inter-granular as well as the intermediate, fractured aquifer units situated within the plume migration footprint(s). The riparian zone aquifer associated with drainage patterns throughout the greater study area can also be viewed as a sensitive groundwater receptor.

ii. Down-gradient drainages and streams including associated riparian zone aquifer system(s) and baseflow contribution.

iii. Private or neighbouring boreholes associated with relevant fracture zones and/or structures(s)if intercepted by the pollution plume migration footprint.

The mass balance equation (Bear and Verruijt, 1992) (advection-dispersion equation) of a pollutant can be expressed as follows:

Equation: Advection-dispersion.

$$\frac{\delta nc}{\delta t} = - \Delta \bullet q_{c,total} - f + n\rho\Gamma - P_c + R_c$$

where:

nc = mass of pollutant per unit volume of porous medium;

n = porosity of saturated zone;

c = concentration of pollutant (mass of pollutant per unit volume of liquid (water));

$\Delta \bullet q_{c,total}$ = excess of inflow of a considered pollutant over outflow, per unit volume of porous medium, per unit time;

f = quantity of pollutant leaving the water (through adsorption, ion exchange etc.);

$n\rho\Gamma$ = mass of pollutant added to the water (or leaving it) as a result of chemical interactions among species inside the water, or by various decay phenomena[13];

[13] This investigation and contaminant transport model are based on a “worst-case” scenario and as such, it is assumed that no decay and/or retardation are taking place in the aquifer.

Γ = rate at which the mass of a pollutant is added to the water per unit mass of fluid;

p = density of pollutant;

Pc = total quantity of pollutant withdrawn (pumped) per unit volume of porous medium per unit time;

Rc = total quantity of pollutant added (artificial recharge) per unit volume of porous medium per unit time.

Advection and hydrodynamic dispersion are the major processes controlling transport through a porous medium. Advection is the component of contaminant movement described by Darcy's Law. If uniform flow at a velocity V takes place in the aquifer, Darcy's law calculates the distance (x) over which a labelled water particle migrates over a time period t as x = Vt. Hydrodynamic dispersion refers to the stretching of a solute band in the flow direction during its transport by an advecting fluid and comprises mechanical dispersion as well as molecular diffusion. Contaminant transport scenarios serve as tool for management purposes and the simulation results indicate the expected plume migration. The latter can be used to establish additional monitoring points to be applied as transient input for model updates and re-calibration.

It should be noted that the contaminant transport scenarios serve as a tool for management purposes with advective transport simulating the potential leachate concentrations from waste facilities, however, does not include biochemical breakdown and cation/anion exchange reactions which will further retard plume migration.

Various source terms and contaminant proxies were applied as part of the mass transport migration simulations and include saline groundwater emanating from the deep, fractured aquifer from leaking gas boreholes (TDS = 7 832.0 mg/l - based on hydrochemical analysis of water samples representing this aquifer unit) as well as contaminated water emanating at the plant footprint and evaporation dam(s) (TDS = 7 832.0 mg/l). Pulles et al (2005) indicates that groundwater associated with the deeper hydrostratigraphical units has TDS concentrations of around 4000.0mg/l, the major salt being sodium chloride.

A contaminant transport scenario was conducted simulating stray methane gas (CH_4) from leaking gas proposed exploration boreholes. The explorational drilling of gas wells could result in the migration of stray gas from the deep-seated fracture zones to formations higher up in the geological sequence. This impact has been recorded in the US where hydraulic fracturing, dewatering or a combination of these has occurred (Jackson et al, 2013). It should be stated that the applicant does not intend to undertake hydraulic fracturing or any well stimulation and, as such, no dewatering will be required. Accordingly, the risk of stray gas migration is therefore expected to be low. It should be noted that this scenario is highly unlikely under natural conditions as the exploration zone(s) is separated from the shallow and potable Karoo aquifer by very low permeability shale formations which will act as an aquitard towards any groundwater and stray gas migration. This is however provided that well construction, including cementation and the installation of steel casing, is sound. As such, the impact assessment evaluated represents a worst-case scenario and simulates the eventual occurrence once stray gas does reach the shallow aquifer.

As methane gas reaches saturation in water at 28 milligrams per litre (mg/L) at atmospheric pressure (Eltschlager et al., 2001), this concentration was applied as source term for this scenario. According to the U.S. Environmental

Protection Agency (EPA, 2011) as well as U.S. Department of the Interior, Office of Surface Mining (2011), methane concentrations below 10.0mg/L are generally considered safe.

Various management scenarios were modelled for the purposes of planning and decision making with stress periods listed as follows:

- Year 01 – Year 9: Gas exploration operational phase.
- Year 10 – Year 60: 50-years post closure.
- Year 61 – Year 111: 100-years post closure:

i. **Scenario 01:** Steady state water balance (∞).

  - Recharge is assumed the only source of inflow to the system and has been simulated at $6.37E^{+04}m^3/d$, while the largest loss to the groundwater system is via groundwater contribution to baseflow, $6.36E^{+04}m^3/d$. Water captured as storage equates to $4.63E^{+02}m^3/d$ while water released from storage is calculated as $6.79E^{+04}m^3/d$. The imbalance of the delineated aquifer unit, ignoring internal transfer, is calculated at $1.21E^{+02}m^3/d$.

ii. **Scenario 02:** Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the operational gas exploration phase:

  - This scenario summarises the simulated point source pollution plume migration of saline groundwater emanating from the deep, fractured aquifer should the integrity of the gas exploration boreholes be jeopardised i.e., leaking boreholes for the exploration phase (9-year period).
  - It can be observed that the simulated pollution plume migration is more sluggish within the denser Karoo formations, reaching a maximum distance of ~100.0m, whereas movement through the more unconsolidated alluvial deposits of the riparian zone suggest a larger flux reaching a maximum distance of ~230.0m during the operational exploration phase.
  - The simulation indicates that the potential pollution plumes will not intercept any privately owned, neighbouring boreholes during the duration of the simulation and do not extend beyond the exploration right area. It should be noted that the pollution plumes originating from exploration boreholes situated within the riparian zone might potentially intersect local drainages i.e., Sandrivier and Rietspruit including the associated riparian zone aquifer.
  - The TDS mass load contribution ranges between ~900.0mg/l to approximately 1250.0mg/l, which is slightly above the SANS 241:2015 limits, with the mass load contribution a function of the distance to the source or gas exploration borehole.

iii. **Scenario 03:** Migration of stray methane (CH_4) gas emanating from the exploration zone to the overlying, potable aquifer(s) during the operations gas exploration phase:

  - This scenario summarises the simulated point source pollution plume migration of stray methane (CH_4) gas emanating from the exploration zone should the integrity of the gas exploration boreholes be jeopardised after decommissioning.
  - The simulation indicates that the generated CH_4 pollution plume will generally mimic topography and will migrate in a radial pattern from the gas exploration borehole(s) towards the lower laying drainage system.
  - The simulated pollution plume migration is more sluggish within the denser Karoo formations, reaching a maximum distance of ~90.0m, whereas movement through the more unconsolidated alluvial deposits of the riparian zone suggest a larger flux reaching a maximum distance of ~180.0m during the operational exploration phase.
  - The simulation indicates that the potential pollution plumes will not intercept any privately owned, neighbouring boreholes during the duration of the simulation and do not extend beyond the exploration

right area. It should be noted that the pollution plumes originating from exploration boreholes situated within the riparian zone might potentially intersect local drainages i.e., Sandrivier and Rietspruit including the associated riparian zone aquifer.

iv. **Scenario 04:** Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

- This scenario summarises the simulated point source pollution plume migration of saline groundwater emanating from the deep, fractured aquifer should the integrity of the decommissioned gas exploration boreholes be jeopardised i.e., leaking boreholes for the post-closure phase.

- The simulation indicates that the generated TDS pollution plume will also mimic topography during the post-closure phase and will propagate towards the lower laying drainage system.

- After a simulation period of 100-years, it can be observed that the maximum distance reached is ~450.0m during the post-closure phase. The simulation indicates that the potential pollution plumes will not intercept any privately owned, neighbouring boreholes during the duration of the simulation, however salt load contribution to the host aquifer is observed. It should be noted that the pollution plumes originating from exploration boreholes situated within the riparian zone might potentially intersect local drainages i.e., Sandrivier and Rietspruit including the associated riparian zone aquifer.

- The TDS load contribution to neighbouring boreholes i.e., BH03, MRBH88, MRBH89 and MRBH90 ranges from ~7.0mg/l to 50.0mg/l. While the TDS mass load contribution remains below the SANS 241:2015 limits ranging between ~950.0mg/l to approximately 600.0mg/l.

- TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through open exploration boreholes to the intergranular aquifer in the vicinity of target area 9 for the post-closure phases.

v. **Scenario 05:** Migration of stray methane (CH_4) gas emanating from the exploration zone to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

- This scenario summarises the simulated point source pollution plume migration from of stray methane (CH_4) gas emanating from the exploration zone should the integrity of the decommissioned gas exploration boreholes be jeopardised i.e., leaking boreholes for the post-closure phase.

- The simulation indicates that the generated CH_4 pollution plume will also mimic topography during the post-closure phase and will propagate towards the lower laying drainage system.

- After a simulation period of 100-years, it can be observed that the maximum distance reached is ~350.0m during the post-closure phase. The simulation indicates that the potential pollution plumes will not intercept any privately owned, neighbouring boreholes during the duration of the simulation. It should be noted that the pollution plumes originating from exploration boreholes situated within the riparian zone might potentially intersect local drainages i.e., Sandrivier and Rietspruit including the associated riparian zone aquifer.

- The source term mass load contribution to conceptual receptors remains below the EPA safety threshold (2011) of 10.0mg/l ranging between 1.70-2.80mg/l.

Refer to **Figure 110** to **Figure 115** for the visual representation of the various scenarios. **It should be noted that, due care will be taken to ensure that exploration boreholes will be properly constructed and adequately sealed, a cautious approach i.e., “worst-case” scenario have been followed during the modelling of leaking boreholes (unmitigated scenario).**

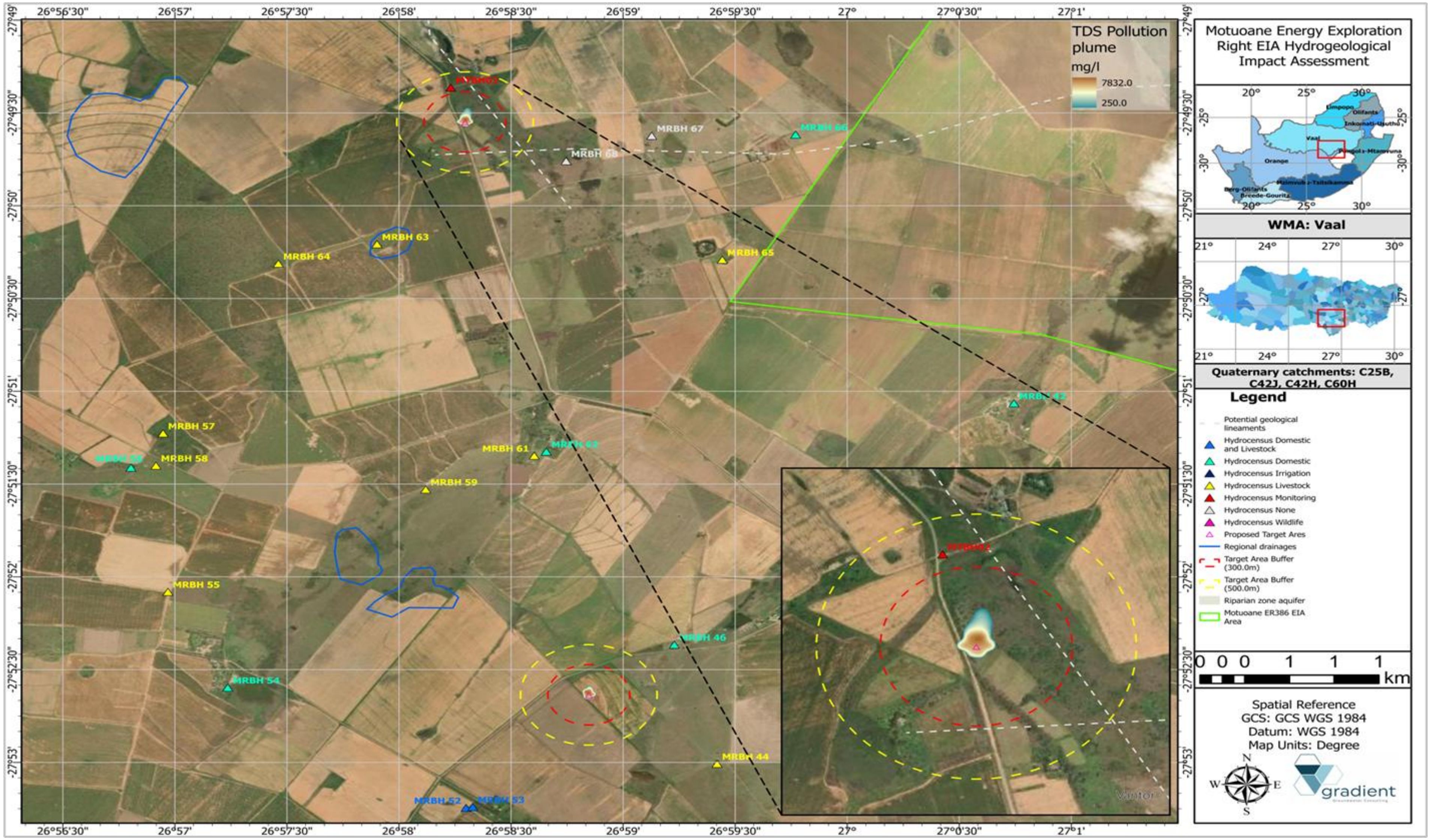


Figure 110: Scenario 02: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through open exploration boreholes to the intergranular aquifer in the vicinity of target areas 10 and 11 (Operational phase) (Gradient Groundwater Consulting, 2026).

Figure 111: Scenario 02: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through open exploration boreholes to the riparian zone aquifer in the vicinity of target areas 1 and 2 (Operational phase) (Gradient Groundwater Consulting, 2026).

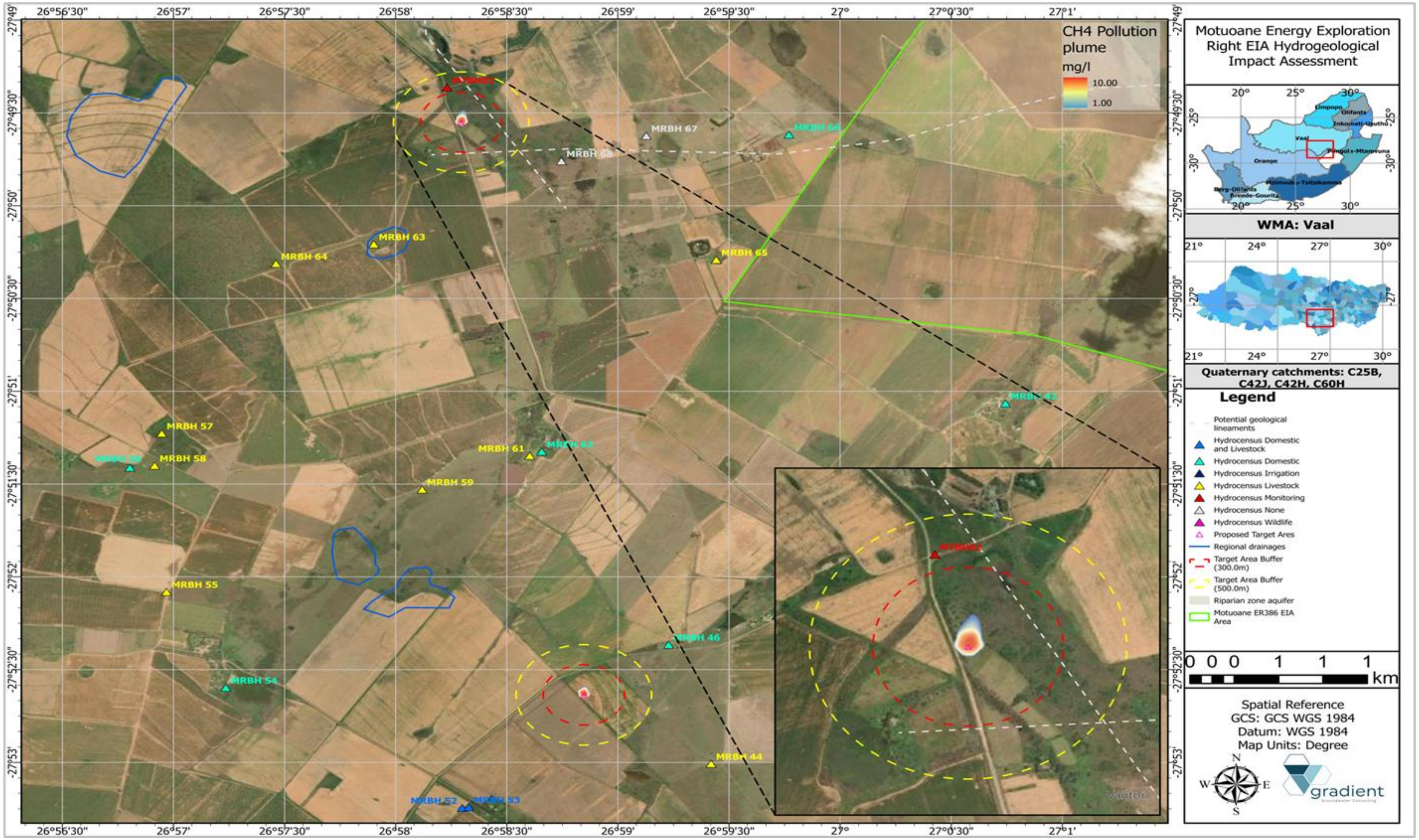


Figure 112: Scenario 03: CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through open exploration boreholes to the intergranular aquifer in the vicinity of target areas 10 and 11 (Operational phase) (Gradient Groundwater Consulting, 2026).

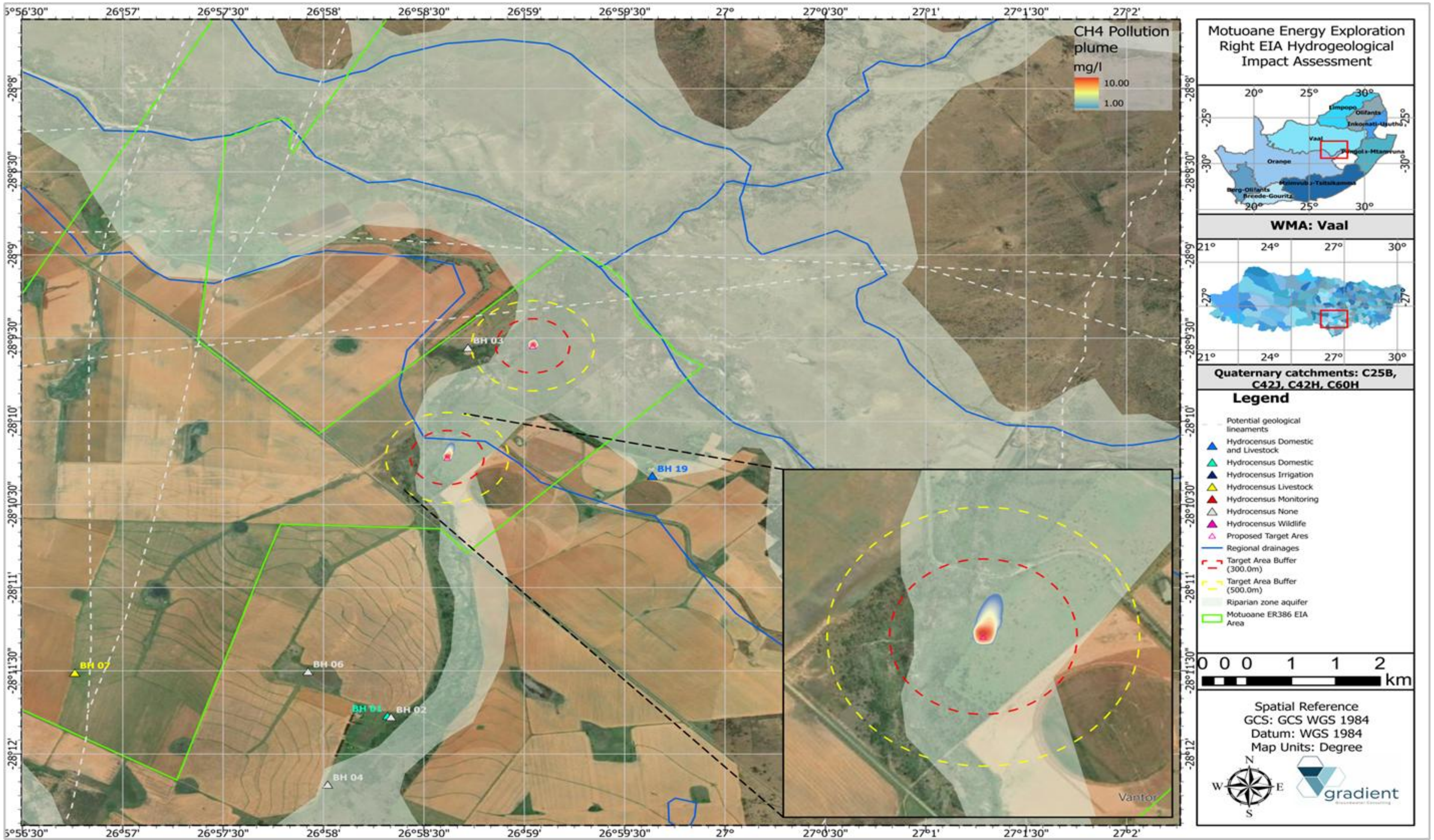


Figure 113: Scenario 03: CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through open exploration boreholes to the riparian zone aquifer in the vicinity of target areas 1 and 2 (Operational phase) (Gradient Groundwater Consulting, 2026).

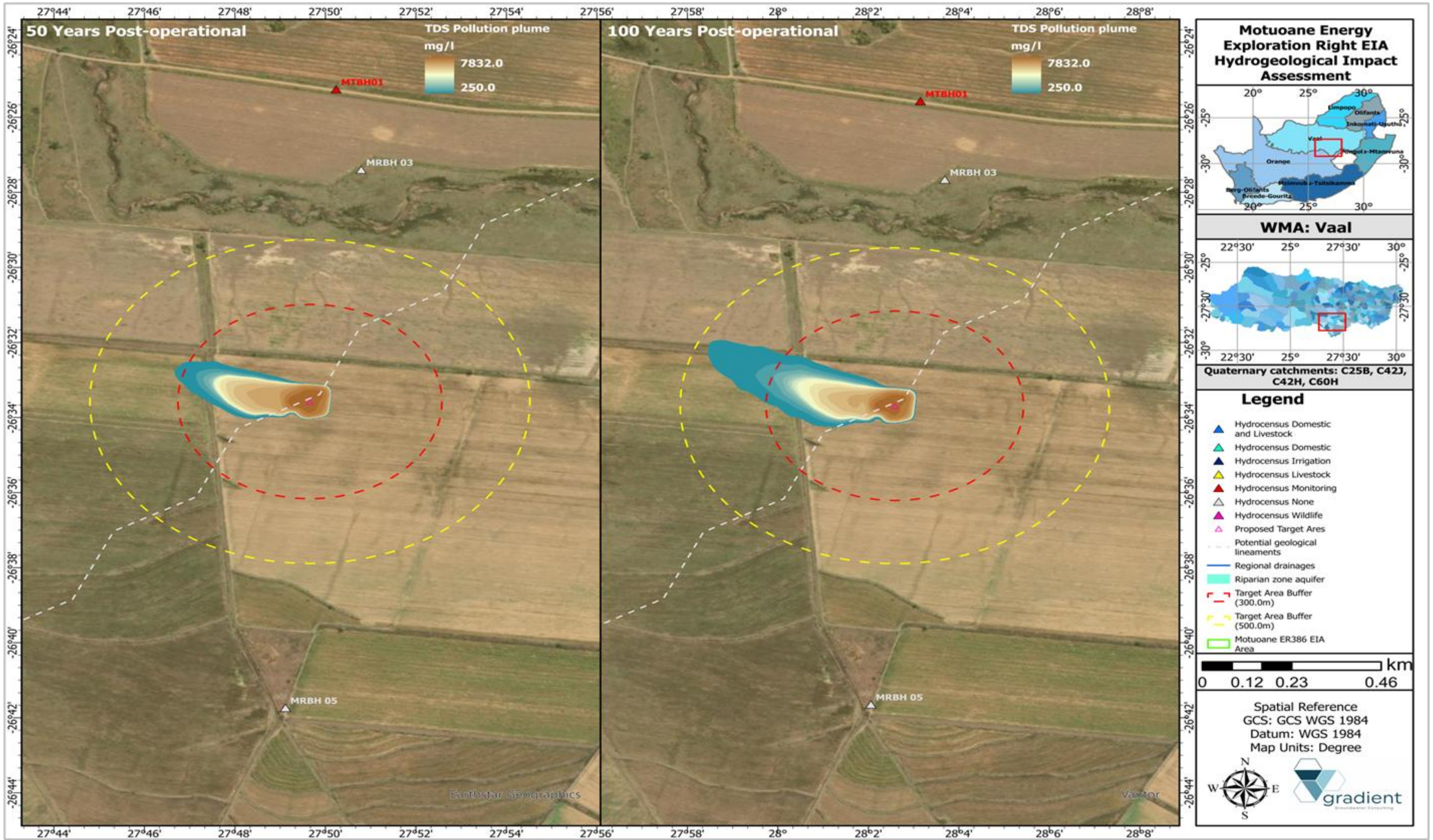


Figure 114: Scenario 04: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through open exploration boreholes to the intergranular aquifer in the vicinity of target area 9 (post-closure phase) (Gradient Groundwater Consulting, 2026).

Figure 115: Scenario 05: CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating through the intergranular aquifer in the vicinity of target area 9 (post-closure phase) (Gradient Groundwater Consulting, 2026).

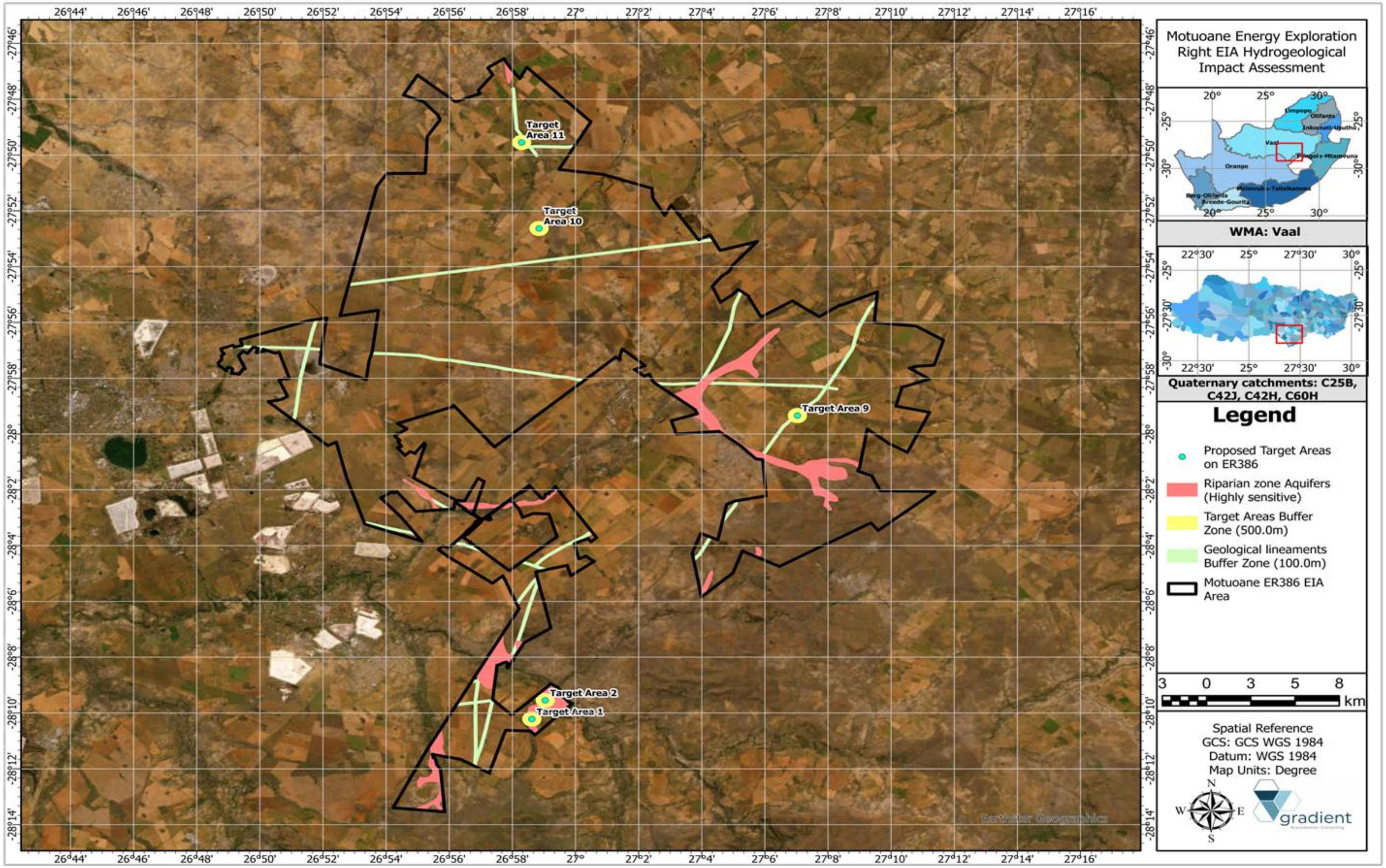


Figure 116: Hydrogeological sensitivity map. (Gradient Groundwater Consulting, 2026).

7.3.8.1.4 PRE-CONSTRUCTION PHASE: ASSOCIATED ACTIVITIES AND IMPACTS

During the pre-construction phase (site establishment) the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium to high without implementation of remedial measures and medium to low with implementation of proposed mitigation measures. The main impacts associated with the construction phase activities include the following:

i. Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area as well as drilling pads.
ii. Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.
iii. Mobilisation and maintenance of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.
iv. Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution

7.3.8.1.5 OPERATIONAL / CONSTRUCTION PHASE: ASSOCIATED ACTIVITIES AND IMPACTS

During the operational phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium to high without implementation of remedial measures and medium to low with implementation of proposed mitigation measures. The main impacts associated with the operational phase activities include the following:

i. Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase.
ii. Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase.
iii. Groundwater pollution as a result of wastewater spills and seepage from drilling sumps.
iv. Poor quality leachate may emanate from the workshop and/or drilling pad footprint areas which may have a negative impact on groundwater quality.
v. Operation and maintenance of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.
vi. Poor storage and management of hazardous chemical substances on-site may cause surface water and groundwater pollution.
vii. Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.
viii. Groundwater pollution as a result of contact with drilling fluids, additives and lubricants.
ix. Groundwater pollution as a result of unforeseen events such as saline water encountered during well blow-out.

7.3.8.1.6 POST-OPERATIONAL AND DECOMMISSIONING PHASE: ASSOCIATED ACTIVITIES AND IMPACTS

During the decommissioning phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium to high without implementation of remedial measures and medium to low with implementation of proposed mitigation measures. The main impacts associated with the decommissioning phase activities include the following:

i. Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.

ii. Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) borehole closure and decommissioning phase.

iii. Poor quality leachate may emanate from the workshop and/or drilling pad footprint areas which may have a negative impact on groundwater quality.

iv. De-mobilisation of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.

7.3.8.2 IMPACT RATING

The impact ratings associated with the proposed exploration activities related to groundwater are indicated in **Table 62**.

Table 62: Summary of impacts related to groundwater (Gradient Consulting, 2026).

Project Phase		Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction	Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area as well as drilling pads.	Negative	Medium to High	Medium to Low	Medium to Low
	Poor quality leachate may emanate from the construction camp which may have a negative impact on groundwater quality.	Negative	Medium to Low	Medium to Low	Medium to Low
	Mobilisation and maintenance of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.	Negative	High	Medium to Low	Medium to Low
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Negative	High	Medium to Low	Medium to High
Construction / Exploration	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase.	Negative	High	Medium to Low	Medium to Low
	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase.	Negative	High	Medium to Low	Medium to Low
	Groundwater pollution as a result of wastewater spills and seepage from drilling sumps.	Negative	Medium to High	Medium to Low	Medium to Low
	Poor quality leachate may emanate from the workshop and/or drilling pad footprint areas which may have a negative impact on groundwater quality.	Negative	Medium to High	Medium to Low	Medium to Low
	Operation and maintenance of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.	Negative	Medium to High	Medium to Low	Medium to Low
	Poor storage and management of hazardous chemical substances on-site may cause surface water and groundwater pollution.	Negative	Medium to High	Medium to Low	Medium to Low
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.	Negative	Medium to High	Medium to Low	Medium to Low

Project Phase		Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	Groundwater pollution as a result of contact with drilling fluids, additives and lubricants.	Negative	High	Medium to Low	Medium to Low
	Groundwater pollution as a result of unforeseen events such as saline water encountered during well blow-out.	Negative	Medium to High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation	Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the borehole closure and decommissioning phase.	Negative	High	Medium to Low	Medium to Low
	Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) borehole closure and decommissioning phase.	Negative	High	Medium to Low	Medium to Low
	Poor quality leachate may emanate from the workshop and/or drilling pad footprint areas which may have a negative impact on groundwater quality.	Negative	Medium to High	Medium to Low	Medium to Low
	De-mobilisation of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.	Negative	Medium to High	Medium to Low	Medium to Low

7.3.8.3 **CUMULATIVE IMPACT**

Although during the exploration activities, there is potential for alteration of the hydraulic regimes (head). However, the small scale of the impacts that would be perceived would not significantly alter the drainage patters over a large area and if perceived would be of short duration. This will likely be limited to the site and surrounding areas. The insertion of casing in the underground aquifer zones (as presented in the EMPr) is anticipated to prevent any adverse impacts on groundwater quantity and quality for surrounding groundwater users. Furthermore, a monitoring programme is proposed in the EMPr for the continued monitoring of surface and groundwater quantity and quality. As such, this impact is anticipated to have a low negative cumulative significance through the implementation of these mitigation measures.

7.3.8.4 **PROPOSED MITIGATION MEASURES**

The proposed mitigation measures to avoid adverse impacts on groundwater due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix H**):

- Ensure that detailed baseline water quality and quantity samples are obtained and analysed for reference purposes.
- Ensure that all mitigation measures as stipulated in the EMPr relating to the drilling (specifically technical specifications) as well as the MPRDA regulations are adhered to.
- The best drilling fluid option should be selected during construction towards minimising the potential for groundwater contamination and the exploration wells should be constructed such no gas or oil leakage occurs during the operational phase.
- The correct type of fluids should be used during the construction phase and the boreholes should be correctly constructed so that no gas leakage occurs during the construction or operational phases. Biodegradable drilling fluids should be used wherever possible.
- Excavations should be open for as short period as practically possible and drilling circulation fluid sumps be cleaned out and rehabilitated.
- Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum.
- Spill trays must be provided if refuelling of drilling rig and vehicles are done on site.
- Chemical sanitary facilities should be provided for drilling crew. Construction workers should only be allowed to use temporary chemical toilets on the site. Chemical toilets shall not be within close proximity of the drainage system. Frequent maintenance should include the removal without spillages.
- Adequate fuel containment facilities to be used during exploration phase.
- The use of all materials, fuels and chemicals which could potentially leach into the environment must be controlled.
- All materials, fuels and chemicals must be stored in a specific and secured area to prevent pollution from spillages and leakages.
- No uncontrolled discharges from the drilling pad or site shall be permitted. and
- Any spills that occur during the exploration phase must immediately be cleaned up and the contaminated soils, etc. suitably disposed of at a registered waste disposal facility. and
- Sound groundwater management measures need to be developed based on the results of the impact assessment.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Mitigation and management measures as set out in the groundwater management plan of the EMPr should be implemented as far as practically possible.
- Due to the sensitivity of the riparian zone, any development and/or drilling which takes place within the primary porosity aquifer associated with alluvium material deposited in flood plains must be restricted if it cannot be avoided. Pitless drilling must be implemented for drilling within the riparian zone (i.e., Target Areas 1 & 2) to further reduce the risk of contamination from the drill sump.
- Drilling localities should be determined in consultation with a suitably qualified hydrogeologist and sited means of a geophysical survey to target lineaments and weathered zones acting as preferred groundwater flow pathways and contaminant transport mechanisms.
- Newly established monitoring boreholes should be subjected to aquifer hydraulic parameters testing to supplement and verify existing hydraulic parameters interpreted as part of the first phase drilling and testing run.
- A well design must be developed by a suitably qualified professional (such as a well/ reservoir engineer) and submitted to the PASA for approval prior to commencement of a specific drill site.
- The well design shall comply with Good International Industry Practice (GIIP) and must ensure that all installed casing strings and associated cementing are engineered to withstand anticipated worst-case formation pressures and the pressures associated with contingency well control (kill) operations.
- Adequate contingency provisions shall be maintained on site or within close proximity, including the availability of base fluids and additives if required and/or pre-mixed drilling fluids, to enable the rapid preparation and deployment of kill mud where required.
- Due to limited aquifer characterisation data pertaining to the deep hydrostratigraphical unit, it is recommended that potential water strikes encountered during proposed exploration drilling be recorded along with associated water levels in order to get a better understanding of the deeper aquifer piezometric head and expected behaviour.
- Geological exploration logs and data recording should include major water strikes and depths, water loss or water make volumes and depths as well as blow yields if applicable. Should water from the deeper, fractured aquifer be encountered, a sample should be collected to be subjected for inorganic testing as well as isotopes ($\delta^{18}O$, $\delta^{2}H$) and radionuclide analysis in order to determine potential risks as well as validate surface water and groundwater interactions
- Groundwater flow modelling assumptions should be verified and confirmed. The calibrated groundwater flow model should be updated on a biennial (once every two years) basis as newly gathered site characterisation data and monitoring results become available in order to be applied as groundwater management tool for future scenario predictions.
- It is recommended that the monitoring program and network as set out in this report should be implemented and adhered to. It is imperative that monitoring be conducted to serve as an early warning and detection system. Monitoring results should be evaluated on a bi-annual basis by a suitably qualified person for interpretation and trend analysis and submitted to the Regional Head: Department of Water and Sanitation.
- It is recommended that a weather station be established on-site in order to keep record of all rainfall events and assess potential climatic changes. The latter should be incorporated into the numerical groundwater flow model update accordingly.

7.3.9 SURFACE WATER (HYDROLOGICAL) IMPACTS

This section presents the identified hydrological impacts as per the Aquatics and Wetlands Impact Assessment undertaken by The Biodiversity Company (**Appendix F).**

7.3.9.1 **DESCRIPTION OF IMPACT**

7.3.9.1.1 NORMAL / PLANNED OPERATIONS

The Risk / Impact Assessment considered the indirect impacts to the wetland systems. The mitigation hierarchy as discussed by the Department of Environmental Affairs et al., 2013 will be considered for this component of the assessment. In accordance with the mitigation hierarchy, the preferred mitigatory measure is to avoid impacts by considering options in project location, sitting, scale, layout, technology and phasing to avoid impacts.

For this assessment, the specialist was provided with the Target Areas for the proposed drilling activities and the Seismic Survey Transect. It is assumed that the proposed activities will be able to avoid the delineated wetlands, and where no avoidance is possible, the wetlands will be rehabilitated. It is therefore imperative that all the impacted wetlands are correctly rehabilitated with indigenous wetland vegetation, and an Alien Invasive Management/ Monitoring Plan be implemented. This will be sufficient to result in no net loss of wetland area. Emphasis was therefore placed on minimising impacts by means of mitigation.

The proposed Seismic Transect survey is anticipated to result in localised, predominantly temporary disturbance within the project footprint, primarily associated with vehicle movement along the planned transect lines and related field activities. The principal freshwater-related risk is that ground disturbance, particularly under wet conditions, may lead to rutting/compaction, vegetation disturbance and the development of localised erosion hotspots, with the potential for increased sediment and contaminant mobilisation toward wetlands and drainage features. Although direct impacts to wetlands are not anticipated based on an avoidance approach, inappropriate routing, wet-weather access or uncontrolled driving could result in incidental encroachment into sensitive wetland areas. The only phases assessed for the Seismic Transect survey was the Construction (Exploration Phase) and Post-Exploration (Rehab and Closure Phase) as the nature of seismic surveys is such that all significant activities and associated impacts occur during the initial data acquisition period.

The proposed exploration drilling wells are expected to cause localised and largely temporary disturbance within the designated drilling sites and immediate surroundings. The primary freshwater-related risks are associated with site clearance and earthworks required for the drilling pads, drilling operations themselves, and the movement of vehicles and equipment to and from the well locations (Construction Phase). These activities may result in soil compaction, vegetation removal, and the generation of drill cuttings and fluids, which, if not properly managed, could lead to increased sedimentation, hydrocarbon or chemical contamination, and altered surface drainage patterns. While it is assumed that direct impacts to wetlands are to be avoided through careful site selection and adherence to buffer zones, accidental spills, improper waste handling, or inadequate containment of drilling fluids could result in the mobilisation of pollutants into adjacent wetland and drainage features. The risk of impact is heightened during wet conditions or if mitigation measures are not strictly implemented.

7.3.9.1.2 ABNORMAL OR UNPLANNED EVENTS

Abnormal operations during gas exploration refer to deviations from standard drilling protocols, such as well-pressure spikes, equipment failures, or uncontrolled releases. These incidents significantly escalate safety and environmental risks, potentially triggering methane venting, groundwater contamination, or catastrophic blowouts. Although when they do occur, they carry high-risk consequences, primarily driven by equipment failure, poor cement sealing, and human error, it is important to note that abnormal operations in onshore gas exploration such as well blowouts, toxic gas releases, and uncontrolled fluid leakages are statistically rare:

a) Well Blowouts

The statistical likelihood of a major loss of well control (blowout) during modern onshore drilling is very low, with reported frequencies typically in the order of **10^{-4} to 10^{-3} per well drilled (approximately 1 event per 1,000–10,000 wells)**, based on industry and regulatory datasets (U.S. Environmental Protection Agency & The International Association of Oil & Gas Producers). This low probability is largely attributable to modern well control measures, including the use of blowout diverter / preventer systems and layered safety barriers.

b) Surface Spills & Equipment Failure

Minor spills (e.g. drilling muds, brines) and mechanical failures in surface equipment such as pumps, compressors, and storage systems represent the more probable types of incidents in oil and gas operations, compared to major loss-of-control events. These releases are typically small in volume and contained on-site, but repeated or poorly managed releases can result in cumulative environmental impacts over time, particularly affecting soils and shallow groundwater (EPA, 2016; Vidic et al., 2013; GAO, 2012).

c) Methane Venting/Migration

Uncontrolled subsurface migration of stray gas from abandoned or improperly decommissioned wells is a well-documented and persistent risk. Studies have shown that legacy wells can act as conduits for gas migration due to degradation of casing and cement barriers over time. Furthermore, older wells are associated with higher leakage probabilities than modern, regulated wells, owing to historical construction standards and weaker long-term integrity (Kang et al., 2014; Ingraffea et al., 2014; Watson & Bachu, 2009.

From a hydrological aspect, abnormal operations during gas exploration can significantly impact surface water systems through chemical contamination, salinisation, hydrocarbon pollution, sedimentation, and gas migration. Although such events are relatively infrequent, their consequences can be severe and long-lasting, particularly where containment and mitigation measures fail.

7.3.9.2 **IMPACT RATING**

The impact ratings associated with the proposed exploration activities related to groundwater are indicated in **Table 63** and **Table 64.**

Table 63: Summary of impacts on surface water due to the drilling activities (The Biodiversity Company, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction	Increased runoff, erosion and sedimentation from exposed areas	Negative	Medium to Low	Low	Low
	Edge effects associated with proliferation of alien species from vegetation clearance	Negative	Medium to Low	Low	Low
	Impaired water quality from contaminated runoff (accidental chemical and oil spills from machinery and equipment)	Negative	Medium to Low	Low	Low
Construction / Exploration	Altered surface flows from soil compaction and creation of preferential flow paths leading to erosion and sedimentation	Negative	Medium to Low	Low	Low
	Soil compaction leading to increased risk of erosion and sedimentation	Negative	Medium to Low	Low	Low
	Disturbance to wetland vegetation and soil leading to proliferation of alien invasive plants	Negative	Medium to Low	Low	Low
	Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff	Negative	Medium to Low	Low	Low
	Chemical contamination, salinisation, hydrocarbon pollution, sedimentation, and gas migration during abnormal drilling operations / events	Negative	Medium to High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation	Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff	Negative	Medium to Low	Low	Low
	Continued degradation of wetlands from improper post-exploration rehabilitation	Negative	Medium to Low	Low	Low
	Improvement in wetland functionality from successful rehabilitation	Positive	Low	Medium to Low	Medium to Low

Table 64: Summary of impacts on surface water due to the seismic activities (The Biodiversity Company, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construct ion	Altered surface flows from soil compaction and creation of preferential flow paths leading to erosion and sedimentation	Negative	Medium to Low	Low	Low

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	Disturbance to wetland vegetation and soil leading to proliferation of alien invasive plants	Negative	Medium to Low	Low	Low
	Impaired water quality from contaminated runoff (accidental chemical and oil spills from machinery and equipment)	Negative	Medium to Low	Low	Low
Construction / Exploration	Altered surface flows from soil compaction and creation of preferential flow paths leading to erosion and sedimentation	Negative	Medium to Low	Low	Low
	Soil compaction leading to increased risk of erosion and sedimentation	Negative	Medium to Low	Low	Low
	Disturbance to wetland vegetation and soil leading to proliferation of alien invasive plants	Negative	Medium to Low	Low	Low
	Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff	Negative	Medium to Low	Low	Low
Decommissioning / Rehabilitation	Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff	Negative	Medium to Low	Low	Low
	Continued degradation of wetlands from improper post-exploration rehabilitation	Negative	Medium to Low	Low	Low
	Improvement in wetland functionality from successful rehabilitation	Positive	Low	Medium to Low	Medium to Low

7.3.9.3 CUMULATIVE IMPACT

Concerns were previously raised by I&APs during similar EA Applications (i.e., D3 Energy ER12/3/315) surrounding the potential for contamination of water resources (including surface water resources). In terms of the relevant legislation, no drilling may take place on or near to surface water features and furthermore, mitigation measures have been put forward to prevent pollution on or near to the drill sites which will prevent contaminated surface water runoff from entering water resources. The accumulative surface water impact associated with the proposed development is low and this impact has been rated with a low negative significance.

7.3.9.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on surface water due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix H**):

- Ensure that detailed baseline water quality and quantity samples are obtained and analysed for reference purposes.

- Construction/drilling should preferably not be conducted during rainy days. If drilling is to be undertaken during rainy days, additional precautionary measures in consultation with the ECO must be implemented to prevent contamination on surface water.
- Excavations should be open for as short period as practically possible and drilling circulation fluid sumps be cleaned out and rehabilitated.
- Construction vehicles and machines must be maintained properly to ensure that oil spillages are kept at a minimum.
- Spill trays must be provided if refuelling of drilling rig and vehicles are done on site.
- Chemical sanitary facilities should be provided for drilling crew. Construction workers should only be allowed to use temporary chemical toilets on the site. Chemical toilets shall not be within close proximity of the drainage system. Frequent maintenance should include the removal without spillages.
- Adequate fuel containment facilities to be used during exploration phase.
- The use of all materials, fuels and chemicals which could potentially leach into the environment must be controlled.
- All materials, fuels and chemicals must be stored in a specific and secured area to prevent pollution from spillages and leakages.
- No uncontrolled discharges from the drilling pad or site shall be permitted.
- Any spills that occur during the exploration phase must immediately be cleaned up and the contaminated soils, etc. suitably disposed of at a registered waste disposal facility.
- No seismic activities nor drilling activities are to be permitted within on wetlands or watercourses (32m prelitigation and a 15m post-mitigation buffer.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Engage wetland specialists or ECO to review rehabilitation success and recommend improvements.
- The Emergency Response Plan must be updated to contain measures to prevent and react to abnormal events including but not limited to:
    - Blowout Diverters / Preventers
    - Shut-In Procedures to trigger the Blowout Diverters / Preventers system to physically seal the well and stop the flow of fluids
    - Emergency Shutdown Systems (ESD) to isolate valves and shuts rig power to prevent escalation into a major incident
    - High-Efficiency Flare Systems for flaring of excess gas to destroy toxic Volatile Organic Compounds (VOCs) and prevent dangerous emissions
    - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
    - A 500-meter danger zone is immediately enforced around the wellhead
    - Active Spill Prevention, Control, and Countermeasure
    - Emergency contact numbers of nearby response team with sufficient containment materials and berms to be used to prevent leaked fluids from entering local waterways or soil.

7.3.10 IMPACTS ON SOILS AND AGRICULTURAL POTENTIAL

This section presents the identified potential soils and agricultural impacts as per the Soils and Agricultural Assessment undertaken by The Biodiversity Company (**Appendix F**).

7.3.10.1 DESCRIPTION OF IMPACT

Fourteen (14) representative soil forms were identified in the proposed seismic survey drilling areas namely, Ermelo, Griffin, Hutton, Clovelly, Pinedene, Westleigh, Katspruit, Kroonstad, Rensburg, Sepane, Arcadia, Johannesburg, Stilfontein and Grabouw soil forms (**Figure 54**). The most sensitive soil forms suitable for crop production identified within the seismic survey drilling areas includes the Ermelo, Griffin, Hutton and Clovelly soil forms. These soils are usually used for crop farming due to their good drainage, aeration and nutrient and water holding capabilities. Furthermore, these soils are characterised with a high suitability for crop production due to the permeability of their underlying horizons that promotes water infiltration, root penetration and gas exchange.

The Land Capability (LC) was determined by using the guidelines described in "The farming handbook" (Smith, 2006). The most sensitive soil forms associated with the project area are restricted to land capability "I" (i.e. maize and soyabean cultivation), land capability "II" (i.e. Ermelo, Clovelly, Griffin, Hutton, Pinedene and Westleigh soil forms), land capability "III" (i.e. Sepane and Arcadia soil forms), land capability "V" (i.e. Katspruit, Kroonstad and Rensburg soil forms) and land capability "VIII" (i.e. Johannesburg, Stilfontein and Grabouw soil forms). Refer to **Table 18** for the LC for the soils within the project area. Following Smith, (2006) which the national DAFF, (2017) land capabilities protocols were further expanded from, the above-mentioned identified soil forms associated with active cropping is restricted to land capability class "I" (i.e. Maize and soyabeans) categorised by LC 8-10 (Moderate to Moderate-High), land capability classes "II" (i.e. Ermelo, Clovelly, Griffin, Hutton, Pinedene and Westleigh soil form) categorised by LC 6-7 (Low-Moderate); land capability "III" (i.e. Sepane and Arcadia soil forms) categorised by LC 1-5 (Very Low to Low), land capability "V" (i.e. Katspruit, Kroonstad and Rensburg soil forms) categorised by LC 6-7 (Low-Moderate), and land capability "VIII" (i.e. Johannesburg, Stilfontein and Grabouw soil forms) categorized by LC 1-5 (Very Low to Low). The soil land capability was aligned and - compared to the National Land Capability data (DAFF, 2017).

The following land potential levels have been determined:

- Land potential level 4 (this land potential level is characterised by moderate potential. Moderately regular and/or severe to moderate limitations due to soil, slope, temperatures or rainfall. Appropriate permission is required before ploughing virgin land. Arable soils);
- Land potential level 5 (this land potential level is characterised by restricted potential. Regular and/or moderate to severe limitations due to soil, slope, temperatures or rainfall. Arable);
- Land potential level 6 (this land potential level is characterised by a very restricted potential. Regular and/or severe limitations due to soil, slope, temperatures or rainfall. Non-arable);
- Land potential level 8 (this land potential level is characterised by very low potential. Very severe limitation due to soil, slope, temperatures or rainfall. Non-arable); and
- Vlei

The climatic conditions, soil forms, land use and land capability features were used to determine the overall sensitivity of the soil resources. The land capability level "I" areas were scored a "High" sensitivity, land capabilities "II" and "Vlei" were assigned "Medium" sensitivity. Land capabilities "III" and "VIII" was assigned "Low" sensitivity (**Figure 117**).

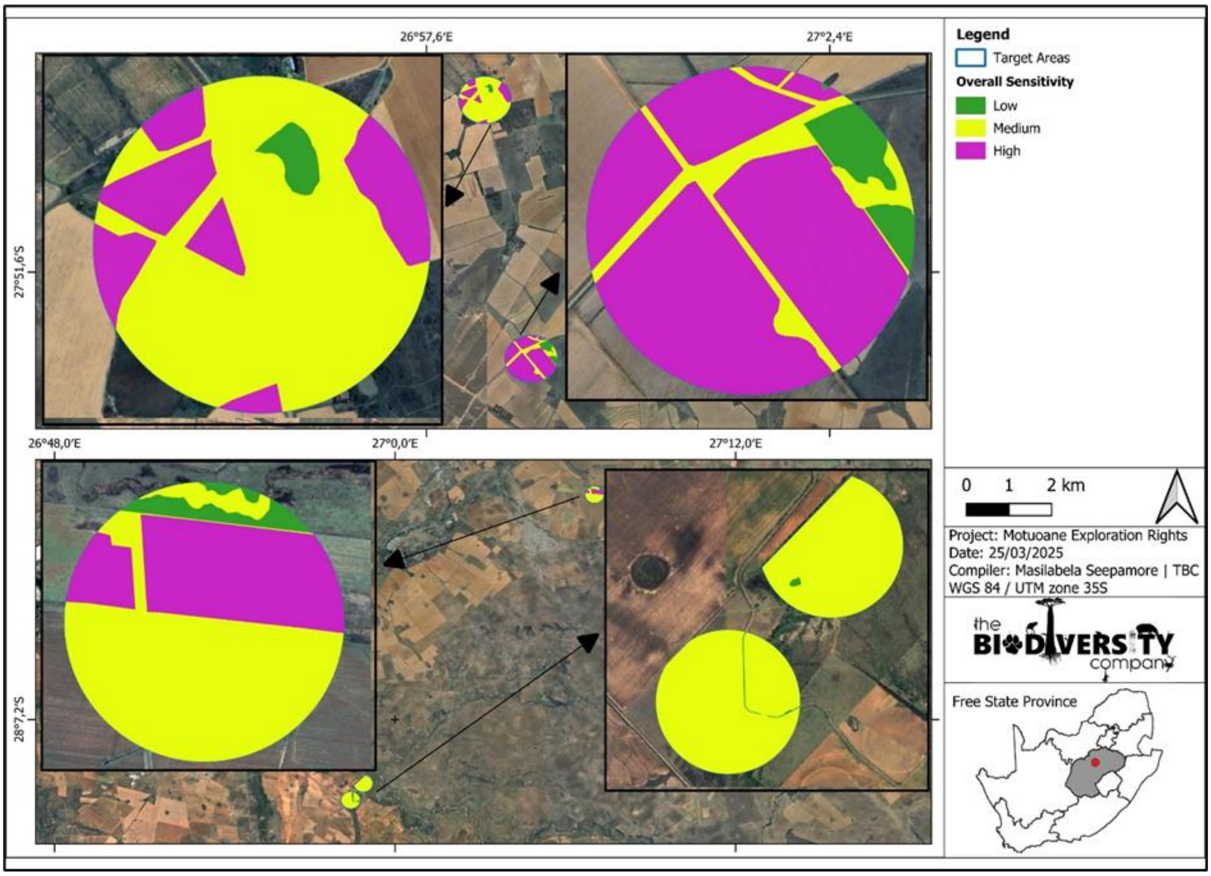


Figure 117: Overall sensitivity for the proposed project area (The Biodiversity Company, 2026).

7.3.10.1.1 NORMAL / PLANNED OPERATIONS

Soils and agricultural potential / activities may be affected by the proposed activities and in particular during the drilling of the wells and undertaking of the seismic activities. The drill rig and supporting machinery may require new access roads and the establishment of drilling pads within largely farming areas which may affect the soils and agricultural activities. The geochemical and soil sampling activities are anticipated to have a low impact on existing soils and agricultural activities. The seismic transects may overlap with farming grounds which may result in temporary loss and/impact on soils agricultural fields and production. The seismic activities will have a short duration, use existing gravel roads as far as possible and are therefore anticipated to have a low impact on existing soils and agricultural activities. The impact ratings associated with the proposed exploration activities related to soil potential and agricultural activities are indicated in **Table 65.**

7.3.10.1.2 ABNORMAL OR UNPLANNED EVENTS

Abnormal operations during gas exploration refer to deviations from standard drilling protocols, such as well-pressure spikes, equipment failures, or uncontrolled releases. These incidents significantly escalate safety and environmental risks, potentially triggering methane venting, groundwater contamination, or catastrophic blowouts. Although when they do occur, they carry high-risk consequences, primarily driven by equipment failure, poor cement sealing, and human error, it is important to note that abnormal operations in onshore gas exploration such as well blowouts, toxic gas releases, and uncontrolled fluid leakages are statistically rare:

a) Well Blowouts

The statistical likelihood of a major loss of well control (blowout) during modern onshore drilling is very low, with reported frequencies typically in the order of **10^{-4} to 10^{-3} per well drilled (approximately 1 event per 1,000–10,000 wells)**, based on industry and regulatory datasets (U.S. Environmental Protection Agency & The International Association of Oil & Gas Producers). This low probability is largely attributable to modern well control measures, including the use of blowout diverter / preventer systems and layered safety barriers.

b) Surface Spills & Equipment Failure

Minor spills (e.g. drilling muds, brines) and mechanical failures in surface equipment such as pumps, compressors, and storage systems represent the more probable types of incidents in oil and gas operations, compared to major loss-of-control events. These releases are typically small in volume and contained on-site, but repeated or poorly managed releases can result in cumulative environmental impacts over time, particularly affecting soils and shallow groundwater (EPA, 2016; Vidic et al., 2013; GAO, 2012).

From a soils and agricultural aspect, abnormal operations during gas exploration - such as well blowouts, pipeline leaks, and fluid evaporation pit failures - threaten soils and agriculture through chemical contamination, altered biological activity, and physical degradation. The severity of these impacts depends on proximity to arable land and the speed of containment.

7.3.10.2 IMPACT RATING

Table 65: Summary of impacts related to soil potential and agricultural activities (The Biodiversity Company, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics & Drilling)	Loss of land capability	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Low	Low	Low
Pre-Construction (Seismics & Drilling)	Soil compaction	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Low	Low	Low
Pre-Construction (Seismics & Drilling)	Loss of cultivated lands	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Low	Low	Low
Pre-Construction (Seismics & Drilling)	Soil erosion	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Low	Low	Low

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Construction / Exploration (Drilling)	Soil erosion and loss of land capability during abnormal operations / events	Negative	Medium to High	Medium to Low	Medium to Low

7.3.10.3 **CUMULATIVE IMPACT**

The quantitative impact of the proposed project in isolation on agriculture is anticipated to be low negative due to the avoidance of highly sensitive field crops. The cumulative impact of the proposed project is anticipated to be medium negative. The project area has undergone historic and current modification, like the developmental disturbances associated to the mining activities that the local area has currently. After implementation of the mitigation measures such as implementation of erosion control methods, preventing soil contamination and rehabilitating disturbed and bare surfaces as stipulated above the agricultural productivity of the area is not expected to deteriorate further because of the proposed development and no irreplaceable loss of resources is anticipated.

The proposed activities and associated infrastructure will result in compaction and increased soil erosion during the construction / exploration phase and accumulatively increase the erosion rate in the area through the removal of the vegetation soil disturbance from vehicular movement and drilling. However, considering that no seismic activities nor drilling activities are permitted on or near to watercourses, the risk of sedimentation of watercourses is considered very low. Through the implementation of the proposed mitigation measures, this impact is considered to have an overall low negative cumulative impact significance as the area has small soil erosion surfaces (i.e. drainage lines) and the activities will not be permitted on the erosion surfaces to further enlarge them

7.3.10.4 **PROPOSED MITIGATION MEASURES**

The proposed mitigation measures to avoid adverse impacts on soils and agricultural activities due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- As far as possible interference with existing land uses/livelihoods should be avoided. If any interference takes place, the landowner should be compensated for their losses.
- Make use of existing roads or upgrade tracks before new roads are constructed. The number and width of internal access routes must be kept to a minimum.
- The duration of the construction should be minimized to as short term as possible, to reduce the period of disturbance on soils and agricultural activities.
- Rehabilitation of the disturbed areas must be made a priority. Any disturbed area must be re-habilitated to its pre-disturbed state. Any disturbed area must be re-habilitated to its pre-disturbed state as defined in the pre-drill survey. Disturbed areas must be rehabilitated to support its post-closure land use, and this must be undertaken within six (6) months post drilling activities.
- Use native adapted plant species for revegetation to prevent the spread of invasive species.
- All construction / exploration and access must make use of the existing roads to avoid unnecessary disturbance to soils and agricultural land.

- Soils and agricultural fields outside the direct project footprint, should under no circumstances be disturbed.
- Landowner engagement must be undertaken during the project phases to investigate possible scenarios for appropriate compensation of landowners for loss / disturbance of high land capability and/or grazing areas where necessary.
- There must be stormwater management and erosion prevention implemented for the development.
- Conduct post-plugging inspections and long-tern monitoring to confirm the integrity of the seals and detect any potential leaks.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Apply mulch, geotextiles, or cover crops to protect bare soil while vegetation establishes.
- Use physical structures such as retaining walls or silt fences on steep or unstable slopes to prevent soil erosion.
- The Emergency Response Plan must be updated to contain measures to prevent and react to abnormal events including but not limited to:
    - Blowout Diverters / Preventers
    - Shut-In Procedures to trigger the Blowout Diverters / Preventers system to physically seal the well and stop the flow of fluids
    - Emergency Shutdown Systems (ESD) to isolate valves and shuts rig power to prevent escalation into a major incident
    - High-Efficiency Flare Systems for flaring of excess gas to destroy toxic Volatile Organic Compounds (VOCs) and prevent dangerous emissions
    - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
    - A 500-meter danger zone is immediately enforced around the wellhead
    - Active Spill Prevention, Control, and Countermeasure
    - Emergency contact numbers of nearby response team with sufficient containment materials and berms to be used to prevent leaked fluids from entering local waterways or soil

7.3.11 IMPACTS ON VEGETATION AND FLORAL SPECIES

This section presents the identified potential vegetation and floral impacts as per the Terrestrial Biodiversity Assessment undertaken by The Biodiversity Company (**Appendix F**).

7.3.11.1 DESCRIPTION OF IMPACT

7.3.11.1.1 VEGETATION AND FLORAL ASSESSMENT

The vegetation assessment was conducted throughout the extent of the target areas. The species composition within the assessment area aligns with what is typically found in the vegetation types, considering some impact. This is largely due to some disturbance, as the land is primarily used for livestock grazing. Within this vegetation type, distinct communities were identified and can be categorized which varied across the ER. The list of plant species recorded is not exhaustive (can be provided upon request), and additional surveys conducted during different phenological periods, those not yet covered, could potentially reveal up to 20% more flora species in the ER. Nevertheless, the floristic analysis completed thus far is considered a reliable representation of the local flora for the ER.

Two (2) species of provincially protected plant were recorded for the Target areas – *Ammocharis coranica* and *Helichrysum nudifolium*. These species occurred in close proximity to water resources and the associated grassland. They are protected under the Free State Nature Conservation Ordinance No. 8 of 1969. According to the list of protected species under the Schedule, if any individuals of these plant species are to be disturbed, permits must be obtained from the Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA). Due to suitable grassland habitat present on site, more protected species are expected for the ER and a site walkdown must be conducted prior to development activities and any protected species identified on site marked and relocated to a nearby area of similar habitat which will not be impacted by the project activities.

Alien Invasive Plants (AIPs) tend to dominate or replace indigenous flora, thereby transforming the structure, composition and functioning of ecosystems. Therefore, it is important that these plants are controlled by means of an eradication and monitoring programme. Some invader plants may also degrade ecosystems through superior competitive capabilities to exclude native plant species. Twelve (12) AIP species were recorded for the PAOI. These species are listed under the Alien and Invasive Species List 2020, Government Gazette No. GN1003. Nine (9) of these species are NEMBA category 1b AIP species that must be controlled by implementing an AIP Management Programme, in compliance with section 75 of NEMBA (refer to **Section 3.1.10.2**).

7.3.11.1.2 POTENTIAL IMPACTS

The clearance of vegetation is required in order to prepare the drill site and may be required for new access roads. An area of approximately 50 x 50m will be impacted upon for each drilling site and potential new temporary access roads. No clearance of vegetation is required for the geochemical and soil sampling activity. The clearance of vegetation may also be required for the seismic activities. Approximately 70km of seismic transects will be undertaken along existing gravel and potential new temporary access roads which may require clearance of vegetation. The impact ratings associated with the proposed drilling and seismic activities related to indigenous vegetation are indicated in **Table 66**.

Localised loss of floral habitat and diversity may occur within areas of increased ecological sensitivity, such as the rocky grassland and water resource habitat. Due to the clearance of indigenous vegetation for new temporary access roads and drilling pads, drilling activities, vibroseis and vehicular movement, disturbance and mortalities of flora species is anticipated. Clearing of vegetation for construction purposes as well as compaction of soils due to vehicular movement will result in reduced floral habitat availability and re-establishment success post exploration phase. Disturbances to soil and vegetation on site will also favour alien plants in places. As indicated in **Section 3.1.10.2**, twelve (12) IAP species were recorded within the project area. Nine (9) species are NEMBA Category 1b IAP species that must be controlled by implementing an IAP Management Programme, in compliance of section 75 of the NEMBA. The impact ratings associated with the proposed drilling activities related to flora species are indicated in **Table 66**.

7.3.11.2 **IMPACT RATING**

Table 66: Summary of impacts related to indigenous vegetation and floral species (The Biodiversity Company, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics & Drilling)	Destruction, further loss and fragmentation of the vegetation community	Negative	High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Medium to Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Introduction of alien species, especially plants	Negative	Medium to High	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to High	Low	Low

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Medium to Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Displacement of faunal community (including SSCs) due to habitat loss, direct mortalities and disturbance (road collisions, noise, light,	Negative	High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Medium to Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Potential leaks, discharges, pollutant from machinery and storage leaching into the surrounding environment	Negative	High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Medium to Low	Medium to Low

7.3.11.3 CUMULATIVE IMPACT

The proposed activities will result in a loss of vegetation supporting the floral and fauna. However, due to the small scale of clearing required for the proposed activities, the short duration thereof and the rehabilitation that will occur, this impact has a low negative significance. In addition, the impacts are mainly anticipated during the drilling phase and the vegetation cover is expected to recover during the closure and rehabilitation. The cumulative impact for impact on floral species is, therefore, expected to be low negative..

7.3.11.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on vegetation and floral species due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- Minimise vegetation clearance. Existing gravel roads must be used as far as possible, and the closest disturbed areas must be considered for drill pads. Clearance of vegetation must be kept to the required footprint (i.e. 50 x 50 m drill pad). Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed. A vegetation clearance management plan should be compiled prior commencement of activities which at minimum should state how the minimisation with be managed based on the affected environmental aspect or phase of the exploration.
- Rehabilitation of the disturbed areas must be made a priority. Any disturbed area must be re-habilitated to its pre-disturbed state. Any disturbed area must be re-habilitated to its pre-disturbed state as defined in the pre-drill survey. Disturbed areas must be rehabilitated to support its post-closure land use, and this must be undertaken within six (6) months post drilling activities.
- All construction / exploration and access must make use of the existing roads as far as possible.
- A suitable qualified Environmental Officer (EO) or Environmental Compliance Officer (ECO) must be appointed prior to the construction / exploration phase. If the final seismic transect route and/or the

drilling location changes from the currently proposed areas, but within the assessed footprint and is situated within the high sensitive area, the EO / ECO must undertake final walkdown along the specific final planned transect route/s and drilling location/s in order to ensure that no sensitive vegetation or floral SCC are to be impacted.

- Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed.
- Areas rated as High sensitivity outside of the direct construction / exploration areas should be declared as 'no-go' areas during the life of the project, and all efforts must be made to prevent impacts and access to these areas from construction workers and machinery.
- All laydown, chemical toilets etc. should be restricted to low / medium sensitivity areas. Any materials may not be stored for extended periods of time and must be removed from the project area once the construction/exploration phase has been concluded.
- An Alien Invasive Plant Management Plan must be compiled and implemented during the construction / exploration phase.
- All activities must be restricted too within the very low sensitivity areas as far as possible. No further loss of high sensitivity areas should be permitted.
- All construction/operational and access must make use of the existing roads as far as possible.
- Identified protected or SCC flora species that will be impacted upon must be relocated by a suitably qualified environmentalist / ecologist.
- The exploration activities may only be undertaken within the assessed corridors i.e. 50 corridors for seismic transects and 1km corridors for drilling wells.
- Should additional seismic surveys and/or drilling wells fall outside of the assessed footprint areas, but within the Exploration Right, then depending on the final location of the seismic survey / drill site with respect to the locations sensitivity as defined by the Sensitivity maps, and in consultation with the ECO and relevant specialists, the following must be undertaken prior to surveying / drilling:
  - In low sensitive areas, the conditions of the EMPr must be complied with;
  - In medium sensitive areas, the respective specialists must be brought to site to assess the final seismic survey / drill site and surroundings (1km radius around the site) and develop site. Furthermore, the conditions of the EMPr must be complied with; and
  - In high sensitive areas, the respective specialists must be brought to site to assess the seismic survey / drill sites and surroundings (with relevant buffer zones, e.g. 1km radius for wetlands, etc.) and develop site specific mitigation measures. These measures (site specific EMPr conditions) must be submitted to the PASA for approval prior to commencement with the seismic survey / drilling operations.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- A walkdown by a qualified independent ECO must be undertaken at final drilling sites and along final seismic transects as part of the preconstruction survey. The ECO must advise on additional mitigation measures where applicable.
- A walkdown by a suitable specialist (ecologist) must be undertaken along final seismic transects as part of the preconstruction survey. The specialist must investigate and/or confirm presence of SCCs. Should any SCCs be identified, the specialist must provide additional mitigation measures to avoid impacts on the identified SCCs. Permits / Licenses must be obtained prior any disturbance and/or relocation of SCCs.

7.3.12 IMPACTS ON NATURAL HABITAT

This section presents the identified potential impacts on natural habitats as per the Terrestrial Biodiversity Assessment undertaken by The Biodiversity Company (**Appendix F**).

7.3.12.1 DESCRIPTION OF IMPACT

As indicated in **Section 4.9.6.1** there are six (6) identified habitats in the area namely, Alluvial Vegetation, Water Resources, Disturbed Vaal Vet Sandy Grassland, Degraded Vaal Vet Sandy Grassland, Secondary Vaal Vet Sandy Grassland, and Modified Habitat.

The proposed drilling activities on site will lead to localised disturbance to an area approximately 50 x 50 m per well with a total of 5 exploration wells across the entire study area. There will possibly also be damage to habitats associated with travelling from existing access routes to sites selected for wells. The activities will fragment these habitat units regarded as important, not only within the within the local landscape, but also regionally as they are used for habitat, foraging and movement corridors for fauna within a landscape fragmented by agriculture and mining to more natural areas where they may reproduce. The impact ratings associated with the proposed drilling activities related to natural habitat are indicated in **Table 67**.

The proposed activities on site will lead to localised disturbance of approximately 70 km seismic transects across the entire study area. There will possibly also be damage to habitats associated with travelling from existing access routes to sites selected for seismic transects. The activities will fragment these habitat units regarded as important, not only within the within the local landscape, but also regionally as they are used for habitat, foraging and movement corridors for fauna within a landscape fragmented by agriculture and mining to more natural areas where they may reproduce. The impact ratings associated with the proposed seismic activities related to natural habitat are indicated in **Table 67**.

7.3.12.2 IMPACT RATING

Table 67: Summary of impacts related to natural habitat (The Biodiversity Company, 2026).

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction **(Seismics and Drilling)**	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration **(Seismics and Drilling)**	Negative	Medium to High	Low	Low
Decommissioning / Rehabilitation **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low

7.3.12.3 CUMULATIVE IMPACT

The activities will result in a loss of natural habitat units regarded as important, not only within the within the local landscape, but also regionally as they are used for habitat, foraging and movement corridors for fauna within a landscape fragmented by agriculture and mining to more natural areas where they may reproduce. However, due to the small scale of clearing required for the proposed activities, the short duration thereof and the rehabilitation that will occur, this impact has a low negative significance upon implementation of the mitigation measures.

7.3.12.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on natural habitat due to the proposed activities are provided below.

Existing approved relevant management and mitigation measure (**Appendix F**):

- Minimise vegetation clearance. Existing gravel roads must be used as far as possible, and the closest disturbed areas must be considered for drill pads. Clearance of vegetation must be kept to the required footprint (i.e. 50 x 50 m drill pad). Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed. A vegetation clearance management plan should be compiled prior commencement of activities which at minimum should state how the minimisation with be managed based on the affected environmental aspect or phase of the exploration.
- Rehabilitation of the disturbed areas must be made a priority. Any disturbed area must be re-habilitated to its pre-disturbed state. Any disturbed area must be re-habilitated to its pre-disturbed state as defined in the pre-drill survey. Disturbed areas must be rehabilitated to support its post-closure land use, and this must be undertaken within six (6) months post drilling activities.
- An Invasive Species Management Plan must be compiled and implemented during the lifecycle of the project.
- All construction/exploration and access must make use of the existing roads as far as possible.
- A suitable qualified Environmental Officer (EO) or Environmental Compliance Officer (ECO) must be appointed prior to the construction / exploration phase. If the final seismic transect route and/or the drilling location changes from the currently proposed areas, but within the assessed footprint and is situated within the high sensitive area, the EO / ECO must undertake final walkdown along the specific final planned transect route/s and drilling location/s in order to ensure that no sensitive vegetation or floral SCC are to be impacted.
- Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed further.
- Areas rated as High sensitivity outside of the direct development areas should be declared as 'no-go' areas during the life of the project, and all efforts must be made to prevent development access to these areas from construction workers and machinery.
- All laydown, chemical toilets etc. should be restricted to low / medium sensitivity areas. Any materials may not be stored for extended periods of time and must be removed from the project area once the construction/exploration phase has been concluded.
- The exploration activities may only be undertaken within the assessed corridors i.e. 50 corridors for seismic transects and 1km corridors for drilling wells.
- Should additional seismic surveys and/or drilling wells fall outside of the assessed footprint areas, but within the Exploration Right, then depending on the final location of the seismic survey / drill site with respect to the locations sensitivity as defined by the Sensitivity maps, and in consultation with the ECO and relevant specialists, the following must be undertaken prior to surveying / drilling:
    - In low sensitive areas, the conditions of the EMPr must be complied with;
    - In medium sensitive areas, the respective specialists must be brought to site to assess the final seismic survey / drill site and surroundings (1km radius around the site) and develop site . Furthermore, the conditions of the EMPr must be complied with; and
    - In high sensitive areas, the respective specialists must be brought to site to assess the seismic survey / drill sites and surroundings (with relevant buffer zones, e.g. 1km radius for wetlands, etc.) and develop site specific mitigation measures. These measures (site specific EMPr conditions) must be submitted to the PASA for approval prior to commencement with the seismic survey / drilling operations.

New relevant management and mitigation measures:

- A walkdown by a qualified independent ECO must be undertaken at final drilling sites and along final seismic transects as part of the preconstruction survey. The ECO must advise on additional mitigation measures where applicable.

7.3.13 IMPACTS ON FAUNAL SPECIES

This section presents the identified potential impacts on fauna species as per the Terrestrial Biodiversity Assessment undertaken by The Biodiversity Company (**Appendix F**).

7.3.13.1 DESCRIPTION OF IMPACT

As indicated in **Section 4.9.6.3**, various mammal species recorded for the ER during the field survey are presented in **Table 21** below. Additional common mammal species are expected for the ER. One mammal SCC was recorded, namely *Leptailurus serval* (Serval). Although no reptile or amphibian species were recorded for the ER, common reptile and amphibian species are expected for the ER. It should also be noted that SCC *Pyxicephalus adspersus* (Giant Bull Frogs may also occur within the ER. Thirty (30) species of bird were recorded for the ER during the survey based on either direct observation, vocalisations, or the presence of visual tracks and signs (**Table 22**). Three species namely *Anas undulata* (Yellow-billed Duck), *Elanus caeruleus* (Black-winged Kite), and *Scopus umbrette* (Hamerkop) are SCC. These species are likely to make use of the water resource and the surrounding grassland habitats.

Localised loss of modified habitat may occur within the remaining areas providing shelter for faunal species due the clearance of vegetation for new temporary access roads, drilling pads, vibroseis, vehicular movement and drilling. The loss of habitat will directly result in the loss of fauna community (i.e., mammals and birds). Disturbance and mortalities of fauna species such as amphibians, reptiles and birds are anticipated. Loss of habitat also means loss of food and nesting resources, cover and movement corridors, which could lead to the disappearance of the affected species from the area. The impact ratings associated with the proposed exploration activities related to fauna species are indicated in **Table 68**.

7.3.13.2 IMPACT RATING

Table 68: Summary of impacts related to fauna species (The Biodiversity Company, 2026).

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction **(Seismics and Drilling)**	Negative	Medium to High	Low	Low
Construction / Exploration **(Seismics and Drilling)**	Negative	Medium to High	Low	Low
Decommissioning / Rehabilitation **(Seismics and Drilling)**	Negative	Medium to Low	Low	Low

7.3.13.3 CUMULATIVE IMPACT

Five (5) mammal species and thirty (30) avifauna species were recorded in the project area during the survey based on either direct observation, vocalisations, or the presence of visual tracks & signs. Four of the fauna species are SSCs. Although these species may be negatively impacted due to the construction / exploration, there is a high likelihood that they can easily relocate to the adjacent properties and may even resettle during the post exploration phase of the project. The cumulative impact for impact on fauna species is, therefore, expected to be low with mitigation.

7.3.13.4 **PROPOSED MITIGATION MEASURES**

The proposed mitigation measures to avoid adverse impacts on fauna species due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- The duration of the construction / exploration should be minimized to as short term as possible, to reduce the period of disturbance on fauna.
- Noise must be kept to an absolute minimum during the evenings and at night to minimize all possible disturbances to amphibian species and nocturnal mammals.
- No trapping, killing, or poisoning of any wildlife is to be permitted on site.
- Outside lighting should be designed and limited to minimize impacts on fauna.
- Rehabilitation of the disturbed areas must be made a priority. Any disturbed area must be re-habilitated to its pre-disturbed state. Any disturbed area must be re-habilitated to its pre-disturbed state as defined in the pre-drill survey. Disturbed areas must be rehabilitated to support its post-closure land use, and this must be undertaken within six (6) months post drilling activities.
- All construction/operational and access must make use of the existing roads as far as possible.
- Construction impacts associated with the proposed project must be contained within the footprint of the demarcated areas as indicated on the final approved project layout plan.
- A suitable qualified Environmental Officer must be appointed prior to the construction / exploration phase. The EO must undertake walkdowns / surveys along the final planned transect routes and drilling locations in order to ensure that no sensitive, protected or SCC fauna species are to be directly impacted
- Identified protected or SCC fauna species that will be impacted upon must be relocated by a suitably qualified environmentalist / ecologist.
- Areas of indigenous vegetation, even secondary communities outside of the direct project footprint, should under no circumstances be fragmented or disturbed further.
- Areas rated as High sensitivity outside of the direct development areas should be declared as 'no-go' areas during the life of the project, and all efforts must be made to prevent impacts / access to these areas from construction workers and machinery.
- The exploration activities may only be undertaken within the assessed corridors i.e. 50 corridors for seismic transects and 1km corridors for drilling wells.
- Should additional seismic surveys and/or drilling wells fall outside of the assessed footprint areas, but within the Exploration Right, then depending on the final location of the seismic survey / drill site with respect to the locations sensitivity as defined by the Sensitivity maps, and in consultation with the ECO and relevant specialists, the following must be undertaken prior to surveying / drilling:
  - In low sensitive areas, the conditions of the EMPr must be complied with;
  - In medium sensitive areas, the respective specialists must be brought to site to assess the final seismic survey / drill site and surroundings (1km radius around the site) and develop site . Furthermore, the conditions of the EMPr must be complied with; and
  - In high sensitive areas, the respective specialists must be brought to site to assess the seismic survey / drill sites and surroundings (with relevant buffer zones, e.g. 1km radius for wetlands, etc.) and develop site specific mitigation measures. These measures (site specific EMPr conditions) must be submitted to the PASA for approval prior to commencement with the seismic survey / drilling operations.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- A walkdown by a qualified independent ECO must be undertaken at final drilling sites and along final seismic transects as part of the preconstruction survey. The ECO must advise on additional mitigation measures where applicable.
- A walkdown by a suitable specialist (ecologist) must be undertaken along final seismic transects as part of the preconstruction survey. The specialist must investigate and/or confirm presence of SCCS. Should any SCCs be identified, the specialist must provide additional mitigation measures to avoid impacts on the identified SCCs. Permits / Licenses must be obtained prior any disturbance and/or relocation of SCCs.

7.3.14 IMPACTS ON CULTURAL HERITAGE FEATURES

This section presents the identified potential impacts on archaeological and cultural heritage as per the Heritage Impact Assessment by Dr James (**Appendix F**).

7.3.14.1 DESCRIPTION OF IMPACT

As described in previous sections, finds include the identified 32 structures, buildings, or complexes, two large in-situ colonial period artefacts as well as six grave sites. Some of these features were identified occurring along the seismic transects, as well as in the proposed well Target Areas. It is unlikely that these features will be disturbed by the proposed activities as they can be easily avoided. It is here proposed that buffers be placed around each of these features, with proposed activities not taking place within 30 meters of the buildings or structures, and 50 meters of the grave sites. It is here argued that the features should be avoided, and in doing so, there will be little to no impact on the features. The impact assessment methodology has therefore been applied considering scenarios where the proposed activities would impact identified features.

Two Grade II provincial heritage features were also identified intersecting with the ER Area. Proposed activities, particularly the proposed seismic survey transects, intersect with the assigned 2km buffers of these features. It is argued that due to the nature of the proposed seismic activities, the project will have no impact on these features nor the sense of place the buffers aim to preserve.

While the features identified represent markers of heritage significance (in particular, ruins and graves), the occurrence of below-ground heritage finds may be possible. For this reason, as a mitigation measure proposed, a Heritage Finds or Chance Find Procedure for addressing heritage finds must be adopted as part of construction processes. Should finds of an alarming significance, for example, a grave or high density of small finds be discovered during construction, this procedure will inform the next steps taken to ensure the documentation of these finds, and further action to be taken should a heritage professional deem necessary.

Altogether, post-mitigation of the identified heritage impacts is rated a Medium to Low Negative (refer to **Table 69**), given that the impacts can be avoided, and the potential for a heritage procedure to allow for the documentation, recording, and further assessment of undiscovered finds and sites. A heritage procedure can present opportunity to limit the impact of development on heritage finds to construction activities, with the potential to document and further assess finds should they be related to broader sites. This ultimately presents opportunity to reverse the adverse effects of development of heritage finds, given that their value can be evaluated through documentation. This also presents opportunity to better understand the heritage significance of the area to be developed.

7.3.14.2 IMPACT RATING

Table 69: Summary of impacts related to archaeological and cultural heritage (Dr James, 2026).

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics & Drilling)	Destruction of disturbance of structures and artefacts older than 60 years	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Low
Pre-Construction (Seismics & Drilling)	Destruction or disturbance of identified graves	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Low
Pre-Construction (Seismics & Drilling)	Destruction or disturbance of undiscovered below-ground heritage features.	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			Medium to High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Low

7.3.14.3 CUMULATIVE IMPACT

The main impact on archaeological sites/ remains will be the physical disturbance of the material and its context. The clearing of vegetation for the proposed activities will expose, disturb and displace archaeological sites / material. However, from the specialist investigations, it appears that the cultural heritage features are easily identifiable and with the 30m recommended buffer, these will ideally be not impacted upon. However, there is always a risk of impacts on new discoveries during the construction / exploration phase which will impact on irreversible loss of cultural heritage features. Therefore, the cumulative impact on heritage resources is medium negative.

7.3.14.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on archaeological and cultural heritage due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- Should additional seismic surveys and/or drilling wells fall outside of the assessed footprint areas, but within the Exploration Right, then depending on the final location of the seismic survey / drill site in relation to known heritage features (less than 500m from a known heritage feature), a public participation process must be implemented during which the Interested & Affected Parties are invited to come forward and state whether they are aware of any sacred water sites (secret or not) located within a 500m radius area from each proposed exploration positions.

- The planning of all additional exploration footprints must take cognizance of the heritage sensitivities depicted on the heritage sensitivity maps. To the extent possible, identified heritage sensitivities must be avoided in the establishment of additional exploration footprints.
- An independent and suitably qualified ECO must be appointed and must train the Contractor to recognise potential heritage features.
- All archaeological structures be retained and avoided with a buffer zone of 30m as per SAHRA guidelines. If this is not possible, the graves could be relocated after completion of a detailed grave relocation process, that includes a thorough stakeholder engagement component, adhering to the requirements of s36 of the NHRA and its regulations as well as the National Health Act and its regulations.
- Should any heritage features be exposed during excavation, work on the area where the artefacts were discovered, shall cease immediately and the ECO shall be notified within 24hours, and a Chance Find Protocol must be implemented. The responsible heritage resources authority (FSPHRA), as well as the South African Police Service (SAPS) must be notified within 72hours.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- A walkdown by a qualified archaeologist must be undertaken at final drilling sites and along final seismic transects as part of the preconstruction survey. The archaeologist must advise on additional mitigation measures should any heritage features be identified along the seismic transects and/or drilling site.
- A 50m buffer around all identified graves must be implemented within which no proposed activities are to take place.

7.3.15 IMPACTS ON PALAEONTOLOGICAL HERITAGE FEATURES

This section presents the identified potential impacts on palaeontological heritage as per the Palaeontological Impact Assessment by Dr Fourie (**Appendix F**).

7.3.15.1 DESCRIPTION OF IMPACT

No fossiliferous outcrop was detected in the proposed footprint by the specialist. This could be attributed to the lack of outcrops as well as the lush grassy vegetation in the area. Based on the site investigation as well as desktop research it is concluded that fossil heritage of scientific and conservational interest in the development footprint is rare. However, fossils can occur in dongas, as nodules, in fresh rock exposures, and in riverbeds. Finding fossils require the experience and technical knowledge of the professional palaeontologist, but that does not mean that an amateur can’t find fossils. The geology of the region was used to predict what type of fossil and zone will be found in any particular region. Archaeozoologists concentrate on more recent fossils in the quaternary and tertiary deposits.

Threats to palaeontological resources are earth moving equipment/machinery (for example haul trucks, drilling rigs, vibroseis, front end loaders, excavators, graders, dozers) during drilling and seismic activities. The impact ratings associated with the proposed drilling and seismic activities related to palaeontological heritage are indicated in **Table 70**.

7.3.15.2 IMPACT RATING

Table 70: Summary of impacts related to palaeontological heritage (Dr Fourie, 2026).

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score

Pre-Construction (Seismics & Drilling)	Negative	Medium to Low	Low	Medium to Low
Construction / Exploration (Seismics & Drilling)	Negative	Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)	Negative	Medium to Low	Low	Low

7.3.15.3 CUMULATIVE IMPACT

The main impact on palaeontology remains (if any) will be the physical disturbance of the material and its context. The clearing of vegetation, excavations and/or drilling may expose, disturb and displace archaeological sites/material. However, there are no known palaeontological features on site and an impact (if any) will be local and not result in extensive significant loss of palaeontological features in the regional scale as there will likely be more similar features in the extended area. Therefore, the cumulative impact on palaeontological resources is low negative with mitigation.

7.3.15.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on palaeontological heritage due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- The planning of all additional exploration footprints must take cognizance of the heritage sensitivities depicted on the heritage sensitivity maps.
- Once the drilling sites are final, the applicant should invite a professional palaeontologist to monitor drilling samples for subsurface fossil remains that may be intersected by the drilling process.
- The palaeontologist must apply for a valid permit from SAHRA for the collection / removal of fossils if necessary.
- All known heritage features should be retained and avoided with a buffer zone of 30m as per SAHRA guidelines. If this is not possible, the graves could be relocated after completion of a detailed grave relocation process, that includes a thorough stakeholder engagement component, adhering to the requirements of s36 of the NHRA and its regulations as well as the National Health Act and its regulations;
- An independent and suitably qualified ECO must be appointed and must train the Contractor to recognise potential palaeontological features; and
- Should any palaeontological features be exposed during excavation, work on the area where the artefacts were discovered, shall cease immediately and the ECO shall be notified within 24hours, and a Chance Find Protocol must be implemented. The responsible heritage resources authority (FSPHRA), as well as the South African Police Service (SAPS) must be notified within 72hours.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- None.

7.3.16 IMPACTS ON HEALTH AND SAFETY OF THE COMMUNITY

This section presents the identified potential impacts on health and safety of the community sourced from potential impacts on the various specialist studies.

7.3.16.1 DESCRIPTION OF IMPACT

The exploration activities (drilling and seismic) may have health and safety implications for the personnel that will be working on the project. Required access to the property for exploration activities may result in a risk to the safety and security of landowners, lawful occupiers, and community members due to the increase in number of unfamiliar people in the area. Property gates may also be left open resulting in the robbery, loss or theft of livestock. The drilling activities may also expose gases which may ignite during the project causing fire that may result in loss of fauna and flora, livestock and/or human life. The impact ratings associated with the proposed exploration activities related to health and safety of the community are indicated in **Table 71**.

7.3.16.2 IMPACT RATING

Table 71: Summary of impacts related to health and safety of the community.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics & Drilling)	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)	Negative	Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)	Negative	Medium to Low	Low	Low

7.3.16.3 CUMULATIVE IMPACT

Based on information obtained from the herders during the site inspection, there will relatively low crime in the area and the last unnatural fire event was several years ago. Therefore, with the proposed mitigations, it is anticipated there will low negative cumulative impacts as there will be an implementation of security as well as fire control.

7.3.16.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts health and safety due to the proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the activities in the same region adopted for the proposed activities (**Appendix F**):

- All farm gates must be closed immediately upon entry/exit.
- Fencing of all drill sites with security access control and warning signs.
- All drilling sites must be properly sealed to trap gases from escaping. Wells should be plugged to prevent crossflow of gas into aquifers and isolate all potential hydrocarbon / water bearing formations by utilizing placed cement plugs extending at least 30m above and below the reservoir.
- There must be access control to the entry / exit points of the exploration sites.
- Vehicles should be clearly marked as construction vehicles.
- The Applicant must ensure that the Emergency Preparedness and Response Plan make provision for environmental emergencies, including, but not limited to:
  - Fire Prevention;
  - Fire Emergency Response;
  - Spill prevention;
  - Spill Response;
  - Contamination of a water resource;

- Accidents to employees; and
- Use of hazardous substances and materials, etc.

- The Applicant and Contractor must ensure that lists of all emergency telephone numbers/contact persons (including fire control) are kept up to date and that all numbers and names are posted at relevant locations throughout the lifespan of the project.
- In the event of an emergency incident (unexpected sudden occurrence), including a major emission, fire or explosion leading to serious danger to the public or potentially serious pollution of or detriment to the environment, whether immediate or delayed, the Applicant shall notify the relevant authorities in accordance with legal requirements (e.g. Section 30 of NEMA and Section 20 of the NWA).

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- The Holder should work with the existing and preferred farmers' security group and implement the AgriSA farm access protocol (or equivalent protocol) for everybody that need to access the properties.

7.3.17 IMPACTS ON SOCIO-ECONOMIC DYNAMICS

This section presents the identified potential socio-economic impacts as per the Social Impact Assessment by Equispectives Research & Consulting Services (**Appendix F**).

7.3.17.1 DESCRIPTION OF IMPACT

Social impacts are the result of social change, and to fully understand the potential impacts it is important to know the impact pathways. A social change process is a discreet, observable and describable process that changes the characteristics of a society, taking place regardless of the societal context (that is, independent of specific groups, religions etc.). Social change processes can be measured objectively. The way in which social change processes are perceived, given meaning or valued, depend on the social context in which various societal groups act. Some groups in society are able to adapt quickly and exploit the opportunities of a new situation. Others (e.g. vulnerable groups) are less able to adapt and will bear most of the negative consequences of change. These social change processes may, in certain circumstances and depending on the context, lead to the experience of social impacts. Social impacts are therefore completely context-dependent (Vanclay, 2003).

7.3.17.1.1 IMPACT ON FARMING COMMUNITY LIVELIHOODS AND INTERFERENCE WITH EXISTING LAND USES

The proposed exploration activities within ER386, which include gas well drilling, seismic surveys, and vegetation clearing, pose an impact on the livelihoods of the local farming communities. A livelihood refers to the way of life of a person or household and how they make a living, in particular, how they secure the basic necessities of life, e.g., their food, water, shelter and clothing, and live in the community (Vanclay et al., 2015). The project area is characterised by high levels of commercial agriculture which is the main livelihood sources for affected communities in the area who are primarily involved in crop farming (mainly maize, soya, sunflowers) and livestock farming (cattle, game, and sheep). These activities are highly dependent on the sustainable use of land, soil quality, water availability, and uninterrupted access to farming areas throughout specific agricultural seasons.

Drilling in a farmer's field or part of the field can render the land unusable for agricultural production for up to two years, primarily due to soil compaction caused by heavy machinery. This physical disruption affects not only soil health but also the farmer's ability to sustain regular planting cycles, impacting financial resource and livelihoods. The land typically requires rehabilitation, often through mechanical loosening before it can support crops again.

7.3.17.1.2 WATER CONTAMINATION AND GROUNDWATER SAFETY

Concerns about water contamination and the safety of groundwater came up consistently during community consultations, with many affected stakeholders viewing it as one of the most serious risks of the proposed gas exploration activities. In the project area which includes both urban townships and nearby farms around Welkom, Virginia, Hennenman, and Odendaalsrus people rely heavily on boreholes for drinking water, farming, and daily household use. For many landowners and workers, borehole water is not just a supplementary or backup resource but often the sole reliable water source for households, livestock, and crops, especially in areas where municipal service delivery is inconsistent or absent. In this context, the potential for contamination due to gas exploration activities is perceived as a direct threat to livelihoods and public health.

Farmers and residents expressed concern that the drilling of core wells, installation of casing and cement barriers, and execution of seismic surveys could lead to unintended breaches or leakage pathways that allow contaminants whether chemical residues, dust, disturbed heavy metals, or surface pollutants to enter the groundwater system. Even though D3 Energy plans to seal the wells with steel pipes and cement after exploration, there is a concern about whether these measures will hold up over time. Some boreholes in the area are quite shallow (as little as 17 meters deep, according to one farmer), and landowners fear they would easily be contaminated if the drilling and exploration process is not well managed. Research has shown that poorly constructed or aging well infrastructure can result in vertical migration of contaminants into aquifers, particularly in regions with high water dependency and shallow groundwater tables (Vidic et al., 2013).

7.3.17.1.3 DAMAGE TO FARM ROADS, EXISTING SERVICES AND INFRASTRUCTURE

D3 Energy exploration activities will need to use the existing farm road to access the identified drilling wells. Farm roads, which are often unpaved or only lightly maintained gravel pathways, are integral to the day-to-day operations of agricultural enterprises. They facilitate the movement of agricultural machinery, transportation of produce, and access to critical resources such as water points, feed storage, and livestock enclosures. Unlike public roads maintained by local authorities, these roads are typically privately maintained by farmers themselves and are therefore more vulnerable to deterioration under the pressure of heavy machinery and increased vehicle traffic associated with exploration activities.

The introduction of large and frequent vehicle movements, such as trucks transporting drilling equipment, seismic survey machinery such as vibroseis trucks, and other operational support vehicles, places stress on these roads. This can lead to potholing, rutting, dust generation and surface erosion. Infrastructure damage, in this context, refers to the unintentional physical impact on above or below-ground facilities such as water pipelines, boreholes, cattle watering points, gates, and fencing. For example, a broken water pipeline due to heavy vehicle crossing can interrupt irrigation cycles or create water scarcity for livestock.

7.3.17.1.4 DISTRUST FROM PREVIOUS DEVELOPMENT PROJECTS

Local landowners and farmers expressed a sense of distrust stemming from past experiences with other development projects mainly mining and renewable energy projects. There is a shared sentiment among farmers that previous developers often neglected to restore the land to its original condition after project activities concluded, resulting in long-term negative effects on agricultural productivity. For example, in areas previously disturbed by drilling, landowners observed diminished crop yields and changes in soil performance, which directly affect their income and food production capabilities. This poor follow-through on environmental restoration commitments has not only led to financial losses but has also created a perception that companies prioritise extraction over sustainable land stewardship.

This lingering distrust is compounded by the perception that external developers tend to approach local engagements with a “tick-box” mentality, obtaining agreements or access without adequate follow-up, accountability, or ongoing communication. Several farmers indicated that they or their family members had previously signed agreements without fully understanding the long-term implications, leading to unfavourable outcomes that now serve as cautionary tales. Consequently, affected parties are now demanding stronger assurances, including written documentation outlining the scope and limits of exploration activities, clearly defined timelines, and commitments to meaningful post-activity restoration. The expectation going forward is that exploration proponents such as D3 Energy must not only meet technical and environmental standards but also rebuild confidence through transparency and consistent, respectful engagement.

7.3.17.1.5 INCREASE IN POACHING INCIDENTS AND LIVESTOCK THEFT

There are game and livestock farms located within the exploration right area with wells indicated to be drilled on their properties. Exploration activities typically involve the movement of personnel, vehicles, and equipment across multiple farm portions, which can create new access points to previously secure or isolated areas. This increased movement on and off properties if not properly regulated, can weaken existing security systems, making it difficult for landowners to monitor who is entering or leaving the farm. With multiple contractors and vehicles present, unauthorised individuals can exploit the operational cover to trespass or target livestock without immediate detection. Livestock or game farm properties that host vulnerable animal populations such as sheep, valued for their meat and often lightly guarded may be at risk during periods of active exploration.

7.3.17.1.6 IMPACTS ON SAFETY AND SECURITY OF RESIDENTS

Safety and security emerged as a significant concern among all affected landowners. Given the prevailing socio-economic and political conditions in South Africa, individuals residing in remote farming areas are particularly vulnerable to crime and violence. The introduction of unfamiliar personnel through the project may increase this risk, as these individuals could unintentionally share sensitive information about local conditions with outsiders or opportunistic criminals. With farms often stretched over large areas and having multiple entry points, the absence of clearly communicated access arrangements could compromise both the personal safety of residents and the security of their property, including crops, livestock, and equipment.

Farmers noted the importance of knowing who is entering their property, for what purpose, and for how long. Without this information being shared in advance, it becomes difficult to distinguish between authorised project-related movements and unauthorised intrusions. The residents expressed concern that the burden of safeguarding both their property and the project's equipment might unintentionally fall on them, unless the proponent establishes a clear, accountable site security plan. There is a need for a dedicated contact person responsible for ongoing updates and rapid response to security concerns. In previous developments in the region, poor communication often led to misunderstanding, fear, and resistance.

7.3.17.1.7 OVERLAPPING LAND USE WITH RENEWABLE ENERGY PROJECTS

A key concern raised during consultations was the overlap between the proposed gas exploration areas and land portions already earmarked, authorised or leased for renewable energy projects mainly solar farms and vice versa. Several landowners indicated that they have signed option agreements or are in advanced discussions with solar energy companies. This overlap introduces a layer of complexity in land management and planning, as it may compromise the implementation of already approved renewable energy projects or limit the available land area for these developments.

These overlapping claims raise legal and social concerns for landowners, who feel they are now caught up in the middle of competing development interests. Without clear agreements, landowners are placed at risk of reputational damage, legal disputes, or income loss especially if one project delays or undermines the viability of another. This uncertainty can discourage investment in renewable energy, disrupt contractual obligations between landowners and energy developers, and create tension between project proponents (gas and solar) vying for use of the same land (Hurlbert & Gupta, 2016).

In addition, if proper coordination is not achieved, the perceived prioritisation of extractive activities, such as gas exploration, over renewable energy projects may undermine public trust in environmental governance structures and raise broader environmental and social justice concerns (McCauley, & Heffron 2018). Communities may question whether development decisions truly align with national sustainability goals or are instead influenced by short-term economic interests. This issue is particularly relevant in South Africa, where there is a growing shift toward clean energy as part of the country's Just Transition framework

7.3.17.1.8 GENDER AND SOCIAL INCLUSION IMPACTS

One of the key social dimensions identified during the consultation process is the issue of gender inequality and the exclusion of women and other vulnerable groups from decision-making processes and the distribution of project benefits. Although communities living within and around the ER386 exploration area are hopeful about potential job creation, particularly if the project moves to production phase, participants noted that women are often left out when these opportunities arise. This exclusion reinforces existing gender inequalities, particularly in rural and farming communities where access to diverse income-generating activities, land rights, and technical training is already limited for women.

The consulted stakeholders noted that women are being left out of job opportunities or engagement processes, despite their active roles in farming households and community life. In many rural settings, women are not only caretakers but also central to agricultural production, small-scale enterprise, and environmental stewardship. Failing to consider their roles and perspectives risks undermining their insights and experience which might aid to the sustainability of the project. The IFC recommends early engagement of women in project planning and implementation to avoid reinforcing systemic exclusion and to leverage their unique insights, especially in relation to environmental resource use, household livelihoods, and community health, issues particularly sensitive in agricultural regions like those covered under ER386. The project presents an opportunity to promote gender inclusion by ensuring that both men and women are actively involved in all stages of the project consultation, monitoring, employment, and capacity building. Addressing gender-based disparities through inclusive employment practices not only improves social equity but can also contribute to reducing gender-based violence (GBV), which is often linked to economic dependence and marginalisation. Women in the area are already underrepresented in formal employment and when opportunities related to new projects become available, they are disproportionately offered to men. Women should be given priority consideration for skills development, employment, and leadership roles.

7.3.17.1.9 JOB CREATION AND LOCAL ECONOMIC EXPECTATIONS

In the long run, the outcomes of the proposed project may create positive economic impacts in the area. The communities around the proposed area have high expectation for job creation as a direct result of the proposed gas exploration activities. In a context marked by widespread unemployment, particularly among youth, stakeholders indicated that the project is seen as a potential avenue for employment, skills development, and improved livelihoods. This expectation is rooted not just in economic necessity, but also in the hope that new development initiatives will offer long-term socioeconomic benefits to local people, especially as legacy mining operations such as Harmony which have predominantly employed majority of people in local communities begin to wind down. Given that the exploration activities will create very limited opportunities, it is critical that the community expectations about job creation must be managed.

Beyond direct employment, the project presents a short-term limited opportunity to stimulate local business development and procurement. Small and medium enterprises (SMEs) involved in catering, accommodation, transport, construction, and equipment supply can benefit through local sourcing agreements. Prioritising procurement from black-owned, women-owned, and community-based businesses can contribute to the limited developmental benefits of the project. The unrealistically high expectation about opportunities that will be created in the exploration phase is coupled with concerns around equity and fairness in opportunity distribution. There is a sentiment among stakeholders that historically employment and procurement processes were dominated by personal networks, raising fears that only a select few might benefit from the exploration phase, while the majority of disadvantaged and unemployed residents are left out. There is a call for D3 Energy to prioritise local hiring, especially for disadvantaged groups, including women and youth. Stakeholders recommended that job creation efforts be coordinated with legitimate, registered community organisations or Trusts to ensure that opportunities are fairly and equitably shared. This measure will help to manage expectations and build trust with local communities.

While community members acknowledge that exploration activities are not as labour-intensive and long-term based as full-scale production phase, they still expect to be engaged early in any short-term work opportunities, such as land clearing, security, or logistics support. Overall, they see the project is seen as a potential catalyst for socio-economic upliftment provided that employment processes are well-structured, transparent, and inclusive. The impact ratings associated with the proposed exploration activities related to socio-economic dynamics are indicated in **Table 72**.

7.3.17.2 **IMPACT RATING**

Table 72: Summary of impacts related to socio-economic dynamics (Equispectives Research & Consulting Services, 2026)

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pre-Construction (Seismics & Drilling)	Impact on farming community livelihoods and interference with existing land uses	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			Medium to High		Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Water contamination and groundwater safety	Negative	Medium to High	Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			Medium to High	Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to High	Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Damage to farm roads, existing services and infrastructure	Negative	High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to High	Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Distrust from previous development projects	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			Medium to High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to High	Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Increase in poaching incidents and stock theft	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			Medium to High	Medium to Low	Medium to Low

Project Phase	Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to High	Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Impacts on safety and security of local residents.	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			Medium to High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to High	Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Overlapping land use with renewable energy projects	Negative	Medium to High	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)			Medium to High	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to High	Low	Medium to Low
Pre-Construction (Seismics & Drilling)	Gender and social inclusion impacts	Negative	Medium to Low	Low	Low
Construction / Exploration (Seismics & Drilling)			Medium to Low	Low	Low
Decommissioning / Rehabilitation (Seismics & Drilling)			Medium to Low	Low	Low
Pre-Construction (Seismics & Drilling)	Job creation and local economic expectations	Positive	Medium to Low	Medium to Low	Medium to Low
Construction / Exploration (Seismics & Drilling)		Positive	Medium to Low	Medium to Low	Medium to Low
Decommissioning / Rehabilitation (Seismics & Drilling)		Negative	Medium to Low	Medium to Low	Medium to Low

7.3.17.3 CUMULATIVE IMPACT

Employment opportunities for some unskilled, skilled labour as well as providing services during construction (e.g. accommodation, transportation, etc.) may arise from this project. It is important to note that employment opportunities for local will be minimal as the project entails aspects which require qualified and skilled personnel (i.e. vibroseis techniques and drilling). The proposed activities also cover a small footprint and a short period of survey. Therefore, there will be minimal opportunities for locals for tasks largely related to unskilled labour, resulting in low positive cumulative impact on socioeconomics.

7.3.17.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts socio-economy due to the proposed activities are provided below.

Existing approved relevant management and mitigation measure (**Appendix F**):

- All farm gates must be closed immediately upon entry/exit.
- Developer must allow for a transparent employment opportunity for locals.
- Local suppliers and workers must be prioritised as far as possible for economic and professional growth.
- Prior to accessing any portion of land, the Applicant must enter into formal written agreements with the affected landowner. This formal agreement should additionally stipulate landowners special conditions which would form a legally binding agreement.
- Landowners must be notified beforehand of the activities to be undertaken in their properties and requested to indicate the type and location of services within their properties.
- There must be a formal procedure in place on how to report incidents to ensure records of all grievances are kept, and responses are given within a certain time.
- Before the project commences, an asset and services baseline of services that may be affected within 50 m of the exploration area must be compiled. A copy of the baseline records should be given to each landowner/ service provider, and a master document kept by the applicant.
- D3 Energy must appoint a public / landowner liaison officer that must continue to deal with the affected landowners throughout the life of the project.
- The specification of the cement and steel casing that will be used to secure the drilled well and prevent fluid migration and protect freshwater aquifers must be according to the key international standards and best practices.
- Conduct a water quality assessment of all identified boreholes and surface water sources near the exploration sites before any field activity begins. Share results with landowners.
- exploration and drilling be planned for the dry / sunny days to avoid causing additional damage and/or erosion of the gravel access roads due to movement of heavy machinery.
- Develop and implement a Spill Prevention and Response Plan, with adequate resources and capacity in place to ensure its effective implementation. The plan should address potential spill scenarios involving gas, chemicals, and fuel, originating from fixed facilities, transportation vehicles, loading and unloading operation. Ensure onsite staff are trained on emergency spill procedure.

New relevant management and mitigation measures:

- To prevent conflicts between gas exploration activities and pre-existing or planned renewable energy developments, site-specific agreements must be negotiated with affected landowners and renewable energy developers prior to any on-site activities.

- D3 Energy should work with the existing and preferred farmers' security group and implement the AgriSA farm access protocol (or equivalent protocol) for everybody that need to access the properties.
- Co-develop Access and Rehabilitation Agreements outlining duration, extent of disturbance, rehabilitation obligations, biosecurity protocols, and opt-out clauses for landowners.
- Prior to commencement on a property, conduct one-on-one meetings with affected landowners to explain the exact scope and timing of exploration activities on the specific property.
- Maintain regular and proactive communication with landowners to inform them of activities, schedules, and any changes to personnel or site access.
- D3 Energy should adopt a formal recruitment policy that ensures equal access to employment and training opportunities for women and other marginalised groups.
- If the drill pads and/or site camps are fenced, the fences must be checked for snares on a daily basis for the duration of the exploration activities. All incidences must be recorded and the ECO must be informed to advise on additional mitigation measures. Anti-poaching toolbox talks should form part of the induction process of all the fencing teams. Any contractor or employee caught poaching should be removed from site.

8 SENSITIVITY MAPPING

Environmental sensitivity mapping provides a strategic overview of the environmental, cultural and social assets in a region. The sensitivity mapping technique integrates numerous datasets (base maps and shapefiles) into a single consolidated layer making use of Geographic Information System (GIS) software and analysis tools. Environmental sensitivity mapping is a rapid and objective method applied to identify areas which may be particularly sensitive to development based on environmental, cultural and social sensitivity weightings – which is refined by specialists' input within each respective specialist field based on aerial or ground-surveys. Therefore, the sensitivity mapping exercise assists in the identification of sensitive areas within and surrounding the proposed application area. **Table 73** provides an overview of the sensitivity ranking system.

This sensitivity mapping approach allows for the identification of lower risk areas for positioning the project infrastructure whilst protecting identified sensitive environmental areas/ features through more rigorous mitigation (where possible). Areas identified as no-go would be fully excluded from any project related development regardless of the level of mitigation put forward. Furthermore, environmental sensitivity is used to aid in decision-making during consultation processes, forming a strategic part of environmental assessment processes. This sensitivity mapping approach allows for the proposed activities to be undertaken whilst protecting identified sensitive environmental areas / features. Furthermore, environmental sensitivity is used to aid in decision-making during consultation processes, forming a strategic part of Environmental Assessment processes. **Table 73** below provides a breakdown of the sensitivity rating and weightings applied to determine the sensitivity score of each aspect. **Figure 118** presents the combined sensitivity map for the project. Identified sensitivities indicated in **Figure 118 and Figure 119** include the following:

- High Heritage Sensitivity;
- Sensitive air quality receptors;
- Species of conservation concern;
- Natural habitats with high SEI; and
- Wetlands with high PES and SEI and

The compilation of this map has taken into consideration the individual raking of sensitivity by all the identified specialist disciplines (e.g. Air Quality, Geohydrology, Terrestrial and Aquatic Ecology, Heritage, Social, etc.). Work within the various sensitivity rankings must be managed according to the EMPr as well as the recommendations in the individual specialist reports. A desktop sensitivity map (**Figure 120**) was also generated based on latest available datasets to inform the EMPr approach of the procedure to be implemented based on environmental sensitivity of the area should the final drilling activities fall within the ER but outside the assessed areas as part of this EIA:

Should additional seismic surveys and/or drilling wells fall outside of the EA assessed footprint areas, but within ER386, then depending on the final location of the seismic survey / drill site with respect to the locations sensitivity as defined by the sensitivity maps, and in consultation with the ECO and relevant specialists, the following must be undertaken prior to surveying / drilling:

- In low sensitive areas, an ECO walkdown (at minimum) must be undertaken by an independent ECO to assess potential impacts and/or provide site-specific mitigation measures as well as identify any additional specialist input requirements prior the commencement of activities. The conditions of the EMPr (as a minimum) must be complied with;
- In medium sensitive areas, the respective specialists must be brought to site to assess the final drill site and surroundings (1km radius around the site) and develop site-specific mitigation measures. Furthermore, the conditions of the EMPr must be complied with; and
- In high sensitive areas, the respective specialists must be brought to site to assess the final drill sites and surroundings (with relevant buffer zones, e.g. 1km radius for wetlands, etc.) and develop site specific mitigation measures. These measures (site specific EMPr conditions) must be submitted to the PASA for approval prior to commencement with the drilling operations.

Table 73: Sensitivity rating and weighting system.

Sensitivity Rating	Description	Weighting
Least concern	The inherent feature status and sensitivity is already degraded. The proposed development will not affect the current status and/or may result in a positive impact. These features would be the preferred alternative for mining or infrastructure placement.	0
Low	The proposed development will have not have a significant effect on the inherent feature status and sensitivity.	1
Medium	The proposed development will negatively influence the current status of the feature.	2
High	The proposed development will negatively significantly influence the current status of the feature.	3
No-Go	**The proposed development cannot legally or practically take place. No development permitted under any circumstances.**	99

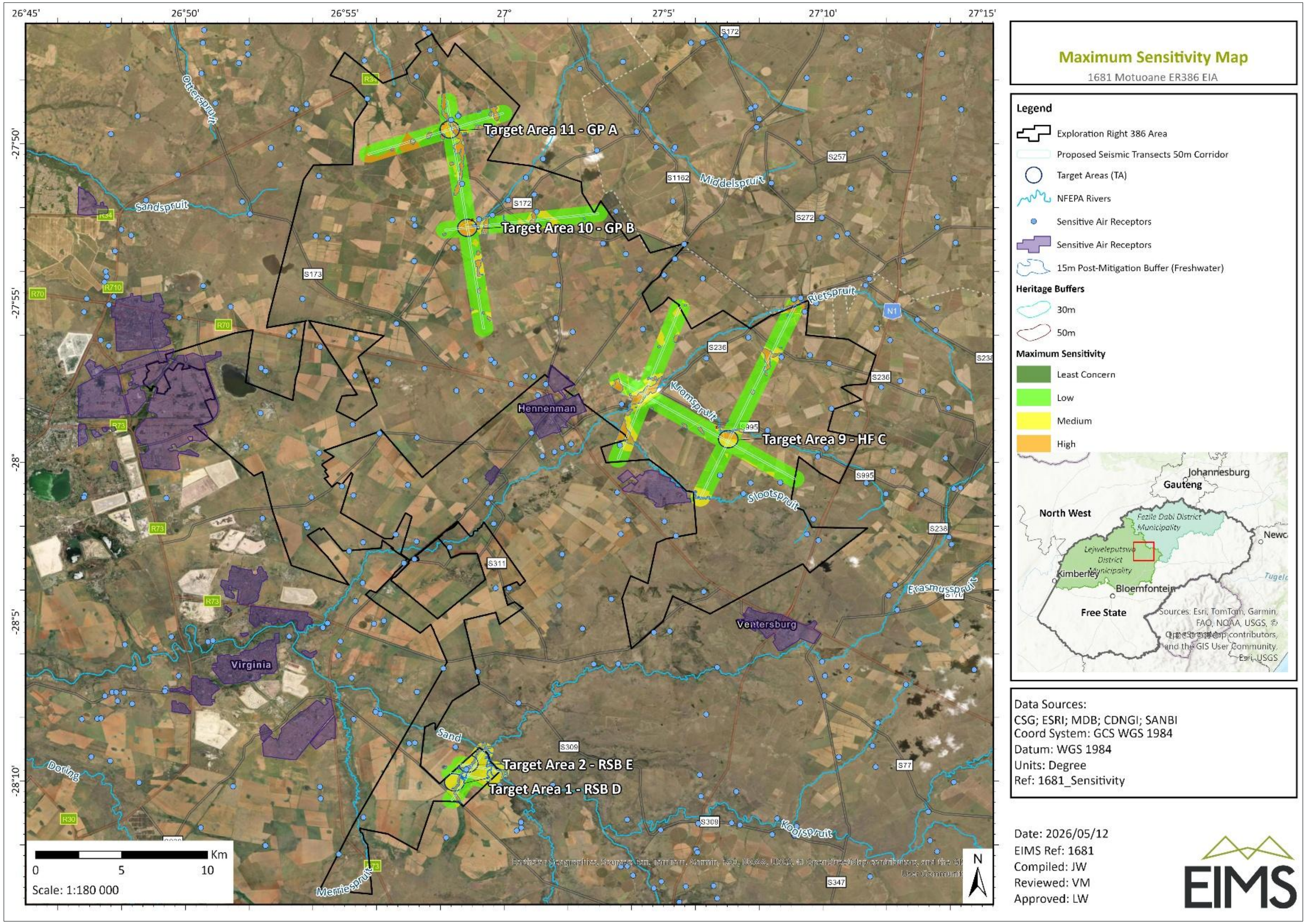


Figure 118: Site-specific maximum sensitivity map.

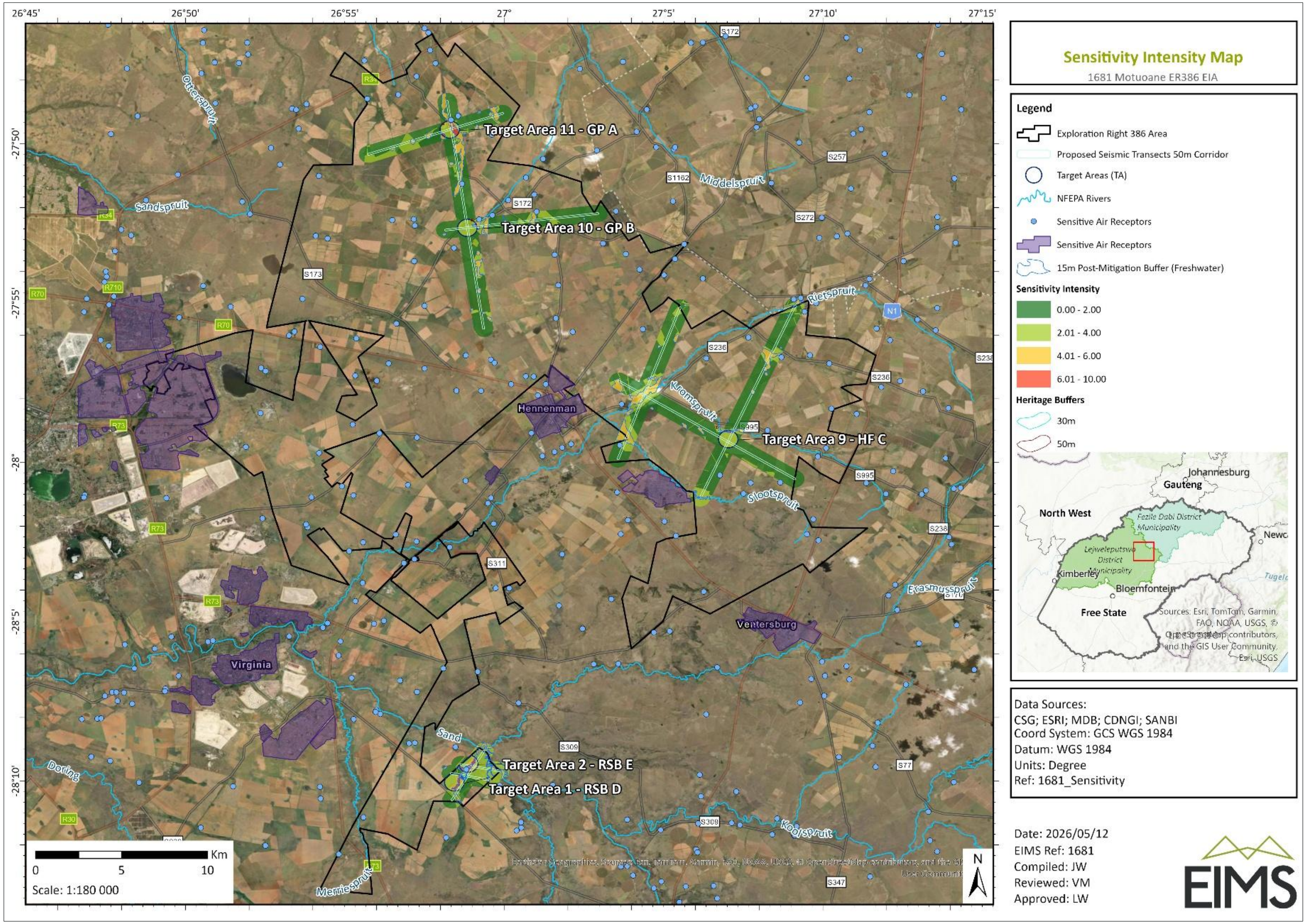


Figure 119: Site-specific sensitivity intensity map.

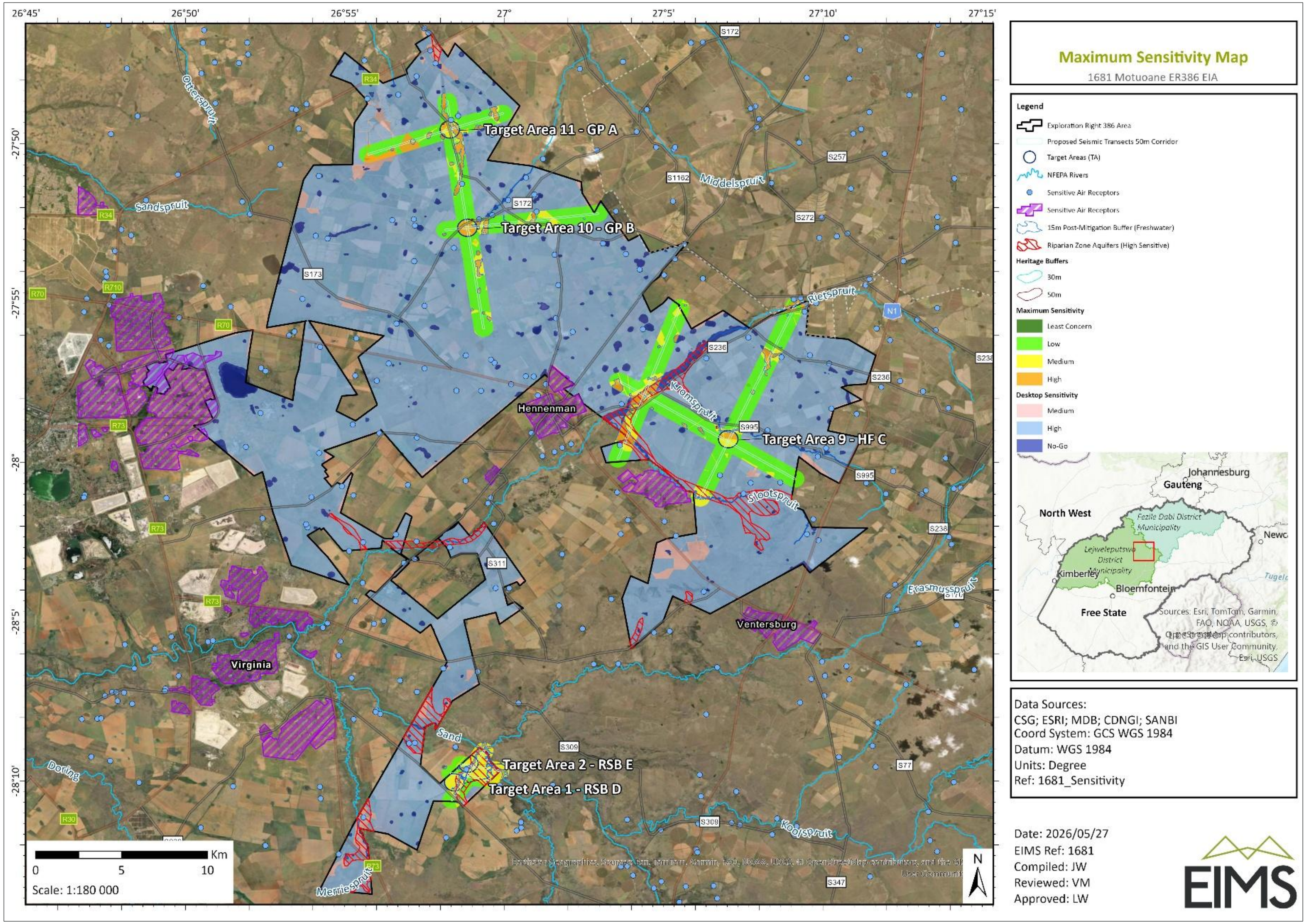


Figure 120: Desktop sensitivity map to inform the procedure should activities fall within the ER but outside of the assessed areas.

9 CLOSURE COSTING

Apart from the short short-term objectives and strategies that will require implementation and monitoring over the full life of mine, even after closure of operation, The specific objectives that the Applicant will adopt for rehabilitation and closure are to:

- Comply with national regulatory requirements;
- Protect the environment and public health and safety by using safe and responsible closure practices;
- Improve water quality;
- Establish self-sustaining vegetation;
- Develop end land uses that incorporate beneficial uses;
- Prevent health and safety risks to the surrounding community;
- Reduce the requirement for long-term monitoring and maintenance by establishing stable landforms;
- Enhance a positive socio-economic impact by achieving a sustainable land-use condition or alternatively as agreed upon with the applicable government regulator and affected communities; and
- Avoid or reduce costs and long-term liabilities to the company, government and public.

EIMS was commissioned to develop a report with conceptual volumes and scheduled and unscheduled NEMA Closure Costing as part of the EIA for the proposed D3 Energy ER386.

It must be noted that funds must be available at any time, equal to the sum of the actual costs of implementing the plans and reports for a period of 10 years (as per Section 7, Chapter 2 of the Financial Provisions Regulations). NEMA Financial Regulations specify a level of accuracy level of 90%, the aim will be to ensure 100% accurate costings for closure at all times. The remainder of this section provides details on the proposed closure cost. Motivation must be provided to indicate the accuracy in the reported number and as accuracy improves, what actions resulted in an improvement in accuracy. The remainder of this section provides details on the proposed closure cost.

The closure cost has been calculated through the following steps:

- Review of available information to inform the closure battery limits for the D3 Energy operation;
- Verify unit rates for infrastructure dismantling and demolition as well as associated rehabilitation of disturbed areas, considering the latest demolition equipment available;
- Develop layout plans indicating existing and proposed infrastructure to be included in the rehabilitation and closure cost estimation;
- Unit rates were sourced from available precedents, inputs from specialists in the field, and experience;
- Rates are based on third-party contractor rates and not mining rates; and
- Apply the verified unit rates and associated quantities measured from the layout plans in spreadsheets to determine the closure costs.
- Methane/natural gas monitoring to be conducted every six months during the post closure period.
- Vegetation monitoring to be undertaken once per year during post-closure phase.

The battery limits for this closure provision assessment are limited to:

- Access roads;
- Well heads;
- Operational, abandoned and suspension wells;
- Fencing and firebreak;
- Temporary Hazardous waste storage;
- Temporary General waste storage; and
- Mobile offices and ablution facilities.

9.1 CLOSURE VISION, OBJECTIVE AND TARGETS

The vision, and consequent objective and targets for rehabilitation, decommissioning and closure, aim to reflect the local environmental and socio-economic context of the project, and to represent both the corporate requirements and the stakeholder expectations.

The receiving environment within which the exploration activities will be undertaken include the following key land-uses:

- Agriculture- cultivated fields;
- Natural and Degraded Veld primarily utilised or livestock grazing;
- Mining areas; and
- Low density rural residential.

With reference to both the environmental context of the project and the feedback from the consultation process the vision for closure is to:

- *Ensure that the post closure land use aligns with the surrounding land-use and does not affect the sustained utilisation of the land.*

In practice the post closure land-use will depend on the pre-exploration land-use applicable to the specific location of the invasive exploration activities. Considering that the exact locations of a large portion of the planned exploration is unknown at this stage, there is a need to revisit and refine this closure plan on a site-specific basis, as and when site specific location are known. This FRDCP does however aim to address the key closure objectives which are likely to remain consistent for the majority of the exploration activities.

Driven by the closure vision and with due consideration of the project context the following closure objectives are presented:

- Set the course for eventual ecosystem restoration, including the restoration of the natural vegetation community, hydrology, and wildlife habitats.
- Prevent future environmental issues related to fluid or gas leakage or lateral movement through the well.
- Protection of water resources.
- Ensure that land is usable, in alignment with surrounding land uses

9.2 ALTERNATIVE CLOSURE AND POST CLOSURE OPTIONS

There are various alternative closure and post closure options available. The identification and consideration of the most suitable alternatives are driven by, inter alia the following considerations:

- The ability of the selected alternative to adequately meet the specified closure vision and objectives.

- The efficiency, viability, and practicality of the selected alternative.
- The alignment with the local environmental and socio-economic context and associated opportunities and constrains.

Table 74 presents some available options and alternatives related to the process of abandoning and closure of a well site. The options in the table below that are marked with an "X" are considered the preferred options.

Table 74: Closure alternatives.

Exploration Activity	Aspect	Options	Comment
Exploration wells	Casing	**Retain**	The retention of the casing is strongly dependant on the nature of the geological strata and location of groundwater aquifer and other permeable zone. The presence of thief zones may also be a hindrance to the removal of a casing string.
		Remove	Casing is often removed in an attempt to recover and salvage the steel. Depending on the nature of the well corrosion of the casing over time may affect the integrity of the plug.
	Plugging extent	**Complete**	The well bore is to be cemented for the full length and diameter of the wellbore to surface.
		Partial/ intermittent	Due to the cost of complete cementing, there may be instances where intermittent casing could be used. This is dependent on the nature of the well and the geological strata.
	Plugging Material	**API Standard**	The cement to be used should comply with the relevant API standards. API standards provide recognized requirements for well design, cementing, plugging and abandonment to ensure boreholes are safely sealed and isolated. Their relevance to plugging concrete is that the concrete/cement slurry used must be durable, low-permeability, and suitable for downhole conditions so it can form an effective long-term seal and prevent fluid or gas migration.
	Plugging techniques	Dump Bailer	Outdated. This technique has the potential to allow for contamination of the well plug and therefore may affect the plug integrity.
		Squeeze	The displacement method minimizes the contamination of the cement by being able to displace fluid within the well. Allows for a more stable well plug.
	Surface Infrastructure	**Complete removal**	The surface area of a decommissioning well must be clear of obstructions and equipment. In order to allow unhindered land use of the well area, it is suggested that all surface infrastructure be removed.
		Retain	Surface infrastructure would typically include the well, cap, flange, and /or collar.
Drill site	Surface Infrastructure	**Complete removal**	The surface area of a decommissioning well site must be clear of obstructions and equipment. In order to allow unhindered land use of the well area, it is suggested that all surface infrastructure be removed.
		Retain	Surface infrastructure of the drill site would typically include containers, temporary offices, ablutions, vehicles, waste bins/skips and the drill rig.

Exploration Activity	Aspect	Options	Comment
	Sump	**Emptied and backfilled**	Sumps will be emptied and content thereof disposed at a suitably licensed facility. It has been suggested to replace sumps with mobile containers above ground to minimize the impacts.
		Retain	The sumps were emptied by evaporating the liquids and removing the drill muds but are not backfilled.
	Access roads	**Rehabilitate**	The intention is to rehabilitate the area, including the access route, to the pre-exploration condition.
		Retain	In certain instances, the landowner may request the retention of the access route.
	Revegetation	Proactive revegetation	Actively reestablish natural indigenous vegetation via hydroseeding.
		Passive revegetation	Allow for natural reestablishment of indigenous vegetation and implement an Alien Invasive Management programme and monitoring of vegetation growth.

The final closure and decommissioning of an exploration well must be pre-empted by a site-specific assessment and where applicable the implementation of the most appropriate rehabilitation and closure strategy. Furthermore, the annual review of the Final Rehabilitation, Decommissioning and Closure Plan (FRDCP) must, where applicable, include an assessment and adjustment of the closure strategy to reflect the most recent technical development and industry best practice, as well as any lessons learnt from the implementation of closure on this project.

9.3 MOTIVATION FOR PREFERRED CLOSURE OPTION

The preferred closure option is as follows:

- Retain casing (informed by a pre-closure inspection of casing integrity) and plug using a pump/squeeze technique, the full length of the well with a suitable plugging cement, as prescribed by, and in accordance with, the applicable American Petroleum Institute (API) Guidelines and standards.
- Cut surface casing at a depth to be informed by end land-use (presumed below plough depth), remove and bury.
- Rehabilitate access routes or retain when requested by a landowner.
- It is anticipated that the closure option presented above, together with monitoring of the post closure period, will achieve the stipulated closure objective. This closure option is in line with industry best practice and the requirements of the MPRDA Regulations.
- Effective abandonment depends on knowledge of the well construction, geology, and the hydrogeology. In this regard it is recommended that prior to commencement of closure and decommissioning of any specific well the following must be undertaken:
- A detailed site-specific decommissioning plan must be prepared by an appropriately qualified specialist or specialists. This plan must take into consideration the following site-specific factors:
    - Current condition and design of the well (informed by suitable well integrity testing);
    - Records of the drilling results (geological logs), cement used and testing results for the life of each well, including the cement bond log tests immediately after grouting and prior to decommissioning as well as any periodic maintenance checks during the operational life;

- Height of cement in annulus outside casing;
- Considerations for the composition and placement of the plug or barriers should include:
  - Location of potential flow zones and pore pressures.
  - Location of useable water sources.
  - Formation fracture pressure of natural seals.
  - Crossflow potentials; direction and resultant equalised pressures.
  - Future field plans.
  - Compaction, subsidence, and recharged formations.
  - Corrosion risks.
  - Locations of natural faults and their ability to transmit fluids and/or pressure.
  - Ability to be able to verify the barrier.
  - Operating environment (temperature, pressures, chemical characteristics).
- Cement casing overlaps;
- The need for abandonment plugs to cover the full diameter of the hole;
- The type of fluid in annuli above cement;
- The chemical composition of the prevailing groundwater;
- The following considerations apply to determining the composition of the barrier material/s:
  - Inability for wellbore fluids to bypass in either direction.
  - No degradation of sealing capacity over time.
  - The specific host rock thermal and effective stress characteristic which may affect permanent plug integrity.
  - Avoidance of movement.
  - Appropriate for the environment (e.g. Temperature, pressure, chemical exposure) and application[14]

- Potential difficulties of injecting cement into the annulus;
- Future monitoring of the integrity of the well plug; and
- The depth below surface at which casing must be cut.
  - The applicable landowner must be consulted and input obtained regarding the current and planned land-uses applicable to the area and the need to retain surface infrastructure, well accessibility and/or access tracks.

The revised decommissioning plan and the feedback from the landowner consultation must be submitted to the PASA for review and approval prior to implementation.

[14] The development of an applicable well bore stress model would assist in planning the final specific barrier characteristics.

Table 75 provides a list of threats, opportunities and uncertainties related to the preferred closure options. Where applicable actions to address these uncertainties are presented in **Section 9.1**.

Table 75: Threats, opportunities and uncertainties associated with preferred closure option.

Item:	Description:
Threats:	- Insufficient financial provision to adequately implement closure plan. - Insufficient management commitment to effective rehabilitation. - Inadequate topsoil management during construction phases to allow for adequate topsoil cover to enable rehabilitation. - Inability to identify and implement a suitable alternative land use on the defined alternative land use areas. - Groundwater modelling inaccurately predicts the potential medium to long term impacts on the groundwater resources. - Incorrect plug/ barrier materials used for well bore plugging could result in long term degradation of plug effectiveness. - Third party activities may affect the success of the rehabilitation and closure strategies (e.g. ongoing mining activities such as blasting and excavations may impact on the long-term integrity of well barriers and casing). - Movement of faults which may intersect the zone of influence of a well may compromise the long-term stability of the barrier or casing.
Opportunities:	- NEMA requires annual review of the rehabilitation and closure plans and associated financial provisions- this provides an ideal opportunity to ensure that the rehabilitation process is assessed for relevance on a continual basis.
Uncertainties:	- There are certain closure actions and parameters which are uncertain prior to actual closure. These include the status of the well bores at the time of closure. The specific circumstances will need to be assessed at the time of closure by a qualified well engineer and a decommissioning plan prepared. - The extent to which the infrastructure established for the production may be of value for reuse or repurposing by the landowners is uncertain at this stage and must be ascertained prior to final closure. - The groundwater model should continue to be updated based on monitoring data and the predictions of impacts to water resources should be reviewed and revised. - An adaptive land management approach will be adopted on-site, allowing for implementation of alternative and improved rehabilitation strategies and corrective action, where required.

9.4 CLOSURE PERIOD AND POST CLOSURE REQUIREMENTS

The closure period is defined as the period between the cessation of exploration, and the completion of active rehabilitation actions on the applicable site. It may become necessary to decommission and plug unsuccessful or dry wells during the operational phase (should a Production Right be obtained). In these instances, it is suggested that closure on these specific wells is initiated as soon as possible. Monitoring will be conducted on an annual basis until a closure certificate is issued, confirming that rehabilitation is complete. For the purpose of this assessment, a five-year monitoring period has been assumed before closure is complete. The following actions, to be adjusted based on the completion of the pre-closure site assessment, are proposed:

- Groundwater and surface water monitoring via the proposed monitoring boreholes and surface water monitoring points will be utilised to analyse groundwater and surface water quality. Sampling will test for dissolved methane, as well as changes to physical parameters such as electrical conductivity and pH. This will serve as an early indicator for migrating saline groundwater or gas resulting from potential subsurface casing or cement annulus failures. Following decommissioning, monitoring will be conducted bi-annually for the first year. Thereafter, monitoring will proceed on an annual basis for a period of four years, or until a formal closure certificate is issued.

- Fugitive gas emissions using either soil vapour probes, effluxes, Flir Methane Cameras, or surface methanometers will be monitored annually for 5 years after decommissioning;
- Well plugging and abandonment verification to confirm that there is proper and effective vertical isolation (this could include: bond log tests, cementing tests, communication tests, hydraulic pressure tests, applied weight test); and
- Biodiversity assessments mid-wet season (i.e. annual) should be undertaken by a qualified ecologist/botanist to monitor the rehabilitation progress with regards to flora for a period of 3 years after rehabilitation.

There are however certain residual and latent impacts which may manifest in the post-closure phase. These relate primarily to the risk of well plug integrity and associated long-term management of vertical migration of gas and/or fluids to the shallow water resources or the surface. The management and monitoring associated with these residual and latent risks are addressed in **Appendix H**.

9.5 FINAL POST-EXPLORATION LAND-USE

The ultimate aim of most closure and land rehabilitation is to return the land to the same or similar state to what it was pre-exploration. In order to inform this target, it is important to have a clear understanding of what the pre-exploration land use and land capability were. Land use is the way land is used by people for a defined purpose and may comprise one or more land uses. In most instances, one landscape can support numerous land uses within the constraints of land capability, creating a multifunctional landscape.

The main economic activities within and/or surrounding the exploration right area relate to farming (livestock/ game grazing and cultivated lands), renewable energy sites, and mining (primarily gold mining). The final post closure land use will depend on the specific site circumstances, in so far as it relates to the pre-exploration uses and also the prevailing uses, at the time of closure. It is proposed that, prior to initiating closure, a suitably qualified environmental scientist undertake an assessment and consult with the landowner and prepare a site-specific decommissioning plan for submission to PASA for review and approval. For the purposes of this FRDCP it is assumed that the post closure land use will be congruent with the agricultural and natural veld mix of land use and capability in the region

9.6 CLOSURE ACTIONS

In order to align with the defined closure plan and final land use objectives, the Holder will need to implement a series of actions which address the infrastructure, facilities, and rights area, as well as ongoing maintenance and management thereof. These actions and obligations apply to all infrastructure, activities, and aspects both within the exploration right area and off the exploration right area which were associated with the exploration activities and over which the Holder has responsibility.

The anticipated closure actions can be summarised as follows:

- Phase 1: Preparation for closure.
- Phase 2: Making safe.
- Phase 3: Rehabilitation.
- Phase 4: Monitoring and maintenance

9.7 FINAL REHABILITATION, DECOMMISSIONING AND CLOSURE SCHEDULE

This section presents a high-level list of rehabilitation and closure components, and the key actions related to the final rehabilitation, decommissioning, and closure. The key schedule drivers for each activity are presented in **Table 76**. It is important to note that there are potential permits and licences which may be required before initiating closure activities these may include water use licences and/or environmental authorisations. These should be initiated as soon as practically possible as the timeframes for these processes can be extensive.

Table 76: Closure schedule drivers.

Activity	Closure schedule driver
Ongoing activities.	Ongoing decommissioning and closure of abandoned exploration wells. The timing of this will depend on when a decision is made to abandon a specific well.
Planning and preparation for Closure.	Updated FRDCP and compliance with the Financial Provision Regulations. Obtain relevant closure related environmental authorisations, licenses, and permissions (if applicable).
Dismantling and removal of any on-site infrastructure.	Progressively as infrastructure is no longer required. Final dismantling of all infrastructure not to be retained at cessation of exploration activities.
Rehabilitation of access roads.	Cessation of exploration activities and where relevant rehabilitation activities- if possible, rehabilitation of access roads should be done progressively as these roads are no longer required.
Decommissioning and closure of well sites.	Well decommissioning and plugging will be initiated once a well site is no longer yielding viable gas volumes or lapsing of the approved suspension period. The closure will commence on completion and approval of the site-specific decommissioning plan.
Removal and safe disposal of processing waste deposits, including PCD's and evaporation ponds/ dams.	PCDs/Sumps to be decommissioned once dirty water areas and need for PCDs ends (i.e. once pollution source terms are removed)- most likely at the end of decommissioning and rehabilitation.
General surface rehabilitation (incl. backfilled open cast areas and voids, stockpile areas, compacted areas, etc.).	Completion of decommissioning. Seeding and planting is most successful when done at or immediately after the first rains in spring, and into freshly prepared, fine-tilled seedbeds (where soils are not prone to crusting). It has been determined that natural reestablishment of indigenous vegetation is sufficient, should an alien invasive management plan be in effect.
Rehabilitation Monitoring.	Ongoing throughout rehabilitation activities and into the closure and post closure periods.
Social and economic change management.	Ongoing throughout rehabilitation activities and into the closure period.

9.8 CLOSURE COST AND FINANCIAL PROVISION

The closure cost estimation is based on the requirements of GNR 1147. The quantum is expected to represent a realistic estimation of the required cost for effective decommissioning, rehabilitation, closure, and management of ongoing residual, and potential future latent, impacts.

9.8.1 APPROACH TO FINAL CLOSURE COST DETERMINATION

Funds must be available at any time, equal to the sum of the actual costs of implementing the plans and reports for a period of 10 years (as per Section 7, Chapter 2 of the Financial Provisions Regulations). Although the NEMA Financial Provisioning Regulations (2015) specify an accuracy level of 90%, the aim will be to ensure 100% accurate costings for closure at all times. The remainder of this section provides details on the proposed closure cost. The assumptions and limitations stated in Section 4.5.8 the Financial Provisions for Closure and Rehabilitation (**Appendix F**), also underpin the basis of this closure cost determination.

The closure cost has been calculated through the following steps:

- Review of available information to inform the closure battery limits for the D3 Energy operation;
- Verify unit rates for infrastructure dismantling and demolition as well as associated rehabilitation of disturbed areas, considering the latest demolition equipment available;
- Develop layout plans indicating existing and proposed infrastructure to be included in the rehabilitation and closure cost estimation;
- Unit rates were sourced from available precedents, inputs from specialists in the field, and experience;
- Rates are based on third-party contractor rates and not mining rates; and
- Apply the verified unit rates and associated quantities measured from the layout plans in spreadsheets to determine the closure costs.
- Methane/natural gas monitoring to be conducted every six months during the post closure period.
- Vegetation monitoring to be undertaken once per year during post-closure phase.

The battery limits for this closure provision assessment are limited to:

- Access roads;
- Well heads;
- Operational, abandoned and suspension wells;
- Fencing and firebreak;
- Temporary Hazardous waste storage;
- Temporary General waste storage;
- Mobile offices and ablution facilities;

9.8.2 DESCRIPTION OF UNIT RATES

Unit rates that were applied during the closure determination were obtained from third-party quotes. The rates are recorded in a database, which is updated in consultation with the civil contractors. The post-closure unit rates that are included in the applied rates are summarised in the subsections below. Site-specific unit rates were calculated based on experience and rates obtained from contractors. The site-specific unit rates and assumptions are discussed in **Table 77**.

Table 77: Site-specific unit rates and assumptions.

Aspect	Comment and Assumptions	Rates
General Surface Rehabilitation		
Surface Water Monitoring	Allowance has been made to conduct the surface water monitoring at five monitoring points near the wells. If assumed that it would take at least one man-day of an independent specialist (including the preparation of the sampling equipment) to conduct the sampling at these points. It has been assumed that surface water monitoring should continue bi-annually for the first year after decommissioning. Thereafter, monitoring will proceed on an annual basis for a period of four years, or until a formal closure certificate is issued.	**R 29 167.84** per sampling event (2 boreholes and one surface water monitoring points at each well, with five wells equating to a total of 15 monitoring sites per sampling event) for professional fees and associated disbursements.
Groundwater Monitoring	It has been assumed that 10 groundwater monitoring boreholes would be required to reflect post-closure groundwater quality. The water quality monitoring program will include the sampling of two boreholes at each of the five proposed well locations. It has been assumed that groundwater monitoring should continue bi-annually for the first year after decommissioning. Thereafter, monitoring will proceed on an annual basis for a period of four years, or until a formal closure certificate is issued	
Rehabilitation / ECO Monitoring	Rehabilitation monitoring to be undertaken by a qualified specialist or EAP annually as required in the EMPr. The purpose of a Rehabilitation Monitoring Program is to ensure that the management measures, rehabilitation and decommissioning objectives for the management of various environmental aspects, are met and that the rehabilitation process is followed. The frequency of monitoring must be adequate to identify potential gaps in the effectiveness of the management plans. A rehabilitation programme must be implemented during the exploration and decommissioning phases of the exploration activities. The following identified aspects require monitoring during the exploration and decommissioning phase: Erosion and sedimentation status of disturbed areas; Surface drainage and surface water quality; Groundwater quality; Successful re-vegetation and basal cover proportions; Rehabilitation effectiveness; Fauna and flora re-colonization; and Control of invasive vegetation species. To achieve the primary objective, management infrastructure must be designed and operated with the following objectives in mind (DWAF, 2008): Visual impacts of disturbed areas should be minimized by restoring the landform to a condition suited to the surrounding landscape; Management of invasive/alien vegetation;	These costs amount to about **R 25 200.00** per event and can run concurrently with the groundwater monitoring

Aspect	Comment and Assumptions	Rates
	Restoration of native vegetation covers and ecology; Minimize the area of vegetation clearing for exploration activities; Ensure that water management measures take into account and fit into the broader regional water management context; Ensure that water of different quality (clean and dirty water) is kept separate and managed separately if possible. This implies minimizing the contact between water of different qualities to minimise potential deterioration of water quality; Address water pollution issued at sources; and The need for long-term monitoring must be reduced.	
Rehabilitation Care and Maintenance	It is assumed that this would require 1 weeks per year of a team of 5 workers and 1 TLB as supporting equipment to conduct the corrective measures over 5 ha. It is assumed that the hourly rate of the workers is R 56.14/hr and the equipment R 3 545.46/d (per machine). Care and maintenance should continue for 3 years post-closure. It has been assumed that the workers and equipment could be sourced locally.	The overall rate is **R 28 954.54/year.**
Site Specific		
Downhole Surveys	Allowance was made to survey the existing and proposed wells for blockages to ensure the wells are plugged/rehabilitated to the ultimate depth. Unit rate composition: - Set up of Rig, TLB, and equipment, at R36 000, (R18 000 per way). - Setup of drill machine and site @ R 600.00/hr (assume 12 hours per site), - Inter-hole moving of rig and equipment @ R3 300/hr (assume 4 hours per move). - Clean out string to identify and investigate potential blockages/cavities within the well @ R 2 800.00/hour, this also includes unblocking, cleaning and/or flushing of the well.	Total cost for conducting pre-closure down hole survey for all five wells is **R 212 800.00**
Bond Log Testing	Allowance was made to test the integrity of the grouting in the wells to ensure there are no poor grouting bonds or inconsistent densities. All gas well locations will require CBL test work to be done prior to final closure. The cost provided by Quicklog Geophysics comes down to R 28 833.33 per well.	Total cost for all five wells amounts to **R 144 166.67**

Aspect	Comment and Assumptions	Rates
Borehole plugging	Allowance was made for the cementing of the wells to a depth of 600 m. An additional 25% cementing volume was allowed, resulting in a total volume of 9.4m^3 per well. Unit rate composition: - Supply and install cement plug within well. Grouting of the well (filling the annulus) is undertaken during drilling, therefore only cementing of the open well will be required. The cost is assumed to be similar to that of grouting, for the well plugging. Cement formulations and volumetric calculations to be approved by well engineer/cement specialist). Total cost of cement @ R 5 625.00/cube, totalling to R 52 603.51.00 per well; - Operational Time - Preparing cementing equipment @ R 3 330.00/h, assuming it will take 3 hours, totalling to R 9 990 per well; - Operational Time - Cementing of well @ R 3 477.63/h, assuming it will take 4 hours, totalling to R 16 650.00 per well; - Operational Time - Cleaning of cementing equipment @ R 3 330.00/h, assuming it will take 3 hours, totalling to R 9 900.00 per well; - Cementation integrity testing (Integrity of the plugs must be confirmed by setting weight down on the upper most plug (using the drill string) as well as a differential pressure test for 4 hours at determined pressure with less than 10% bleed over the period. Pressure test data to be captured in 15-minute intervals for the entire 4-hour testing period.), @ R 3 330.00/hr, assuming 1 hour per well, giving a total of R 3 300.00 per well.	Total cost for well cement plug is **R 396 217.57** for all five wells.
Surface Infrastructure	All above ground infrastructure will be dismantled/demolished and sealed off. - Excavation of material and demolition hammer and casing (for access to plugs), @ R 600/hr, assume 9 hours per well, giving a total of R 5 400.00 per well.	Total cost for all five well sites is **R 39 000.00**.

10 CONCLUSIONS AND RECOMMENDATIONS

The Scoping Phase of the EIA process identified potential issues and impacts associated with the proposed project and defined the extent of the studies required within the EIA Phase. The EIA Phase addresses those identified potential environmental impacts and benefits (direct, indirect and cumulative impacts) associated with all phases of the project including design, construction and operation, and recommends appropriate mitigation measures for potentially significant environmental impacts. The EIA report provides sufficient information regarding the potential impacts and the acceptability of these impacts in order for the Competent Authority to make an informed decision regarding the proposed project. The release of an EIA Report for public review provides stakeholders with an opportunity to verify that the issues they have raised through the EIA process had been captured and adequately considered.

The EIA Phase aimed to achieve the following:

- Provide an overall assessment of the social and biophysical environments affected by the proposed project.
- Assess potentially significant impacts (direct, indirect and cumulative, where required) associated with the proposed coal mine extension project and associated infrastructure.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts.

10.1 CONCLUSIONS FROM SPECIALIST STUDIES

The conclusions and recommendations of this EIA are the result of the assessment of identified impacts by specialists, and the parallel process of public participation. The public consultation process has been extensive, and every effort has been made to include representatives of all stakeholders in the study area. The main conclusions from each of the specialist studies are presented below.

10.1.1 AGRICULTURAL POTENTIAL, SOILS & LAND CAPABILITY

The land capability sensitivity (DAFF, 2017) indicates the proposed project area falls within “Low-Moderate” and “Moderate to Moderate-High” land capability sensitivities and with marginal areas having “Very Low to Low” land capability sensitivity. Furthermore, highly and very highly sensitive field crop boundaries were also identified using the DFFE Screening Tool Report. The verified baseline findings, current land uses and the calculated land potential concur to an extent with areas associated with “Low-Moderate” and “Very Low to Low” land capability sensitivities and highly sensitive field crop boundaries. They further dispute to an extent with all areas demarcated with very highly sensitive field crop boundaries and “Moderate to Moderate-High” land capability sensitivity within the proposed target areas. Commercial maize and soyabean production under rainfed conditions were confirmed within the target drilling areas alongside historical crop fields. It is worth noting that the proposed drilling within the target areas will have a minor footprint (50 × 50 m) and. Therefore, is expected to have a negligible impact of soil and agricultural resources of the area.

Active crop fields (Maize and Soyabeans) were identified within the proposed target drilling areas. The proposed project will result in marginal land segregation and fragmentation of high production crop fields with the current proposed infrastructure layout. It is the opinion of the specialist that the proposed D3 Energy ER386 Application project and associated infrastructure project can be considered for authorisation with recommended mitigations to be adhered to, by the Competent Authority.

10.1.2 AIR QUALITY IMPACT ASSESSMENT

Available data for the Welkom South African Weather Service Station was used to establish baseline meteorological conditions for the proposed project site. The dataset included a minimum of hourly average wind speed, wind direction and temperature. The main pollutant of concern from the proposed project are Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Volatile Organic Compounds (VOC) and Particulate Matter (PM), with PM_{10} and $PM_{2.5}$ the fractions associated with health impacts. Nuisance impacts as from dust fallout would be more localised. The flow field is dominated by winds from the northeastern sector.

Potential sensitive receptors within the project area include individual households and residential areas (i.e. Welkom, Hennenman, Virginia and Ventersburg). Sources of pollution in the study area include agriculture, mining, biomass burning, vehicle entrainment, vehicle tailpipe and wind erosion. The project is expected to have medium negative significance rating without mitigation and low negative significance rating with mitigation.

The main findings from the impact assessment due to project activities were as follows:

- Target areas:
  - Construction:
    - Maximum daily PM_{10} ground level concentrations due to drill activities and land clearing, exceeds the daily PM_{10} NAAQ limit up to a distance of 50m from the drill and 35 m from the target area site respectively. It should be noted, however, that the daily NAAQS allows for 4 exceedances of the limit per calendar year. Land clearing (up to 35m from the target area) and drilling activities (up to 50 m from the drill) would thus exceed the NAAQS if activities are longer than 4 days per target area per year.
    - Maximum daily $PM_{2.5}$ ground level concentrations due to truck and drill activities, exceeds the daily $PM_{2.5}$ NAAQ limit up to a distance of 30 m from the truck and 60 m from the drill respectively. Given that the NAAQS allows for 4 daily exceedances of the limit per year, the $PM_{2.5}$ NAAQS may be exceeded up to 60m from the drill if drill activities are for more than 4 days per target area per year.
    - Maximum hourly NO_2 ground level concentrations due to truck and drill activities, exceeds the hourly NO_2 NAAQ limit up to a distance of 260m from the truck and 520 m from the drill respectively. The NAAQS allows for 88 hourly exceedances of the limit per year. Given that the trucks are moving sources, it is unlikely that this source would result in an exceedance of the NAAQS at any one location. Similarly, the drills would operate for 54 hours and 10 minutes as a worst case. The drilling activity would thus not result in an hourly NO_2 NAAQS exceedance.
    - Maximum daily VOC ground level concentrations due to drill activities, exceeds the comfort level of 200 µg/m³ up to a distance of 25m from the drill. It should be noted that the VOC comfort level used for screening is not a health effect level or a NAAQS.
    - Significance rating:
      - Without mitigation: high-medium negative significance rating as there could be exceedances of the PM NAAQS up to 35m from the target area due to land clearing and up to 60m from the drill if these activities are for more than 4 days per target area per year.
      - With mitigation: low negative significance rating. Mitigation measures would include having target areas and exploration wells at least 35m and 60m from sensitive receptors respectively.
      - Overall significance rating: low negative significance rating.
  - Operation:
    - Maximum daily VOC ground level concentrations due to testing well gaseous releases, exceeds the comfort level of 200 µg/m³ up to a distance of 150m from the source. It should be noted that the VOC comfort level used for screening is not a health effect level or a NAAQS.

- Significance rating:
  - Without mitigation: medium-low negative significance rating. The significance rating is based on a comfort level and not a health effect level. The magnitude of the impact is thus given as low providing an overall significance rating of medium-low.
  - With mitigation: low negative significance rating. Mitigation measures would include robust Leak Detection and Repair programs.
  - Overall significance rating: low negative significance rating.

- Closure:
  - Assuming impacts due to rehabilitation activities to be similar to construction (i.e. land clearing), maximum daily PM_{10} ground level concentrations exceed the daily PM_{10} NAAQ limit up to a distance of 35m from the target area site. Given that the daily PM_{10} NAAQS allows for 4 exceedances of the limit per year, the activities should be limited to less than 4 days per target area per year to avoid exceedances of the NAAQS.
  - The testing wells must be capped and sealed and should not have any gaseous releases if properly managed.
  - Significance rating:
    - Without mitigation: high-medium negative significance rating, as there could be exceedances of the PM NAAQS up to 35m from the target area due to rehabilitation activities.
    - With mitigation: low negative significance rating. Mitigation measures would include limiting rehabilitation activities to less than 4 days per target area per year.
    - Overall significance rating: low negative.

- Seismic transects:
  - Construction:
    - No air quality impacts expected.
  - Operation:
    - Maximum daily $PM_{2.5}$ ground level concentrations due to truck activities, exceeds the daily $PM_{2.5}$ NAAQ limit up to a distance of 30m from the source.
    - Maximum hourly NO_2 ground level concentrations due to truck activities, exceeds the hourly NO_2 NAAQ limit up to a distance of 260m from the source.
    - Given the nature of the activity and that the truck will not be operating continuously or in the same location, it is unlikely that the NO_2 and $PM_{2.5}$ NAAQS (which allows for 88 hours or 4 days of exceedance of the hourly and daily limit per year respectively) will be exceeded.
    - Significance rating:
      - Without mitigation: low negative significance rating.
      - With mitigation: low negative significance rating.
      - Overall significance rating: low negative.

It should be noted that the maximum short-term ground level concentrations due to criteria pollutants were conservatively screened against NAAQS which allows for a number of exceedances per year (i.e. 88 hours for hourly NAAQS and 4 days for daily NAAQS). The maximum daily VOC concentrations were also conservatively screened against comfort levels (not health effect levels).

Based on the findings of the AQIA, it is the specialist's opinion that the project can be authorised as there is no significant impact on the surrounding potentially sensitive receptors, provided that the recommendations are taken into account.

10.1.3 CLIMATE CHANGE IMPACT ASSESSMENT

The Climate Change Specialist Study assessed the significance of impacts of the project greenhouse gas (GHG) emissions generated, along with the potential impact of climate change on the operation of the project. Several hazards were identified during the baseline assessment including wildfires: the settlements within the study area are at low risk of wildfires with the projection of 30 fire danger days per year over the project area; drought: the settlements within the study area are at very low risk of drought with the Standardized Precipitation Index (SPI) of -0.38 for the project area; exposure to heat extremes: the settlements within the study area are at high risk of encountering increasing heat stresses; and, flooding: the settlements within the study area are at slight to moderate risk of increased extreme rainfall days with low increase in exposure to urban flooding.

Project specific information together with local and internationally published emission factors were used to calculate Scope 1 (direct), Scope 2 (indirect) and Scope 3 (indirect) Greenhouse Gases (GHG) emissions for the project. Based on the study, the project is likely to result in an estimated total GHG emissions as follows:

- Scope 1 direct emissions:
  - 21 236 tonne (t) Carbon dioxide equivalent (CO_2e) over a 9-year period
  - 2 360 t CO_2e per annum
- Scope 2 indirect emissions:
  - None
- Scope 3 indirect emissions:
  - 288 t CO_2e over a 9-year period
  - 32 t CO_2e per annum

The GHG emissions from the project was calculated to represent 0.0007% of the remaining South African annual budget for 2030 and 2035 respectively. The contribution to the South African annual budget will also progressively increase throughout the life of the project as the country's NDCs decrease. The impact of the project on climate change was assessed to have a low negative risk rating for GHG emissions. Subsequently, it is the specialist's opinion that the project may be authorised provided that the mitigation measures recommended are adhered to.

10.1.4 AQUATICS AND WETLAND IMPACT ASSESSMENT

Twenty-one Hydrogeomorphic (HGM) units were identified and delineated within the 500 m Buffer of the Seismic Transects. These features were classified as channelled valley-bottoms, unchannelled valley-bottoms, seeps, depressions and floodplain systems. In addition, two main riparian systems and several non-perennial drainage features and dams (instream and off-channel) were identified. Furthermore, several artificial wet areas were delineated, which have resulted from stormwater management and land-use practices (agriculture). Five of the identified HGM units were delineated within the Target Areas, these consist of two unchannelled valley-bottoms, a depression, a seep, and a channelled valley-bottom. In addition, non-perennial drainages, artificial drainage channels, and dams were identified within the Target Areas

The wetlands exhibited different degrees of modification resulting from natural physical changes as well as anthropogenically induced impacts at both the local and catchment level. Resultingly, the wetlands have scored an average Present Ecological State (PES) score within the "C – Moderately Modified" and "D – Largely Modified"

PES classes. The Ecological Importance and Sensitivity (EIS) assessment was applied to the HGM units in conjunction with the ecosystem service scores in the preceding sections, to assess the levels of sensitivity and ecological importance of the wetland. The results indicate that wetlands range between the “Moderate” and “High” EIS class.

Construction could result in the encroachment into water resources and result in the loss or degradation of this system, most of which are functional and provide ecological services. These disturbances could also result in the infestation and establishment of alien vegetation which would affect the functioning of the systems. Leaks and/or spillages could result in contamination of the receiving water resources. Contaminated water resources are likely to influence the associated biota. An increase in stormwater runoff could result in physical changes to the receiving systems caused by erosion, run-off and sedimentation, and the functional changes could result in changes to the vegetative structure of the systems.

The overall post-mitigation residual risk of the proposed development was calculated to be “Low” and is deemed acceptable given that the mitigation measures are adhered to. Furthermore, the cumulative impacts based on avoidance on the wetlands and their prescribed buffers is considered to be “Low” with no irreplaceable loss of freshwater ecosystems expected. Considering the assessment findings, no fatal flaws are evident for the proposed project. It is the opinion of the specialists that the project can be considered for authorisation by the Competent Authority, subject to implementation of the provided mitigations.

10.1.5 ARCHAEOLOGICAL AND CULTURAL HERITAGE ASSESSMENT

The heritage of the landscape has been altered over the years through the extensive farming activities which took place and has been taking place. Hennenman was noted as the most central urban space in proximity to the ER. Six (6) features of archaeological significance were identified in addition to the thirty-two (32) heritage features inclusive of structures, buildings, or complexes as well as three grave sites identified through the desktop assessment. These features consisted of three (3) additional grave sites, as well as three (3) structures or in-situ features related to mid-20th Century farming activities. Features noted included abandoned farmhouses, windmills or windpumps, farm dams, whole farm complexes including several buildings of the mid-20th Century, as well as in-situ farming implements and devices. Some of the farm buildings identified through the desktop assessment were verified through the field survey.

The graves and graveyards in question are protected by the National Heritage Resources Act (NHRA) and have been provisionally graded as Grade III A or of High significance. All structures, buildings, complexes, or ruins thereof have been provisionally graded as Grade IV A or of High to Medium significance. This suggests that mitigation must take place should proposed activities have the potential to disturb these features. The two large artefacts identified have been graded as Grade IV B or Medium sensitivity.

Some of these features were identified occurring along the seismic transects, as well as in the proposed well Target Areas. It is unlikely that these features will be disturbed by the proposed activities as they can be easily avoided. It is here proposed that buffers be placed around each of these features, with proposed activities not taking place within 30 meters of the buildings or structures, and 50 meters of the grave sites. It is here argued that the features should be avoided, and in doing so, there will be little to no impact on the features. The impact assessment methodology has therefore been applied considering scenarios where the proposed activities would impact identified features.

Altogether, post-mitigation of the identified heritage impacts is rated a Medium to Low Negative, given that the impacts can be avoided, and the potential for a heritage procedure to allow for the documentation, recording, and further assessment of undiscovered finds and sites. A heritage procedure can present opportunity to limit the impact of development on heritage finds to construction activities, with the potential to document and further assess finds should they be related to broader sites. This ultimately presents opportunity to reverse the adverse effects of development of heritage finds, given that their value can be evaluated through documentation. This also presents opportunity to better understand the heritage significance of the area to be developed. Subsequently, from an Archaeological perspective, the development will not have significant foreseeable impacts and can proceed as long as the recommended mitigation measures are implemented.

10.1.6 PALAEONTOLOGICAL IMPACT ASSESSMENT

The bulk of the site is underlain by the Karoo Supergroup Formations covered by vegetation, grass, trees, roads, and buildings. According to the Council for Geoscience (CGS) 1:250 000 geological maps (Geological Map Sheet 2726 Kroonstad and Geological Map Sheet 2826 Winburg), the surface geology of the study area is characterized by a variety of lithologies, formations, and intrusions. According to the PalaeoMap of the South African Heritage Resources Information System (SAHRIS) the Palaeontological Sensitivity of all Karoo Supergroup geological formations are ranked as Very Low to Very High, and here the impact is potentially Very High for the Beaufort Group, High for Quaternary (Qs), Moderate for Ecca rocks and the Quaternary (Qc). A wide range of possible fossil remains occur in the Cenozoic, though these are often sparse, such as: mammalian bones and teeth, tortoise remains, ostrich eggshells, non-marine mollusc shells, ostracods, diatoms, and other micro fossil groups, trace fossils (e.g. calcretised termitaria, rhizoliths, burrows, vertebrate tracks), freshwater stromatolites, plant material such as peats, foliage, wood, pollens, within calc tufa. The Jurassic Dolerite does not contain fossils.

However, it is anticipated that no visible evidence of fossiliferous outcrops will be found in within the target areas and seismic transects based on previous studies in the area and thus an overall medium palaeontological significance is likely to be allocated for the project area. It is therefore, currently considered that the proposed development will not lead to detrimental impacts on the palaeontological reserves of the area and construction of the development may be authorised in its whole extent. The ECO for this project must be informed that the Adelaide Subgroup (Beaufort Group, Karoo Supergroup) has a Very High Palaeontological Sensitivity. If Palaeontological Heritage is uncovered during surface clearing and excavations the Chance find Protocol attached should be implemented immediately. Fossil discoveries ought to be protected and the ECO/site manager must report to South African Heritage Resources Agency (SAHRA) (Contact details: SAHRA, 111 Harrington Street, Cape Town. PO Box 4637, Cape Town 8000, South Africa. Tel: 021 462 4502. Fax: +27 (0)21 462 4509. Web: www.sahra.org.za) so that mitigation (recording and collection) can be carried out.

10.1.7 TERRESTRIAL BIODIVERSITY IMPACT ASSESSMENT

The ER overlaps with the Critical Biodiversity Areas (CBA) 1, CBA 2, Ecological Support Areas (ESA) 1, and ESA 2 according to the Free State Biodiversity Spatial Plan CBA map. Moreover, the ER also overlaps with one (1) South Africa Protected and Conservation Areas Data (SAPAD), namely Thabong Game Ranch (previously a conservation area but now a transformed are part of the Harmony mining area and Thabong residential area), an Endangered vegetation type (Vaal-Vet Sandy Grassland) as well as National Protected Area Expansion Strategy (NPAES) areas. According to the Mining and Biodiversity Guidelines, the ER overlaps with highest biodiversity importance, correlating to the highest risk for mining. There are three (3) bird Species of Conservation Concern (SCC) namely *Anas undulata* (Yellow-billed Duck), *Elanus caeruleus* (Black-winged Kite), and *Scopus umbrette* (Hamerkop) and one (1) mammal SCC (*Leptailurus serval* (Serval)) recorded within the ER. There is also a high likelihood of *Pyxicephalus adspersus* (Giant Bullfrog) and Sensitive Species 15[15] being present with the ER. Although there are no identified floral Species of Conservation Concern (SCC), there are two (2) species of provincially protected plant were recorded for the Target areas – *Ammocharis coranica* (Karoo lily or sore-eye flower) and *Helichrysum nudifolium* (Hairy Everlasting/Hottentots Tea). These species occurred in close proximity to water resources and the associated grassland. They are protected under the Free State Nature Conservation Ordinance No. 8 of 1969.

The assessment indicates that, although the project area has been subject to substantial historical and ongoing disturbance from agriculture, grazing, and associated infrastructure, it still contains areas of notable ecological importance. These include remaining natural and semi-natural grassland habitats, wetlands, and watercourses. The presence of threatened and sensitive ecological features means that the receiving environment cannot be regarded as uniformly low sensitivity, despite the modified nature of large portions of the ER.

From a terrestrial biodiversity perspective, no fatal flaws were identified that would preclude the proposed exploration activities. However, the key risks associated with the development include habitat loss and fragmentation, disturbance to fauna, the spread of alien invasive plant species, and pollution-related impacts on sensitive habitats, particularly wetlands and intact grassland areas. These risks can be reduced to acceptable

[15] Species name of SCC that are sensitive to illegal harvesting are withheld from the EIA Report and specialist reports released into the public domain to protect the species from illegal harvesting.

levels only through the strict application of mitigation measures, including the avoidance of high-sensitivity areas, minimisation of vegetation clearance and surface disturbance, protection of fauna and flora, effective alien invasive species control, and the rehabilitation of disturbed areas. Overall, the proposed project is considered potentially acceptable from a biodiversity perspective, provided that exploration activities are carefully planned and implemented in line with the mitigation and management measures outlined in this report. Ongoing environmental monitoring and compliance will be essential to ensure that ecological impacts remain as low as possible and that the long-term functioning of the affected terrestrial ecosystems is maintained. It should be further noted that twelve (12) Alien Invasive Plants (AIP) species were recorded within the ER. These species are listed under the Alien and Invasive Species List 2020, Government Gazette No. GN1003. Nine (9) of these species are National Environmental Management: Biodiversity Act (NEMBA) category 1b AIP species that must be controlled by implementing an AIP Management Programme, in compliance with section 75 of NEMBA.

10.1.8 HYDROGEOLOGICAL IMPACT ASSESSMENT

The topography of the greater study area generally has a jagged topography and can be classified as a central interior plain or plateau. Large dolerite intrusions are observed throughout the study area and because of its relative resistance to erosion. The greater study is situated in primary catchment (C) of the Vaal River drainage system. The resource management falls under the Vaal Water Management Area (WMA5) (previously Middle Vaal WMA). The study area encompasses several quaternary catchments of the Vaal WMA including C25B, C42H, C42J and C60H. The primary rivers in and around the study area include the Vals River towards the northeast of the study area, the Sand River in the central parts of the study area, and the Vet River towards the southwest of the study area.

The regional geology consists of various lithologies, formations, and intrusions. These include geologically recent Quaternary deposits; sediments of the Beaufort and Ecca Groups within the Karoo Supergroup; dolerite dykes, sheets, and sills associated with the Karoo Dolerite Suite; and post-Karoo kimberlite pipes and dykes. According to the DWS Hydrogeological map (DWS Hydrogeological map series 2726 Kroonstad) the study area is predominantly underlain by a Class d2 intergranular and fractured aquifer (typically associated with median borehole yields ranging between 0.1 and 0.5 L/s), while small portions towards the northwest of the study area are underlain by a Class d3 intergranular and fractured aquifer (typically associated with median borehole yields ranging between 0.5 and 2.0 L/s). Three main hydrostratigraphic units/aquifer systems can be inferred in the saturated zone: - a shallow Quaternary (perched and unconfined) aquifer, a shallow, intergranular and fractured aquifer within the Beaufort Group, and a deeper, fractured aquifer within the Ecca Group and pre-Karoo rocks. Under natural conditions this area exhibits certain regions where there is pronounced interaction between surface and groundwater. The average thickness of the unsaturated zones of Groundwater are between 14.90m to 18.20m while an approximation of recharge for the study area is estimated at ~2.01% of MAP i.e. ~10.67 mm/a.

A hydrocensus user survey within the greater study area was conducted where relevant hydrogeological baseline information was gathered. A geophysical survey was conducted wherein the sub-strata in the direct vicinity of the study area was investigated by applying the magnetic and electro-magnetic geophysical exploration techniques which were applied according to traverse array design for delineation of sub-surface lineaments and identification of potential preferential groundwater flow pathways to be targeted for site characterisation and monitoring boreholes. Following the geophysical survey, four drilling targets were identified and incorporated as part of the drilling program. Following the drilling phase, the newly established site characterisation boreholes were subjected to hydraulic testing in order to supplement published aquifer parameter data that was available for the site conditions and setting.

All site characterization information gathered were evaluated and incorporated into the formulation of a conceptual groundwater model. The conceptual model formed the basis for the numerical groundwater model development. The latter was calibrated to an acceptable error margin and applied as groundwater management tool for simulation of management scenarios. The following was observed from the simulation:

- It is noted that the overall ambient groundwater quality with reference to dissolved methane and ethane is good with the no boreholes exceeding the U.S. Department of the Interior guidelines.

- The simulation indicates that the generated Total Dissolved Solids (TDS) pollution plume, methane (CH_4) will generally mimic topography and will migrate in a south to southwestern direction within the northern catchment of the Sandrivier while the pollution plume will migrate in a general northern direction within the southern catchment of the Sandrivier propagating in a radial pattern from the gas exploration borehole(s) towards the lower laying drainage system.
- For TDS, it was observed that the simulated pollution plume migration is more sluggish within the denser Karoo formations, reaching a maximum distance of ~100.0m, whereas movement through the more unconsolidated alluvial deposits of the riparian zone suggest a larger flux reaching a maximum distance of ~230.0m during the operational exploration phase.
- For methane, it was observed that the simulated pollution plume migration is more sluggish within the denser Karoo formations, reaching a maximum distance of ~90.0m, whereas movement through the more unconsolidated alluvial deposits of the riparian zone suggest a larger flux reaching a maximum distance of ~180.0m during the operational exploration phase.
- A scenario was simulated by assigning a point source pollution plume migration of saline groundwater emanating from the deep, fractured aquifer should. After a simulation period of 100-years, it can be observed that the maximum plume migration distance reached is ~450.0m during the post-closure phase. It can be observed that the TDS mass load contribution remains below the SANS 241:2015 limits ranging between ~950.0mg/l to approximately 600.0mg/l
- The simulation indicates that the potential pollution plumes will not intercept any privately owned, neighbouring boreholes during the duration of the simulation, however salt load contribution to the host aquifer is observed
- The expected seepage rate from potential contamination originating at the proposed exploration activities as well as associated infrastructure is estimated at an average of approximately 3.55m/a, with a maximum distance of ~6.18m/a in a general southern direction.

Potential sources identified include the migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase, migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas exploration phase and migration of contaminants from the plant footprint as well as associated waste facilities and infrastructure into local water resources and host aquifers. Potential aquifer pathways have been identified are vertical flow through the unsaturated/vadose zone as well as saturated zone to the underlying intergranular and fractured rock aquifers. Preferential flow-paths include the contact between the depth of weathering and fresh un-weathered rock, fractures, faults, joints and bedding planes. If not adequately sealed and suitably mitigated, gas exploration and exploration wells will form preferential flow paths and serve as a direct connection between the deeper, fractured aquifer and shallow, potable aquifer unit(s). Three potential receptors were identified as follows; shallow, inter-granular as well as the intermediate, fractured aquifer units situated within the plume migration footprint(s); down-gradient drainages and streams including associated riparian zone aquifer system(s) and baseflow contribution, and private or neighbouring boreholes associated with relevant fracture zones and/or structures(s)if intercepted by the pollution plume migration footprint. During the operational phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium to high without implementation of remedial measures and medium to low with implementation of proposed mitigation measures. During the decommissioning phase the environmental significance rating of groundwater quality impacts on down-gradient receptors are rated as medium to high without implementation of remedial measures and medium to low with implementation of proposed mitigation measures

It is the specialist's opinion that the proposed activities may be authorised provided that the mitigation measures are adhered to especially relating to an integrated groundwater and surface water monitoring protocol and network be developed for implementation. It is imperative that monitoring be conducted to serve as an early warning and detection system.

10.1.9 SOCIAL IMPACT ASSESSMENT

The local economy primarily relies on the gold mining sector and agriculture; however, both sectors have experienced a prolonged decline, contributing to persistent socio-economic challenges including high unemployment, poverty, infrastructural decay, and poor service delivery. The proposed exploration project presents both opportunities and risks for host communities. While it has the potential for short-term job creation, skills development, and enhanced local procurement during the exploration phase, significant concerns have emerged regarding the interference with existing farming livelihoods, damage to infrastructure such as farm roads, biosecurity risks, and the overlap with existing renewable energy projects.

The various identified potential social impacts can be mitigated. The importance of addressing the potential impacts as early in the project cycle as possible must be underlined, since failure to do so may result in the development of risks and an exponential increase in project cost. By implementing these recommendations, Motouane can proactively manage the social impacts of the exploration activity, helping to ensure the well-being of local communities while navigating the complexities of overlapping land uses and socio-economic challenges. It is therefore, the specialist's opinion that the proposed activities can be authorised provided that the mitigation measures area adhered to.

10.1.10 NOISE IMPACT ASSESSMENT

The regulatory framework, including national noise control regulations and South African National Standards, and comparison to International Finance Corporation guidelines were used to inform the noise study. Potential Noise Sensitive Receptors (NSRs) were identified from maps of the area using Google EarthTM aerial imagery. The ability of the environment to attenuate noise as it travels through the air was studied by considering meteorology, land use, and terrain data. Potential sensitive receptors within the project area include homesteads and farmhouses surrounding the Target Areas and Seismic Transects, primarily individual households and residential areas (i.e., Welkom, Hennenman, Virginia and Ventersburg).

Due to the prevailing winds, noise impacts are expected to be slightly more notable to southwest of the project activities. There are no distinguishable topographical features between the Target Areas / Seismic Transects and nearby noise sensitive receptor locations. Daytime and night-time noise measurements were conducted from 2 to 4 June 2025 at five locations in the exploration rights area. At the survey sites closest to the proposed Target Areas and Seismic Transects, both daytime and night-time sound pressure levels were well below the typical rating levels for rural areas and mainly influenced by natural and agricultural noise sources. At survey sites located to the east of the town of Welkom and closer to the mining operations within the study area, higher day- and night-time sound pressure levels were recorded, mainly influenced by mining, processing operations and vehicle traffic.

In terms of noise generating sources that form part of the exploration activities, the main sources will include drill rigs, seismic vibrators, trucks for equipment transport, vibroseis trucks, recording trucks and light vehicles. The propagation of noise generated during the operational phase was calculated with CadnaA in accordance with ISO 9613). The South African Draft Environmental Noise Standards were adopted as assessment criteria for the assessment. Due to very low baseline noise levels in the study area, exploration activities, particularly drilling activities, could be audible up to 5 km away from operational areas, while vehicle movements and seismic surveys could be audible up to 2.5 km away from the seismic transects. Based on noise attenuation modelling results, noise levels could be disturbing (>7 A-weighted decibels (dBA) increase from baseline) to residents up to 2 km from drilling activities and 1 km from seismic surveys. There are several identified residential receptors within these areas. It is the specialist's opinion that the project can be authorised as there is no significant impact on the current acoustic climate provided that the proposed mitigation measures are adhered to

10.2 CONCLUSION FROM THE ALTERNATIVE ASSESSMENT

In terms of the EIA Regulations published in Government Notice (GN) R982 of 2014, as amended, feasible and reasonable alternatives must be identified and considered within the environmental assessment process. The conclusions and recommendations of this EIA on project alternatives are the result of input from the specialist, process of public participation and requirements from relative Departments. The main conclusions from each of the alternative is presented below.

10.2.1 LOCALITY / PROPERTY ALTERNATIVES

The proposed exploration activities entail the undertaking of up to five (4) drilling sites and up to nine (9) seismic surveys within the exploration right footprint. For purposes of this report, location alternatives will be in reference to preliminary identified target exploration locations which are assessed in detail and preliminary general exploration footprint which is only assessed on desktop level. Detailed of the preliminary identified target exploration locations are indicated in **Section 2** (**Table 6**) while the preliminary identified target exploration locations and the general exploration footprint indicated in **Figure 1** and **Figure 2**. The locality / property alternatives assessed in this report are:

(i) Exploration Activities Within Preliminary Identified Target Exploration Locations; or

(ii) Exploration Activities Within Preliminary Identified Target Exploration Locations <u>excluding</u> directly affected renewable energy projects; or

(ii) Exploration Activities Outside Preliminary Exploration Target Areas.

Based on the advantages and disadvantages indicated in **Table 36** above, it is recommended that the proposed activities be ideally undertaken within the preliminary identified target exploration locations through co-existence agreements (where applicable), should that not be successful, then the second preferred alternative would be the undertaking exploration activities within preliminary identified target exploration locations excluding directly affected renewable energy projects and the undertaking of the exploration activities outside preliminary exploration target is the least preferred alternative. However, the nature of the exploration activities is such that the target sites are somewhat adjustable. This provides the operator with flexibility to move the sites for on-the-ground- activities to avoid local sensitivities that must be avoided (e.g. residence, wetlands and watercourse, etc.) buffers where required provided that the relevant processes outlined in the EMPr (**Appendix H**). The specific locality of the exact drilling location can only be identified once the initial phases have been undertaken, environmental sensitivities identified and faults / fractures within the target rocks identified. It is therefore recommended that, both areas inside the target areas and outside the target areas be considered for approval provided that relevant processes / measures are in place indicated in the EMPr (**Appendix H**) are adhered to.

10.2.2 TECHNOLOGY / PROCESS ALTERNATIVES

Drilling penetration into rock becomes more difficult with increasing hole diameters and rock compressive strength. In piling applications, hard rock formations have to be cut and excavated prior to the installation of the foundation piles and/or piled retaining walls. Commonly, conventional rotary drill tools are used for bored piles in medium to very high strength rocks. For harder rock formations different methods have to be adopted as much larger cutting energy and force input are normally required to break the material at the rock tool interface. Different drilling methods include rotary, percussion, rotary-percussion drilling and core drilling techniques, each utilizing distinct techniques to penetrate various soil and rock conditions, with rotary drilling using a rotating drill bit and percussion drilling using a hammering action. The technology / design alternatives assessed in this report are:

(i) Exploration Drilling Alternatives

- Rotary Drilling Method;
- Percussion Drilling Method;
- Rotary-Percussion Drilling Method; or
- Diamond Core Drilling Method.

(ii) Seismic Survey Alternatives

- vibroseis Technique;

- Accelerated Weight Drop; or
- Magnetotelluric Survey.

In general, percussion drilling is a versatile and cost-effective method of geological exploration that is widely used in the exploration industry. While it has some drawbacks, such as its limited depth capabilities and potential for rock damage, it remains a popular choice for many exploration projects. As with any drilling method, it is important to weigh the pros and cons carefully before deciding whether to use percussion drilling for a specific geological exploration task. Based on the advantages and disadvantages indicated in **Table 37** above, each method has its own pros and cons, the seismic surveys will inform the type of drilling technique required but from an environmental point, percussion drilling has the least impacts while diamond core drilling has the most environmental impacts.

10.2.3 SCALE ALTERNATIVES

Scale alternatives" refer to evaluating different development sizes, scopes, or production capacities for a proposed project. The scale alternatives assessed in this report are:

(i) Undertaking Limited Drilling and Seismic Activities within the ER; or

(ii) Undertaking Unlimited Drilling and Seismic Activities within the ER.

Based on the advantages and disadvantages indicated in **Table 39** above, it is recommended that the proposed activities ideally be limited to the proposed five (5) drilling activities and nine (9) seismic activities.

10.2.4 DESIGN OR LAYOUT ALTERNATIVES

Design alternatives are the consideration of different designs for technical efficiency, aesthetic purposes or different construction materials in an attempt to optimise local benefits and sustainability. It must be noted that there are two types of drilling pit sumps, aboveground sumps and underground sumps. Underground sumps are used in underground mining operations to collect and pump water from working and therefore, not feasible nor applicable for the proposed exploration project. The design alternatives assessed in this report are:

(i) Traditional lined pond (drill sump pits); or

(ii) Aboveground sumps with secondary containment (Pitless drilling).

Based on the advantages and disadvantages indicated in **Table 40**, both sump pits and aboveground sumps have noticeable advantages and disadvantages. However, sump pits are compulsory in onshore oil and gas facilities primarily to prevent groundwater contamination, ensure site safety, and contain hazardous spills as they act as controlled, low-point collection basins that capture spilled hydrocarbons, contaminated wash water, and stormwater before they can seep into the surrounding environment. In addition, during well cementing, pits safely catch cement returns, equipment wash water, and cement slurry overflows. Furthermore, in addition to the small size of the pits (approximately 4m x 4m and 1.5m deep), air drilling is proposed for the drilling activities which uses compressed air, nitrogen, or gases instead of conventional liquids (like drilling mud) to cool the drill bit and lift rock cuttings out of the wellbore. Therefore, it is the **EAP's opinion that sump pits can be considered favourable for the exploration activities provided that the size and capacity is restricted to 4m x 4m and 1.5m deep per sump**. Additional containment if required (i.e., for emergency situations) should be aboveground sumps with secondary containment.

10.2.5 NO-GO ALTERNATIVE

The no go alternative would imply that the explorations activities do not proceed. This would result in the status quo of the environment remaining in its current condition. Potential impacts such as some direct / indirect loss of habitats, direct / indirect mortalities, and displacement of fauna including SCC and Protected species would not occur. There would also be no potential for contamination of water resources (including surface water resources) associated with the exploration activities. In addition, the clearing of vegetation for the proposed activities which could expose, disturb and displace archaeological sites / material would be avoided. However, the approval of the proposed activities would allow the applicant to improve the accuracy of their exploration for an economically viable resource (natural gas including Helium) available in the area. It is important to note that the exploration right will not provide the required authorisation for production activities to be undertaken. As such, any future intention to undertake production of hydrocarbons within the exploration right area would require a further application, investigation and public consultation process.

Exploration for additional domestic hydrocarbon reserves is considered important, and any discoveries would be well received by the local market. The Department of Energy's Integrated Resource Plan (2010-2030) supports this view, stating that regional and domestic gas options should be pursued. The government's official position is that exploration and development of oil and gas fields should be encouraged. The identification of potential geological structures or "prospects" within the proposed exploration licence area for future exploration and possible well-drilling provides an opportunity to develop a South African oil and gas industry resulting in long-term benefits consisting of access to new energy sources, improved security of supply, major in-country investments in a development project and reduced dependence on the importation of hydrocarbons. There is also potential in the long-term for local economic stimulation through direct employment, future business opportunities, royalties and tax revenues. In addition, there are known mitigation measure to avoid and/or reduce potential impacts mentioned above as per the various specialist studies and knowledge from past exploration activities. As such, the no go alternative is not considered feasible or reasonable for this application, also refer to the detailed need and desirability of the project indicated in **Section 2.6**.

10.3 ENVIRONMENTAL IMPACT STATEMENT

The findings of the specialist studies conclude that there are no environmental fatal flaws that should prevent the proposed project from proceeding, provided that the recommended mitigation and management measures are implemented. Despite the negative impacts caused by the project, it must be considered that there are positive impacts as well, mostly based on the employment opportunities (although minimal). Based on the nature and extent of the proposed and the predicted impacts as a result of the construction, operation and closure of the facility, the findings of the EIA, and the understanding of the mostly low - moderate post-mitigation significance level of potential environmental impacts, it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed D3 Energy ER386 activities can be mitigated to an acceptable level and the project should be authorized.

10.4 RECOMMENDATIONS FOR INCLUSION IN THE ENVIRONMENTAL AUTHORISATION

As indicated in **Section 10.3**, it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed D3 Energy ER386 activities can be mitigated to an acceptable level and the project should be authorized. The following key specialist recommendations are made for inclusion in the EA for the project:

- Ensure that all mitigation measures as stipulated in the EMPr relating to the drilling (specifically technical specifications) as well as the MPRDA regulations are adhered to.
- As part of mitigation of contamination of groundwater, Chapter 8 and Chapter 9 of the MPRDA R. 527 Regulations for petroleum exploration and production should be adhered to wherever these regulations apply to exploration drilling.
- After exploration coring has been completed, samples removed and borehole cleaning has been completed, the boreholes should be fully grouted/cemented with the casing left in correct stratigraphic and aquifer zones as described by the MPRDA Petroleum exploration and production R. 527 Regulations, Chapter 8 and Chapter 9.
- A well design must be developed by a suitably qualified professional (such as a well/ reservoir engineer) and submitted to the PASA for approval prior to commencement of a specific drill site.
- The well design shall comply with GIIP and must ensure that all installed casing strings and associated cementing are engineered to withstand anticipated worst-case formation pressures and the pressures associated with contingency well control (kill) operations.

- Adequate contingency provisions shall be maintained on site or within close proximity, including the availability of base fluids and additives if required and/or pre-mixed drilling fluids, to enable the rapid preparation and deployment of kill mud where required
- Sump pits can be undertaken provided that that they are suitably lined with an impermeable barrier (i.e., High-Density Polyethylene or PVC Damtarp (Tarpaulin)) and the size and capacity is restricted to 4m x 4m and 1.5m deep per sump. Additional containment if required (i.e., for emergency situations) should be aboveground sumps with secondary containment. However, due to the sensitivity of the riparian zone, pitless drilling (aboveground sumps) must be implemented for drilling within the riparian zone (i.e., Target Areas 1 & 2) to reduce the risk of contamination from the drill sump.
- The correct type of fluids should be used during the construction phase and the boreholes should be correctly constructed so that no gas leakage occurs during the construction or operational phases. Biodegradable drilling fluids should be used wherever possible.
- Minimise vegetation clearance. Existing gravel roads must be used as far as possible, and the closest disturbed areas must be considered for drill pads. Clearance of vegetation must be kept to the required footprint (i.e. 50 x 50 m drill pad).
- Rehabilitation of the disturbed areas must be made a priority. Any disturbed area must be re-habilitated to its pre-disturbed state. Any disturbed area must be re-habilitated to its pre-disturbed state as defined in the pre-drill survey. Disturbed areas must be rehabilitated to support its post-closure land use, and this must be undertaken within six (6) months post drilling activities.
- A suitable qualified Environmental Officer (EO) or Environmental Compliance Officer (ECO) must be appointed prior to the construction / exploration phase.
- The exploration activities may only be undertaken within the assessed corridors i.e. 50 corridors for seismic transects and 1km buffers for drilling wells. Should additional seismic surveys and/or drilling wells fall outside of the assessed areas, but within ER386, then depending on the final location of the seismic survey / drill site with respect to the locations sensitivity as defined by the sensitivity maps, and in consultation with the ECO and relevant specialists, the following must be undertaken prior to surveying / drilling:
  - In low sensitive areas, an ECO walkdown (at minimum) must be undertaken by an independent ECO to assess potential impacts and/or provide site-specific mitigation measures as well as identify any additional specialist input requirements prior the commencement of activities. The conditions of the EMPr (as a minimum) must be complied with;
  - In medium sensitive areas, the respective specialists must be brought to site to assess the final drill site and surroundings (1km radius around the site) and develop site-specific mitigation measures. Furthermore, the conditions of the EMPr must be complied with; and
  - In high sensitive areas, the respective specialists must be brought to site to assess the final drill sites and surroundings (with relevant buffer zones, e.g. 1km radius for wetlands, etc.) and develop site specific mitigation measures. These measures (site specific EMPr conditions) must be submitted to the PASA for approval prior to commencement with the drilling operations.
- A walkdown by a qualified independent ECO must be undertaken at final drilling sites and along final seismic transects as part of the preconstruction survey. The ECO must advise on additional mitigation measures where applicable.
- A walkdown by a suitable specialist (ecologist) must be undertaken along final seismic transects as part of the preconstruction survey. The specialist must investigate and/or confirm presence of SCCS. Should any SCCs be identified, the specialist must provide additional mitigation measures to avoid impacts on the identified SCCs. Permits / Licenses must be obtained prior any disturbance and/or relocation of SCCs.

- A walkdown by a qualified archaeologist must be undertaken at final drilling sites and along final seismic transects as part of the preconstruction survey. The archaeologist must advise on additional mitigation measures should any heritage features be identified along the seismic transects and/or drilling site.
- All archaeological structures be retained and avoided with a buffer zone of 30m as per SAHRA guidelines. If this is not possible, the graves could be relocated after completion of a detailed grave relocation process, that includes a thorough stakeholder engagement component, adhering to the requirements of s36 of the NHRA and its regulations as well as the National Health Act and its regulations.
- A 50m buffer around all identified graves must be implemented within which no proposed activities are to take place.

11 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations relating to this EIA assessment should be noted:

- The application is limited to the proposed D3 Energy ER386 footprint and associated infrastructure in Welkom within the Matjhabeng and Moqhaka Local Municipalities, Free State Province.
- The information provided by the applicant is considered accurate, adequate, unbiased, and no information that could change the outcome of the EIA process has been withheld.
- The information provided by the specialists is considered accurate, adequate, unbiased, and no information that could change the outcome of the EIA process has been withheld.
- In determining the significance of impacts, with mitigation, it is assumed that mitigation measures proposed in the report are correctly and effectively implemented and managed throughout the life of the project.
- In accordance with the Protection of Personal Information Act (Act 4 of 2013), personal information (emails, contact numbers, address) were blanked out and/or excluded during the Public Participation and only provided to the competent authority officials.
- Personal information of I&APs made available to the competent authority will only be used by the authorities to confirm or obtain information regarding this specific project.
- The information presented in this report was the most accurate and relevant at the time of compilation of the report.
- The Administrative and Competent Authority did not have any objections on the Scoping Report

It must be noted that specialist gaps, assumptions and limitations relevant to their studies are indicated in the respective specialist reports (**Appendix F**).

12 UNDERTAKING REGARDING CORRECTNESS OF INFORMATION

I **Vukosi Mabunda** herewith undertake that the information provided in the foregoing report is correct to the best of my knowledge, and that the comments and inputs from stakeholders and Interested and Affected Parties has been correctly recorded in the report where applicable.

…………………………….

Signature of the EAP

Date: 2026/06/08

13 UNDERTAKING REGARDING LEVEL OF AGREEMENT

I **Vukosi Mabunda** herewith undertake that the information provided in the foregoing report is correct, and that the level of agreement with Interested and Affected Parties and stakeholders has been correctly recorded and reported herein.

…………………………….

Signature of the EAP

Date: 2026/06/08

14 REFERENCES

Airshed Planning Professionals. (2028). Air Quality Impact Assessment for the Motuoane Exploration Right Application (ER386), Free State Province.

Airshed Planning Professionals. (2026). Climate Change Assessment for the Motuoane Exploration Right Application (ER386), Free State Province.

Airshed Planning Professionals. (2026). Environmental Noise Impact Assessment for the Motuoane Exploration Right Application (ER386), Free State Province.

Bear, J. & Verruijt, A. (1992). Modeling groundwater flow and pollution. Dordrecht: Kluwer Academic Publishers.

Cachier, H. (1992). Biomass burning sources.

Climate Change & Infectious Diseases Group. (2023). World Maps of the Koppen-Geiger Climate Classification. [online]. Available at: World Maps of Köppen-Geiger climate classification. [Accessed: February 2025].

Conservation of Agricultural Resources, 1983 (Act 43 of 1983), Republic of South Africa.

Council of Geoscience geological map sheet 2726: Kroonstad and 2826: Winburg (1:250 000).

Council for Geoscience. (2000). Sheet 2726 Welkom, 1:250 000 Geological series. Council For Geoscience, Pretoria.

Department of Environmental Affairs. (2013, November 22). List of Activities which Result in Atmospheric Emissions which have or may have a Significant Detrimental Effect on the Environment, Including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage. Government Gazette No. 37054.

Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, and South African National Biodiversity Institute (DEA, DMR, CoM, SAMBF, SANBI). (2013). Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Pretoria.

Department of Environmental Affairs. (2014). Regulations regarding Air Dispersion Modelling. Department of Environmental Affairs, Government Gazette No. 37804, 11 July 2014.

Department of Energy. (2010). Integrated Resource Plan for Electricity 2010-2030.

Department of Energy. (2013). Draft Integrated Energy Plan (IEP).

Department of Environment Forestry and Fisheries (DEFF) 2020: Protocols for Specialist Assessments. Published in Government Notice No. 320 Government Gazette 43110.

Department of Environmental Affairs. (2009, December 24). National Ambient Air Quality standards. Government Gazette No: 32816.

Department of Environmental Affairs. (2012, June 29). National Ambient Air Quality Standard for Particulate Matter with an Aerodynamic Diameter less than 2.5 micrometres (PM2.5). Government Gazette No. 35463.

Department of Environmental Affairs. (2013, November 1). National Dust Control Regulations. Government Gazette No. 36974.

Department of Environmental Affairs. (2015, April 2). National Atmospheric Emission Reporting Regulations. Government Gazette No. 38633.

Department of Environmental Affairs. (2015, June 12). Amendments to the List of Activities which Result in Atmospheric Emission which have or may have a Significant Detrimental Effect on the Environment, including Health, Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage. Government Gazette No. 38863.

Department of Water Affairs and Forestry (1998). National Water Act, Act 36 of 1998

Department of Water Affairs and Forestry (1999). "Government Notice 704 (Government Gazette 20118 of June 1999)

Department of Environmental Affairs and Tourism (DEAT). (1992). Integrated Environmental Management Series. Pretoria.

Department of Minerals and Energy. (1998). White Paper on the Energy Policy of the Republic of South Africa.

Department of Mineral Resources. (2013). Mining and Biodiversity Guidelines (2013).

Department of Water Affairs and Forestry, South Africa. (2004). Internal Strategic Perspective: Middle Vaal Water Management Area. Prepared by PDNA, WMB and WRP on behalf of the Directorate National Water Resources Planning. Report no. 09/000/00/0304.

Department of Water Affairs (DWA). (2012). Groundwater Reserve Determination for the Middle Vaal Water Management Area. Department of Water Affairs, Pretoria, RSA.

Driver, A., Maze, K., Rouget, M., Lombard, A.T., Nel, J., Turpie, J.K., Cowling, R.M., Desmet, P., Goodman, P., Harris, J., Jonas, Z., Reyers, B., Sink, K And Strauss, T. (2005). National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia 17. South African National Biodiversity Institute, Pretoria.

Eltschlager, K.K., Hawkins, J.W., Ehler, W.C. & Baldassare, F.J. (2001). Technical measures for the investigation and mitigation of fugitive methane hazards in areas of coal mining. Pittsburgh: U.S. Department of the Interior, Office of Surface Mining.

Engelbrecht, F. (2019). Technical Report: Green Book – Detailed Projections of Future. Report reference number: CSIR/BE/SPS/ER/2019/0005/C. Pretoria: CSIR (Council for Scientific and Industrial Research).

Environmental Impact Management Services. (2026). Financial Costing for Closure and Rehabilitation for the Proposed Motuoane Exploration Right 386 Project.

Environmental Impact Management Services. (2026). Heritage Impact Assessment Report for the Proposed Motuoane Exploration Right 386 Project.

Equispectives Research & Consulting Services. (2026). Proposed Motouane 386 Exploration Right Application Social Impact Assessment.

Fezile Dabi District Municipality Integrated Development Plan 2022 – 2027.

Fourie, H. (2025). Palaeontology Impact Assessment for the Motuoane Exploration Right 386, Welkom, Free State.

Gradient Groundwater Consulting. (2026). Motuoane Energy Exploration Right EIA Hydrogeological Investigation and Groundwater Impact Assessment.

Groenewald, G.H., Groenewald D.P., and Groenewald S.M. (2014). Palaeontological Heritage of the Free State, Gauteng, Limpopo, Mpumalanga and North West Provinces. Internal Palaeotechnical Reports, SAHRA.

Hurlbert, M. and Gupta, J. (2016) 'The split ladder of participation: A diagnostic, strategic, and evaluation tool to assess when participation is necessary', *Environmental Science & Policy*, 50, pp. 100–113

International Finance Corporation (IFC). (2012). Performance Standards on Environmental and Social Sustainability. Washington, DC: World Bank Group

iKapa Resources (Pty) Ltd. (2024). Motuoane Energy Basis of Design.

Ingraffea, A.R., Wells, M.T., Santoro, R.L. & Shonkoff, S.B.C. (2014). Assessment and risk analysis of casing and cement impairment in oil and gas wells in Pennsylvania, 2000–2012. Proceedings of the National Academy of Sciences, 111(30), pp.10955–10960.

International Union for Conservation of Nature. (2001). IUCN Red Data List categories and criteria: Version 3.1. IUCN Species Survival Commission: Gland, Switzerland.

IPPC. (2022). *IPCC WGI Interactive Atlas: Regional information (Advanced)*. Retrieved January 6, 2023, from https://interactive-atlas.ipcc.ch

Jackson, R.B., Vengosh, A., Darrah, T.H., Warner, N.R., Down, A., Poreda, R.J., Osborn, S.G., Zhao, K. & Karr, J.D. (2013). Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction. Proceedings of the National Academy of Sciences, 110(28), pp.11250–11255.

Kang, M., Kanno, C.M., Reid, M.C., Zhang, X., Mauzerall, D.L., Celia, M.A., Chen, Y. & Onstott, T.C. (2014). Direct measurements of methane emissions from abandoned oil and gas wells in Pennsylvania. Proceedings of the National Academy of Sciences, 111(51), pp.18173–18177.

Land Type Survey Staff. (1972 - 2006). Land Types of South Africa: Digital Map (1:250 000 Scale) and Soil Inventory Databases. Pretoria: ARC-Institute for Soil, Climate, and Water.

Lejweleputswa District Municipality Draft IDP 2022-2027.

Macfarlane, D.M., Bredin, I.P., Adams, J.B., Zungu, M.M., Bate, G.C. and Dickens, C.W.S. (2014). Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries. Final Consolidated Report. WRC Report No TT 610/14, Water Research Commission, Pretoria.

Matjhabeng Local Municipality Integrated Development Plan Final Review 2024-2025.

McCauley, D. and Heffron, R. (2018). 'Just transition: Integrating climate, energy and environmental justice', Energy Policy, 119, pp. 1–7.

Moqhaka Local Municipality Integrated Development Plan 2022 – 2027.

Mucina, L. & Rutherford, M.C. (eds) (2006). The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Mine Health and Safety Act, 1996 (Act No. 29 of 1996), Republic of South Africa.

Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002), Republic of South Africa.

National Energy Act, 2008 (Act 34 of 2008), Republic of South Africa.

National Environmental Management Act, 1998 (Act 107 of 1998), Republic of South Africa.

National Environmental Management: Air Quality Act, 2004 (Act 39 of 2004), Republic of South Africa.

National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004), Republic of South Africa.

National Environmental Laws Amendment Act, 2022 (Act No. 2 of 2022), Republic of South Africa.

National Environmental Management: Waste Act, 2008 (Act 59 of 2008), Republic of South Africa.

National Development Plan (2012), Republic of South Africa.

National Environmental Management: Protected Areas Act, (Act 57 of 2003), Republic of South Africa.

National Water Act, 1998 (Act 36 of 1998), Republic of South Africa.

Natural Heritage Resources Act, 1999 (Act 25 of 1999), Republic of South Africa.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L., and Nienaber, S. (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801

Oberholzer, B. 2005. Guideline for Involving Visual and Aesthetic Specialists in the Environmental Impact Assessment (EIA) process (the DEA&DP Guidelines). Provincial Government of the Western Cape Department of Environmental Affairs and Development Planning.

Parsons R, (1995). A South African Aquifer System Management Classification. WRC Report No KV 77/95, Pretoria.

Pulles, W., Heath, R. & Van Wyk, E. (2005). A practical guide to the estimation of groundwater recharge in South Africa. Pretoria: Water Research Commission.

Royal Society & Royal Academy of Engineering. (2012). Shale gas extraction in the UK: A review of hydraulic fracturing. London: The Royal Society

SAHRA. (2012). Minimum standards: palaeontological component of heritage impact assessment reports, 15 pp. South African Heritage Resources Agency, Cape Town.

South African National Biodiversity Institute. (2018). “Vegetation Map of South Africa, Lesotho and Swaziland 2018”

Statistics South Africa. (2011). Census 2011, Republic of South Africa.

Statistics South Africa. 2014. The South African MPI: Creating a multidimensional poverty index using census data.

Statistics South Africa. (2015). Methodological report on rebasing of national poverty lines and development on pilot provincial poverty lines – Technical Report.

Statistics South Africa. (2016). Community Survey 2016 Provinces at glance. Pretoria.

Stephenson, W.J., Yong, A. & Martin, A. Flexible multimethod approach for seismic site characterization. J Seismol 26, 687–711. (2022). https://doi.org/10.1007/s10950-022-10102-y

The Biodiversity Company. (2026). Soils Impact Assessment - Motuoane Energy (Pty) Ltd Gas Exploration Project.

The Biodiversity Company. (2026). Terrestrial Biodiversity Impact Assessment - Motuoane Energy (Pty) Ltd Gas Exploration Project.

The Biodiversity Company. (2026). Aquatics and Wetland Impact Assessment - Motuoane Energy (Pty) Ltd Gas Exploration Project.

Tiwary, A., & Colls, J. 2010. Air pollution: measurement, monitoring and mitigation (3rd Edition ed.). Oxon: Routledge.

U.S. Environmental Protection Agency (EPA). (2011). Methane in drinking water wells. Washington, DC: U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency (EPA). (2016). Hydraulic fracturing for oil and gas: Impacts from the hydraulic fracturing water cycle on drinking water resources in the United States. Washington, DC: U.S. EPA.

U.S. Department of the Interior. (2011). Methane control and safety guidance. Washington, DC: Office of Surface Mining Reclamation and Enforcement.

U.S. Environmental Protection Agency (EPA) & International Association of Oil & Gas Producers (IOGP). (2015). Well control and blowout risk in oil and gas exploration: Industry performance and safety data. Washington, DC: EPA & IOGP.

United States Government Accountability Office (GAO). (2012). Oil and gas: Information on shale resources, development, and environmental and public health risks. Washington, DC: GAO

Vanclay, F. (2003). ‘International principles for social impact assessment’, Impact Assessment and Project Appraisal, 21(1), pp. 5–12.

Vanclay, F., Esteves, A.M., Aucamp, I. and Franks, D.M. (2015). Social Impact Assessment: Guidance for assessing and managing the social impacts of projects. Fargo ND: International Association for Impact Assessment (IAIA).

Vidic, R.D., Brantley, S.L., Vandenbossche, J.M., Yoxtheimer, D. & Abad, J.D. (2013). Impact of shale gas development on regional water quality. Science, 340(6134), pp.1235009.

Water Research Commission. (2012). Water Resources of South Africa.

Water Research Commission. (2016). Rainfall and meteorological data: https://im-mining.com/2020/03/02/multotec-builds-integrity-with-hydrocyclone-solution-at-zambia-tailings-facility/

Watson, T.L. & Bachu, S. (2009). Evaluation of the potential for gas and CO_2 leakage along wellbores. SPE Drilling & Completion, 24(01), pp.115–126.