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ENVIRONMENTAL IMPACT ASSESSMENT REPORT

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D3 ENERGY SOUTH AFRICA (PTY) LTD (PREVIOUSLY MOTUOANE ENERGY (PTY) LTD.)
PRODUCTION RIGHT APPLICATION ON VARIOUS FARMS IN MATJHABENG AND MASILONYANA LOCAL MUNICIPALITIES, LEJWELEPUTSWA DISTRICT MUNICIPALITY IN FREE STATE PROVINCE, SOUTH AFRICA

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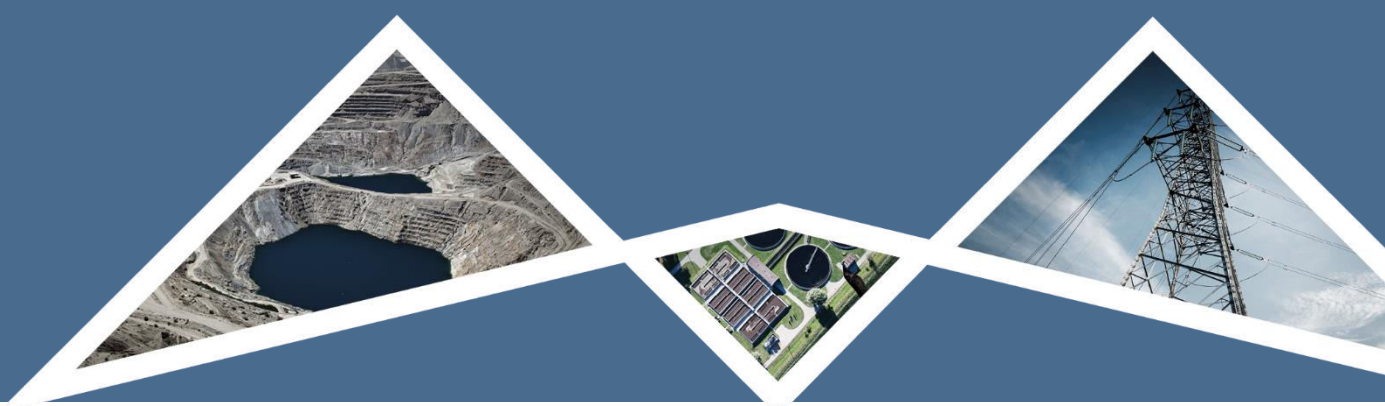

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Appendix G: Impact Assessment Matrix

Appendix H: Environmental Management Programme

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
D3 Energy	D3 Energy South Africa (Pty) Ltd
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&APs	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
$PM_{2.5}$	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**
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**

Term	Definition	Reference
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**
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 (I&APs)	a) any person, group of persons or organisation interested in or affected by such operation or activity; and (b) any organ of state 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**
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

A) INTRODUCTION AND OVERVIEW

D3 Energy South Africa (Pty) Ltd, previously Motuoane Energy (Pty) Ltd (Motuoane)[1] hereafter referred to as D3 Energy or Applicant, holds an Exploration Right (ER315) for hydrocarbons, granted in terms of Section 80 of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 – MPRDA, as amended) in September 2017. The then Department of Mineral Resources and Energy (DMRE), now the Department of Mineral and Petroleum Resources (DMPR) issued an Environmental Authorisation (EA – reference number: 12/3/315) to the Applicant in terms of the National Environmental Management Act (Act 107 of 1998 – NEMA).

The originally approved exploration area is located over an area of approximately 149 377 hectares (ha), covering various farms near the city of Welkom, within the Free State Province, extending north from approximately Theunissen, northeast towards Kroonstad, and east of Virginia and Hennenman. D3 Energy were subsequently required to relinquish part of their ER land position during their first and second renewals which reduced the ER footprint to approximately 95 483 ha, decrease of approximately 54 000 ha less than the originally approved area. In accordance with the National Environmental Management Act (Act 107 of 1998 – NEMA) an application for amendment of the EA through a Part 2 EA Amendment process was submitted to Competent Authority in 2024 to undertake an additional ten new exploration boreholes, approximately 30 km of new onshore seismic transects, and amend the approved Environmental Management Programme (EMPr). The amended EA was granted in terms of Regulation 33 of the NEMA EIA Regulations on the 31st of October 2024. A subsequent EA Amendment was submitted to the Administrative Authority in June 2026 to amend the Holder's details from Motuoane Energy (Pty) Ltd to D3 Energy South Africa (Pty) Ltd. The EA Amendment was granted on the 24th of July 2026.

The Applicant has applied for a Production Right (PR) over a portion of their existing authorised Exploration Right (ER) 315 area. The proposed extraction and production will target helium and methane gas, and will consist of up to 43 production wells plus 5 contingent wells, gas gathering pipelines, a helium recovery and gas processing plant (CNG and/or LNG) and associated infrastructure. In addition, ongoing development activities will include drilling of up to 48 development wells, and approximately 120 km (overall) of seismic surveys. The proposed production right application area covers a total of ~14 440 hectares. The proposed project will involve the following activities:

- Pre-drilling seismic and/or audio magnetotelluric surveys to optimize well locations for maximum deliverability;
- Drilling and completion of wells;
- Maintenance workovers of wells;
- Construction of gas gathering pipeline systems;
- Installation of gas compression and processing facilities;
- Construction of a helium recovery facility (gas or liquid helium) and gas (methane) processing plant (CNG and/or LNG); and
- Construction of associated infrastructure including roads, communications facilities and temporary accommodation facilities, if necessary.

The proposed project infrastructure triggers various listed activities in terms of the NEMA Listing Notices 1, 2 and 3 and a full Scoping and Environmental Impact Assessment process is being undertaken in line with 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 has been **changed from Motuoane Production Right 16 EA Application**, Within Various Farms in Matjhabeng and Masilonyana Local Municipalities, Lejweleputswa District Municipality, Free State Province, South Africa **to D3 Energy Production Right 16 EA Application**, Within Various Farms in Matjhabeng and Masilonyana Local Municipalities, Lejweleputswa District Municipality, Free State Province, South Africa and will be reflected accordingly in the final submission of the EIA Report and EA Application Form.

requirements of NEMA EIA Regulations, 2014 as amended. The relevant General Authorisation / Water Use Licence (WUL) application will be submitted for the triggers (Section 21 c & i and any other applicable water uses as identified in consultation with the Department of Water and Sanitation) under the National Water Act (Act 36 of 1998 – NWA) in a separate but parallel application. D3 Energy 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.

B) PURPOSE OF THIS 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 (EIAr) 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.

C) NEEDS AND DESIRABILITY OF THE PROJECT

As noted above the project aims to produce 2 products, namely helium and natural gas (methane).

Helium has several unique properties with numerous applications that make it an essential and irreplaceable element for many industries. This is because it cannot be synthesised, manufactured or substituted in many cases. Helium is listed on the critical materials lists for several major economies. Helium is a vital resource, essential in modern technologies with major critical uses throughout the science, medicine and manufacturing industries. It is an inert gas for cryogenic, heat transfer, shielding, leak detection, analytical and lifting applications. It is the most important element in studying super-cold conditions in low-temperature physics studies. It is a critical component in the manufacturing process, specifically ones which serve unique high-tech applications in MRIs, fibre optics and semiconductor chip manufacturing. More recent uses include hybrid air vehicles, helium filled hard drives and nuclear fusion technology.

Helium is a non-renewable natural resource that is predominantly recovered as a by-product of natural gas production. Globally, helium occurs in economically recoverable concentrations at a limited number of locations, many of which are experiencing progressive depletion. Recent studies of the Virginia gas fields in the Free State Province indicate an unusually high helium concentration, suggesting a geologically distinctive resource when compared to most conventional gas fields. This characteristic presents a notable departure from prevailing global practice, as the proposed D3 Energy development has the potential to prioritise helium as the primary product, with methane recovered as a secondary by-product. This approach contrasts with the conventional model, where helium recovery is contingent on sustained natural gas production. As international pressures to reduce fossil gas production increase, global helium supply is expected to decline accordingly. In contrast, the Virginia gas fields represent a scenario in which helium recovery is not dependent on large-scale gas production, positioning the resource as a potentially strategic source of helium. The economic need and desirability of the

proposed development are underpinned by the current and projected demand for helium, which is widely recognised as strong and enduring due to its critical applications and limited substitutes. Available market indicators suggest that demand for helium is expected to remain robust over the medium to long term, thereby supporting the economic justification and desirability of the proposed production project.

An increase in domestic natural gas reserves such as methane would also contribute to security of energy supply including in the gas to liquids industry, which currently relies on feedstock from coal, oil and gas reserves. The Draft Integrated Energy Plan (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). Natural gas is widely regarded in South Africa as a transitional or "bridging" energy source, largely because its combustion produces significantly lower carbon and other harmful emissions than coal. In this context, natural gas is generally viewed as a cleaner alternative to coal, and therefore comparatively more desirable as part of the country's energy mix.

In summary, production success would likely result in long-term benefits for South Africa consisting of access to new energy sources, improved security of supply, 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 also includes significant renewable power generation.

D) PUBLIC PARTICIPATION

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 is undertaken in accordance with the requirements of the NEMA EIA Regulations, 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.

The PPP commenced on the 17th of November 2025 with an initial notification and call to register for a minimum period of 30 days. The initial notification was undertaken in English, Afrikaans and Sesotho and was given in the following manner:

- Registered letters, faxes, emails and sms's: Notification were distributed to all pre-identified I&APs including government organisations, NGOs, relevant municipalities, ward councillors, landowners and other organisations that may be interested or affected.
- Advertisements describing the proposed project and EIA process were published in the Vista Newspaper with circulation in the vicinity of the study area. The initial advertisements were placed in the Vista newspaper in English, Afrikaans and Sesotho on the 20th of November 2025 with a government gazette published (also in 3 languages) on the 14th of November 2025.
- A1 Correx site notices in English, Afrikaans and Sesotho were placed at 50 locations within and around the application area from 17th to 19th of November 2025.
- A3 posters in English, Afrikaans and Sesotho were placed at local public gathering places in Virginia, Welkom, Ventersburg and Theunissen.

Notification regarding the availability of the Scoping Report for public review was given in the following manner to all registered I&APs:

- Registered letters with details on where the scoping report can be obtained and/or reviewed, EIMS contact details as well as the public review comment period;
- Facsimile notifications with information similar to that in the registered letter described above; and/or

- Email notifications with a letter attachment containing the information described above.

The scoping report was made available for public review from the 23rd of January 2026 to 23rd of February 2026. The comments received from I&APs during the initial call to register and Scoping Phase commenting period so far have been captured in Public Participation Report in **Appendix C.**

Comments received during this EIAr review period will similarly be collated and added to the Public Participation Report submitted to the Competent Authority (CA). This EIAr 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 the 29th of October 2026** through the following means:

- Environmental Impact Management Services (Pty) Ltd (EIMS)
- Phone: 011 789 7170 / Fax: 011 787 3059
- Contact: Mbali Tshabalala
- EIMS Reference No: 1709
- Email: motuoanepr@eims.co.za

E) IMPACT ASSESSMENT AND MITIGATION

The scoping-level assessment identified a range of potential environmental and socio-economic impacts associated with the construction, operation and decommissioning phases of the proposed D3 Energy Production Right Project. The assessment was undertaken using a structured impact identification and screening methodology, taking into account the nature, extent, duration, intensity and probability of identified impacts, as well as the sensitivity of the receiving environment. Each of the identified risks and impacts at the various project phases have been assessed during this EIA Phase and summarized below.

Construction activities, including the processing plant footprint, well pad establishment, access road construction and pipeline installation, may result in the disturbance or loss of natural vegetation, habitat fragmentation, and disturbance to fauna. Indirect impacts may include the introduction of alien invasive species and increased human activity within previously undisturbed areas. Mitigation focuses on impact avoidance and minimisation through micro-siting of infrastructure to avoid sensitive habitats, restriction of disturbance footprints, and implementation of rehabilitation measures. Alien invasive species management, controlled vehicle access, and post-construction rehabilitation. Biodiversity mitigation measures have been developed in this EIA phase, informed by specialist ecological assessments which have been adopted into the EMPr (**Appendix H**).

Potential surface water impacts include alteration of surface drainage patterns, sedimentation of watercourses, and contamination risks associated with drilling activities, accidental spills or poor waste management. Wetlands and drainage lines may be particularly sensitive during construction. Buffer zones around watercourses and wetlands need to be applied in accordance with best practice and specialist recommendations. Stormwater management controls, spill prevention measures, and emergency response procedures have been stipulated and will require the Applicant to implement the controls and measures accordingly. Where required, Water Use Authorisations must be obtained in terms of the National Water Act.

Potential groundwater impacts may arise from drilling activities, well integrity failure, or accidental contamination during handling and storage of drilling fluids and hydrocarbons. Groundwater is an important resource in the project area, particularly for agricultural and domestic use. Well design and construction are required to comply with recognised industry standards to ensure casing integrity and isolation of aquifers. Groundwater monitoring programmes as stipulated in the Geohydrological Impact Assessment Report (**Appendix F7**) will be implemented, and handling of hazardous substances will follow strict containment and spill prevention protocols.

Soil disturbance, compaction and erosion may occur during construction and operational activities. Loss of topsoil could affect agricultural productivity and rehabilitation success if not properly managed. Topsoil will be

stripped, stockpiled and reused for rehabilitation. Erosion control measures as stipulated in the Soils and Agricultural Impact Assessment Report (**Appendix F12**) and EMPr (**Appendix H**) will be implemented, including stabilisation of disturbed areas and rehabilitation following construction. Activities will be confined to approved footprints to minimise land degradation.

Potential air quality impacts include dust generation during construction and emissions associated with gas processing, flaring during commissioning or maintenance, and vehicle movements. Dust suppression measures will be implemented during construction, including water spraying where necessary. Gas handling and processing infrastructure will be designed to minimise emissions, and flaring will be limited to commissioning, maintenance and/or emergency scenarios where necessary. Currently the project designs and anticipated emissions do not trigger a requirement for an Air Emissions Licence (AEL), however, should there ever be any changes which results in significant emissions triggering the National Environmental Management: Air Quality Act (NEMAQA) Listed Activities, the Applicant will be required to obtain in terms of the NEMAQA and comply with set Minimum Emission Standards (MES).

Noise impacts may occur during drilling, construction and maintenance activities, potentially affecting nearby receptors such as farmsteads and rural communities. Noise-generating activities will be limited to daytime hours where feasible. Equipment will be maintained to minimise noise emissions, and noise monitoring may be implemented where sensitive receptors are present. A noise management plan will be developed if required.

Ground-disturbing activities may impact heritage or palaeontological resources that have not yet been identified. As per the Archaeological and Cultural Heritage Impact Assessment (HIA) (**Appendix F2**) A total of thirteen (13) distinct heritage features were identified which may potentially be impacted by the proposed development. These included burial grounds or graves, historical period remains, structures associated with farmsteads, and a Later Stone Age site. Based on the current layouts, the construction activities will not affect any of the features identified provided the recommended 30m and 50m buffers around heritage infrastructure and graves respectively is adhered to, particularly for MPR018 and MPR021. A Chance Find Procedure is also recommended to manage any discoveries during development should finds be discovered during the proposed construction activities. This includes halting activities if significant finds are discovered during construction, recording their location, and consulting a qualified archaeologist for further evaluation. Any identified resources will be managed in consultation with the South African Heritage Resources Agency (SAHRA) and relevant provincial authorities.

Positive socio-economic impacts include employment creation, skills development and local economic stimulation during construction and operation. Potential negative socio-economic impacts may include land use conflicts, disruption to agricultural activities, and increased traffic on local roads. Engagement with landowners and affected communities will continue throughout the project life cycle. Local employment and procurement will be prioritised where feasible. Traffic management measures will be implemented to minimise disruption, and compensation arrangements will be agreed with affected landowners where applicable.

Health and safety risks may arise from construction activities, handling of hazardous substances, and operational processes. Compliance with occupational health and safety legislation will be enforced. Site-specific Health and Safety Plans, emergency response procedures and staff training programmes will be implemented throughout the project life cycle.

Cumulative impacts may arise from the proposed project in combination with existing and planned production/mining, energy and agricultural activities in the region, particularly in relation to land use, water resources and socio-economic change. Cumulative impacts have been assessed in detail in this EIAr, informed by the specialist studies and regional context. Mitigation measures will be aligned with broader land use planning and regulatory requirements.

The most significant risks and impacts identified were those that remain high in terms of significance even post mitigation measures being considered, resulting in a residual impact. The following identified potential impacts were determined to have a potentially moderate negative final significance:

- Potential impacts on groundwater quality during operation and closure phases;

- Potential impacts on identified wetlands and aquatic species;
- Potential impacts on renewable energy developments;
- Potential impacts mining activities;
- Potential impacts air quality and climate change;
- Potential risks to nearby communities;
- Potential impacts on archaeological and cultural heritage features;
- Potential impacts on soils and agricultural activities;
- Potential impacts on vegetation and habitats;
- Potential mortality / disturbance of terrestrial species; and
- Potential positive socio-economic impact through employment opportunities.

The negative impacts have been further interrogated and assessed during this EIA phase of the project. Potential mitigation measures have been identified and refined based on input from the Environmental Assessment Practitioner (EAP), public consultation, and specialist assessments. 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.

F) SPECIALIST ASSESSMENTS

Various specialist assessments were identified through the Department of Forestry, Fisheries and the Environment (DFFE) National Web-Based Environmental Screening Tool Report and Site Sensitivity Verification undertaken to support the EA Application. The specialist assessments were 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 detailed specialist studies form part of the EIA report:

- Appendix F1: Air Quality Impact Assessment (Airshed Planning Professionals);
- Appendix F2: Archaeological and Cultural Heritage Impact Assessment (EIMS)
- Appendix F3: Aquatics and Wetland Impact Assessment (The Biodiversity Company);
- Appendix F4: Climate Change Impact Assessment (Airshed Planning Professionals);
- Appendix F5: Financial Provisions for Closure & Rehabilitation (Minelock Environmental Engineers & EIMS)
- Appendix F6: Hydrological / Floodline Assessment (Smec South Africa)
- Appendix F7: Geohydrological Impact Assessment (Gradient Groundwater Consulting);
- Appendix F8: Noise Impact Assessment (Enviro-Acoustic Research);
- Appendix F9: Palaeontological Impact Assessment (Banzai Environmental);
- Appendix F10: Quantitative Risk Assessment (Riscom);
- Appendix F11: Social Impact Assessment (Equispectives Research and Consulting Services);
- Appendix F12: Soils & Agricultural Impact Assessment (The Biodiversity Company); and
- Appendix F13: Terrestrial Biodiversity Impact Assessment (The Biodiversity Company).

G) ENVIRONMENTAL IMPACT STATEMENT

The EIA evaluated the potential biophysical, social, economic and safety implications of the proposed D3 Energy Production Right project, which includes up to 43 production wells (plus 5 contingent wells), gas gathering pipelines, seismic surveys, a helium recovery and gas processing facility (CNG and/or LNG), access roads and

associated infrastructure. The assessment incorporated specialist studies covering biodiversity, wetlands, groundwater, soils and agricultural potential, air quality, heritage resources, social impacts and quantitative risk.

Overall, the studies concluded that the majority of identified impacts are site-specific, predictable and capable of being effectively managed through appropriate avoidance measures, engineering design, operational controls, rehabilitation and ongoing environmental management. No fatal environmental, social or safety flaws were identified that would preclude the development from proceeding.

The Quantitative Risk Assessment confirmed that the proposed facilities do not present unacceptable risks to neighbouring communities. Potential incident consequences are largely confined to operational areas, individual and societal risks fall within internationally accepted criteria, and the development does not qualify as a Major Hazard Installation based on the projected inventories. Appropriate engineering design, emergency preparedness and regulatory compliance will be required to maintain acceptable risk levels.

Alternative assessments identified the preferred development configuration as the option that best balances resource recovery, environmental protection and operational feasibility. This includes production corridors that allow coexistence with renewable energy developments, a preferred gas plant location outside sensitive wetland and floodplain areas, an optimised gas pipeline alignment and the use of aboveground wellheads with appropriately managed drilling sump systems. The No-Go Alternative was not considered preferable, as it would prevent development of strategically important domestic helium and natural gas resources without providing environmental benefits that outweigh the associated socio-economic and energy security advantages.

Based on the findings of the specialist studies, stakeholder engagement process, impact assessment and alternatives evaluation, the proposed D3 Energy Production Right project is considered environmentally acceptable and technically feasible, provided that all recommended mitigation measures, monitoring programmes, environmental management commitments and specialist recommendations are implemented throughout the project lifecycle.

1 INTRODUCTION

D3 Energy South Africa (Pty) Ltd (previously Motuoane Energy (Pty) Ltd[2] hereafter referred to as D3 Energy or the Applicant holds an Exploration Right (ER315) for hydrocarbons, granted in terms of Section 80 of the Mineral and Petroleum Resources Development Act (Act 28 of 2002 – MPRDA, as amended) in September 2017. The then Department of Mineral Resources and Energy (DMRE), now the Department of Mineral and Petroleum Resources (DMPR) issued an Environmental Authorisation (EA – reference number: 12/3/315) to the Applicant in terms of the National Environmental Management Act (Act 107 of 1998 – NEMA).

The originally approved exploration area is located over an area of approximately 149 377 hectares (ha), covering various farms near the city of Welkom, within the Free State Province, extending north from approximately Theunissen, northeast towards Kroonstad, and east of Virginia and Hennenman. D3 Energy were subsequently required to relinquish part of their ER land position during their first and second renewals which reduced the ER footprint to approximately 95 483 ha, decrease of approximately 54 000 ha less than the originally approved area. In accordance with the National Environmental Management Act (Act 107 of 1998 – NEMA) an application for amendment of the EA through a Part 2 EA Amendment process was submitted to Competent Authority in 2024 to undertake an additional ten new exploration boreholes, approximately 30 km of new onshore seismic transects, and amend the approved Environmental Management Programme (EMPr). The amended EA was granted in terms of Regulation 33 of the NEMA EIA Regulations on the 31st of October 2024. A subsequent EA Amendment was submitted to the Administrative Authority in June 2026 to amend the Holder's details from Motuoane Energy (Pty) Ltd to D3 Energy South Africa (Pty) Ltd. The EA Amendment was granted on the 24th of July 2026.

The Applicant has applied for a Production Right (PR) over a portion of their existing authorised Exploration Right (ER) 315 area. The proposed extraction and production will target helium and methane gas, and will consist of up to 43 production wells plus 5 contingent wells, gas gathering pipelines, a helium recovery and gas processing plant (CNG and/or LNG) and associated infrastructure. In addition, ongoing development activities will include drilling of up to 48 development wells, and approximately 120 km (overall) of seismic surveys. The proposed production right application area covers a total of ~14 440 hectares. The proposed project will involve the following activities:

- Pre-drilling seismic and/or audio magnetotelluric surveys to optimize well locations for maximum deliverability;
- Drilling and completion of wells;
- Maintenance workovers of wells;
- Construction of gas gathering pipeline systems;
- Installation of gas compression and processing facilities;
- Construction of a helium recovery facility (gas or liquid helium) and gas (methane) processing plant (CNG and/or LNG); and
- Construction of associated infrastructure including roads, communications facilities and temporary accommodation facilities, if necessary.

The proposed project infrastructure triggers various listed activities in terms of the NEMA Listing Notices 1, 2 and 3, subsequently, a Scoping and Environmental Impact Assessment process is being undertaken. The relevant Water Use Licence (WUL) and Air Emissions Licence (AEL) applications will be submitted where relevant for the triggers under the National Water Act (Act 36 of 1998 – NWA) and National Environmental Management Air

[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 have been **changed from Motuoane Production Right 16 EA Application**, Within Various Farms in Matjhabeng and Masilonyana Local Municipalities, Lejweleputswa District Municipalities, Free State Province, South Africa **to D3 Energy Production Right 16 EA Application**, Within Various Farms in Matjhabeng and Masilonyana Local Municipalities, Lejweleputswa District Municipalities, Free State Province, South Africa and will be reflected accordingly in the final submission of the EIA Report and EA Application Form.

Quality Act (Act 39 of 2004 – NEMAQA), respectively. D3 Energy 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.

1.1 REPORT STRUCTURE

This report has been compiled in accordance with the NEMA EIA Regulations, 2014, 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 1.2**
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;	**Section 2**
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 2 and Section 3**
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 3**

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 4**
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 5**
Appendix 3(g):	A motivation for the preferred development footprint within the approved site;	**Section 6**
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 5** **Section 6** **Section 7** **Section 9** **Section 12.2**

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 9.1** and **Section 9.2**

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 9.3**
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 9.3** **Section 12.1**
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 12.3** **Appendix A**
Appendix 3(m)	Based on the assessment, and where applicable, recommendations from specialist reports, the recording of proposed impact management objectives,	**Section 9.3** **Section 12.1**

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	and the impact management outcomes for the development for inclusion in the EMPr as well as for inclusion as conditions of authorisation;	**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 5** **Section 9.3** **Section 12.1** **Section 12.2**
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 12.4**
Appendix 3(p)	Description of any assumptions, uncertainties and gaps in knowledge which relate to the assessment and mitigation measures proposed;	**Section 13**
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 12.3**
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 3** is for exploration and production 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	**Section14** **Section 15**

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
	(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;	
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 11** and **Appendix F5**
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 Listed activities associated road developments or expansions (NEMA GNR 983 Activity 24, NEMA GNR 983 Activity 56, NEMA GNR 985 Activity 4 and NEMA GNR 985 Activity 18) have been removed as they are not triggered. It should also be noted that the overall length of seismic surveys has increased from ~70 km to ~120km but remain within the assessment corridors.
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. Refer to **Appendix C.**
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 5**); (ii) a systematic investigation and assessment of the potential environmental consequences and the significance of those impacts (**Section 9**); and

Environmental Regulation	Description – NEMA Regulation 982 (2014) as amended	Section in Report
		(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 7** and **Appendix C**). The assessment further includes: (i) consideration of reasonable and feasible alternatives, including the "no-go" option (**Section 6**); (ii) identification of mitigation measures to avoid, minimise and manage adverse impacts (**Section 9**); (iii) disclosure of gaps, assumptions and uncertainties (**Section 13**); 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 9.3.14** (ii) considers relevant environmental sensitivity attributes identified through available mapping/screening information (**Section 10** and (iii) confirms that requirements of other applicable specific environmental management legislation are considered in the impact management measures and EMPr commitments (**Section 4** and **Appendix H**).

1.2 DETAILS OF THE EAP

EIMS has been appointed by D3 Energy as the independent Environmental Assessment Practitioner (EAP) to prepare and submit the EA application, Scoping and EIA Reports, and undertaking a Public Participation Process (PPP) in support of the proposed production right within the existing D3 Energy ER315 footprint. 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

In terms of Regulation 13 of the EIA Regulations, 2014, 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.

EIMS is a private and independent environmental management-consulting firm that was founded in 1993. EIMS has in excess of 30 years' experience in conducting EIA's. Please refer to the EIMS website (www.eims.co.za) for further details of expertise and experience.

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.

1.3 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.

1.4 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 4.1.3.1**. These listed activities triggered by the proposed project must follow the required Environmental Impact Assessment process as required by the National Environmental Management (Act 107 of 1998) (NEMA) Environmental Impact Assessment (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 PR is a mining 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.

1.5 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
Agricultural Potential, Soils & Land Capability	The Biodiversity Company
Air Quality Assessment	Airshed Planning Professionals
Climate Change Assessment	Airshed Planning Professionals
Noise Impact Assessment	Enviro Acoustic Research
Archaeological and Cultural Heritage Assessment	EIMS (Pty) Ltd
Palaeontological Impact Assessment	Banzai Environmental
Terrestrial Biodiversity Assessment	The Biodiversity Company
Aquatics and Wetland Assessment	The Biodiversity Company
Geohydrological Assessment	Gradient Groundwater Consulting
Hydrological Assessment	SMEC South Africa
Social Assessment	Equispectives Research and Consulting Services
Financial Provisions	Minelock Engineering Consultants & EIMS (Pty) Ltd
Quantitative Risk Assessment (QRA)	Riscom (Pty) Ltd

The specialist studies listed above in **Table 4** involved the gathering of data relevant to identifying and assessing potential 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 9.1**). Mitigation / management measures to minimise potential negative impacts or enhance potential benefits are put forward in this EIA Report (**Section 9.3**) 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.

2 DESCRIPTION OF THE PROJECT AREA

Table 5 provides a description of the property details of the proposed D3 Energy PR site as well as the distance to the nearest towns. The proposed project will be located within the Matjhabeng Local Municipality and Masilonyana Local Municipalities. See **Figure 1** and **Figure 2** for the locality of the proposed production right area.

Table 5: Locality details.

Property Area	The proposed project area is located southeast of the town of Welkom in the Free State Province of South Africa.				
Property Name, 21-digit Surveyor General Code	**Farm Name**	**Farm Number**	**Portion**	**LPI Code**	Parcel
	Azeka Farm 1019	1019	0	F04200000000101900000	RE/1019
	Azeka Farm 1019	1019	1	F04200000000101900001	1/1019
	Beginsel 75	75	0	F03500000000007500000	RE/75
	Blomskraal 216	216	0	F03500000000021600000	RE/216
	Delaporte Farm 887	887	0	F04200000000088700000	RE/887
	Detente Farm 744	744	0	F03500000000074400000	RE/744
	Detente Farm 744	744	1	F03500000000074400001	1/744
	Detente Farm 744	744	2	F03500000000074400002	2/744
	Detente Farm 744	744	2	F03500000000074400002	2/744
	Detente Farm 744	744	3	F03500000000074400003	3/744
	Doornnek Farm 905	905	0	F04200000000090500000	RE/905
	Doornnek Farm 905	905	1	F04200000000090500001	1/905
	Doornnek Farm 905	905	2	F04200000000090500002	2/905
	Doornnek Farm 905	905	3	F04200000000090500003	3/905
	Duikerbos 246	246	0	F03500000000024600000	RE/246
	Eureka 2101	2101	0	F04200000000210100000	RE/2101
	Gooi Die Hoed Farm 5	5	1	F04200000000000500001	1/5
	Grootspruit No. 943	943	0	F04200000000094300000	RE/943
	Hazor Farm 381	381	0	F04200000000038100000	RE/381
	Hazor Farm 381	381	1	F04200000000038100001	1/381
	Junctiondrift 217	217	0	F03500000000021700000	RE/217
	Junctiondrift 217	217	1	F03500000000021700001	1/217
	Junctiondrift 217	217	2	F03500000000021700002	2/217
	Junctiondrift 217	217	3	F03500000000021700003	3/217
	Kriegers Kraal 708	708	0	F03500000000070800000	RE/708
	Kriegers Kraal 708	708	1	F03500000000070800001	1/708
	Le Roux 717	717	1	F03500000000071700001	1/717
	Le Roux 766	766	0	F03500000000076600000	RE/766
	Le Roux 766	766	1	F03500000000076600001	1/766
	Leeuwkuil 428	428	0	F03500000000042800000	RE/428

Lelievlei 407	407	0	F03500000000040700000	RE/407
Mazelspruit Farm 1	1	0	F04200000000000100000	RE/1
Mazelspruit Farm 1	1	1	F04200000000000100001	1/1
Mazelspruit Farm 1	1	2	F04200000000000100002	2/1
Mazelspruit Farm 1	1	4	F04200000000000100004	4/1
Paardekuil Farm 228	228	0	F03300000000022800000	RE/228
Paardekuil Farm 228	228	0	F04200000000022800000	RE/228
Palmiet Fontein 229	229	0	F04200000000022900000	RE/229
Palmiet Fontein 229	229	0	F04200000000022900000	RE/229
Palmiet Fontein 229	229	1	F04200000000022900001	1/229
Palmiet Fontein 229	229	2	F04200000000022900002	2/229
Palmiet Fontein 229	229	3	F04200000000022900003	3/229
Palmiet Fontein 229	229	3	F04200000000022900003	3/229
Palmiet Fontein 229	229	4	F04200000000022900004	4/229
Palmiet Fontein 229	229	5	F04200000000022900005	5/229
Palmiet Fontein 229	229	6	F04200000000022900006	6/229
Palmiet Fontein 229	229	7	F04200000000022900007	7/229
Palmiet Fontein 229	229	8	F04200000000022900008	8/229
Palmiet Fontein 229	229	9	F04200000000022900009	9/229
Pieter's Gift Farm 1890	1890	0	F04200000000189000000	RE/1890
Pieter's Gift Farm 1890	1890	1	F04200000000189000001	1/1890
Pieter's Gift Farm 1890	1890	2	F04200000000189000002	2/1890
Pieter's Gift Farm 1890	1890	3	F04200000000189000003	3/1890
Quaggafontein Farm 3	3	0	F04200000000000300000	RE/3
Randjesfontein Farm 297	297	0	F03500000000029700000	RE/297
Rietvallei Farm 4	4	9	F04200000000000400009	9/4
Rooiheuvel Farm 57	57	0	F03500000000005700000	RE/57
Schoemanskop Farm 654	654	0	F04200000000065400000	RE/654
Siberiasfontein 605	605	0	F04200000000060500000	RE/605
Siberiasfontein 605	605	1	F04200000000060500001	1/605
Uithoek Farm 847	847	5	F04200000000084700005	5/847
Venters Paalmyn Farm 298	298	0	F03500000000029800000	RE/298
Vruchtenfontein Farm 942	942	0	F04200000000094200000	RE/942
Zanddraai Farm 58	58	0	F03500000000005800000	RE/58
Zanddraai Farm 58	58	1	F03500000000005800001	1/58
Zoutfontein 841	841	0	F04200000000084100000	RE/841
Zoutfontein 841	841	1	F04200000000084100001	1/841
Zoutfontein 841	841	2	F04200000000084100002	2/841

Application Area (Ha)	The D3 Energy PR is approximately 14 440 ha.
Magisterial District	The project area falls within the Matjhabeng and Masilonyana Local Municipalities, Lejweleputswa District Municipalities.
Distance and	The site boundary is ~15km southeast of the town of Virginia, ~28km southeast of the town of Welkom, ~13km southwest of the town of Ventersburg and ~21km northeast of the town

direction from nearest towns	of Theunissen. The geographic coordinates at the approximate centre of the application area are 28°14'38.37"S and 26°57'54.97"E
Surrounding land uses	Neighbouring land-use in the surrounding of the proposed project comprises predominantly of agriculture activities with mining activities to the southwest.

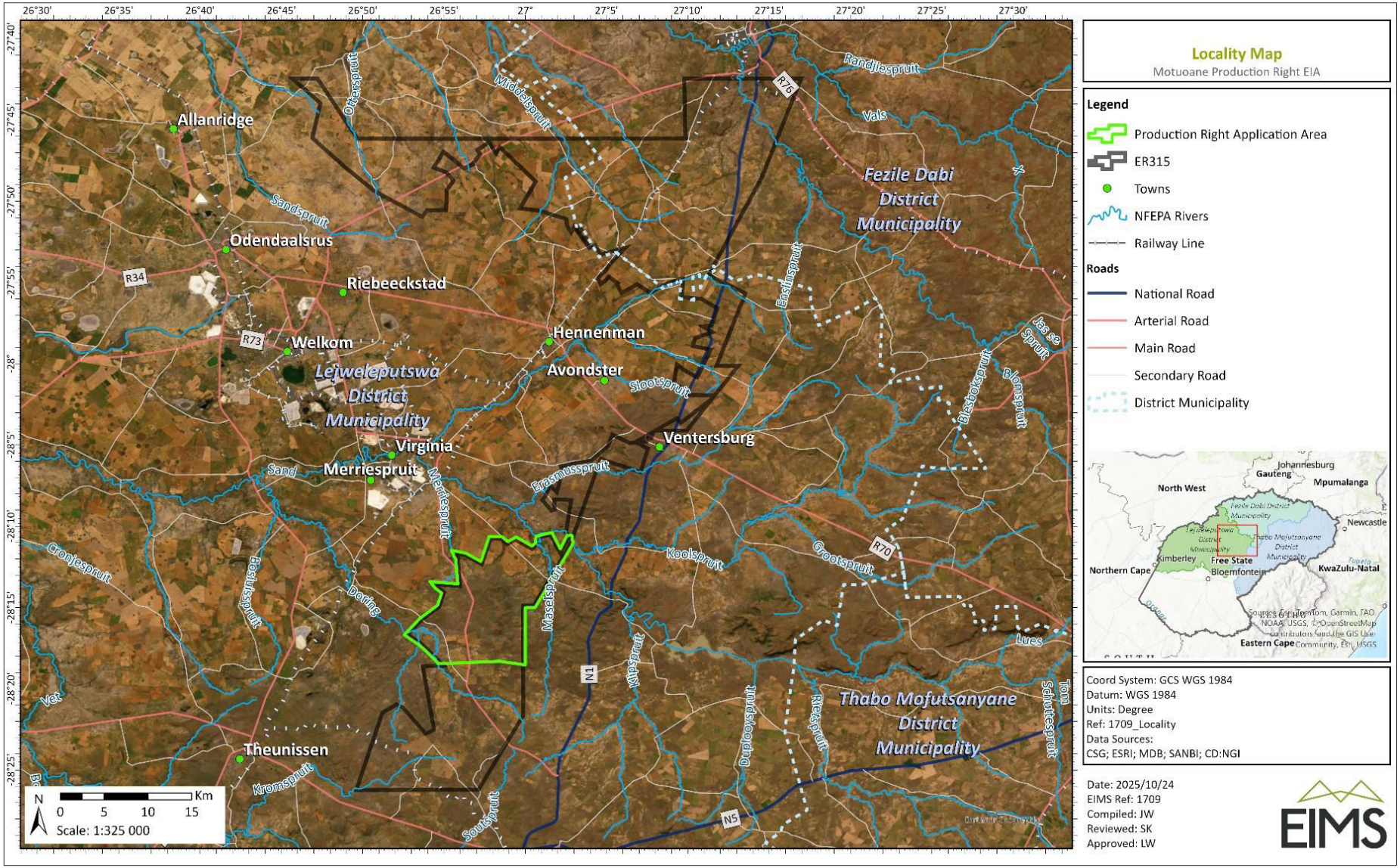


Figure 1: Aerial imagery locality map indicating the location of the proposed D3 Energy PR in relation to ER315.

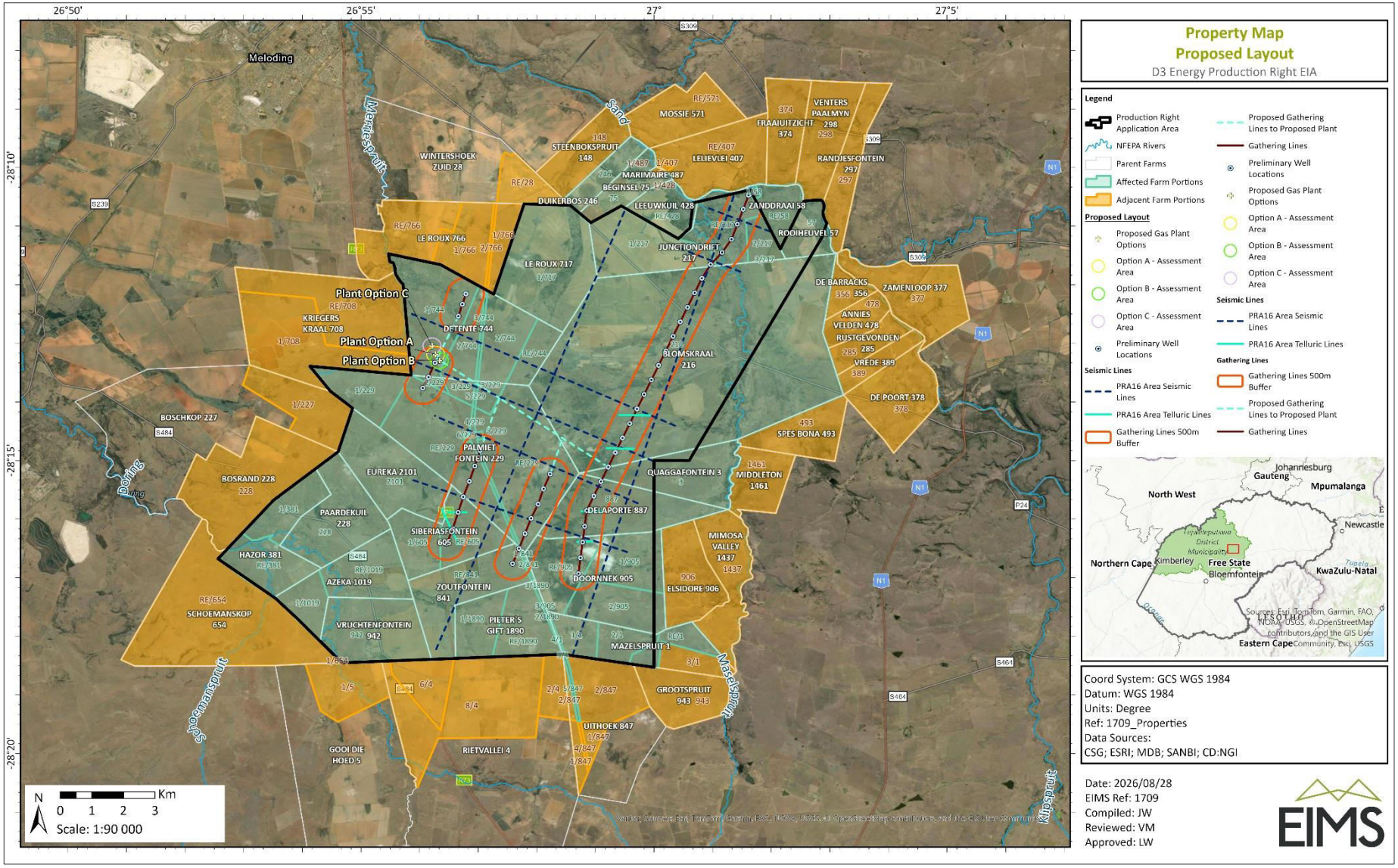


Figure 2: Locality map indicating the boundary of the proposed PR footprint and associated properties.

3 DESCRIPTION AND SCOPE OF THE PROPOSED PROJECT

This section provides a detailed description for the proposed D3 Energy Production project with its associated infrastructure. Most of the key information presented in this section was obtained from the applicant. The aim of the project description is to describe the proposed activities. Furthermore, the project description is designed to facilitate the readers understanding of the proposed project related activities which are anticipated to lead to impacts identified and assessed in this EIA Report, and for which management measures have been, or will be designed.

3.1 PROJECT DESCRIPTION

D3 Energy wishes to convert a portion of their existing ER315 into a Production Right (PR) (**Figure 1**). D3 Energy applied for a Production Right (PR 12/4/016) 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 August 2025. The proposed extraction and production will target helium and methane gas, and will consist of up to 43 production wells (plus 5 contingent wells), gas gathering pipelines, a helium recovery and gas processing plant (CNG and/or LNG) and associated infrastructure. In addition, ongoing development activities will include drilling of development wells, seismic and/or audio magnetotelluric surveys. The production right application area covers a total of ~14 440 hectares. The proposed project of the Production Right area will involve the following activities:

- Pre-drilling seismic and/or audio magnetotelluric surveys to optimize well locations for maximum deliverability;
- Maintenance workovers of wells;
- Drilling and completion of wells;
- Construction of gas gathering pipeline systems;
- Installation of gas compression and processing facilities;
- Construction of a helium recovery facility (gas or liquid helium) and gas (methane) processing plant (CNG and/or LNG); and
- Construction of associated infrastructure including roads, communications facilities and temporary accommodation facilities if necessary.

The D3 Energy PR proposed infrastructure layout and alternative layout footprint are presented in **Figure 3** and **Figure 4**. The locations of all proposed production wells and infrastructure have been chosen using desktop studies and available information from publicly available mapping services. All production well locations, gas gathering pipelines and processing plant infrastructure will be located in consultation with the landowners and any other stakeholders and be located to minimize damage to existing services, vegetation and land. Proposed infrastructure and production wells will be located close to existing fence lines and farm roads / tracks where practically possible and not be located within close proximity to housing and major structures. **Figure 3** and **Figure 4** depicts the proposed project locations for production wells, gas gathering pipelines and processing plant. In must be noted that although up to 43 production wells (plus 5 contingent wells) are proposed, additional wells have been plotted in the locality maps below to make allowance for areas where wells may intersect solar development projects in the PR. This will allow for the exclusion of those wells that intersect or may interfere with the solar developments in the area should it be required (Refer to **Section 6.2**). The applicant is still in discussions with the solar companies in an attempt to pursue a coexistence arrangement.

The D3 Energy PR lies within the broader Free State Goldfields mining region, historically one of South Africa's most significant gold-producing provinces. Historic and current mining activities in the broader region include:

- Deep-level gold mining;
- Tailings storage facilities;
- Mine residue deposits; and
- Mining-related processing infrastructure.

As per the Geographic Information System (GIS) file provided by Sibanye Stillwater, the proposed D3 Energy PR overlaps with the FS 10005 MR Sibanye Stillwater Robijn Project (refer to **Figure 7**). According to Sibanye Stillwater website[3], in June 2017, a mining right consolidating four areas of the property (Bloemhoek, De Bron Merriespruit, Hakkies and Robijn) was approved for a 23-year period and executed. The mining right is contiguous to the north-east of the Beatrix mining right. The Robijn Project is an advanced exploration-stage gold project located in the Free State province of South Africa, forming part of Sibanye-Stillwater's broader Southern Free State (SOFS) project portfolio. However, based on available information at the time of compilation of this report, The Robijn Project does not have active shafts nor any underground tunnels because it is still an advanced exploration-stage venture. No actual shaft-sinking or underground mining infrastructure has been constructed yet. It must be noted that Sibanye Stillwater was engaged by the EAP and requested to provide information to be considered / or assessed as part of this EIAr for current and future mining activities within the proposed D3 Energy PR. The only information provided to the EAP is the MR footprint and project names as indicated on **Figure 7**, no information relating to activities and/or active mining areas within the D3 Energy PR was provided to the EAP.

The proposed production wells are located along known faults (i.e. Virginia and Ventersburg faultlines) and close to either existing blowers (gas emitting wells) or exploration wells drilled by D3 Energy. The initial development will focus on the wells located on the Virginia fault where there are 13 new well locations and 3 existing wells that will be utilised in the development. There are an additional 27 well locations located on the Ventersburg fault that will be drilled as required to maintain the required sales production. The production right area has an expected life of at least 30 years.

The proposed project consists of both non-invasive and invasive exploration and production activities. Non-invasive exploration activities include desktop studies, geological mapping, geophysical surveys and environmental baseline investigations, which are expected to result in negligible physical disturbance. Invasive exploration activities, such as drilling, trenching and bulk sampling, will require localized vegetation clearance and soil disturbance. During the production phase, non-invasive activities will primarily comprise monitoring, inspection and operational control functions, while invasive activities will include infrastructure development, extraction operations, processing facilities, access roads and associated support infrastructure. These activities have the potential to result in significant biophysical and socio-economic impacts and therefore require the implementation of appropriate mitigation, management and rehabilitation measures. The proposed activities are detailed in the sub-sections below.

[3] https://www.sibanyestillwater.com/business/southern-africa/gold-operations/projects/

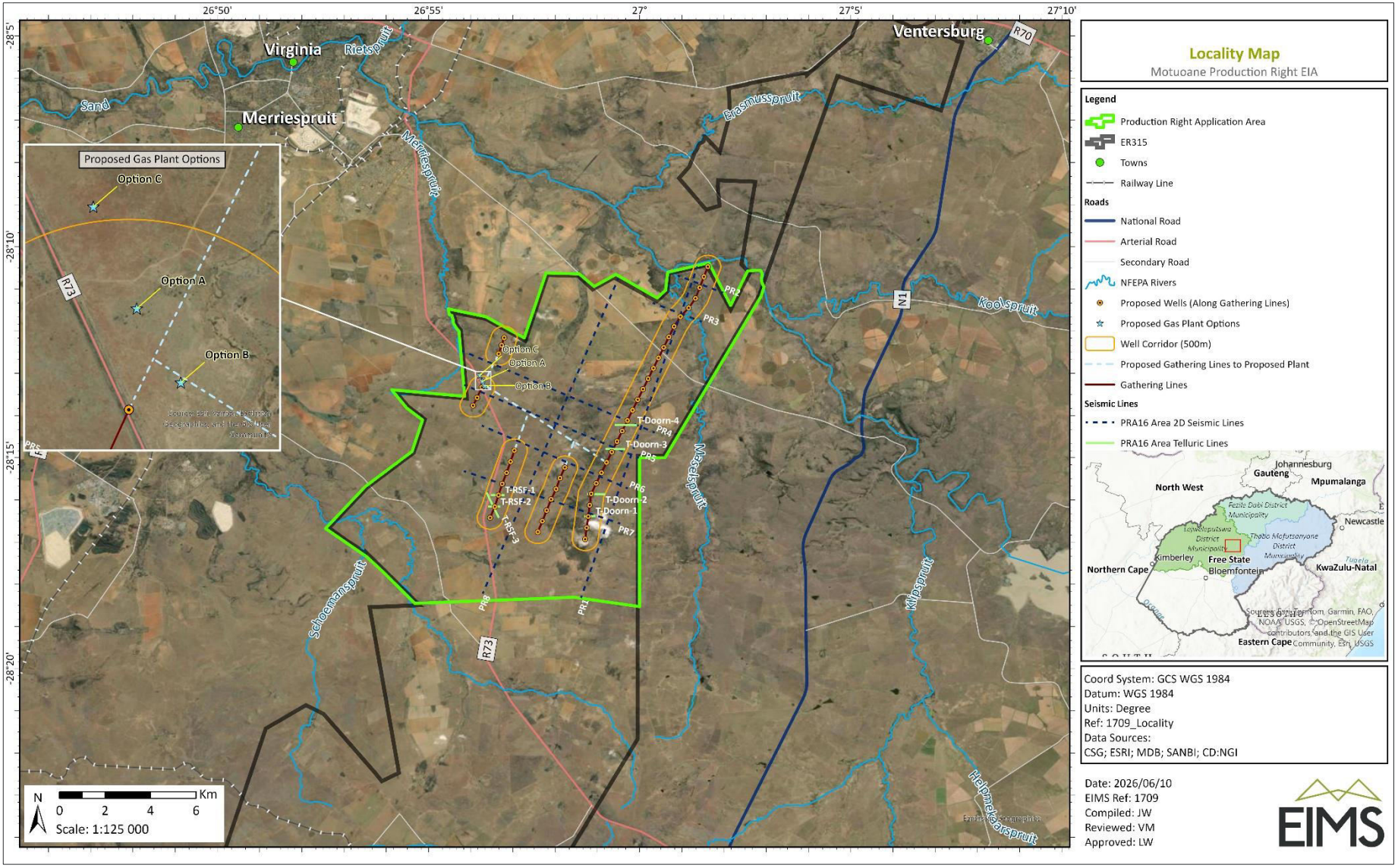


Figure 3: D3 Energy PR study area and proposed layout infrastructure footprint.

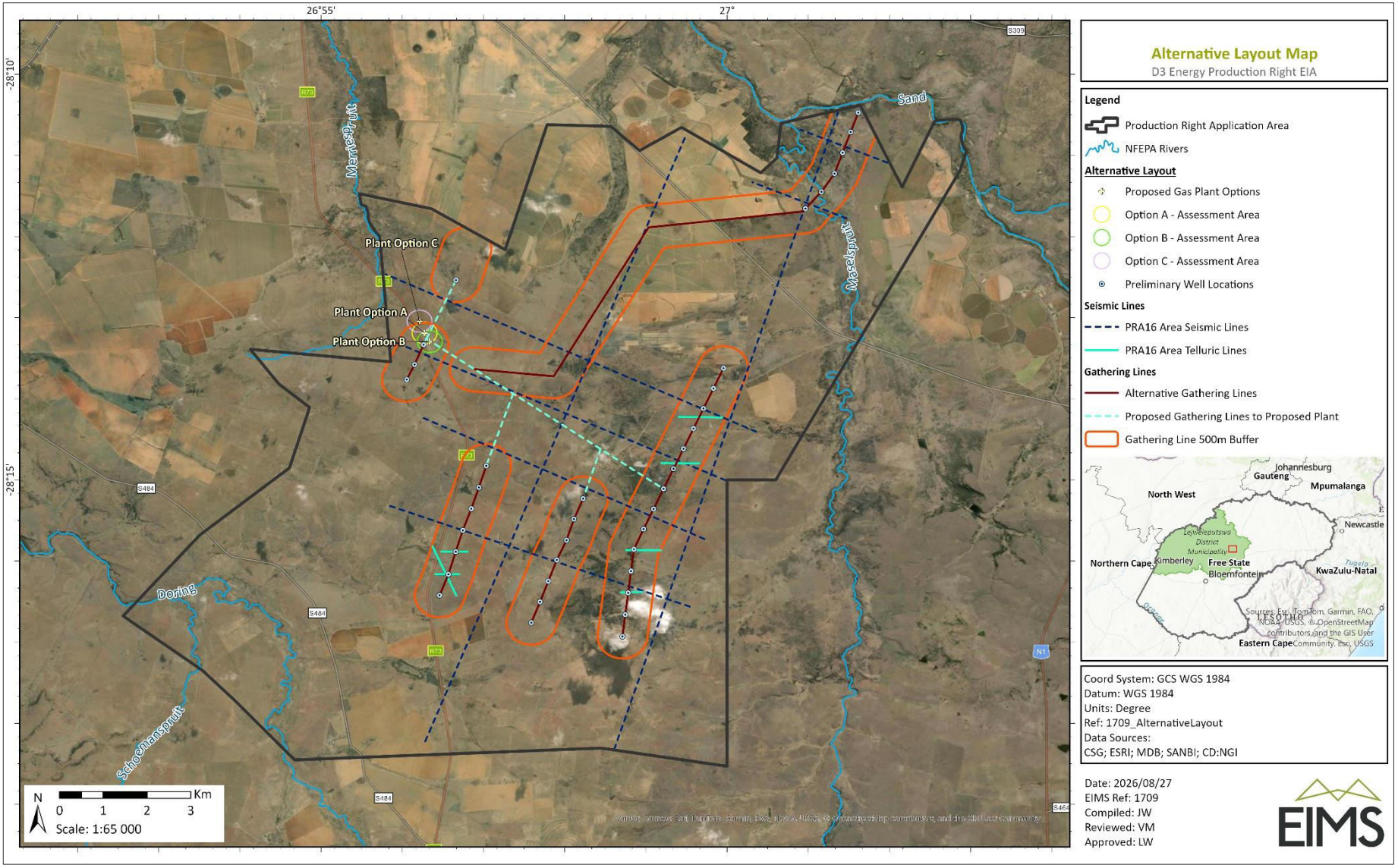


Figure 4: D3 Energy PR study area and alternative layout infrastructure footprint.

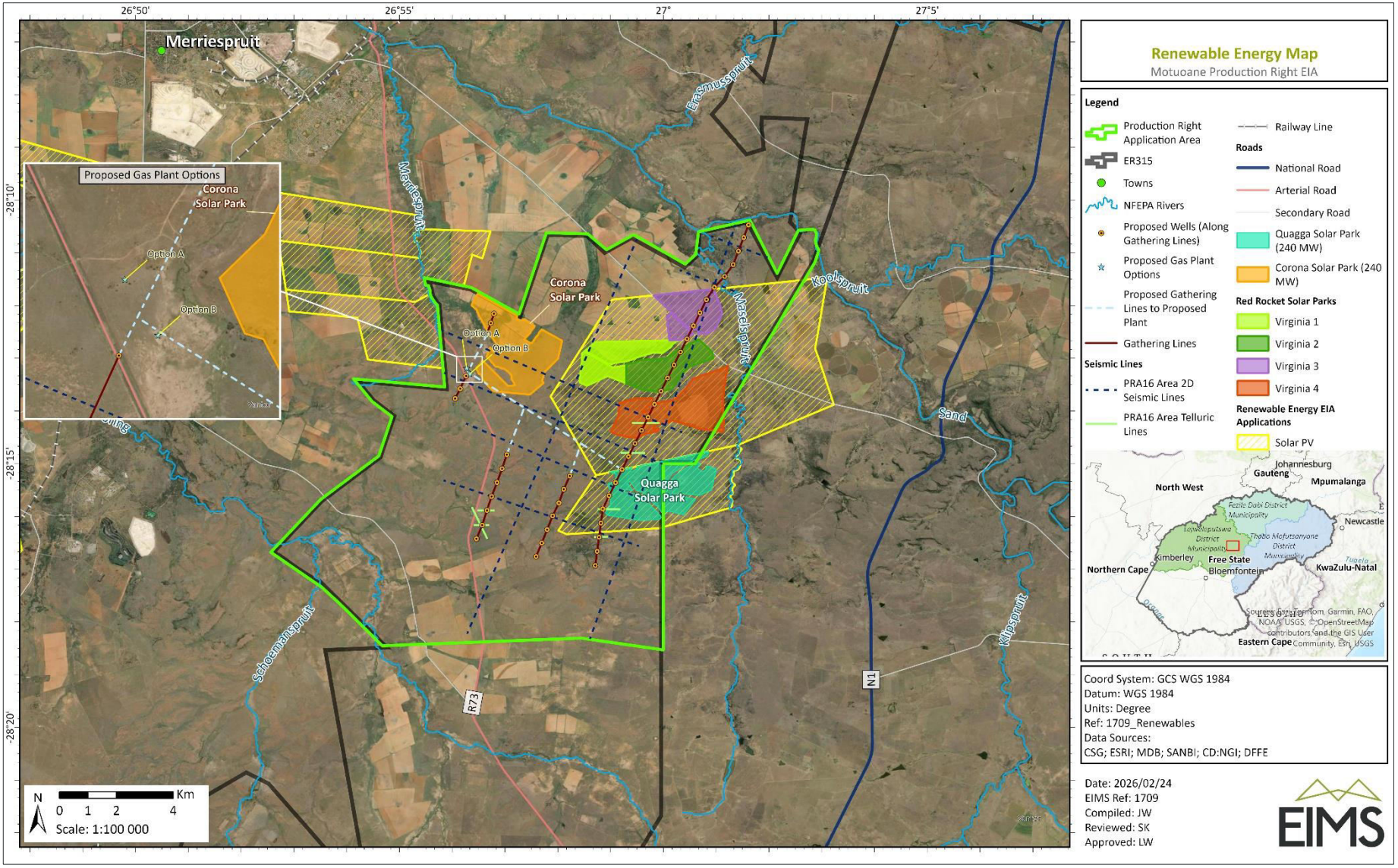


Figure 5: D3 Energy PR study area proposed layout in relation to renewable energy developments.

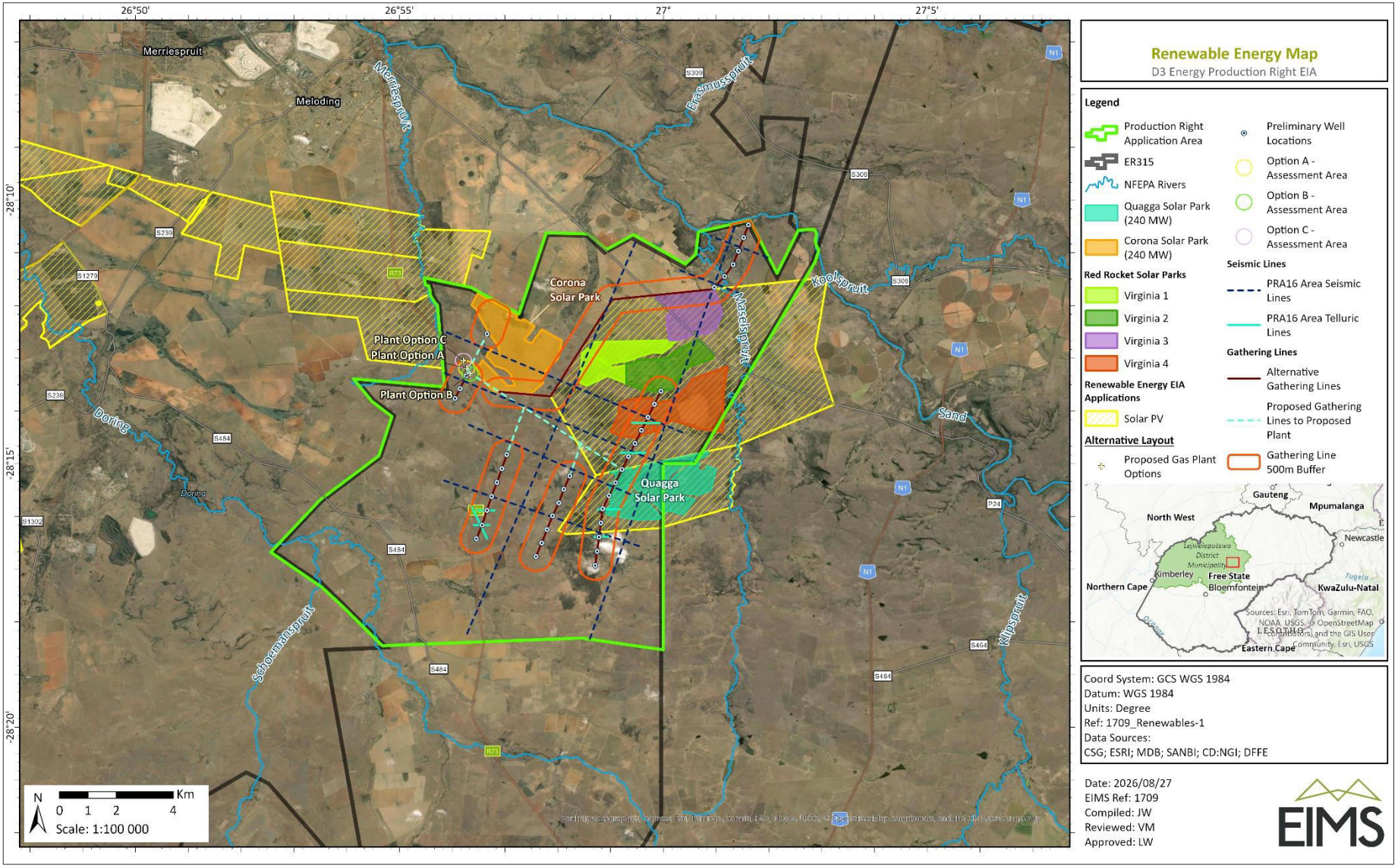


Figure 6: D3 Energy PR study area alternative layout in relation to renewable energy developments.

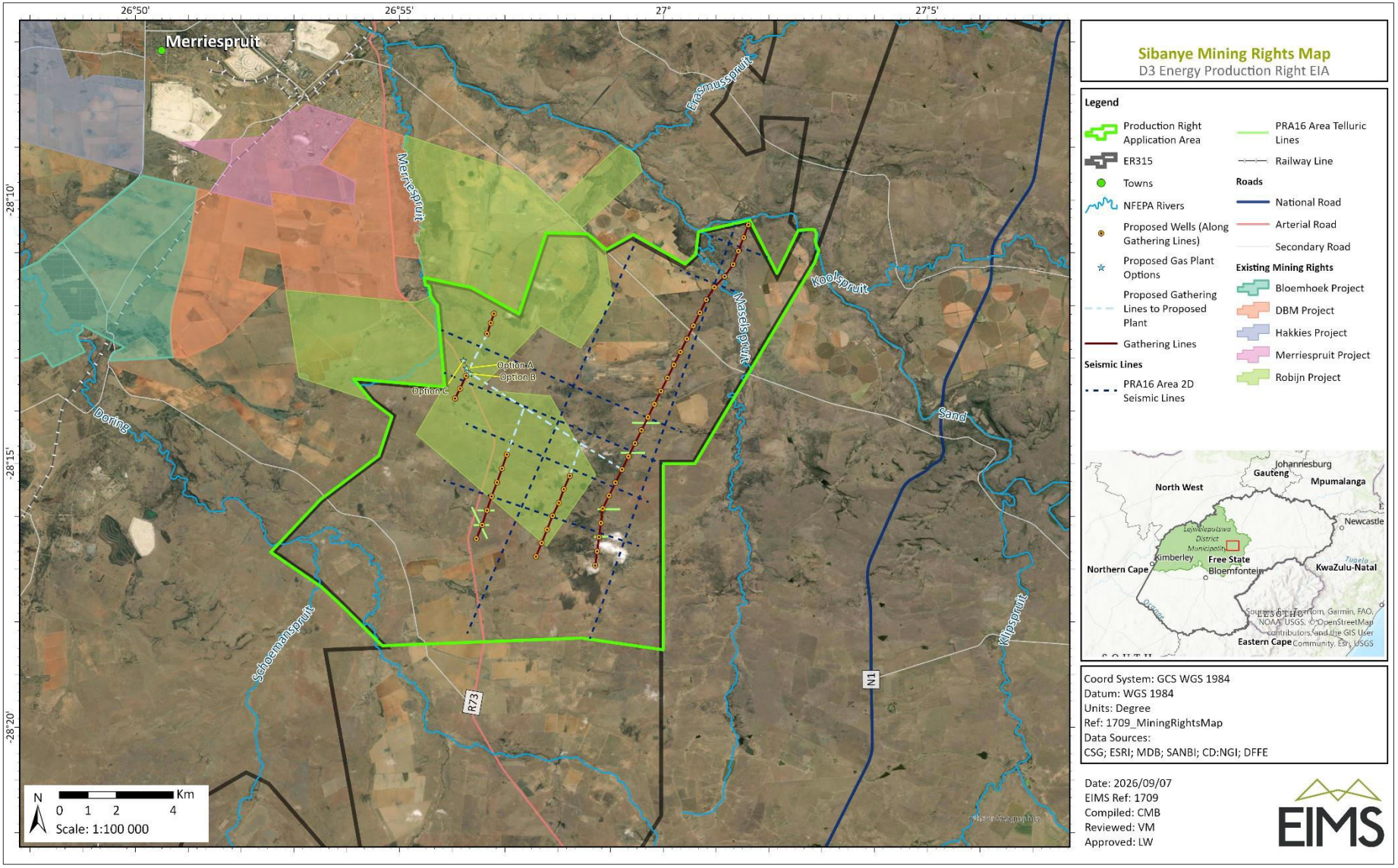


Figure 7: Existing mining rights within the proposed D3 Energy PR footprint.

3.1.1 SEISMIC AND AUDIO MAGNETOTELLURIC SURVEYS

Seismic and audio magnetotelluric (MT) surveys are geophysical methods that use different physical principles to characterise the subsurface and may be used individually or in combination. Seismic methods use acoustic waves to detect variations in acoustic impedance (related to density and wave velocity), while MT survey methods use natural electromagnetic fields to map variations in electrical resistivity. Various survey techniques may be employed along pre-determined seismic transects as depicted in **Figure 6** below.

Seismic surveying along the transects through a Vibroseis technique are undertaken by a small team (approximately 5-10 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 6**). A single Seismic Vibrator consisting of a vibrating baseplate that is connected to the ground is used. The vibrating plate emits a low frequency signal (4-80 Hz) into the ground, called a sweep. The vibrator 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. Several small geophones are used to convert the ground movements or seismic waves from the Seismic Vibrator into voltage, which is recorded at a nearby recording station. The survey team then generates and analyses the 2-D sub-surface geological network and identify areas of interest for well optimisation. The outcome of the seismic survey will be used to inform preferable drilling locations.

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 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 6**). 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. 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). The audio magnetotelluric surveys will be utilised to optimize well locations for maximum deliverability. Approximately 120 km (overall) of seismic surveys are proposed.

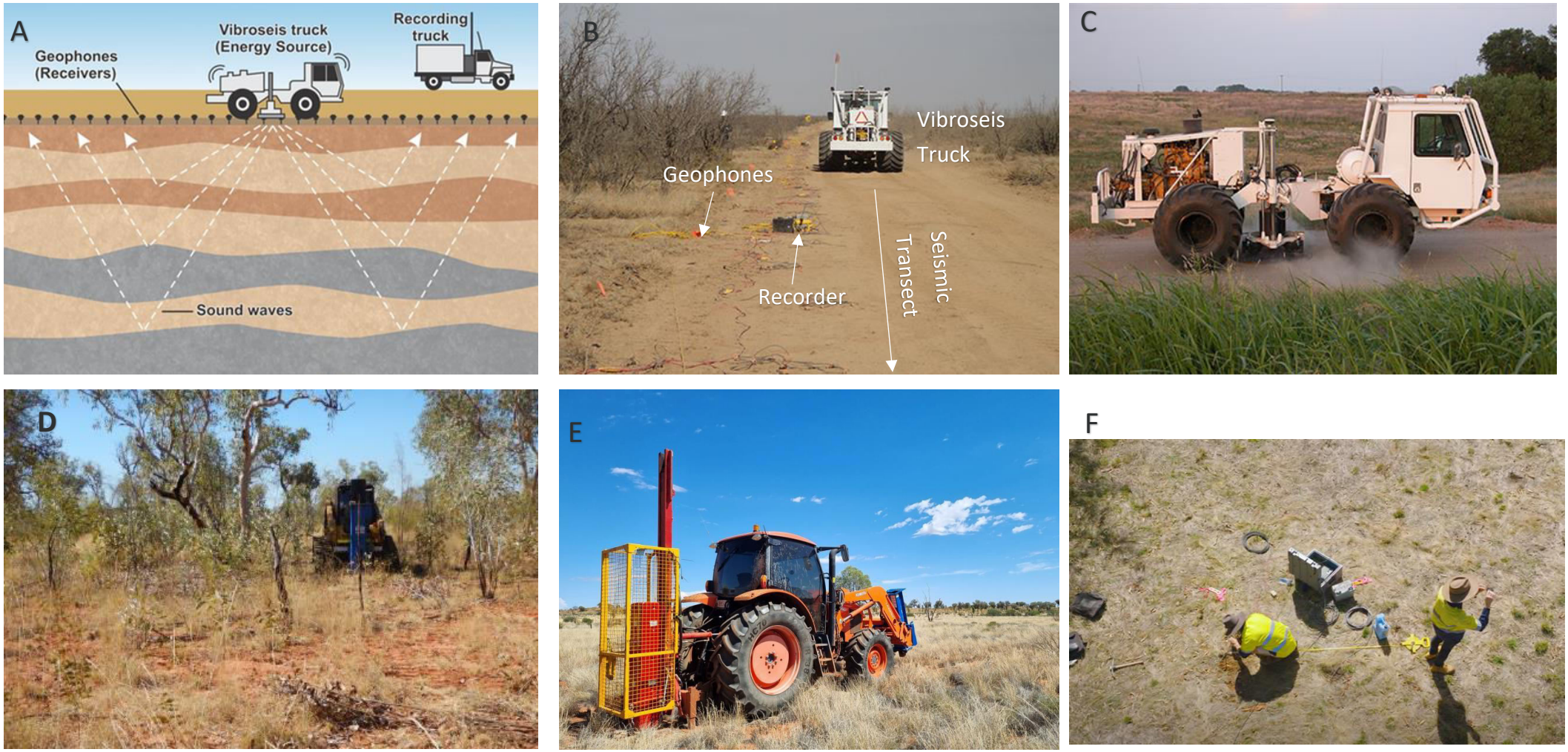


Figure 8: Seismic surveying process and potential impacts. (A) Showing an animated Vibroseis process, (B) Showing a real life Vibroseis process, (C) Showing minimal dust generated from the process, (D) Showing minimal vegetation impact associated with a new access path (transect route), (E) Showing the weight drop alternative method and (F) showing magnetotelluric survey.

3.1.2 WELL WORKOVER AND INTERVENTION

The proposed activities to be undertaken as part of the development include identifying existing blowers (pre-existing boreholes that were drilled as part of exploration programmes for gold mining) 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[4].

3.1.2.1 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 Production:

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.

3.1.2.2 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 interventions or workovers. These interventions are crucial for optimizing production, addressing specific issues, and ensuring the continued functionality of the well. Unlike major workovers, which involve substantial interventions, interventions are generally minor in nature and focus on improving well productivity and efficiency. The process of Well Intervention will be one or a combination of the following (but **will exclude any well stimulation techniques such as hydraulic fracturing activities associated with well intervention**):

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

[4] 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.

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.

3.1.2.3 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, workover may be undertaken (appropriate to be determined following technical assessment). 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.
- Chemical management: proper handling, storage, and disposal of chemicals.
- Casing and plugging of the wells: steel casing and cement barriers to prevent leaks as well as plugging at the end of production to prevent groundwater seepage.
- Rehabilitation: each well site will be rehabilitated to support the existing land-use.

3.1.3 WELL DRILLING

Using the data gathered during the preceding background review and surveying, up to 43 production wells and 5 contingent wells will be drilled. All wells must be drilled and cased in accordance with applicable international standards and best practice guidelines and will be sealed with a combination of steel casing and grouting (cement) to ensure there is no mixing of gas or deep saline water with the shallower freshwater aquifers. The drilling of wells is a temporary and short-lived activity (~30 days) and the equipment to be used during drilling activities includes a truck/trailer or skid mounted drill rig, TLB, light motor vehicles for transport of personnel and chemical toilets. Drilled wells will be evaluated based on gas flow, pressure and gas composition, prior to making a decision to either complete the well as a production well or to safely decommission and rehabilitate it. Well testing may include venting and/or flaring of the gas where it is safe to do so (Refer to **Section 6.3**)

Using the data gathered during the preceding background review, surveying and exploration, up to 43 production wells (plus 5 contingent wells) will be sited. A development spacing of 500 – 650 m has been chosen for the production wells to be drilled. This spacing has been chosen following a review of geological formations and reservoir properties including well interference testing. The wells will be drilled to a total depth of approximately 500-600 m and open hole completed (i.e. without casing) in the reservoir zone (**Figure 9**).

Production casing from the surface to the base of the Karoo will be cemented to the surface to ensure wellbore integrity. Then, the well will be drilled into the Witwatersrand formation in order to encounter gas-producing fractures. Initially, D3 Energy will log the open hole Karoo, run and set casing, then run a Casing Bond Log (CBL). Upon reaching Total Depth (TD), D3 Energy will log the open hole beneath the casing. This logging program may evolve as drilling continues. The wells will be completed as simple open hole completions, with no tubing or pumping equipment necessary.

Each 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 casing sizes and configurations will vary depending on the specific geological characteristics and functional requirements. Each well will be steel cased and have cement barriers to prevent leaks as well as plugged at the end of production to prevent groundwater seepage (**Figure 10**). Drilling activities are estimated to be one to two weeks per hole during which time there will be a drill rig, a service truck and an LDV on site. Intermittent use of a TLB will be used during site establishment and demobilisation.

The construction of each drill pad will disturb an area of up to 50 x 50 m (**Figure 11**). Within the disturbed area, the drill rig, drill rods, support equipment, temporary waste storage areas, chemical toilets, and any site offices required for drilling operations will be located. The proposed wells will primarily be drilled using an air-drilling method, whereby compressed air, nitrogen and/or other gases are used to cool the drill bit and transport drill cuttings to the surface. Under normal drilling conditions, conventional drilling muds and drilling chemicals will therefore not be used and no drilling fluids are anticipated to be generated during routine drilling operations. Drill cuttings generated during air drilling will be collected and managed within the designated drill pad area.

Notwithstanding the above, site-specific geological conditions may occasionally necessitate the use of limited quantities of environmentally acceptable drilling fluids or loss-circulation materials to maintain borehole stability, control downhole conditions, or address unforeseen drilling challenges. Such situations would be the exception rather than the norm. Should drilling fluids be required, only approved products will be utilized, Safety Data Sheets (SDSs) will be maintained on site, and all drilling-fluid waste will be contained and managed in accordance with this EMPr and applicable waste management requirements.

As a standard environmental protection measure, each drill pad will be equipped with impermeable, lined and fenced-off sumps (approximately 4 m × 4 m and 1.5 m deep). These sumps will primarily be used during well construction and cementing activities to contain cement returns, cement slurry overflows, equipment wash water, and any wastewater generated during drilling operations. The sumps also provide contingency containment capacity should drilling fluids be required under abnormal or unforeseen drilling conditions. The sumps will not be used for the long-term storage of waste.

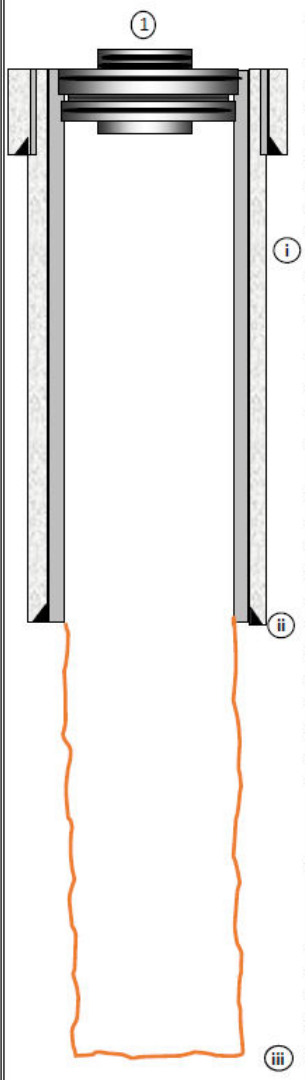
Any liquids, wastewater, cement residues, drill cuttings, or drilling-fluid wastes collected within the sumps will be removed and managed by an appropriately qualified contractor and disposed of, recycled, or treated at suitably licensed facilities, as required. The integrity of the sump lining will be maintained throughout drilling operations to prevent seepage into surrounding soils and groundwater.

Upon completion of drilling and well construction, all temporary infrastructure, including lined sumps, waste storage areas and ancillary facilities, will be removed and the drill pad rehabilitated. Production wells retained for future operation will be fitted with a steel wellhead cap engraved with the borehole identification number in accordance with industry standards pending connection to the gas gathering network.

The wellhead surface facilities will be designed to minimise the footprint to ~5m x 5m. As it is anticipated that there will be no liquids produced from the wells contemplated herein, there will be no need for surface equipment such as water storage and holding tanks to be located at the wellheads. The fencing surrounding the wellsite will be able to be modified easily to maximize the land use available for the landowner. Consideration

will also be given to having the wellsite facilities located below ground level in closed chambers to further reduce the visual and environmental impact- pending discussions and agreement with the respective landowner. . Instrumentation at each well location will consists of gas metering and pressure monitoring only. These instruments are planned to be powered by replaceable lithium batteries, so eliminating the need for any instrumentation that requires gas to be emitted and therefore reducing fugitive emissions.

Figure 9: Typical wellhead surface infrastructure (to be connected to underground pipeline if converted to production well).



Completion Downhole Diagram		Proposed Development Well				
	Well spudded:		Ground Level:		m	
	Comp. Date:					
ITEM No.	DESCRIPTION	Serial Number	Conn. Bottom	Conn. Top	LENGTH (m)	TOTAL DEPTH (m Orig GL)
1	5 1/2" Wellhead Packoff Assembly with 2" Threaded Outlet		N/A	2" Threaded	1	1.00
i	8" Sch 40 Conductor Shoe		Welded	Welded		80.00
ii	5-1/2" Casing Shoe		5 1/2" BTC	5 1/2" BTC		400.00
iii	Total Depth 8" open hole section					500.00

Key Activities:

Notes:

No Tubing in hole.

Associated Documents:

Figure 10: Production Well Typical Design

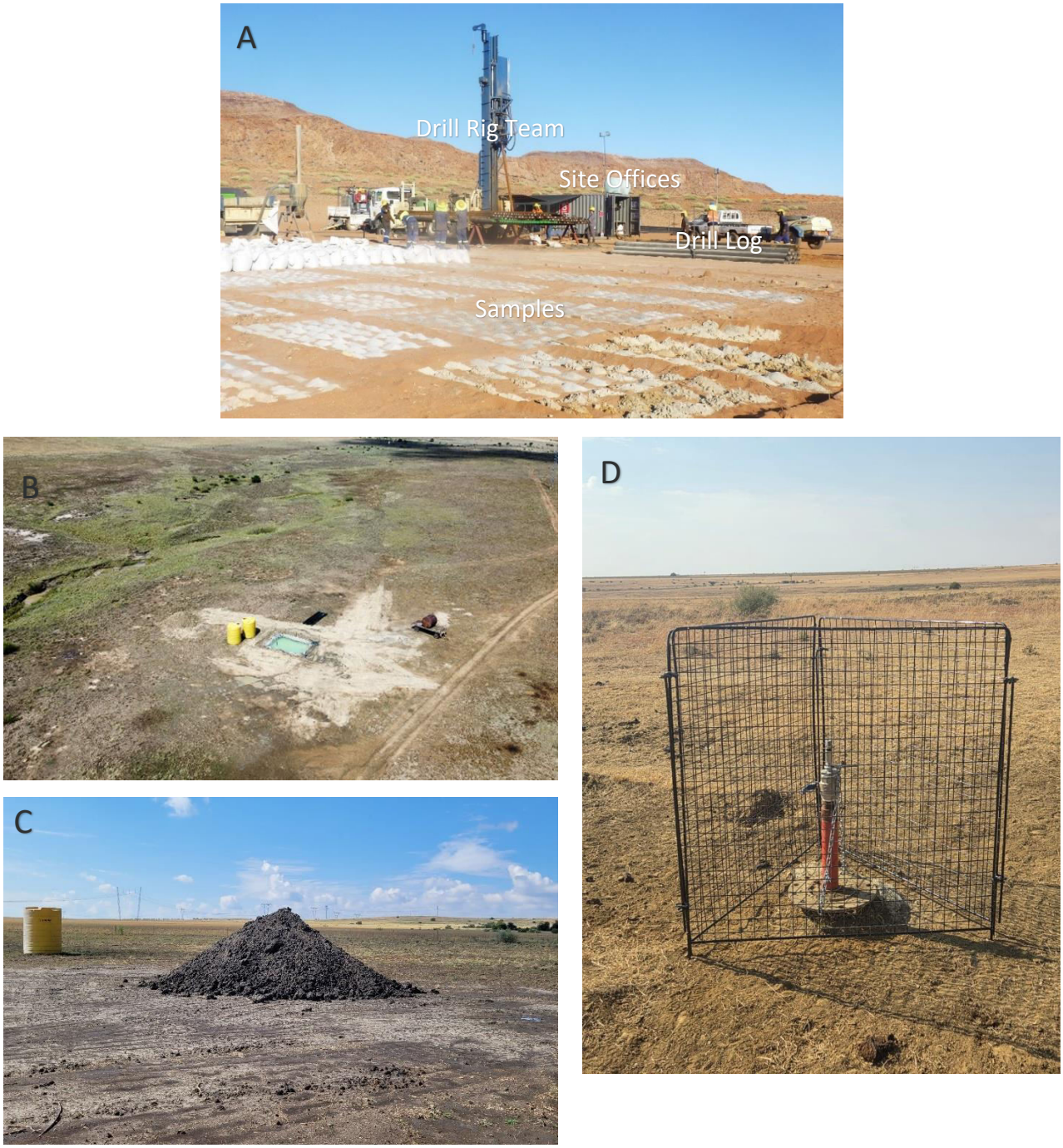


Figure 11: Drilling and potential impacts. (A) Showing the drilling process and associated infrastructure, (B) Showing the drill pad footprint at one of the active D3 Energy drilling sites, (C) Showing some of impacts associated with drilling activities including contained vegetation clearance and topsoil heaps and (D) Showing the final well, steel cased and cemented to prevent leaks with the area rehabilitated.

3.1.4 GAS GATHERING PIPELINES

The gas gathering network covers all low-pressure underground pipework from the wellhead to the gas processing plant. It is critical in this project to keep wellhead pressures low, as this maximizes gas and helium recovery from the field. The pipelines have been designed to have only one gas and helium processing plant within the project area to reduce the requirement for nodal compression. This will reduce the environmental footprint and keep noise emitting equipment to fewer locations. A provision will be made to have field nodal compression powered by the gas in the pipelines should the actual flow rates and pressures differ from the modelling, and it is found that nodal compression is required.

The preliminary conceptual gas gathering systems have been designed to minimize pipeline lengths and pressure loss, while maintaining the required distances from landowner and environmental constraints. As discussed previously all locations will be subject to review once stakeholder and landowner discussions are undertaken. Flow modelling has been conducted to ensure that the wellhead pressures at the wells are kept to a minimum. The sizing of the high-density polyethylene pipe (HDPE) pipelines will range from 110 mm diameter for up to 315 mm for main gas trunkline installed at a minimum depth of approximately 750mm for grazing land and up to 1000mm for cultivated crop land. The pipelines will be constructed from HDPE pipe and be designed to use the natural flow of the land contouring to reduce the need for low point drains.

Low point drains in gas pipelines function to remove condensed water (resulting from the gas temperature dropping) that collects at low points, preventing flow obstruction and ensuring efficient gas transport. Where drains are required, consideration will be given to installing them in underground pits to reduce visual, environmental and landowner impact. Regular pipeline leak detection surveys will be undertaken, detail of which will be included in the detailed EIA report. The total amount of underground gathering pipeline system to be installed is detailed in **Table 6** below. The pipeline routes will be marked with aboveground concrete markers. Servitude corridors (10 m wide) will be maintained free of woody plants to prevent disturbance of the pipeline by root growth and ensure access for regular inspection and maintenance when necessary.

Table 6: Expected HDPE Pipe Size and Quantity

HDPE Pipe Size	~Installed Length
110 mm OD	9,500 m
200 mm OD	6,250 m
250 mm OD	7,650 m
315 mm OD	5,400 m

3.1.4.1 GAS GATHERING PIPELINES ROUTES OPTIONS

There are currently two options considered for the gas gathering pipelines. The pipelines have four distinct corridors with one corridor (western corridor) split into two sections (north and south). The two central corridors are of similar size and parallel to each other while the eastern corridor is the longest corridor. Both the proposed layout and alternative layout have similar pattern with the only difference being on the eastern corridor. The proposed eastern corridor runs in a north-east to south-west direction while the alternative eastern corridor deviates in at the northern section immediately after the Maselspruit in a south-west direction then south and south-west direction again before ending just before intersecting the western corridor. The eastern corridor alternative has been developed to specifically avoid renewable energy currently existing, in progress or near commencement.

3.1.5 HELIUM RECOVERY FACILITY AND GAS PROCESSING PLANT

The proposed development comprises a helium production and processing facility designed to receive, process, separate, store, and export helium and associated gas products from upstream gas production operations. Based on the updated site layout **(Figure 12)**, the facility will consist of gas treatment equipment, helium recovery systems, compression units, cryogenic processing infrastructure, produced water management facilities, loading facilities, utility systems, and a flare system for emergency gas disposal. The facility is planned within a fenced industrial site with an approximate footprint between 1.5 and 3.0 ha, including operational areas, access routes, storage facilities, and safety exclusion zones.

The helium recovery and gas processing facilities **(Figure 12)** will have the optionality of producing either gaseous or liquified helium and methane (refer to **Appendix A** for a larger / clearer layout). It is planned that the plant will be fully gas-powered. One helium recovery and gas processing plant with the optionality of producing either gaseous or liquified helium and methane will be required. The location of the 3 existing wells along the Virginia fault line as well as other production wells proposed on this fault make it the best location for the plant to reduce the length of pipeline require in the initial phase of the project (**Figure 3**). A description of the helium and methane streams for gas and liquefaction processes is given below. A summary of the key project components is provided in **Section 3.1.5.1** and discussed in detail (where applicable) in the sub-sections below. A block diagram to illustrate the process and the components of the processing plant is also given below in **Figure 12** and **Figure 13**.

3.1.5.1 SUMMARY OF KEY PROJECT COMPONENTS

3.1.5.1.1 FEED GAS RECEPTION AND SEPARATION

Raw gas produced by the wells will be received at the facility and directed to an Inlet Separation System, where free liquids such as water and condensates are removed from the gas stream. The separation process is intended to:

- Remove entrained water and water condensate.
- Protect downstream process equipment.

The separated liquids will be managed through designated storage and treatment systems.

3.1.5.1.2 COMPRESSION SYSTEM

Following separation, the gas stream will pass through an **Inlet Compressor** and additional compression units designed to increase gas pressure to process requirements.

The compressor system will include:

- Gas compressors.
- Associated piping and valves.
- Instrumentation and control systems.
- Electrical supply and safety devices.

The compression stage is required to optimize gas flow through the helium recovery and cryogenic separation systems.

3.1.5.1.3 HELIUM RECOVERY UNIT

The facility incorporates a **Helium Recovery Unit (HRU)**, which will recover helium from the natural gas stream through specialized separation technologies.

The unit is expected to:

- Concentrate helium from the feed gas.
- Remove impurities.

- Produce a helium-rich stream suitable for further purification and liquefaction.

Recovered helium will then be processed through cryogenic systems for final product preparation.

3.1.5.1.4 CRYOGENIC PROCESSING FACILITIES

As indicated on the layout below, the following will be present:

- Cryogenic equipment.
- Heat exchangers and cold boxes.
- Refrigeration systems.

These facilities will provide the low-temperature environment necessary for helium purification and separation. Key functions include:

- Removal of residual impurities.
- Helium concentration and purification.
- Cryogenic cooling and product conditioning.
- Recovery of valuable gas components.

Cryogenic systems will operate within insulated equipment designed to minimize heat gain and improve efficiency.

3.1.5.1.5 PRODUCT STORAGE AND LOADING FACILITIES

The development includes a **Loading Manifold System** with multiple truck loading bays.

The loading area will facilitate:

- Transfer of helium and hydrocarbon products into road tankers.
- Product dispatch to domestic and international markets.
- Metering and quality control.

The loading infrastructure will include:

- Loading arms and connections.
- Boil off gas recovery equipment.
- Vehicle circulation areas.
- Safety shutdown systems.

3.1.5.1.6 PRODUCED WATER MANAGEMENT

Produced water[5] will be managed through:

- Two produced water tanks.
- An evaporation pond measuring approximately **25 m × 25 m, with 940 to 1,250 m³ storage capacity**.

Produced water generated during gas processing will be temporarily stored in the water tanks before transfer to the evaporation pond. The evaporation pond will:

- Receive process water and water condensate streams.
- Facilitate evaporation through natural climatic conditions.

[5] Produced water is officially defined under the Minerals and Petroleum Resources Development Act (MPRDA) regulations as water that comes up from underground along with petroleum during exploration or production, which is then separated from the oil or gas with the plan to release it into the environment

- Provide interim management of non-hazardous saline wastewater, subject to water quality classification.

The pond will be constructed with an engineered liner system (high-density polyethylene Liner or similar) to prevent groundwater contamination.

3.1.5.1.7 FLARE SYSTEM

The facility includes a dedicated **flare stack** located within a large safety exclusion zone. The flare system will be used for:

- Emergency depressurization.
- Safe disposal of excess gas.
- Equipment maintenance activities.
- Process upset conditions.
- Disposal of inert gases.

The flare will have a small pilot light that will run continuously (subject to final design) but the flare will only be used intermittently and is designed to ensure safe combustion of hydrocarbons while maintaining compliance with applicable air quality requirements indicated in **Section 4.1.6**.

3.1.5.1.8 UTILITIES AND SUPPORT INFRASTRUCTURE

Supporting infrastructure includes:

- Control room.
- Internal access roads.
- Pipe racks.
- 3 MW gas to power facility and electrical distribution systems.
- Instrument air systems.
- Fire protection systems.
- Security fencing.
- Site drainage infrastructure.

The control room will house operational personnel and process monitoring systems required for continuous plant supervision.

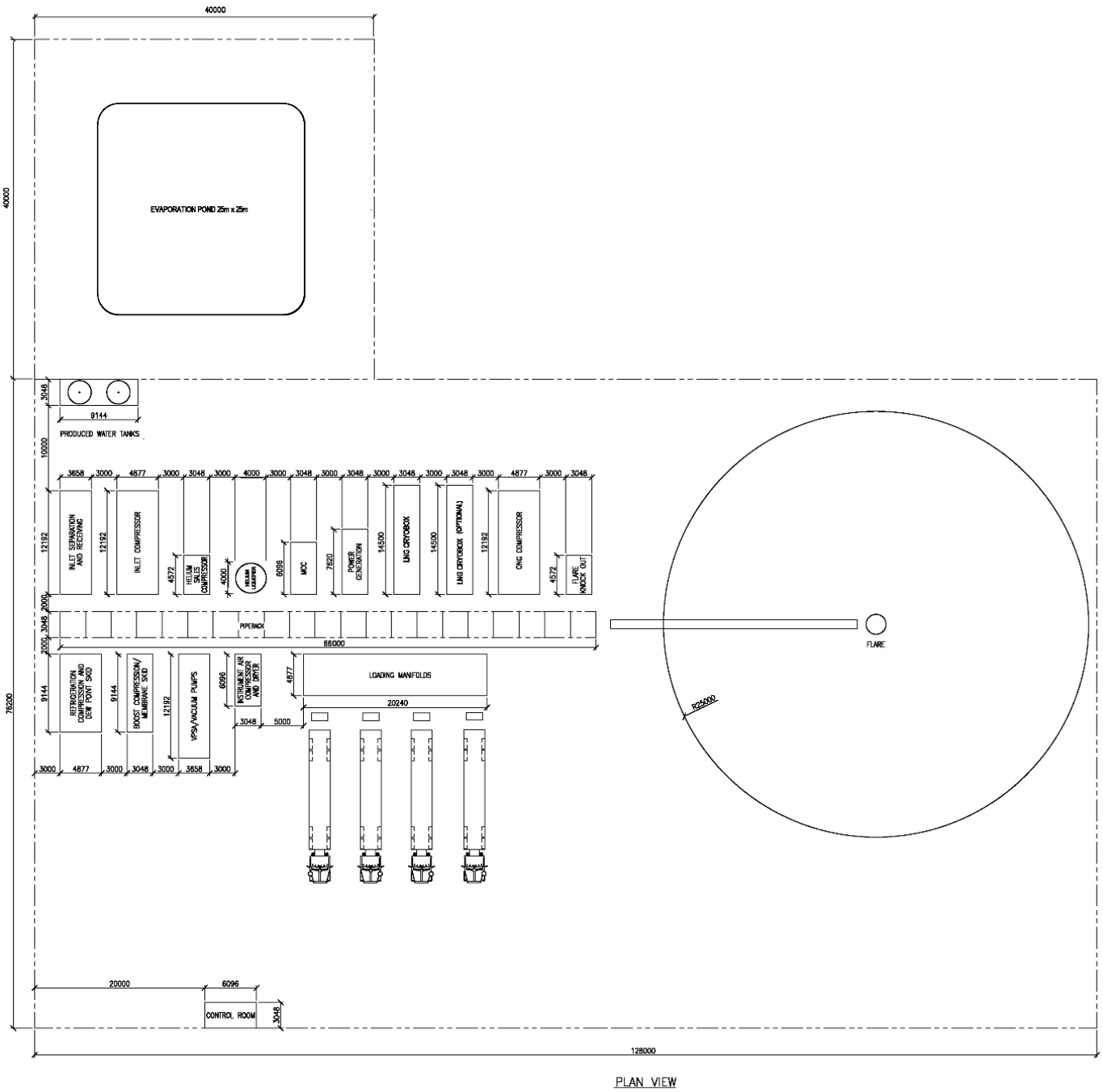


Figure 12: Helium Recovery and Gas Processing Plant layout.

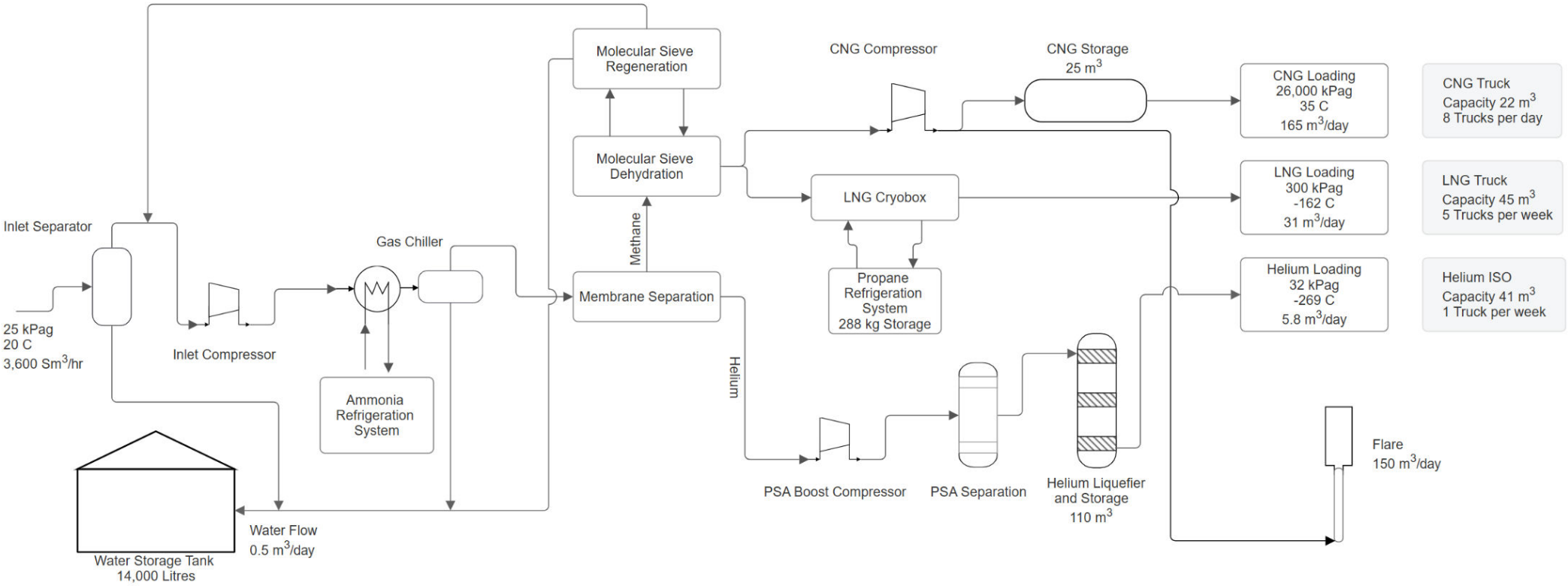


Figure 13: Helium Recovery and Gas Processing Plant Block Diagram.

3.1.5.2 HELIUM RECOVERY

The approximate 3.0 Million Standard Cubic Feet per Day (MMscfd) capacity helium recovery facility design features include a modular-based facility. The process modules include inlet compression, pretreatment, single stage membrane separation or cryogenic separation, Pressure Swing Adsorption (PSA) boost compression, vacuum PSA purification, helium sales compression and/or liquefaction. The process starts with the inlet reception equipment to manage the incoming process stream to the facility. After regulating the pressure and flow to approximately 25 kPag, the inlet gas is compressed to achieve the necessary pressure required to operate the membrane system.

The pretreatment module provides dew point control and removal of water that would otherwise condense in the membrane systems. The condensate water will go into an HDPE lined evaporation pond. The treated gas then flows to the inlet of the membrane separation system. The membrane separation system has been designed for single stage separation. The first stage separates the bulk contaminants from the crude helium permeate stream which flows to the PSA purification unit. The retentate stream (methane) is back-pressure controlled flowing to the package limits where it will flow into the inlet of the gas CNG or LNG facility.

The crude helium from the first stage permeate is compressed on route to the PSA purification package. Within the vacuum PSA module, the crude helium stream is purified to >98% within the PSA vessels before flowing to the helium sales compressor or liquefaction unit. For gaseous helium sales, the gas compressor is designed to deliver pressure up to 26,200 kPag to the 3-truck loading system. The manual loading system is located off the end of the helium sales gas compressor package.

If D3 Energy decides to liquify the helium gas on the project site, the helium liquefaction unit will receive purified helium from the PSA module and will deliver grade 5 helium to the liquid helium dewar at the outlet. From the liquid helium dewar, the liquid helium can be loaded into helium ISO containers for shipment.

3.1.5.3 METHANE GAS PROCESSING

The retentate stream (methane) from the helium recovery facility will flow into the inlet of either the CNG or LNG process modules. The CNG module will compress the gas from the inlet pressure of 2,500 kPag up to the 25,000 kPag required pressure for CNG tube trailers. As with the helium system, the compressed methane will flow from the module exit to the 3-truck loading system. The manual loading system is located off the end of the methane sales gas compressor package.

The LNG module, if installed, will take the feed gas and compress it up to the 5,000 kPag pressure required by the plant. Before liquefaction, impurities contained in the raw natural gas may need to be removed as they may freeze under the low temperature state used in the liquefaction process and block the equipment or reduce the performance of the heat exchanger. The liquefaction element adopts a propane precooling mixed refrigerant refrigeration process. The pre-coolant is propane, and the mixed refrigerant is nitrogen, methane, ethylene and propane components.

The purified, predominately methane gas, will be precooled to -20°C by a pre-coolant before entering the cold box. The gas entering the cold box uses the large amount of cold released by the mixed refrigerant in the cold box to liquefy the natural gas, and the liquefied LNG is sent to the manual loading system used to fill the LNG trucks.

3.1.6 ASSOCIATED ACTIVITIES AND INFRASTRUCTURE

The development of the area will require the construction of associated infrastructure. Although the proposed activity requires highly specialised equipment and professionals, local business / contractors and local communities will be instrumental in providing the workforce and equipment where appropriate and/or feasible.

3.1.6.1 OFFICE AND MAINTENANCE WORKSHOP

D3 Energy has a field office located in the nearby town of Virginia. D3 Energy plans to construct a maintenance workshop beside the helium and gas processing facilities. The multipurpose facility will be used as an office for field staff, company plant and equipment storage, maintenance activities, and storage warehouse. The office

and workshop facility will have provision for storage of consumables and spares needed during the main operating phase of the development. During the initial construction phase, there will be a need to store larger construction equipment, well casing/tubulars and HDPE pipes, these will be stored in the same workshop area.

3.1.6.2 ROADS AND SITE ACCESS

Wherever possible existing roads and tracks will be used for well and plant access. Where upgrades are required due to increased traffic or wet weather access there may be a requirement for utilizing road base materials or surfacing materials. Where access is not available, access tracks to accommodate a vehicle, approximately 3.5m wide will be created. These will be rehabilitated accordingly at the end of production in line with the post land use agreements where applicable. Below is a summary of anticipated number of vehicles and traffic trips during the construction and operational phases.

Table 7: Summary of anticipated number of vehicles/trips.

Phase	Vehicle Type	Number of Vehicles on site/day	Vehicle Trip Numbers
Construction	Light Vehicles	18	45
	Heavy Vehicles	14	30
Total		**32**	**75**
Operational	Light Vehicles	4	12
	Heavy Vehicles	1	2
Total		**5**	**14**
Gas and Helium Sales (Operational)	CNG Truck	8	8 per day
	LNG Trucks	2	5 per week
	Helium Truck	1	1 per week
Total		**11**	**62 per week**

3.1.6.3 ACCOMMODATION AND CONSTRUCTION RESOURCES

The greater majority of construction workers will be based in the local towns of Welkom, Virginia and surrounds. Prior to the commencement of the initial project construction period, D3 Energy will engage with accommodation providers to determine the anticipated availability of rooms throughout the period planned for the construction activities. It is paramount that the existing accommodation that is currently available for regular visitors remains available during the construction activities. Where demand is found to exceed supply, may consider alternative accommodation arrangements if local capacity is insufficient.

Many of the construction activities during the development of the area are very specialized and require specifically skilled contract workers to complete the construction activities. D3 Energy will strive to employ these contract skilled workers locally in the first instance and only when not available locally will specialized non-local contractors be engaged. Equipment for seismic surveys and drilling will be provided by specialist contractors. D3 Energy will concurrently utilize local contractors and workforce in the more non-specialized construction activities with a view to training these employees and contractors to the more skilled job tasks over time.

Electricity, if required during construction, 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, and in accordance with relevant legal requirements. **The water requirements for drilling operations will be a maximum of 70 000 litres per production well for a production well which has a maximum depth of ~650m**. Based on available data, the daily water demand during the operational phase-encompassing domestic use, sanitation, dust suppression, cooling, and miscellaneous requirements is projected to range from 10 500 to 32 000 litres, depending on the scale and intensity of the daily activities. The current plan is to obtain the water from the Local Municipality or authorised landowner boreholes, should the Applicant decide to rather consider abstracting the water from groundwater sources, the necessary assessments and applications will be obtained prior to abstraction.

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 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 licensed waste disposal facility.

3.1.7 WASTE MANAGEMENT

The design philosophies for waste management are based on applicable legislation, in particular NEMWA, DWAF (DWS) best practice guidelines, and currently accepted good industry practice for waste management. Principles of waste minimisation at source, segregation for reuse, recycling and treatment or disposal will be applied to the handling of waste, wherever possible. The waste (general and hazardous) generated during construction and operations will be addressed as detailed below.

3.1.7.1 GENERAL WASTE

The following types of general waste (produced mainly during construction, with minimal amounts post construction/ operation) will be generated by the proposed production project:

- Domestic solid waste;
- Scrap metal; and
- Construction waste.

The project will temporarily store general waste on site in a designated area, and all waste will be collected by an approved, licensed waste contractor for removal and final disposal at a registered general waste disposal facility. No new landfills will be directly established by the project within the project boundaries.

3.1.7.2 HAZARDOUS WASTE

Hazardous waste, including but not limited to hydrocarbon containing waste (used oil and filters, diesel, lubricants, and grease) will be stored in clearly marked skip bins (solids) and containers (liquids). These skip bins/ containers will be placed in an isolated area on a hard, impervious surface. When full, the bins/ containers will be collected by a contractor for safe disposal or recycling companies which will be appointed to collect waste. A waste disposal certificate will be required from the contractor to ensure safe disposal.

Drilling waste will consist of wastewater and drilling mud which will not be stored more than 90 days on site. This waste will be stored in a lined pit adjacent to the drill rig and once drilling is completed, the waste will be removed from site and adequately disposed of at an appropriately licensed waste disposal facility.

During operation, several hazardous waste streams are expected to be generated from both the processing plant and the associated gas pipeline network. These waste streams require appropriate handling, storage, transportation, treatment, and disposal to prevent impacts on soil, groundwater, surface water, air quality, and human health.

Knockout Water[6] and Condensate Water[7] is expected to be generated from; inlet separation units, compressor suction scrubbers, compressor knockout drums, flare knockout drums, refrigeration systems, water catch tanks, and pipeline low-point drains. This water is typically separated from the raw gas stream. This wastewater is generally unsuitable for direct discharge to the environment. The following management principles will be undertaken to manage knockout water and condensate water:

- Collecting all knockout water in designated produced-water tanks.
- Preventing uncontrolled discharge to soil or drainage channels.
- Recycling water where technically feasible.
- Disposal of residual wastewater at licensed wastewater treatment facilities.
- Maintaining spill containment around all storage tanks.

Produced water is expected from; gas inlet separation systems, production gathering pipelines, wellhead facilities and water catch tanks. Produced water is normally the largest liquid waste stream associated with gas production. The following management principles will be undertaken to manage produced water:

- Temporary storage in produced-water tanks.
- Transfer to evaporation pond.
- Regular monitoring of pond integrity.
- Groundwater monitoring.
- Removal of accumulated sludge for disposal at licensed hazardous waste facilities.

Sewage and domestic wastewater from control room facilities, site offices, and ablution facilities will be managed as follows:

- Connecting the plant facilities to the municipal sewage infrastructure (if possible) or collecting sewage in bunded septic tank on site prior to disposal through licensed service providers at a registered facility.
- Preventing discharge to the environment.
- Routine inspects of collection systems for leaks.

All hazardous waste will be temporarily stored on sited, collected by an approved, licensed waste contractor for removal and final disposal at a registered hazardous waste disposal facility.

3.2 PROJECT TIMELINE

The major construction activities will occur during the initial 5 years of the development. The D3 Energy gas production project will comprise of three components namely the production well drilling, gas gathering network and the processing plant construction. The commencement of activities will be dependent on the issuance of relevant permits, authorisations and licences (including the EA). D3 Energy plans to initially conduct a multi-well drilling campaign of approximately 15 wells during 2027 and a further 15 wells during 2028. The CNG plant, and helium separation plant is planned to be ready to accept gas by mid-2028 based on the current indicative development schedule, and subject to obtaining all required regulatory approvals. The remainder of the wells are located on the Ventersburg fault and will be drilled as required to maintain the required sales production. The production right area has an expected life of at least 30 years which will then be followed by decommissioning, rehabilitation and closure.

[6] knockout water (often originating from a Free Water Knockout (FWKO) or a gas-liquid separation system) refers to the water that is mechanically separated from a raw mineral or petroleum production stream.

[7] "Condensate water" is not explicitly given a standalone, custom definition inside the text of either the NEMWA or the MPRDA. Instead, both laws view condensate water—which is liquid water formed when steam or vapor cools down during industrial processes—through its legal classification as either a waste product, a residue, or a potential pollutant.

3.3 ABNORMAL OR IRREGULAR EVENTS OR CONDITIONS

When undertaking an EIA, it is important to consider the potential abnormal operating conditions or unwanted events. These are especially significant in instances where these conditions or events may result in an unacceptable environmental impact. A predictive risk identification and assessment process should be followed by the proponent and updated on a regular basis. Many of these risks can be adequately mitigated through pre-emptive contingency planning and if necessary, embedded into relevant project design. **Table 8** provides a high-level identification and description of potential abnormal operating conditions and the embedded designs / controls that have been considered and incorporated for this project.

Table 8: Abnormal events and conceptual controls.

Abnormal condition/ event	Description	Embedded design or preventative control
Downhole loss of fluids or cement.	Depending on the permeability of the geology through which the drill is moving there may be a potential to lose drilling fluids into the geological formation. Further there is a potential that the cement or grouting being used in the annulus may enter the surrounding geology or resource. This may compromise the functionality of the cementation job or even impact on the gas permeability of the geology (e.g. invasion of the cement into the natural fractures).	Readily available fluid loss control additive for the drilling process when drilling with fluid based mud systems. Drilling with air (underbalanced drilling) greatly reduces the risk of loss of drilling fluids and removes the need for fluid loss control additives. Cement design provides for lightweight slurry. This reduces the hydrostatic weight of the cement slurry. Readily available fluid loss additives would be available to add to the bentonite mix to seal off any voids encountered in susceptible formations. The annulus can be remediated by topping up with cement should losses occur.
Wellbore casing bursts due to excessive pressures	The wellbore may be exposed to additional pressures during the testing or cementing operations. This has the potential to damage or rupture the casing string and result in a loss of gas or fluids, as well as risk of pollution.	Ensure that the correct casing specification is selected and installed in accordance with the well engineer's design requirements and anticipated downhole conditions. The casing pressure rating must be suitable for the maximum pressures expected during drilling, well testing, cementing and production operations, while remaining within the safe operating limits of the drilling equipment and well design. Comprehensive casing and cement integrity verification will be undertaken following casing installation and cementing activities. This may include cement bond logging (CBL), casing pressure testing, and verification of cement compressive strength to confirm wellbore integrity and ensure the effective isolation of geological formations and groundwater resources.
Rupture of gas gathering network pipes.	The gas gathering system will include HDPE piping which could be damaged by unauthorised excavations, tree roots, etc. is susceptible to damage in	To facilitate the early detection of potential loss of containment events, the gas gathering system will incorporate continuous operational monitoring, including real-time

Abnormal condition/ event	Description	Embedded design or preventative control
	abnormal instances. This could be due to excavations, burrowing animals, tree roots, etc.	pressure monitoring at strategic locations such as the wellheads and gas processing facility. Pressure monitoring data will be used to identify abnormal operating conditions, pressure drops, or other indications of a potential leak or pipeline failure, triggering investigation and corrective action where necessary. In addition to pressure monitoring, an Leak Detection and Repair (LDAR) programme will be implemented for above-ground equipment and components where fugitive emissions could occur, such as valves, flanges, connectors, and other fittings at well pads and processing facilities. The LDAR programme will comprise periodic inspection, leak identification, maintenance, and repair activities in accordance with the applicable operational procedures and industry good practice.
Excess water content in gas.	Excessive water content in the raw gas may result in damage to equipment and blockage for gathering lines.	Installation and operation of low point drains where required. Real time monitoring of pressures to detect pressure loss.
Medium to long term climate change vulnerability	The prevailing climatic conditions are predicted to change over time as per the climate change predictions (refer to **Section 8.11** for a description of the likely changes predicted). Changes in temperature and rainfall may affect the optimal functioning of certain infrastructure and equipment.	Equipment design would provide for equipment to be operational under elevated temperatures and rainfall. Excess rainfall events would be catered for in the stormwater designs.
Uncontrolled releases of LNG or CNG from storage vessels.	Storage vessels may be damaged as a result of pressures exceeding design specifications, accidental physical impacts (e.g. vehicle collisions), equipment failure, or other abnormal operating conditions. Depending on the storage medium and the nature of the damage, such incidents could result in a gradual or sudden release of LNG or CNG.	Appropriate engineering controls will be implemented for both LNG and CNG storage systems. LNG will be stored in double-walled, insulated vessels with boil-off gas managed through the facility's gas handling system to prevent excessive pressure build-up. CNG will be stored in pressure-rated vessels fitted with pressure monitoring and relief systems to prevent over-pressurisation. For both storage types, physical barriers will be installed to protect against vehicle and equipment impacts, and routine inspection, maintenance, and integrity monitoring programmes will be undertaken to ensure the

Abnormal condition/ event	Description	Embedded design or preventative control
		continued safe operation of storage infrastructure.
Sabotage, Community unrest, and terrorist attacks.	Production operations or equipment could be damaged as a result of sabotage, community unrest, unauthorised interference, or other deliberate acts, potentially resulting in a loss of containment and the uncontrolled release of gas	The gas gathering and processing system will incorporate continuous monitoring, leak detection, Emergency Shutdown (ESD) systems, and strategically located shut-off valves to enable the rapid detection and isolation of incidents, thereby minimising gas releases. Emergency response procedures and security measures will be implemented to support the safe shutdown of affected infrastructure and reduce the risk of unauthorised interference. Where required, gas will be managed through approved gas handling systems to minimise uncontrolled releases and avoid venting wherever reasonably practicable.

This EIA process will identify and assess potential environmental impacts and make recommendations for relevant alternatives, management and mitigation measures.

3.4 OPERATIONAL ACTIVITIES

During operation, the facility will:

1. Receive raw gas.
2. Separate liquids and impurities.
3. Compress the gas stream.
4. Recover and purify helium.
5. Process gases through cryogenic equipment.
6. Store and manage produced water.
7. Export helium products via road tanker loading facilities.
8. Safely manage emergency gas releases using the flare system.

Operations are expected to be continuous, with routine maintenance undertaken periodically. **The production right area has an expected life of at least 30-years; thus, the activities are expected to be operational for at least 30-years before decommissioning and closure**. Is it important to note that the right may be renewed for further periods, each not exceeding 30 years, subject to compliance with the applicable legislative and licensing requirements.

3.5 DECOMMISSIONING AND CLOSURE

According to the NEMA and the associated Financial Provision Regulations (2015) (NEMA GNR 1147), every right holder must make financial provision for annual rehabilitation, final rehabilitation, decommissioning and closure activities at the end of activitiesand remediation and management of latent or residual environmental impacts

which may become known in the future. As such, D3 Energy is required to prepare and submit, as part of this EIA process, a final rehabilitation decommissioning and closure plan.

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 production operations take place, unless a specific, reasonable alternate land use is requested by the landowner. As such, the intended end use for the disturbed areas and the closure objectives will be defined in consultation with the relevant landowner. Proof of such consultation will 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 the gas production activities. This shall be achieved with a number of specific objectives.

- Ensuring rehabilitation allows for post-closure land-use activities such as agricultural activities, renewable energy developments or mining activities.
- 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.
- Making the area safe. i.e.: Decommission exploration and production activities so as to ensure that the environment is safe for people and animals. This entails refilling excavations, sealing and grouting wells where applicable, etc.
- 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 or align this with the surrounding land and agreed post-closure land use.
- 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.
- Verification of rehabilitation success through appropriate monitoring of rehabilitation.

Rehabilitation 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 provisions attached as **Appendix F5**. A closure certification application will be applied for in accordance with Section 43 of the Mineral and Petroleum Resources Development Act, 2002.

4 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 (PASA being the delegated authority), in accordance with the requirements of the NEMA EIA Regulations 2014, as amended and the MPRDA. 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 project. 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 section is by no means an exhaustive list of the legal obligations of the applicant in respect of environmental management for the proposed D3 Energy PR016 project.

4.1 NATIONAL LEGISLATION

4.1.1 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 EIA and associated impact mitigation actions are conducted to fulfil the requirement of the Bill of Rights.

4.1.2 MINERAL AND PETROLEUM RESOURCES DEVELOPMENT ACT (MPRDA)

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

In terms of Section 83 of the MPRDA, a Production Right must be issued prior to the commencement of any gas production activities. 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 important amendments requires all mining and production related activities to follow the full NEMA process as per the EIA Regulations which came into effect on 4 December 2014 for any new applications. A Production Right is subject to prescribed terms and conditions and is valid for the period specified in the right, which periods, each of which may not exceed 30 years, and becomes effective on the effective date.

In support of the EA 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.

4.1.2.1 UPSTREAM PETROLEUM RESOURCES DEVELOPMENT ACT, 23 OF 2024

It is important to note that the **Upstream Petroleum Resources Development Act 23 of 2024 (UPRDA) has already been enacted and promulgated, but it is pending commencement (coming into force)**. 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.

The proposed D3 Energy PR activities will be directly regulated by the UPRDA (once commencement of the UPRDA comes into operation on a date fixed by the President by proclamation in the Gazette), which establishes the legislative framework for the exploration, appraisal, development and production of petroleum resources in South Africa. The Act was promulgated to provide for the orderly, equitable and sustainable development of the country's petroleum resources, while simultaneously promoting exploration and production, enhancing investor certainty, facilitating local economic participation and ensuring environmental protection. Importantly, the Act recognises that petroleum resources belong to the nation and that the State is the custodian of these resources on behalf of all South Africans. The legislation seeks to accelerate petroleum development while ensuring that resource exploitation contributes to economic growth, skills development, local employment, transformation and environmental sustainability.

For the proposed D3 Energy PR, one of the most significant implications of the UPRDA is the introduction of an **integrated Petroleum Right**, which combines the authority to undertake exploration and production activities under a single right, thereby providing greater security of tenure and regulatory certainty for long-term petroleum projects. The proposed production activities, including the operation of approximately 43 gas production wells, gas gathering pipelines, helium and natural gas processing facilities, gas-to-power generation infrastructure and associated petroleum production systems, will need to be undertaken in accordance with the conditions of the petroleum right granted under the Act. The Petroleum Agency of South Africa (PASA),

designated as the upstream petroleum regulator under the legislation, will be responsible for regulatory oversight, administration of petroleum rights and monitoring compliance throughout the life of the project.

The Act further requires meaningful State and Black Economic Empowerment participation in upstream petroleum projects. D3 Energy will therefore be required to maintain compliance with the transformation provisions of the Act, including prescribed levels of black ownership, participation, local procurement, skills development and supplier development initiatives. In addition, the legislation promotes local content as a strategic development mechanism and requires petroleum right holders to maximise opportunities for local employment, technology transfer, procurement of locally produced goods and services, and capacity building within host communities. The D3 Energy project's construction and operational phases will therefore need to align procurement, workforce development and enterprise development programmes with these legislative requirements.

The UPRDA also places significant emphasis on environmental management and sustainable resource development. Petroleum resources must be developed in an environmentally responsible manner consistent with Section 24 of the Constitution and the environmental management principles contained in the NEMA. Accordingly, D3 Energy will be required to obtain and maintain all environmental authorisations, implement approved EMPr, manage waste streams, control pollution and mitigate impacts on air quality, biodiversity, groundwater, surface water and surrounding land uses. The findings of the specialist assessment indicate that the project does not present any fatal environmental flaws and that predicted impacts are generally low to moderate and manageable through the implementation of appropriate mitigation measures. Nevertheless, compliance with the environmental obligations of the UPRDA will remain a core requirement throughout the life of the project.

Another important implication relates to climate change and greenhouse gas management. While the UPRDA is primarily a petroleum development statute, it operates alongside emerging climate-related legislation, including the Climate Change Act, 2024 and the Carbon Tax Act, 2019. The D3 Climate Change Assessment estimated direct (Scope 1) greenhouse gas emissions of approximately 29,221 tCO_2e per annum, which would constitute a moderate climate change impact but would contribute only approximately 0.009% of South Africa's remaining carbon budget for 2035. The project may therefore become subject to future carbon budget allocations, greenhouse gas mitigation planning and emissions reporting requirements, all of which will need to be integrated into the petroleum right holder's operational management systems. It is reiterated that **the proposed D3 Energy PR activities will be directly regulated by the UPRDA once commencement of the UPRDA comes into operation on a date fixed by the President by proclamation in the Gazette**.

4.1.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA)

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 terms of the NEMA EIA Regulations, the applicant is required to appoint an EAP to undertake the EIA process, as well as conduct the public participation process towards an application for EA. 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 applicable to this project. Exploration and Production activities officially became governable under the NEMA EIA Regulations in December 2014 with the competent authority identified as the DMRE (now DMPR).

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.

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 14** 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 4.1.3.1**.

NEMA sets out the general objectives of IEM in South Africa, including to (section 23(2)), of which the following two are of relevance for this report:

- Identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities. This is to be done with a view to minimising negative impacts, maximising benefits and promoting compliance with the principles of environmental management set out in section 2 (of NEMA).
- Ensure that the effects of activities on the environment receive adequate consideration before actions are taken in connection with them.

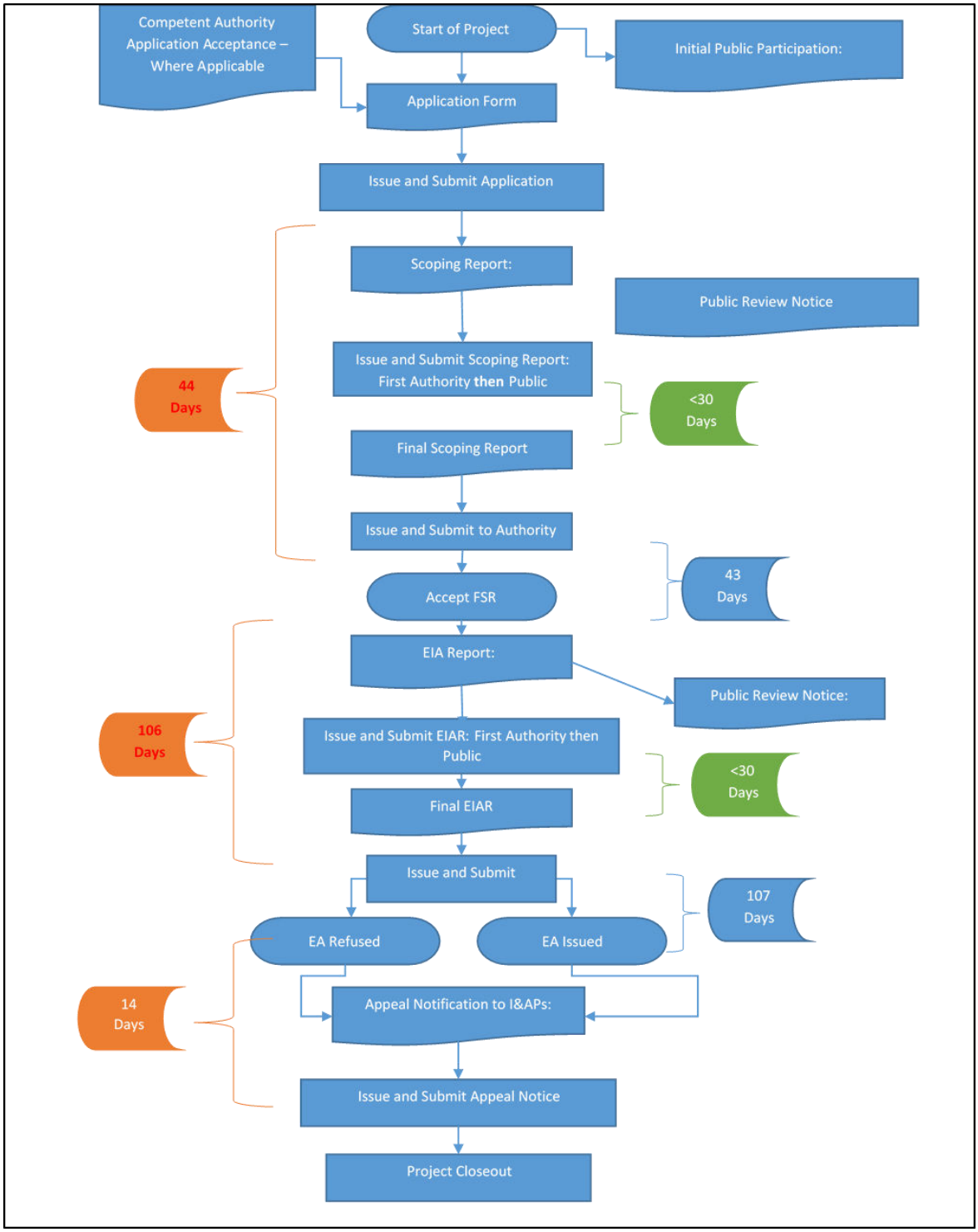


Figure 14: EIA process diagram.

4.1.3.1 LISTED ACTIVITIES

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.

In terms of these regulations a Scoping and EIA process is required for the proposed project. **Table 9** below identifies the listed activities the proposed project triggers and consequently requires authorisation prior to commencement.

Table 9: NEMA listed activities to be authorised

Activity No(s):	Activity	Applicability
Applicable Triggered NEMA EIA Listed Activities applied for		
NEMA 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, 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	The proposed activities include the undertaking of onshore seismic surveys with a combined length of ~120 km around known structures and possible drill locations.
NEMA GN984, Activity 20	Any activity including the operation of that activity which requires a production right in terms of section 83 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 Listing Notice 3 of 2014**, required to exercise the production right.	The proposed activities include the establishment of up to 43 production wells (plus 5 contingent wells), which requires a production right in terms of section 83 of the MPRDA.
Other NEMA EIA Regulations, 2014 as amended applicable listed activities assessed		
NEMA GNR 983 Activity 12	The development of- (i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; or (ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- (a) within a watercourse; (b) in front of a development setback; or (c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse;- excluding- (aa) the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such development activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in Listing Notice 3 of 2014, in which case that activity applies; (dd) where such development occurs within an urban area; (ee) where such development occurs within existing roads, road reserves or railway line reserves; or (ff) the development of temporary infrastructure or structures where such infrastructure or structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.	This project comprises linear activities such as pipelines and access roads which may impact on watercourses or within 32 m of a watercourse when in proximity to these areas.

	This project comprises linear activities such as pipelines (with associated low point drains, pigging, booster and compressor stations) and access roads which will impact on watercourses or within 32 m of a watercourse when in proximity to these areas. NEMA GNR 983 Activity 16 The development and related operation of facilities for the desalination	
NEMA GNR 983 Activity 19	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse; but excluding where such infilling, depositing, dredging, excavation, removal or moving- (a) will occur behind a development setback; (b) is for maintenance purposes undertaken in accordance with a maintenance management plan; (c) falls within the ambit of activity 21 in this Notice, in which case that activity applies; (d) occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or (e) where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies.	This project comprises linear activities such as pipelines and possible access roads which may require infilling or depositing of more than 10 m^3 of material to or from a watercourse when in proximity to these areas.
NEMA 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 hectare or more, but less than 20 hectares of indigenous vegetation for the processing plant (between 1.5 and 3.0 ha). Pipelines and access roads are linear activities and therefore excluded from this listed activity and the calculation of vegetation clearance.
NEMA GNR 983 Activity 28	Residential, mixed, retail, commercial, industrial or institutional developments where such land was used for agriculture, game farming, equestrian purposes or afforestation on or after 01 April 1998 and where such development: (i) will occur inside an urban area, where the total land to be developed is bigger than 5 hectares; or (ii) will occur outside an urban area, where the total land to be developed is bigger than 1 hectare; excluding where such land has already been developed for residential, mixed, retail, commercial, industrial or institutional purposes.	The proposed development is on land previously used for agricultural activities (grazing and crop farming) and covers an area greater than 1 hectare (outside urban area).
NEMA GNR 983 Activity 67	Phased activities for all activities- (i) listed in this Notice, which commenced on or after the effective date of this Notice or similarly listed in any of the previous NEMA notices, which commenced on or after the effective date of such previous NEMA Notices.	The proposed production project will be constructed in a phased manner which may on their own not trigger a listed activity but when

		combined, exceed the threshold for clearance of vegetation.
NEMA GNR 984 Activity 5	The development and related operation of facilities or infrastructure for the processing of a petroleum resource, including the beneficiation or refining of gas, oil or petroleum products with an installed capacity of 50 cubic metres or more per day, excluding activities which are included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the National Environmental Management: Waste Act, 2008 applies.	The helium recovery and gas processing plant will be constructed which serves the purpose of processing of gas of more than 50 m^3/day.
NEMA GNR 984 Activity 7	The development and related operation of facilities or infrastructure for the bulk transportation of dangerous goods- (i) in gas form, outside an industrial complex, using pipelines, exceeding 1 000 metres in length, with a throughput capacity of more than 700 tons per day; (ii) in liquid form, outside an industrial complex, using pipelines, exceeding 1 000 metres in length, with a throughput capacity of more than 50 cubic metres per day; or (iii) in solid form, outside an industrial complex, using funiculars or conveyors with a throughput capacity of more than 50 tons per day.	The proposed project will include the development and operation of gas pipelines exceeding 1 000 metres in length, with a potential throughput capacity of more than 700 tons per day.
NEMA 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; iii. On land, where, at the time of the coming into effect of this Notice or thereafter such land was zoned open space, conservation or had an equivalent zoning; or iv. Areas within a watercourse or wetland; or within 100 metres from the edge of a watercourse or wetland.	Sections of the proposed project footprint fall within CBA areas and watercourses where more than 300 m^2 will be cleared of vegetation.
NEMA GNR 985 Activity 14	The development of- (i) dams or weirs, where the dam or weir, including infrastructure and water surface area exceeds 10 square metres; or (ii) infrastructure or structures with a physical footprint of 10 square metres or more; where such development occurs- (a) within a watercourse; (b) in front of a development setback; or	Sections of the project footprint fall within CBA areas and watercourses and infrastructure in these areas will exceed the 10 m^2 threshold.

	(c) if no development setback has been adopted, within 32 metres of a watercourse, measured from the edge of a watercourse; excluding the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour. Free State i. Outside urban areas: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) National Protected Area Expansion Strategy Focus areas; (cc) World Heritage Sites; (dd) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (dd) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (ee) Sites or areas identified in terms of an international convention; (ff) Critical biodiversity areas or ecosystem service areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (gg) Core areas in biosphere reserves; or (hh) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; or ii. Inside urban areas: (aa) Areas zoned for use as public open space; or (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority, zoned for a conservation purpose.	
NWA Section 21 Activities		
NWA Section 21 (c&i)	impeding or diverting the flow of water in a watercourse and/or altering the bed, banks, course or characteristics of a watercourse.	Gas plant, wells, pipelines and associated infrastructure will be constructed within the regulated area of a watercourse.

The DFFE have published a number of guidelines and protocols which have been considered in the compilation of this report and include but not limited to:

- Public Participation Guideline in terms of NEMA EIA Regulations (2017).
- Need and desirability Guideline in terms of NEMA (2012).
- National guideline on minimum information requirements for preparing Environmental Impact Assessments for mining act activities that require environmental authorisation (2018).
- 2004 Information Series covering various aspects of the EIA process.
- Procedures for assessment and minimum criteria for specialist studies.

4.1.3.2 SCREENING TOOL

A Screening Tool Report was generated from the DFFE Screening tool as per the requirements of Regulation 16 (1)(b)(v) of the EIA Regulations 2014, as amended, and was included in the Application for EA. The screening Tool provided a list of specialist studies for consideration and inclusion in the process. The Screening Tool identified environmental sensitivities are presented in **Table 10.**

Table 10: Screening Tool environmental sensitivities.

Theme	Sensitivity			
	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			

In this regard, as Site Sensitivity Verification Report (SSVR) has been compiled to consider the recommendations of the DFFE Screening Tool Report and to provide a rationale for the selection of specialist studies included in the assessment report. Please refer to **Figure 13** for a summary of the verification process. Please refer to Appendix E for the SSVR.

Table 11: SSVR findings and motivation.

Screening Tool identified specialist	Level of sensitivity	Suggested Sensitivity	Motivation
Agriculture Theme	Very High	**Medium**	Relative Agricultural Sensitivity was confirmed to be *Medium* by the Site Sensitivity Verification Report (SSVR) attached as **Appendix E**. The SSVR found that there are limited agricultural activities within the application area with some agricultural activities being undertaken especially in the southern and northern sections of the PR. However, the bulk of the proposed PR activities are will not directly impact on these areas. Furthermore, the activities will be limited to a maximum footprint of 50m x 50m for drill pads and 10m

Screening Tool identified specialist	Level of sensitivity	Suggested Sensitivity	Motivation
			wide seismic transects which will have an acceptable overall impact on the soils and agricultural potential. In addition, post construction, the disturbed areas will be rehabilitated and only limited above ground infrastructure will remain (i.e. blower (gas emitting well) footprint of 2m x 2m).
Animal Species Theme	Medium	**Medium**	Although there are disturbed / transformed natural areas on site due to the agricultural activities and renewable energy developments, aquatic habitats were noted and certain areas within the PR have intact vegetation, providing potential habitats of fauna species. The biodiversity assessment also indicates that several species of conservation concern are expected to occur within the proposed project area.
Plant Species Theme	Low	**High**	According to the SSVR, 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.
Terrestrial Biodiversity Theme	Very High	**High**	According to the SSVR, certain habitat sensitivities are regarded as high sensitivity due to the role of this intact habitat to biodiversity within the proposed project area.
Aquatic Biodiversity Theme	Very High	**High**	Some production wells and seismic transects are proposed within and/or proximity of watercourses and wetlands. Construction could result in the encroachment into water resources and result in the loss or degradation of these systems, some of which may be functional and provide ecological services.
Archaeological and Cultural Heritage Theme	Low	**Medium**	The desktop Heritage assessment identified a total of 13 distinct heritage features which may potentially be impacted by the proposed development. These included burial grounds or graves, historical period remains, structures associated with farmsteads, and a potential Iron Age or historical settlement.
Civil Aviation Theme	High	**Low**	The proposed project which entails the establishment of up to 43 production gas boreholes (plus 5 contingent wells) and ~28km gas gathering pipelines and a gas processing plant which will 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 project 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	Low	**Low**	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 50 km northeast of the site and there are no anticipated impacts on defence theme emanating from the proposed activities
Palaeontology Theme	Very High	**High**	Based on the site investigation as well as desktop research it is concluded that fossil heritage of scientific and conservational interest in the project footprint may be present. Although no fossiliferous outcrops were noted within the proposed project areas, the SSVR concluded the Relative Palaeontological Theme Sensitivity to be High-Sensitive due to the possibility of subsurface fossils being present.

4.1.4 THE NATIONAL ENVIRONMENTAL MANAGEMENT LAWS AMENDMENT ACT (NEMLA)

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.

4.1.5 THE NATIONAL ENVIRONMENTAL MANAGEMENT PROTECTED AREAS ACT (NEMPAA)

The National Environmental Management Protected Areas Act (Act No. 57 of 2003 – NEMPAA) is intended to *"provide for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes"* and creating a *"national system of protected areas in South Africa as part of a strategy to manage and conserve its biodiversity".*

The NEMPAA defines various kinds of protected areas, namely: *"special nature reserves, national parks, nature reserves (including wilderness areas) and protected environments; world heritage sites; marine protected areas; specially protected forest areas, forest nature reserves and forest wilderness areas declared in terms of the National Forests Act, 1998 (Act 84 of 1998); and mountain catchment areas declared in terms of the Mountain Catchment Areas Act, 1970 (Act 63 of 1970)".*

According to the Terrestrial Biodiversity Impact Assessment undertaken by the Biodiversity Company (**Appendix F13**), the project area falls within >5 km of H. J. Joel Private Nature Reserve, Tara Wildlife Safaris, and LM Safaris Nature Reserve. There are no protected areas within the PR.

4.1.6 THE NATIONAL ENVIRONMENTAL MANAGEMENT AIR QUALITY ACT (NEMAQA)

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).

National Ambient Air Quality Standards (NAAQS) were determined based on international best practice for particulate matter less than 10 and 2.5 µm in aerodynamic diameter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), lead (Pb) and benzene. The NAAQS were published in the Government Gazette (no. 32816) on 24 December 2009 for PM_{10} and other pollutants (South Africa, 2009). The $PM_{2.5}$ NAAQS were published in 2012 (South Africa, 2012).

The NEMAQA also provides for the monitoring and reporting of GHG emissions. The National Greenhouse Gas Emission Reporting Regulations (South Africa, 2017) were published in terms of Section 53 (aA), (o) and (p) of NEM: AQA on 3 April 2017 and amended on 11 September 2020 (South Africa, 2020). The purpose of these Regulations is to implement a single national reporting system for the transparent reporting of GHG emissions.

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.

The National Dust Control Regulations are promulgated under the NEMAQA and the purpose of these Regulations is to prescribe general measures for the control of dust in all areas. Dustfall is assessed for nuisance impact and not for inhalation health impact. The National Dust Control Regulations (Department of Environmental Affairs, 2013) prescribes measures for the control of dust in residential and non-residential areas. Acceptable dustfall rates are measured (using American Standard Testing Methodology (ASTM) D1739:1970 or equivalent) at and beyond the boundary of the premises where dust originates. In addition to the dustfall limits, the National Dust Control Regulations prescribe monitoring procedures and reporting requirements. Dust that may be created from the project (including but not limited to the construction phase) will be managed in accordance with these Regulations.

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.

Based on review of NEMAQA Listed Activities, the project is not expected to trigger a listed activity and therefore, no application for an AEL is required. However, based on the proposed activities (production), the applicant will still be obligated to report on the GHG emissions under these Regulations.

4.1.6.1 NATIONAL DUST CONTROL REGULATIONS

Dustfall is assessed for nuisance impact and not for inhalation health impact. The National Dust Control Regulations (Department of Environmental Affairs, 2013) prescribes measures for the control of dust in residential and non-residential areas. Acceptable dustfall rates are measured (using American Standard Testing Methodology (ASTM) D1739:1970 or equivalent) at and beyond the boundary of the premises where dust originates. In addition to the dustfall limits, the National Dust Control Regulations prescribe monitoring procedures and reporting requirements. Dust that may be created from the D3 Energy PR (including but not limited to the construction phase) will be managed in accordance with these Regulations.

4.1.7 THE NATIONAL ENVIRONMENTAL MANAGEMENT BIODIVERSITY ACT (NEMBA)

The National Environmental Management Biodiversity Act (Act No. 10 of 2004 – NEMBA) provides for the management and conservation of South Africa's biodiversity within the framework of the NEMA as well as the protection of species and ecosystems that warrant national protection. Within the framework of this act, various regulations are promulgated which provide specific requirements and management measures relating to

protecting threatened ecosystems, threatened or protected species as well as the control of alien and invasive species. A summary of these regulations is presented below.

The National List of Ecosystems that are Threatened and Need of Protection (GN 1002 of 2011) are promulgated under the NEMBA and these Regulations provide for listing of threatened or protected ecosystems in one of the following categories:

- Critically Endangered (CR) ecosystems, being ecosystems that have undergone severe degradation of ecological structure, function or composition as a result of human intervention and are subject to an extremely high risk of irreversible transformation;
- Endangered (EN) ecosystems, being ecosystems that have undergone degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems;
- Vulnerable (VU) ecosystems, being ecosystems that have a high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention, although they are not critically endangered ecosystems or endangered ecosystems; and
- Protected ecosystems, being ecosystems that are of high conservation value or of high national or provincial importance, although they are not listed as critically endangered, endangered or vulnerable.

Further regulations published under the NEMBA are the threatened or protected Species Regulations (GN R 152 of 2007) which aims to:

(a) further regulate the permit system set out in Chapter 7 of the Biodiversity Act insofar as that system applies to restricted activities involving specimens of listed threatened or protected species;

(b) provide for the registration of captive breeding operations, commercial exhibition facilities, game farms, nurseries, scientific institutions, sanctuaries and rehabilitation facilities and wildlife traders;

(c) provide for the regulation of the carrying out of a specific restricted activity, namely hunting;

(d) provide for the prohibition of specific restricted activities involving specific listed threatened or protected species;

(e) provide for the protection of wild populations of listed threatened species; and

(f) provide for the composition and operating procedure of the Scientific Authority.

4.1.7.1 THREATENED OR PROTECTED SPECIES REGULATIONS (GN R 152 OF 2007)

The purpose of these regulations is to -

(a) further regulate the permit system set out in Chapter 7 of the Biodiversity Act insofar as that system applies to restricted activities involving specimens of listed threatened or protected species;

(b) provide for the registration of captive breeding operations, commercial exhibition facilities, game farms, nurseries, scientific institutions, sanctuaries and rehabilitation facilities and wildlife traders;

(c) provide for the regulation of the carrying out of a specific restricted activity, namely hunting;

(d) provide for the prohibition of specific restricted activities involving specific listed threatened or protected species;

(e) provide for the protection of wild populations of listed threatened species; and

(f) provide for the composition and operating procedure of the Scientific Authority

According to the Terrestrial Biodiversity Impact Assessment undertaken by the Biodiversity Company (**Appendix F13**), Four (4) avifauna species (*Asio capensis* (Marsh Owl), *Elanus caeruleus* (Black-winged Kite), *Grus paradisea* (Blue Crane) and *Scopus umbrette* (Hamerkop)) within the PR are recorded as Species of Conservation Concern (SCC). These species are likely to make use of the water resource and the surrounding grassland habitats. Importantly, nine (9) species of provincially protected plant were recorded for the Project Area: *Ammocharis*

coranica (Berg Lily), *Anacampseros papyracea* (Karoo Gansmis), *Anacampseros subnuda subnuda, Boophone disticha* (Bushman Poison Bulb), *Eucomis autumnalis* (Pineapple Lily), *Euphorbia clavarioides* (Lion's Spoor), *Gladiolus permeabilis edulis, Helichrysum nudifolium* (Hairy Everlasting) and *Helichrysum zeyheri* (Vaalbergkaroo). These species occurred in various habitat units within the Project Area. All are protected under Schedule 6 in 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). Given the presence of suitable grassland habitat on site, additional protected species may occur within the PR. **A site walkdown must therefore be undertaken prior to development, with any protected species identified on site to be marked and avoided, if not possible to avoid, then relocated to a nearby area of similar habitat outside the project impact area**.

4.1.7.2 ALIEN AND INVASIVE SPECIES

The Alien and Invasive Species Lists are promulgated under the NEMBA with the aim of protecting the quality and quantity of arable land in South Africa. Loss of arable land should be avoided and declared Weeds and Invaders in South Africa are categorised according to one of the following categories, and require control or removal:

- Category 1a Listed Invasive Species: Category 1a Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be combated or eradicated;
- Category 1b Listed Invasive Species: Category 1b Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be controlled;
- Category 2 Listed Invasive Species: Category 2 Listed Invasive Species are those species listed by notice in terms of section 70(1)(a) of the Act as species which require a permit to carry out a restricted activity within an area specified in the Notice or an area specified in the permit, as the case may be; and
- Category 3 Listed Invasive Species: Category 3 Listed Invasive Species are species that are listed by notice in terms of section 70(1)(a) of the Act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of Act, as specified in the Notice.

In giving effect to the above, the Alien and Invasive Species Regulations (GNR 1020 of 2020) provide for amongst others, the prevention of the spread or allowing the spread of, any specimen of a listed invasive species. According to the Terrestrial Biodiversity Impact Assessment undertaken by the Biodiversity Company (**Appendix F13**), nineteen (19) AIP species were recorded for the PR. These species are listed under the Alien and Invasive Species List 2020, Government Gazette No. GN1003. Four (4) 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, as stated above (**Table 12**).

Table 12: Table presenting the alien and invasive species recorded for PR (The Biodiversity Company, 2026)

Family	Scientific Name	Common Name	Category
Asteraceae	*Bidens pilosa*	Blackjack	Naturalized exotics
Asteraceae	*Cirsium vulgare*	Spear thistle	Not indigenous; Naturalised; Invasive
Asteraceae	*Erigeron bonariensis*	Flax-leaf Fleabane	Not indigenous; Naturalised; Invasive
Asteraceae	*Tagetes minuta*	Marigold	Naturalized exotics
Asteraceae	*Xanthium spinosum*	Spiny cocklebur	NEMBA 1b

Family	Scientific Name	Common Name	Category
Asteraceae	*Xanthium strumarium*	Large cocklebur	NEMBA 1b
Asteraceae	*Zinnia peruviana*	Redstar Zinnia	Naturalized exotics
Cactaceae	*Cylindropuntia imbricata*	Imbricate Cactus	Not indigenous; Naturalised; Invasive
Cactaceae	*Opuntia cespitosa*	Saucepan cactus	NEMBA 1b
Cactaceae	*Opuntia lasiacantha*	Red Prickly Pear	Not indigenous; Cultivated; Naturalised; Invasive
Cactaceae	*Trichocereus spachianus*	Torch Cactus	NEMBA 1b
Fabaceae	*Gleditsia triacanthos*	Comon Honeylocust	Not indigenous; Naturalised; Invasive
Malvaceae	*Hibiscus trionum*	Flower-of-An-Hour	Not indigenous; Naturalised
Myrtaceae	*Eucalyptus camaldulensis*	River Red Gum	Not indigenous; Naturalised; Invasive
Myrtaceae	*Eucalyptus sideroxylon*	Red Ironbark	Not indigenous; Naturalised; Invasive
Salicaceae	*Salix babylonica*	Weeping Willow	Naturalized exotics
Solanaceae	*Solanum campylacanthum*	Bitter Apple	Naturalized exotics
Verbenaceae	*Verbena incompta*	Purpletop Vervain	Naturalized exotics
Verbenaceae	*Verbena officinalis*	Wild Verbena	Naturalized exotics

4.1.8 THE NATIONAL ENVIRONMENTAL MANAGEMENT WASTE ACT (NEMWA)

On 2 June 2014, the National Environmental Management: Waste Amendment Act (NEMWA) 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 NEMWA. The objectives of this Act are:

a) to protect health, well-being and the environment by providing reasonable measures for-

   i. minimising the consumption of natural resources;

   ii. avoiding and minimising the generation of waste;

   iii. reducing, re-using, recycling and recovering waste;

iv. treating and safely disposing of waste as a last resort;

v. preventing pollution and ecological degradation;

vi. securing ecologically sustainable development while promoting justifiable economic and social development;

vii. promoting and ensuring the effective delivery of waste services;

viii. remediating land where contamination presents, or may present, a significant risk of harm to health or the environment; and

ix. achieving integrated waste management reporting and planning;

b) to ensure that people are aware of the impact of waste on their health, well-being and the environment;

c) to provide for compliance with the measures set out in paragraph (a); and

d) generally, to give effect to section 24 of the Constitution in order to secure an environment that is not harmful to health and well-being.

Section 16 of the NEMWA states:

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 provides for specific waste management measures to be implemented, as well as providing for the licensing and control of waste management activities. The NEMWA Listed Activities were assessed to determine whether any Waste Management Licence (WML) requirements may be triggered by the proposed D3 Energy PR activities. The waste streams anticipated during construction, drilling and operation include general domestic waste, construction waste, scrap metal, sewage from portable sanitation facilities, used oils, grease, lubricants, hydrocarbon-contaminated materials, spent filters, oily absorbents, and limited quantities of drilling wastewater and drilling muds (refer to **Section 3.1.7**). Drilling muds and wastewater will be temporarily stored in lined above-

ground tanks adjacent to the drilling rig and removed from site following completion of drilling activities for disposal at appropriately licensed facilities. As indicated in **Section 3.1.7**, waste will not be stored on-site for periods exceeding 90 days and all hazardous waste will be removed by suitably licensed waste contractors for treatment, recycling or disposal.

Based on the current project design and waste management approach, the following NEMWA Listed Activities were identified as potentially applicable but are not expected to be triggered:

- **Category A Activity 1**: Storage of general waste in lagoons. Although the drilling sumps can be considered as lagoons, the waste that will be contained within the drill sumps is classified as general waste rather than hazardous waste. Therefore, this activity is not applicable to the proposed activities.
- **Category A Activity 3**: Recovery or recycling of general waste exceeding prescribed thresholds. The proposed project does not include any on-site waste recovery, recycling or treatment facilities. Any recyclable waste such as used oils, filters, contaminated absorbents or hydrocarbon-contaminated materials will be transported off-site to appropriately licensed facilities.
- **Category A Activity 4:** Recovery or recycling of hazardous waste exceeding prescribed thresholds. The proposed project does not include any on-site waste recovery, recycling or treatment facilities. Any recyclable waste such as used oils, filters, contaminated absorbents or hydrocarbon-contaminated materials will be transported off-site to appropriately licensed facilities**.**
- **Category A Activity 7**: Treatment of hazardous waste. No hazardous waste treatment activities are proposed on-site. Drilling muds, wastewater and other hazardous waste streams will be temporarily stored and subsequently removed for treatment or disposal at authorised facilities.
- **Category B Activity 1**: The storage of hazardous waste in lagoons excluding storage of effluent, wastewater or sewage. Not currently triggered, provided: The evaporation pond only receives wastewater, condensate and produced water and no hazardous waste is intentionally disposed of or stored in the pond. The small, lined drilling pits associated with well construction are often considered part of the drilling operation and not necessarily a hazardous waste storage lagoon, particularly where; the pits are temporary (2-3 weeks per well) and operational in nature, the materials are removed shortly after drilling, and the pits are not intended as a waste management facility. Category B Activity 1 of GN 921 would only be triggered where the pits are regarded as lagoons used for the storage of hazardous waste. Based on the current project description, the lined pits are temporary operational containment structures used during drilling and will be decommissioned following removal of the contained materials. Unless waste classification confirms the contents constitute hazardous waste and the pits are considered hazardous waste storage lagoons, Category B Activity 1 is not anticipated to be triggered.
- **Category B Activity 7 and Activity 8**: Disposal of hazardous waste to land or construction of facilities for hazardous waste disposal. The proposed development does not include the establishment of waste disposal sites, hazardous waste landfills or waste disposal cells. All hazardous waste will be transported off-site to suitably licensed disposal facilities.
- **Category B Activity 11**: The establishment or reclamation of a residue stockpile or residue deposit resulting from activities which require a mining right, exploration right or production right in terms of the MPRDA. No residue stockpiles, residue deposits, tailings facilities, slimes dams, discard dumps, evaporation residue stockpiles, or other permanent waste disposal facilities are proposed as part of the project. The proposed evaporation pond will be used for the management of produced water and condensate streams and is not intended to function as a residue stockpile or residue deposit facility. Furthermore, the project design incorporates the routine removal of drilling waste and other operational waste streams from site, thereby avoiding the accumulation of waste materials to the extent that a residue stockpile or residue deposit would be established. Consequently, Category B Activity 11 is not anticipated to be triggered by the proposed activities. Should project operations change in future to include the long-term accumulation, deposition, reclamation or management of mining or petroleum-related residue materials in a dedicated residue storage facility, the applicability

of this listed activity would need to be reassessed and the necessary environmental approvals obtained prior to commencement of such activities.

Accordingly, no NEMWA listed waste management activities are presently expected to be triggered by the proposed D3 Energy PR activities. The anticipated waste quantities are relatively low, waste management infrastructure is temporary in nature, and all waste streams will be removed routinely from site for treatment, disposed by appropriately licensed contractors. However, should project activities change during detailed design or implementation, resulting in hazardous waste storage volumes exceeding the applicable NEMWA thresholds or hazardous waste being stored on-site for prolonged periods beyond operationally incidental storage (for example, exceeding 90 days due to unforeseen circumstances), the applicability of the relevant NEMWA listed activities would need to be reassessed and the necessary Waste Management Licence applications submitted prior to commencement of such activities. In all cases, waste will be managed in accordance with the waste management hierarchy, applicable NEMWA requirements, and the project's EMPr.

4.1.9 THE NATIONAL WATER ACT (NWA)

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

a) meeting the basic human needs of present and future generations;

b) promoting equitable access to water;

c) redressing the results of past racial and gender discrimination;

d) promoting the efficient, sustainable and beneficial use of water in the public interest;

e) facilitating social and economic development;

f) providing for growing demand for water use;

g) protecting aquatic and associated ecosystems and their biological diversity;

h) reducing and preventing pollution and degradation of water resources;

i) meeting international obligations;

j) promoting dam safety;

k) managing floods and droughts,

and for achieving this purpose, to establish suitable institutions and to ensure that they have appropriate community, racial and gender representation.

The 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 15.**

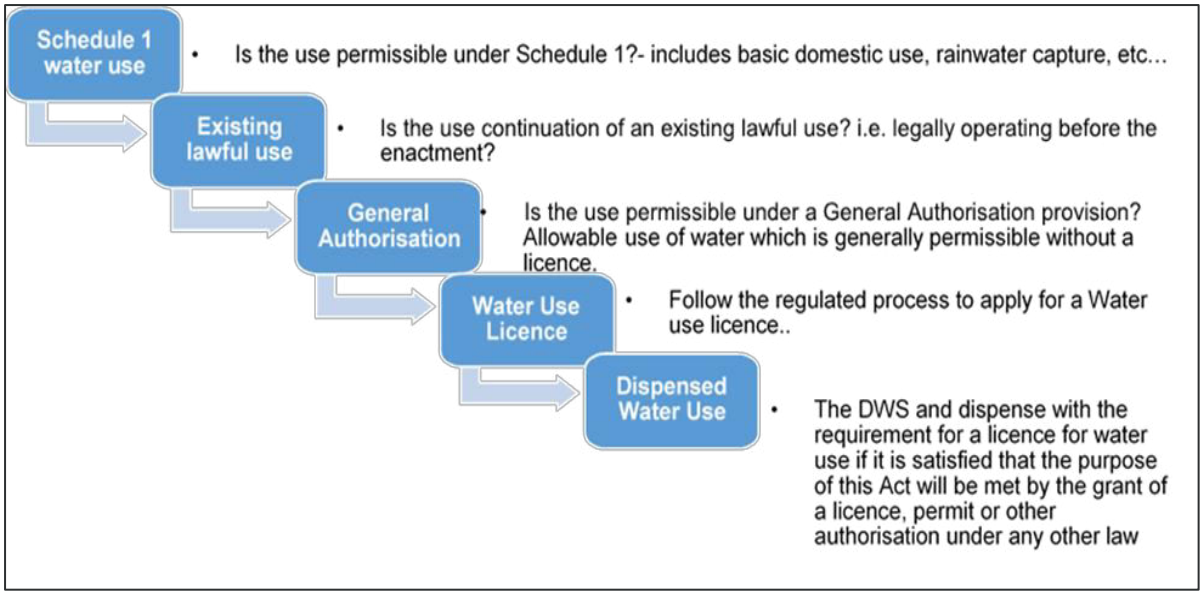


Figure 15: Authorisation processes for new water uses.

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.

A watercourse is defined in terms of the Act as follows:

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;

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.

The proposed production project includes extensive linear infrastructure which will impact on water resources in certain areas. The main water use that will be applicable is the Section 21 (c&i) uses for activities within proximity (or within) the regulated area of a watercourse. However, the proposed activities also include a 25m x 25m evaporation pond (surface area of 625 m²) which typically falls under a General Authorisation (GA) rather than a full Water Use Licence (WUL). In line with the NWA, if the total volume of wastewater or contaminated water stored/evaporated is below the specific limits defined in the relevant national GN 665 / Section 21(g) General Authorisation limits for the specific catchment, a GA applies instead of a full license. Subsequently, S21(g) will likely be applicable for the PR. As per the Risk Assessment Matrix for Section 21 (c) and (i) Water Use activities prepared by The Biodiversity Company for the WUA, several medium-risk ratings were identified, therefore, a full WUL will be applicable for the WUA (Refer to **Appendix F3** and **Appendix F6**). **Although it has been confirmed in this EIA that a Ful WULA will be applicable, it is important to note that the final Section 21 Activities and process to be followed can only be confirmed with DWS during the pre-application phase for the WUA which is a separate application process to the EA**.

4.1.9.1 CATCHMENT MANAGEMENT STRATEGIES

South Africa is divided into nine 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 Catchment Management Strategy (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. According to the DWS water management areas delineations, the D3 Energy Production Project is situated in primary catchment (C) of the Vaal River drainage system which covers a total area of approximately 196,438 km^2. The resource management falls under the Vaal Water Management Area (WMA5) which spans portions of the North West Province, northern Free State as well northern sections of the Northern Cape. The application area is situated within quaternary catchments C42G, C42H and C42K.

4.1.10 THE NATIONAL HERITAGE RESOURCES ACT (NHRA)

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 NEMA 23(2)(b) states that an integrated environmental management plan should, *"…identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage".* A study of subsections (23)(2)(d), (29)(1)(d), (32)(2)(d) and (34)(b) and their requirements reveals the compulsory inclusion of the identification of cultural resources, the evaluation of the impacts of the proposed project on these resources, the identification of alternatives and the management procedures for such cultural resources for each of the documents noted in the Environmental Regulations. A further important aspect to be taken into account of in the EIA Regulations under the NEMA relates to the Specialist Report requirements (Appendix 6 of EIA Regulations 2014, as amended) which apply to Heritage Impact Assessments.

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.

In accordance with the legislative requirements and EIA rating criteria, the regulations of the South African Heritage Resources Agency (SAHRA) and Association of Southern African Professional Archaeologists (ASAPA) have also been incorporated to ensure that a comprehensive and legally compatible Heritage Report is compiled. According to the Heritage Impact Assessment undertaken by the Dr Lucien James (**Appendix F2**), heritage resources were identified within the proposed project footprint. A total of thirteen (13) distinct heritage features were identified which may potentially be impacted by the proposed development. These included burial grounds or graves, historical period remains, structures associated with farmsteads, and a Later Stone Age site. Based on the current layouts, the construction activities will not affect any of the features identified provided the recommended 30m and 50m buffers around heritage infrastructure and graves respectively is adhered to, particularly for MPR018 and MPR021. A Chance Find Procedure is also recommended to manage any discoveries during development should finds be discovered during the proposed construction activities. This includes halting activities if significant finds are discovered during construction, recording their location, and consulting a qualified archaeologist for further evaluation.

4.1.11 ENVIRONMENT CONSERVATION ACT (ECA)

The ECA (Act 73 of 1989) was, prior to the promulgation of the NEMA, the backbone of environmental legislation in South Africa. To date the majority of the ECA has been repealed by various other Acts, however Section 25 of the Act and the Noise Regulations (GN R. 154 of 1992) promulgated under this section are still in effect. These Regulations serve to control noise and general prohibitions relating to noise impact and nuisance.

4.1.11.1 NOISE CONTROL REGULATIONS, 1992 (GN R.154)

In terms of section 25 of the ECA, the National Noise Control Regulations (GN R. 154 – NCRs) published in Government Gazette No. 13717 dated 10 January 1992, were promulgated. The NCRs were revised under GN R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations. Provincial noise control regulations have been promulgated in Gauteng, Free State and Western Cape Provinces.

The NCRs will need to be considered in relation to the potential noise that may be generated mainly during the construction phase of the proposed project. The two key aspects of the NCRs relate to disturbing noise and noise nuisance.

Section 4 of the Regulations prohibits a person from making, producing or causing a disturbing noise, or allowing it to be made produced or caused by any person, machine, device or apparatus or any combination thereof. A disturbing noise is defined in the Regulations as "*a noise level which exceeds the zone sound level or if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more*."

Section 5 of the NCRs in essence prohibits the creation of a noise nuisance. A noise nuisance is defined as "*any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person".* The South

African National Standard 10103 also applies to the measurement and consideration of environmental noise and should be considered in conjunction with these Regulations.

4.1.11.2 NOISE STANDARDS

There are a few South African National Standards (SANS) relevant to noise from mines, industry and roads. They are:

- South African National Standard (SANS) 10103:2008 – 'The measurement and rating of environmental noise with respect to annoyance and to speech communication';
- SANS 10210:2004 – 'Calculating and predicting road traffic noise';
- SANS 10328:2008 – 'Methods for environmental noise impact assessments';
- SANS 10357:2004 – 'The calculation of sound propagation by the Concave method';
- SANS 10181:2003 – 'The Measurement of Noise Emitted by Road Vehicles when Stationary'; and
- SANS 10205:2003 – 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful per se. A Noise Impact Assessment (**Appendix F8**) was undertaken for this project and the findings utilised in the impact assessment (**Section 9**) and associated management measures in the EMPr (**Appendix H**).

4.1.12 THE CONSERVATION OF AGRICULTURAL RESOURCES ACT (CARA)

The law on 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.

4.1.13 THE SPATIAL PLANNING AND LAND USE MANAGEMENT ACT (SPLUMA)

The Spatial Planning and Land Use Management Act (Act 16 of 2013 – SPLUMA) is set to aid effective and efficient planning and land use management, as well as to promote optimal exploitation of minerals and mineral resources. The SPLUMA was developed to legislate for a single, integrated planning system for the entire country. Therefore, the Act provides a framework for a planning system for the country and introduces provisions to cater for development principles; norms and standards; inter-governmental support; Spatial Development Frameworks (SDFs) across national, provincial, regional and municipal areas; Land Use Schemes (LUS); and municipal planning tribunals. The areas of the PR are currently zoned as agricultural and rural. **The Applicant will be required to undertake the relevant rezoning or land use change applications for the Plant.**

4.1.14 NATIONAL VELD AND FOREST FIRE ACT

The National Veld and Forest Fire Act 101 of 1998 is a key piece of legislation in South Africa aimed at reforming the legal framework surrounding veld and forest fires. Its primary purpose is to prevent and manage wildfires through coordinated efforts, particularly in rural and fire-prone areas. The Act encourages the formation of Fire Protection Associations (FPAs), which are legally recognized bodies that facilitate local collaboration among landowners, municipalities, and other stakeholders to predict, prevent, and suppress veldfires. These associations play a vital role in fire management by offering training, support, and technical expertise to their members.

For private developers and landowners, the Act imposes several important obligations. They are legally required to take reasonable precautions to prevent fires from starting or spreading from their property. This includes maintaining firebreaks, ensuring that controlled burns are conducted safely and in accordance with regulations, and joining or cooperating with local FPAs. Failure to meet these responsibilities can result in legal liability, especially if negligence leads to damage or loss caused by a fire. In such cases, landowners may face civil claims for damages, making it essential for them to understand and comply with the Act's provisions.

In essence, the Act not only promotes proactive fire management but also establishes a framework for accountability. Private developers and landowners must be vigilant and informed, as their actions—or lack thereof—can have significant legal and financial consequences. By participating in FPAs and adhering to fire safety regulations, they contribute to a safer and more resilient environment for their communities and the broader ecosystem

4.1.15 OCCUPATIONAL HEALTH AND SAFETY ACT

The Occupational Health and Safety Act (Act 85 of 1993 - OHSA) provides for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work; to establish an advisory council for occupational health and safety; and to provide for matters connected therewith. Worker safety will form part of the contractor's safety requirements and be guided by the OHSA. This would entail a full health and safety file including but not limited to pre-mobilization medical assessments, work environment and task specific risk assessments and method statements etc. The project will be required to comply with the OHSA and or Mine Health and Safety Act (dependent on the specific aspect of the production operations). Therefore, safety of all personnel will be guided by overarching South African legislation.

The Major Hazard Installation Regulations (GNR 692 of 30 July 2001) are promulgated under the OHSA and apply to employers, self-employed persons and users, who have on their premises, either permanently or temporarily, a major hazard installation or a quantity of a substance which may pose a risk that could affect the health and safety of employees and the public.

A "major hazard installation" means an installation-

a) where more than the prescribed quantity of any substance is or may be kept, whether permanently or temporarily; or

b) where any substance is produced, processed, used, handled or stored in such a form and quantity that it has the potential to cause a major incident.

Major Hazard Installation (MHI) risk assessment has been undertaken on both the gas transmission infrastructure as well as the LNG Plant and the report is included in **Appendix F10**. A summary of the findings and recommendations of the MHI studies are as follows:

- The project involves several hazardous materials associated with the well drilling, gas gathering and gas processing operations. These include:
  - Compressed Natural Gas (CNG) stored at 260 bar(g), capable of producing high-energy jet fires, flash fires and vapour cloud explosions (VCEs).
  - Liquefied Natural Gas (LNG) stored and transported at cryogenic temperatures (-162°C), with the potential for pool fires, flash fires and VCEs.
  - Helium, stored at cryogenic conditions (-269°C), non-toxic but capable of displacing oxygen and creating asphyxiant atmospheres.
  - Ammonia, used in the refrigeration system, classified as extremely toxic by the US EPA, with PAC-2 concentrations extending up to 3 km under worst-case conditions.
  - Natural gas from wells and pipelines, capable of producing jet fires and limited flash fire / VCE effects.
  - Flare gas, used for the safe disposal of off-spec gas streams, producing thermal radiation and combustion emissions.
  - These materials require engineered containment, emergency shutdown systems, exclusion zones, and operational controls to ensure compliance with NEMA and SANS risk management principles.
- Well Drilling and Gathering Pipeline
  - The modelling confirms that a catastrophic well failure would generate a vertical jet fire with a 1% fatality distance of approximately 4 m, while flash fire and vapour cloud explosion (VCE) effects are negligible. This demonstrates that well-related risks are spatially constrained and do not pose off-site fatality risks.
  - The 315 mm buried gathering pipeline exhibits similarly limited consequence distances. A full-bore rupture could produce a jet fire extending up to 68 m, a flash fire of 4 m, and a VCE of 9 m. These distances remain completely within the pipeline servitude, and no residential areas fall within the impact zones. Burial of the pipeline, sectional isolation valves, and leak detection systems further reduce the likelihood and consequence of such events.
  - Overall, the wellfield and gathering pipeline present low to medium-low residual risks, with impacts restricted to operational areas and no potential for off-site fatalities.
- Compressed Natural Gas (CNG)
  - Consequence modelling indicates that a catastrophic failure could result in flash fire distances of 206 m - 214 m and VCE distances of 110 m - 117 m.

- Distances may extend toward the R73 road but remain within acceptable industrial land use thresholds.
- Engineering controls such as blast resistant design, automatic isolation valves, and breakaway couplings significantly reduce the likelihood of such events

- Liquefied Natural Gas (LNG)
  - A catastrophic release may generate a pool fire of 145 m, a flash fire of 206 m, and a VCE of 125 m. Flash fire effects dominate the 1% fatality boundary.
  - All consequence distances remain within the gas processing plant boundary, and no residential receptors fall within the impact zones. Proper cryogenic containment, ESD systems, and exclusion zones during loading ensure that LNG-related risks remain medium-high, but manageable.
- Helium
  - Catastrophic failures of storage tanks or tankers produce 1% fatality distances of 44 m - 62 m, all of which remain fully confined to the plant boundary.
  - Helium impacts therefore present medium low residual significance, with risks mitigated through ventilation, oxygen monitoring, and cryogenic equipment integrity controls.
- Flare System
  - Impacts include thermal radiation, combustion emissions, and noise, all of which remain within the plant boundary.
  - With proper design in accordance with suitable standards, flare related impacts are considered low medium and do not pose off site risks.

The MHI Regulations (2022), under Chapter 1, Chapter 2 and Chapter 3, defines the establishment tier for hazardous installations. The hazardous materials stored at the gas processing plant were evaluated by using the aggregation method prescribed in the Regulations. The aggregated hazardous inventory is below the threshold values for all tiers. Therefore, **the gas processing plant is not a MHI Establishment under the MHI Regulations (2022). The gas gathering pipeline system is not classified as Major Hazard Establishment under Chapter 3**. Taken together, the assessment confirms that the project does not pose unacceptable off-site risks and does not trigger fatal flaw conditions under NEMA, the MHI Regulations (2022), or associated SANS standards. All significant impacts are either fully contained within the operational footprint or mitigated to levels consistent with industrial land use planning requirements. The project is therefore considered environmentally viable from a risk and safety perspective.

4.1.16 THE MINE HEALTH AND SAFETY ACT

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;
- to give effect to the public international law obligations of the Republic relating to mining health and safety; and
- 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 PR project.

4.1.17 THE NATIONAL ENERGY ACT

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:

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;

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-

a. training and development in the field of energy research and technology development;

b. establishment and expansion of industries in the field of energy; and

c. commercialisation of energy technologies resulting from energy research and development programmes;

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

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

vi. publish information concerning its objects and functions;

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

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

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

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

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

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

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

D3 Energy has been in discussions with Linde who are the world's leading supplier of helium to customers globally. Linde have expressed a strong interest in purchasing the helium produced from the development plan area. In addition, Linde have also provided detail and costings on a fit for purpose helium recovery and liquefaction plant for the project. Discussions have also been held between the D3 Energy and Renergen discussing a sales arrangement that would see the gaseous helium component sold to Renergen for processing through their liquefaction plant.

In addition to the Helium production, Methane is one of the other products the D3 Energy Gas Production Project will produce. D3 Energy has a gas sales term sheet in place with NOVO Energy, an integrated energy and technology company and licensed gas trader that owns gas infrastructure and provides turnkey customer solutions (industrial, NGV, power generation and feedstock) for companies across South Africa. The processing and supply of this LNG will be subject to the conditions and requirements of this Act, and the gas production on the whole will contribute to the South African economy and promote development in technologies pertaining to helium and LNG extraction and processing.

4.1.18 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 proposed D3 Energy PR16 Production Right Development includes the development and operation of production wells, a gas gathering pipeline network, a central gas processing facility, associated gas handling and storage infrastructure, and the transportation and potential sale of processed natural gas. As such, certain components of the project may fall within the regulatory jurisdiction of the National Energy Regulator of South Africa (NERSA) in terms of the Gas Act, 2001 (Act 48 of 2001). The Gas Act establishes the national regulatory framework for the piped-gas industry and requires licences for specified gas infrastructure and gas-market activities. In terms of section 15 of the Gas Act, a licence may be required for the construction and operation of gas transmission, storage, distribution, liquefaction or regasification facilities, as well as for trading in gas. The applicability of these licensing requirements depends on the final design, capacity, ownership, operational arrangements and intended commercial use of the infrastructure. Accordingly, final confirmation of licensing

requirements will be undertaken during the detailed engineering and permitting phase in consultation with NERSA. Based on the current project description, the following components will require formal regulatory screening exercise:

- Gas gathering pipeline network transporting gas from production wells to processing facility:
    - NERSA assessment required to determine whether the gathering system constitutes licensed gas transmission or distribution infrastructure.
- Central gas processing facility:
    - Processing activities themselves are generally not regulated by NERSA unless associated with licensed gas infrastructure or regulated gas activities.
- Gas storage facilities:
    - Licence may be required for construction and operation of gas storage facilities.
- LNG or CNG facilities:
    - Licences may be required for liquefaction, storage and operation of associated infrastructure.
- Transportation of processed gas via transmission infrastructure:
    - Construction and operation licences may be required for transmission facilities.
- Distribution of gas to third-party customers:
    - Distribution licence may be required.
- Commercial sale or trading of natural gas:
    - Gas trading licence may be required.
- Auxiliary 3 MW gas-fired power generation (if retained in project scope):
    - Registration or licensing requirements to be confirmed based on final configuration and use.

Should the project include commercial gas sales to external customers, industrial users, power-generation facilities, distributors or traders, a gas trading licence may be required. Similarly, should future phases include LNG, CNG, liquefaction, regasification or dedicated gas-storage infrastructure, additional NERSA approvals may become necessary. **The Applicant will therefore be required to undertake a formal regulatory screening exercise with NERSA during the detailed design and implementation phase to confirm all licensing, registration, tariff approval and compliance obligations applicable to the final project configuration**. This approach is considered appropriate given that the exact commercial arrangements, gas off-take agreements, operating pressures, storage requirements and downstream market arrangements will only be finalised during subsequent project development stages. Any licences determined by NERSA to be required in terms of the Gas Act must be obtained prior to the construction or operation of the relevant regulated infrastructure or activity.

4.1.19 EMPLOYMENT EQUITY ACT

The Employment Equity Act (Act 55 of 1998) promotes equity in the workplace, ensures that all employees receive equal opportunities and that employees are treated fairly by their employers. The law protects employees from unfair treatment and any form of discrimination. The law states that an employer may not discriminate against an employee directly or indirectly through employment policy or practice on the grounds of race, gender, pregnancy, marital status, family responsibility, ethnic or social origin, colour, sexual orientation, age, disability, religion, HIV status, conscience, belief, political opinion, culture, language, and birth.

The law aims to redress injustices of the past by implementing affirmative action measures. According to the legislation, it isn't unfair discrimination to promote affirmative action consistent with the Act or to prefer or

exclude any person on the basis of an inherent job requirement. D3 Energy shall abide by the Act for employment opportunities.

4.1.20 PROMOTION OF EQUALITY AND PREVENTION OF UNFAIR DISCRIMINATION

The Promotion of Equality and Prevention of Unfair Discrimination Act (Act 4 of 2000) gives expression to the right to equality. Section 8 stipulates that no person may be unfairly discriminated against on the grounds of gender, expressly including gender-based violence. Section 8 of the Act goes onto prohibit any limitation of women's access to social services, such as health or education, and the denial or systemic inequality of access to opportunities. The employment process to be implemented for the D3 Energy PR project must abide by the requirements of the Act.

4.1.21 CLIMATE CHANGE ACT

The Climate Change Act, 2024 (Act No. 22 of 2024) is South Africa's first comprehensive climate change legislation and came into operation on 17 March 2025, with certain provisions deferred pending the promulgation of supporting regulations. The Act aims to enable an effective national response to climate change and facilitate a long-term, just transition to a low-carbon, climate-resilient economy and society within the broader framework of sustainable development. It establishes a coordinated governance framework through which climate change considerations must be integrated into decision-making across all spheres of government and sectors of the economy.

The Act provides for climate change adaptation and mitigation measures, the setting of national emissions reduction objectives, the determination of sectoral emission targets, the development of carbon budgets for significant greenhouse gas emitters, and the integration of climate risk and vulnerability assessments into planning processes. It also seeks to improve resilience to climate impacts while supporting sustainable economic development and environmental protection.

For environmental assessment processes undertaken in terms of the NEMA, the Climate Change Act reinforces the requirement that climate change implications be considered during project planning and authorisation. This is particularly relevant for the proposed D3 Energy PR project, given the potential for greenhouse gas emissions associated with methane extraction and associated infrastructure, as well as the need to evaluate climate-related risks and opportunities throughout the project lifecycle.

Section 7 of the Climate Change Act is of particular significance to the assessment of the proposed project. The provision requires that the Act be implemented in a manner that promotes alignment between climate change objectives and all relevant legislation, policies and regulatory frameworks. It further provides that organs of state exercising powers or performing functions under other legislation must do so in a manner that gives effect to the objectives and principles of the Climate Change Act where climate change considerations are relevant. Consequently, environmental authorisation processes conducted under NEMA should incorporate climate change considerations and support South Africa's national climate commitments and transition objectives.

In the context of this EIA, the Climate Change Act therefore serves as an important policy and legislative framework for assessing the project's potential contribution to greenhouse gas emissions, its resilience to climate-related impacts, and its consistency with national climate change mitigation and adaptation objectives. Consideration of these factors will assist decision-makers in ensuring that the proposed development aligns with South Africa's evolving climate governance framework and the principles of sustainable development.

4.1.22 CARBON TAX ACT

The Carbon Tax Act, 2019 (Act No. 15 of 2019) is one of South Africa's principal climate change mitigation instruments and is intended to support the country's transition towards a lower-carbon economy through the application of the "polluter pays" principle. The Act imposes a tax on greenhouse gas (GHG) emissions expressed

as carbon dioxide equivalent (CO_2e), thereby creating a financial incentive for entities to improve energy efficiency, reduce emissions and invest in lower-carbon technologies.

The Carbon Tax Act came into operation on 1 June 2019 and forms part of a broader national climate policy framework that includes:

- The Climate Change Act, 2024;
- South Africa's Nationally Determined Contributions (NDCs);
- The National Climate Change Response Policy;
- The National Greenhouse Gas Emissions Reporting Regulations;
- The South African Greenhouse Gas Emission Reporting System (SAGERS); and
- Sectoral emissions targets and carbon budgets.

The Act seeks to ensure that economic sectors gradually internalise the cost of greenhouse gas emissions while allowing time for technological adaptation and transition.

When considered alongside the specialist Climate Change and Air Quality Impact Assessments, the Carbon Tax Act represents a significant but manageable regulatory requirement for the proposed D3 Energy PR activities. The project's estimated Scope 1 emissions of approximately **29,221 tCO_2e per annum** place it within a medium-emitting category, resulting in potential carbon tax obligations and future greenhouse gas management requirements. While the project's contribution to South Africa's national carbon budget is relatively small and no fatal environmental constraints were identified, methane management, venting reduction, flaring minimisation, emissions reporting and carbon budget compliance are likely to become increasingly important over the life of the operation. The implementation of the mitigation measures recommended in the specialist studies will not only reduce environmental impacts but will also reduce long-term carbon tax exposure and align the project with South Africa's evolving climate policy framework.

4.2 NATIONAL POLICY AND PLANNING CONTEXT

4.2.1 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 (NEMAQA). 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.

4.2.2 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.

4.2.3 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.

According to the Terrestrial Biodiversity Impact Assessment undertaken by the Biodiversity Company (**Appendix F13**), the proposed activities are located with Categories B and D (highest and moderate risk for mining, respectively) but importantly does not fall within Category A and therefore, not prohibited from mining activities (**Figure 16**). 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.

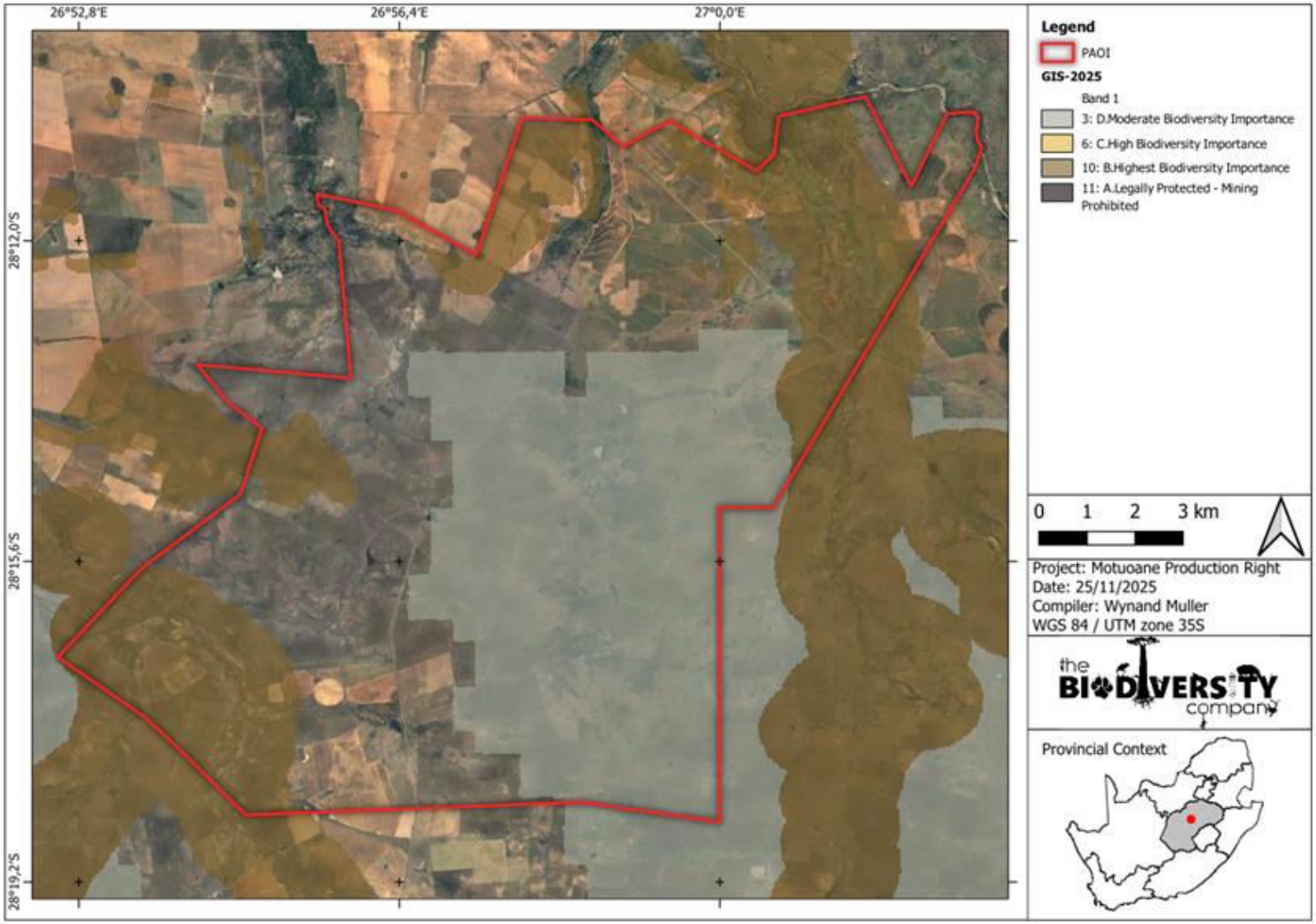


Figure 16: The project area in relation to the Mining and Biodiversity Guidelines (The Biodiversity Company, 2026).

4.2.4 INTEGRATED ENERGY PLAN

The Integrated Energy Plan (IEP) is South Africa's overarching energy planning framework developed in terms of the National Energy Act, 2008 (Act No. 34 of 2008). The IEP is intended to provide a long-term roadmap for the country's energy future, guiding policy development, infrastructure investment and energy security planning across all energy subsectors, including electricity, liquid fuels, gas, renewables, coal and emerging energy technologies.

Unlike the Integrated Resource Plan (IRP), which focuses specifically on electricity generation, the IEP considers energy demand and supply across the entire economy and seeks to ensure that South Africa's future energy requirements are met in a secure, affordable, equitable and environmentally sustainable manner. The IEP adopts a balanced approach to energy planning by considering multiple policy objectives simultaneously. Key objectives include:

- Energy Security
    - Ensuring reliable and uninterrupted access to energy resources is one of the central objectives of the IEP. South Africa has historically relied heavily on imported oil and domestically produced coal. The IEP therefore promotes diversification of energy sources to reduce vulnerability to supply disruptions.
- Diversification of the Energy Mix
    - The IEP seeks to reduce dependence on a limited number of energy sources by encouraging development of:
        - Natural gas;
        - Renewable energy;
        - Nuclear energy;
        - Cleaner liquid fuels;
        - Emerging technologies.
- Economic Development and Industrialisation
    - Energy infrastructure projects that contribute to industrialisation and economic diversification are supported where environmental impacts can be appropriately managed.
- Environmental Sustainability
    - The plan seeks to balance energy development requirements with South Africa's environmental commitments and climate objectives.
- Energy Access and Affordability
    - Another key objective is to improve energy access while ensuring affordability and reliability for both households and industry.

The IEP recognises natural gas as a strategically important component of South Africa's future energy landscape. The IEP specifically envisages development of a domestic gas industry capable of supporting:

- Gas-to-power projects;
- Industrial feedstock requirements;
- Liquefied Natural Gas (LNG) infrastructure;
- Regional economic development;
- Energy security enhancement.

The proposed D3 Energy PR project involves production of indigenous natural gas resources. This directly supports one of the IEP's strategic objectives, namely: increasing utilisation of domestic energy resources and reducing reliance on imported energy supplies. The project's gas production and gas-to-power capability support broader IEP objectives aimed at improving flexibility and reliability within the energy sector.

4.2.5 JUST ENERGY TRANSITION

South Africa's Just Energy Transition ("JET") framework constitutes a key national policy approach intended to support the country's transition toward a lower-carbon economy while simultaneously addressing socio-economic development priorities, energy security and employment considerations. The Just Energy Transition Investment Plan ("JET-IP"), together with associated policy instruments and international partnership commitments, recognises that South Africa's energy transition must occur in a manner that is socially inclusive and economically sustainable, particularly in regions historically dependent on coal mining and coal-based energy generation.

The JET framework acknowledges that South Africa continues to face significant developmental challenges, including high unemployment, poverty, inequality and electricity supply constraints. Accordingly, the transition pathway proposed within the JET framework does not envisage an immediate cessation of fossil fuel utilisation, but rather a phased and managed transition balancing environmental objectives with economic stability and energy reliability. The JET-IP identifies electricity, new energy vehicles and green hydrogen as priority sectors for transition-related investment, while also recognising the importance of maintaining secure and reliable energy supply during the transition period.

Within this broader transition context, gas is increasingly referenced in South African policy and energy planning discussions as a potential "transition fuel" capable of supporting system flexibility and dispatchable electricity generation while renewable energy infrastructure and storage capacity continue to expand. National planning frameworks, including the Integrated Resource Plan ("IRP") 2025, recognise the potential role of gas-fired generation in complementing variable renewable energy sources and supporting grid stability. Consequently, indigenous gas resources are increasingly relevant within discussions concerning energy diversification, industrial development and reduced reliance on imported energy products. At the same time, policy discussions relating to the Just Energy Transition also emphasise the need to progressively reduce greenhouse gas emissions over the longer term and to ensure that future energy developments align with evolving climate commitments and sustainability objectives.

The JET framework further places emphasis on regional economic resilience and the creation of alternative economic opportunities in areas historically associated with mining and energy production. In this regard, energy-related developments that contribute toward infrastructure investment, employment creation, skills development and local economic activity may be considered relevant within the broader objectives of ensuring a managed and socially responsive energy transition. However, all such developments remain subject to applicable environmental authorisations, regulatory requirements and the balancing of socio-economic and environmental considerations within South Africa's evolving energy policy landscape.

4.3 PROVINCIAL POLICY AND PLANNING CONTEXT

4.3.1 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 Free State Department of Economic, Small Business Development, Tourism and Environmental Affairs (FSDESTEA).

According to the Terrestrial Biodiversity Impact Assessment undertaken by the Biodiversity Company (**Appendix F13**), nine (9) species of provincially protected plant were recorded for the Project Area: *Ammocharis coranica* (Berg Lily), *Anacampseros papyracea* (Karoo Gansmis)*, Anacampseros subnuda subnuda, Boophone disticha* (Bushman Poison Bulb)*, Eucomis autumnalis* (Pineapple Lily)*, Euphorbia clavarioides* (Lion's Spoor)*, Gladiolus permeabilis edulis, Helichrysum nudifolium* (Hairy Everlasting) and *Helichrysum zeyheri* (Vaalbergkaroo). These species occurred in various habitat units within the Project Area. All are protected under Schedule 6 in 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 FSDESTEA.

4.3.2 FREE STATE PROVINCIAL SPATIAL DEVELOPMENT PLAN

The Free State Provincial Spatial Development Framework (PSDF) 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 PSDF 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 production activities are within an approved exploration right.

4.3.3 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, CBA 2, ESA 1, ESA 2, ONA and Degraded Areas (**Figure 17**).

4.3.4 FREE STATE PROVINCIAL NOISE CONTROL REGULATIONS (PN 24 OF 1998)

The control of noise in the Free State Province is legislated in the form of the Provincial Noise Control Regulations (PNCR) promulgated in terms of section 25 of the ECA.

It should be noted that the regulations define:

"**ambient sound level**" - means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation;

"**disturbing noise**" - means a noise level that exceeds the ambient sound level measured continuously at the same measuring point by 5 dBA or more.

"**noise level**" - means the reading on an integrating impulse sound level meter taken at a measuring point in the presence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such meter was put into operation, and, if the alleged disturbing noise has a discernible pitch, for example, a whistle, buzz, drone or music, to which 5 dBA has been added;

In addition: In terms of Regulation 2 (d):

"A local authority may – before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests be conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings and that reports or certificates relating to the noise impact to the satisfaction of that local authority be submitted by the owner, developer, tenant or occupant to the local authority;

In terms of Regulation 3 (c):

"No person shall – make changes to existing facilities or existing uses of land or buildings or erect new buildings, if it shall in the opinion of a local authority house or cause activities which shall, after such change or erection, cause a disturbing noise, unless precautionary measures to prevent the disturbing noise have been taken to the satisfaction of the local authority";

In terms of Regulation 4 of the Noise Control Regulations:

"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof".

Noise Impact Assessment was undertaken by Enviro-Acoustic Research (**Appendix F8**). Potential worst-case noise rating levels were calculated using a sound propagation model using conceptual scenarios for the construction and operational phases, using simplified noise propagation modelling to estimate potential noise impacts associated with the decommissioning and rehabilitation phases. The noise assessment indicates that, with the proposed layout and setbacks; construction, operational, decommissioning and rehabilitation activities will result in low significance noise impacts at identified NSR locations. Medium significance may arise pre mitigation for a limited subset of activities, mainly associated with production borehole drilling (when near NSR locations) and abnormal plant operations (plant blowdown, release of gas). Cumulative effects are expected to be insignificant, because noise do not contribute to other noises generated at other locations located further than 2,000m from a noise-generating activity.

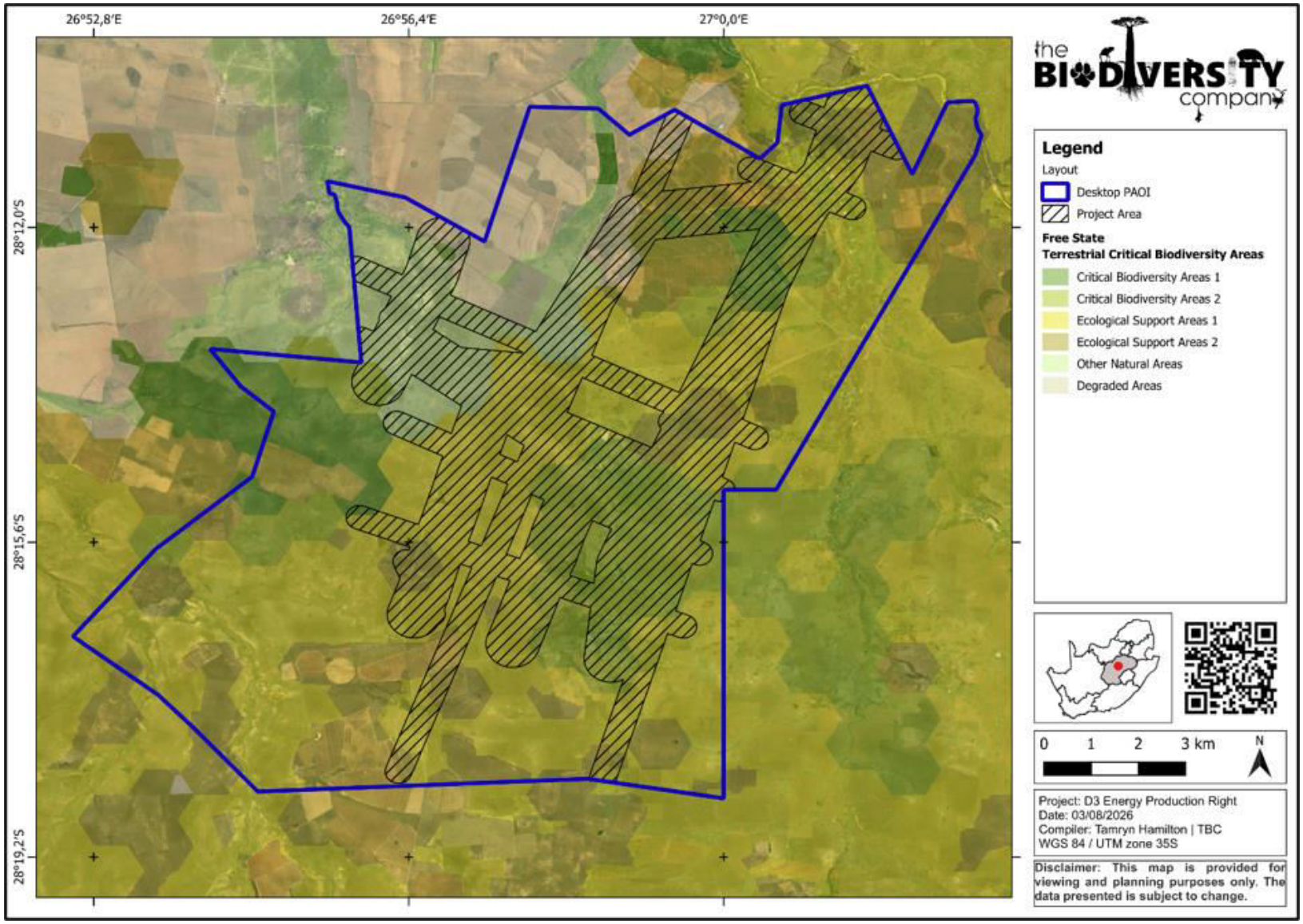


Figure 17: The project area in relation to the to the Free State Terrestrial CBA Plan (The Biodiversity Company, 2026).

4.3.5 MUNICIPAL INTEGRATED DEVELOPMENT PLANS

For the purpose of this project, Integrated Development Plan (IDP) documents of two municipalities need to be considered: the Lejweleputswa District Municipality, the Matjhabeng Local Municipality, and the Masilonyana Local Municipality.

The Lejweleputswa District Municipality IDP (2022-2027) indicates that key sectors for **local economic development** include **agro-processing, manufacturing, renewable energy (particularly solar energy), tourism, real estate, and consulting engineering services**. In addition to economic growth, **basic service delivery and infrastructure development** remain priorities, focusing on **water, sanitation, waste management, electricity, roads, and sports and recreation facilities** to enhance community well-being and sustainability.

The key priorities for the Matjhabeng Local Municipality (IDP 2024/25) are:

- **Water**: Addressing water leakages, replacing meters, and ensuring water connections.
- **Sanitation**: Fixing collapsed sewer networks and eradicating bucket systems.
- **Electricity**: Installing and maintaining high mast lights and streetlights.
- **Road and Stormwater**: Paving, gravelling, and resealing roads, fixing potholes, and constructing stormwater drainage systems.
- **Waste Management**: Removing illegal dumping, ensuring consistent refuse collection, and providing dustbins.
- **Human Settlement**: Allocating residential and business sites, providing RDP houses, and issuing title deeds.
- **Local Economic Development (LED)**: Supporting SMMEs with training and funding and creating business opportunities.
- **Education**: Providing bursaries, learnerships, and internships, and building new educational facilities.
- **Health**: Expanding and maintaining clinics and ensuring access to healthcare services.
- **Community Facilities**: Building and maintaining community halls, sports facilities, and parks.
- **Safety and Security**: Ensuring visible policing, enforcing by-laws, and building new police stations.
- **Agriculture**: Protecting river systems from pollution, promoting sustainable agricultural practices, and developing agro-processing projects.
- **Built Environment**: Prioritizing road linkages, promoting densification, and providing diverse housing options.
- **Revenue and Financial Management**: Enhancing revenue collection, managing expenditures, and ensuring financial sustainability.
- **Performance Management**: Implementing a robust performance management system to monitor and improve service delivery.
- **Integration and Coordination**: Ensuring integrated development planning and aligning projects with national and provincial strategies.
- **Infrastructure Development**: Developing and maintaining essential infrastructure such as water, sanitation, energy, and transport systems.
- **Replacement of Ageing Infrastructure**: Replacing old and deteriorating infrastructure.
- **Housing Accreditation**: Achieving housing accreditation.
- **Internal Capacity Building**: Building internal capacity.
- **Climate Change Strategy**: Developing climate change strategy, adaptation, and mitigation.

- **Private-Public Partnerships**: Improving private-public partnerships for growth and development.
- **Economic Corridors**: Developing economic corridors linking six towns

The latest publicly available Masilonyana Local Municipality Integrated Development Plan (IDP 2024/25, adopted 31 May 2024) identifies its priorities through Key Performance Areas (KPAs) and related strategic objectives. These can be summarized as follows:

- **Basic Service Delivery and Infrastructure Development**
    - Improve access to and reliability of water, sanitation, electricity, roads, stormwater systems, waste management, and other municipal services.
- **Local Economic Development (LED)**
    - Promote economic growth, attract investment, support agricultural development, stimulate business activity, and create employment opportunities.
- **Municipal Transformation and Organisational Development**
    - Strengthen institutional capacity, improve staff performance, ensure effective governance, and enhance municipal efficiency.
- **Financial Viability and Financial Management**
    - Improve revenue collection, maintain sound financial management practices, ensure sustainable budgeting, and strengthen financial controls.
- **Good Governance and Public Participation**
    - Increase community involvement in municipal decision-making, improve accountability, strengthen ward committee systems, and promote transparent governance.
- **Spatial Planning, Human Settlements and Environmental Management**
    - Support sustainable land use planning, housing development, environmental protection, climate change adaptation, and disaster risk management.
- **Social and Community Development**
    - Improve access to community facilities, sports and recreational amenities, arts and culture programmes, and initiatives that enhance the quality of life of residents

The proposed D3 Energy PR development will align and potentially contribute to the Matjhabeng and the Masilonyana Local Municipalities IDPs through:

- Job creation during drilling, construction, operations, logistics, maintenance, and support services would support the municipality's economic development objectives.
- Procurement opportunities for local businesses, contractors, transport providers, accommodation establishments, and suppliers would align with local enterprise development goals.
- Investment in infrastructure, such as roads, electricity connections, communications, and water systems associated with the project, could provide secondary benefits to nearby communities.
- Expansion of the municipal revenue base through economic growth, business activity, and property development would support financial viability objectives.

The IDPs also highlights water, sanitation, environmental management, and climate-change considerations as strategic priorities. Subsequently, as indicated various sections of this report such as **Section 5, 6 7 and Section 9** of this report, the project demonstrates:

- Protection of groundwater and surface water resources;
- Effective management of environmental impacts;

- Compliance with climate and sustainability commitments and
- Meaningful public participation with affected communities.

4.3.6 PROVINCIAL GROWTH AND DEVELOPMENT STRATEGIES

The Free State Provincial Growth and Development Strategy (FGDS) is based on six pillars, each with its own set of drivers (FSDF 2012 revised 2021). The drivers and pillars are:

1. Inclusive economic growth and sustainable job growth creation
    a. Diversify and expand agricultural development and food security.
    b. Minimise the impact of the declining mining sector and ensure that existing mining potential is harnessed.
    c. Expand and diversify manufacturing opportunities.
    d. Capitalise on transport and distribution opportunities.
    e. Harness and increase tourism potential and opportunities.
2. Education, innovation and skills development
    a. Ensure an appropriate skills base for growth and development.
3. Improved quality of life
    a. Curb crime and streamline criminal justice performance.
    b. Expand and maintain basic and road infrastructure.
    c. Facilitate sustainable human settlements.
    d. Provide and improve adequate health care for citizens.
    e. Ensure social development and social security services for all citizens.
    f. Integrate environmental limitations and change into growth and development planning.
4. Sustainable rural development
    a. Mainstream rural development into growth and development planning.
5. Build social cohesion
    a. Maximise arts, culture, sports and recreation opportunities and prospects for all communities.
6. Good governance
    a. Foster good governance to create a conducive climate for growth and development.

The FSDF supplements the FGDS as guidance document for the province to use resources in a way that will ensure sustainable outcomes based on provincial development needs and priorities (FSDF, 2012). The FSDF outlines Vision 2030, a collective response to the need for the province to describe and map its future destiny through long-term development planning, and to forge a common and shared development agenda across a wide spectrum of service delivery mechanisms. The Free State Vision 2030 envisages that, by 2030, *the Free State shall have a resilient, thriving and competitive economy that is inclusive, with immense prospects for human development anchored on the principles of unity, dignity, diversity, equality and prosperity for all* (FSDF, 2012).

Encouraged by this vision, the Free State of 2030 will be characterised by an economy that encourages the development of new growth sectors with emphasis on the knowledge-based industries and the green economy (FSGDS).

The Free State Vision 2030 furthermore envisages that, *by 2030, ownership and control patterns of the economy will be transformed, spatial under-development will be addressed, basic services such as healthcare, education, electricity, water and sanitation will be equitably accessed by the people of the province. In the quest for inclusive*

economic growth and development, the environment will be protected for future generations. Lasting responses to climate changes will be part of the landscape of the development of the province. Steeped within the democratic principles, the Provincial Government will be accountable, transparent, effective, efficient, responsive to people's needs, and corruption will be eliminated (FSDF, 2012).

The Free State economy includes significant; Petrochemicals, Mining, Manufacturing, Agro-processing, and Logistics sectors. Natural gas can support these sectors by:

- Providing industrial fuel
- Serving as chemical feedstock
- Improving energy reliability
- Lowering emissions compared with coal-based energy systems.

The FGDS places significant emphasis on strategic infrastructure investment as a catalyst for development. Gas developments typically require:

- Pipelines
- Storage facilities
- Compression facilities
- LNG infrastructure
- Gas-fired power stations

These investments contribute directly to provincial infrastructure objectives. In addition, during the current review of the provincial growth strategy, the province explicitly identifies an: "Energy Development Corridor" focused on renewable and traditional energy resources. This is important because provincial planning is not exclusively renewable-focused. It recognises both Traditional energy resources and Renewable energy resources within the provincial development landscape. Gas developments align well, particularly where they support diversified energy supply.

4.4 INTERNATIONAL LEGISLATION

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

4.4.1 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**4), 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:
    - 809 057 tonne (t) Carbon dioxide equivalent (CO_2e) over a 30-year period
    - 29 221 t CO_2e per annum
- Scope 2 indirect emissions:
    - There are no Scope 2 emissions as no electricity from the grid will be used during the production activities
- Scope 3 indirect emissions:
    - 1 930 635 t CO_2e over a 30-year period
    - 191 915 t CO_2e per annum

Emissions using the Global Warming Potential (GWP) values (20 and 100 years) from the IPCC Sixth Assessment report amount to 32 772 t CO2e per year and 60 293 t CO2e per year. Even with the more conservative GWP factors, this project would still be considered a medium facility. The project activities will also result in non-methane volatile organic compounds (NMVOCs) which are included in the assessment as they can produce increases in tropospheric ozone concentrations, increasing radiative forcing (warming of the atmosphere).

The GHG emissions from the project was calculated to represent 0.009% of the remaining South African annual budget for 2035. 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 **moderate** negative risk rating for GHG emissions.

4.4.1.1 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 would end in 2020 (UNFCCC, 2017) but due to lack of ratification has not come into force.

The Paris Agreement was adopted by 196 Parties at Conference of the Parties (COP) 21 in Paris, on 12 December 2015 and commenced 4 November 2016. 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 Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°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 is founded on the idea of countries improving on their climate change strategies in 5-year cycles. 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. The Paris Agreement proposes that Parties submit long-term low greenhouse gas emission development strategies (LT-LEDS) by 2020 but this was not mandatory.

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 took stock of the collective efforts in relation to progress towards the goals set in the Paris Agreement 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 September 2024, 195 Parties of the 197 Parties to the UNFCCC, including South Africa, had ratified the Paris Agreement. South Africa submitted its NDC to the UNFCCC on 25 September 2016 and an updated first NDC in September 2021. In July 2025, a draft of the second NDC was gazetted (Government Gazette (GG) 53092) for public comment, and in October 2025 a final second NDC was submitted to the UNFCCC. On January 20, 2025, an executive order was signed by the United States President to withdraw the United States from the Paris Agreement.

4.4.1.2 GLOBAL GHG EMISSION INVENTORY

The proposed D3 Energy PR development 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).

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

4.4.1.3.1 PARIS AGREEMENT - NATIONALLY DETERMINED CONTRIBUTIONS

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 South Africa's first Nationally Determined Contribution (NDC) was published for public comment on 30 March 2021, following which the updated first NDC was formally submitted to the United Nations Framework Convention on Climate Change (UNFCCC) on 27 September 2021 in preparation for the 26th Conference of the Parties (COP26) held in Glasgow, Scotland during November 2021. The updated first NDC strengthened South Africa's greenhouse gas mitigation commitments and adaptation goals, including a revised 2030 emissions target range of 350 to 420 Mt CO_2e per annum. Subsequently, South Africa initiated the development of its second NDC, with a draft second NDC published for public comment in July 2025. The final second NDC was submitted to the UNFCCC in October 2025 and introduces emissions targets for the period 2031 to 2035. The second NDC commits South Africa to limiting annual greenhouse gas emissions to between 320 and 380 Mt CO_2e by 2035, while also expanding climate adaptation objectives related to water security, disaster risk reduction, climate-resilient infrastructure, food security, ecosystem protection, climate services and institutional capacity building. The NDC further outlines South Africa's climate finance requirements and reinforces the country's commitment to a just transition towards a low-carbon, climate-resilient economy in line with the Paris Agreement and the objectives of the Climate Change Act, 2024

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 13**.

Table 13: 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

4.4.1.3.2 UPDATED NATIONALLY DETERMINED CONTRIBUTION (2021)

South Africa submitted its Updated Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) in September 2021 in accordance with the requirements of the Paris Agreement. The latest NDC submitted by South Africa is the Second NDC, submitted in October 2025 under the Paris Agreement and outlines mitigation, adaptation, and implementation goals for the periods 2026-2030 and 2031-2035. It represents a progression beyond the 2021 Updated NDC and aligns with South Africa's commitment to achieve net-zero emissions by 2050. The NDC seeks to balance:

- Climate action,
- Economic development,
- Poverty reduction,
- Employment creation,
- Energy security, and
- A just transition to a low-carbon economy.

The NDC emphasizes that climate action must support South Africa's developmental priorities while contributing fairly to the global effort to limit warming to well below 2°C and pursue efforts to limit it to 1.5°C. South Africa commits to reducing economy-wide greenhouse gas emissions to **320-380 $MtCO_2e$ by 2035**. This represents a tighter emissions trajectory compared with previous NDC commitments and reinforces the country's declining emissions pathway beyond 2030.

The NDC recognises that decarbonisation must:

- Protect workers and communities dependent on carbon-intensive sectors;
- Promote new economic opportunities;
- Support skills development and reskilling;
- Ensure social inclusion during the transition process

The NDC does **not prohibit natural gas development**, but it clearly signals that all future energy investments must support the country's long-term decarbonisation pathway.

Gas projects are most likely to be viewed favourably where they:

- Replace higher-emission coal or liquid fuels;
- Support grid stability alongside renewables;

- Facilitate industrial decarbonisation;
- Are compatible with hydrogen, CCS, or other future low-carbon technologies.

The proposed D3 Energy PR programme is generally consistent with the objectives of South Africa's Updated Nationally Determined Contribution (2025). The project's quantified GHG emissions are expected to make a negligible contribution to national emissions inventories and carbon budgets, while the Climate Change Assessment concluded that climate-related impacts are of low significance. Furthermore, the incorporation of emissions reduction measures and climate adaptation interventions supports the broader mitigation and resilience objectives contained within the NDC. Provided that the recommended mitigation, monitoring and adaptive management measures are implemented throughout the production lifecycle, the proposed activities are not anticipated to materially compromise South Africa's ability to meet its national climate commitments.

4.4.1.3.3 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.

4.4.1.3.4 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.

4.4.1.3.5 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.

4.4.1.3.6 2020 LONG-TERM LOW-EMISSION DEVELOPMENT STRATEGY

South Africa's Long-Term Low Emission Development Strategy (LT-LEDS) (2020) was developed in terms of Article 4 of the Paris Agreement and provides the country's long-term vision for transitioning towards a climate-resilient, low-carbon economy by 2050. The strategy outlines pathways for reducing greenhouse gas (GHG) emissions while supporting economic growth, energy security, employment creation, and sustainable development. The LT-LEDS recognizes that South Africa's economy remains heavily dependent on fossil fuels and that a gradual, just transition is required to achieve national climate objectives while maintaining socio-economic stability. It therefore promotes a decarbonisation pathway that prioritises energy efficiency, renewable energy deployment, industrial transformation, sustainable transport systems, and improved management of land-based carbon sinks. The strategy is closely aligned with South Africa's Nationally Determined Contributions (NDCs), the National Climate Change Response Policy, and the Climate Change Act (Act 22 of 2024).

The LT-LEDS further acknowledges that natural gas may serve as a transitional energy source during South Africa's energy transition, particularly where it can contribute to reducing reliance on coal-fired electricity generation and support energy security. The strategy treats gas as a transitional fuel within the framework of the Integrated Resource Plan (IRP), aiming to shift away from coal toward a decarbonized power system by 2050.

The proposed activities are generally considered to be consistent with the objectives of the LT-LEDS for the following reasons:

- The estimated GHG emissions are extremely small in the context of national emissions and carbon budgets.
- No grid electricity usage is anticipated during the proposed activities, resulting in zero Scope 2 emissions.

- The project includes temporary and reversible activities with limited physical infrastructure requirements.
- Proposed activities may contribute to the improved understanding of domestic gas resources that could potentially support South Africa's transitional energy requirements if future development is proven feasible and environmentally acceptable.

Nevertheless, alignment with the LT-LEDS will require continued implementation of emission reduction measures throughout the exploration phase, including the prevention of fugitive methane emissions, optimisation of vehicle and drilling equipment efficiency, and rehabilitation of disturbed areas following the proposed activities.

4.4.1.3.7 SOUTH AFRICA'S NET-ZERO 2050 TARGET

South Africa has now formally positioned net-zero greenhouse gas emissions by 2050 as its long-term climate objective. This commitment is reflected in the country's Second Nationally Determined Contribution (NDC) submitted in October 2025, which states that South Africa's 2035 emissions target is aligned with a pathway to achieve net-zero emissions by 2050. South Africa's long-term climate policy trajectory is guided by its commitment to achieving a net-zero GHG emissions economy by 2050, as articulated through the Long-Term Low Emission Development Strategy (LT-LEDS) (2020), the Updated Nationally Determined Contribution (NDC) (2025), the National Climate Change Response Policy, and more recently the Climate Change Act (Act 22 of 2024). The net-zero objective seeks to balance anthropogenic greenhouse gas emissions with removals by natural and technological carbon sinks, thereby contributing to the global effort to limit warming to well below 2°C and pursue efforts to limit temperature increases to 1.5°C above pre-industrial levels.

The net-zero pathway requires a gradual but sustained reduction in emissions across all sectors of the economy, including electricity generation, transport, industry, mining, agriculture and waste management. South Africa's decarbonisation strategy is founded on the principles of a just transition, which seeks to balance environmental objectives with socio-economic considerations such as employment, energy security, economic growth and poverty alleviation. Key interventions supporting the net-zero objective include increasing renewable energy generation, improving energy efficiency, deploying low-carbon technologies, reducing methane emissions, promoting sustainable transport systems and strengthening climate resilience across vulnerable sectors.

The Climate Change Act further reinforces this objective through the establishment of national emissions trajectories, sectoral emission targets and carbon budget mechanisms, which will progressively guide South Africa toward achieving its long-term net-zero ambitions.

The specialist Climate Change Assessment concluded that the proposed D3 Energy PR programme would result in a negligible contribution to South Africa's overall greenhouse gas emissions profile and would account for only approximately 0.0007% of the country's remaining annual carbon budget. The project's climate impact was accordingly assessed as being of low significance. Given the limited and temporary nature of the proposed exploration activities, the negligible emissions contribution and the implementation of recommended mitigation measures, the proposed D3 Energy programme is not expected to materially compromise South Africa's pathway towards its net-zero 2050 target. Continued implementation of emissions reduction measures, climate-resilient operational practices and responsible environmental management will further support alignment with national climate policy objectives and sustainable development principles.

5 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 PR.

5.1 POTENTIAL PROJECT BENEFITS

The expected benefits of the proposed project to the South African economy and especially the Free State Province will include:

- LNG is devoid of some of the criteria pollutants contained in crude oil and coal and thus produces significantly less carbon dioxide emissions making it a cleaner fossil fuel energy source, a potential transition fuel from coal;
- Large capital investment for the gas production infrastructure with associated local and regional benefits to the economy (drilling; setting the gas producing wells, pipeline, LNG/LHe plant; etc.);
- Local business opportunities whereby there is potential to make use of empowered local contracting companies;
- Training and transferring experience and skills to local people employed;
- Social benefits such as through Social and Labour Plan (SLP) interventions and other social responsibility programmes;
- Will prompt further investigations on gas production and use in South Africa as well as other industries that would have beneficial use of the gas (e.g.: fertilizer production, gas powered vehicles, etc);
- Promotion of gas as a bridging fuel towards South Africa achieving the renewable energy use targets as opposed to the extensive use of fossil fuels in the short to medium term;
- Reduce the amount of Helium and LNG that South Africa needs to import; and
- Possible international investment into the country.

5.2 DEMAND FOR HELIUM

Helium has several unique properties with numerous applications that make it an essential and irreplaceable element for many industries. This is because it cannot be synthesised, manufactured or substituted in many cases. Helium is listed on the critical materials lists for Canada, the EU, China and other major economies. Helium is a vital resource, essential in modern technologies with major critical uses throughout the science, medicine and manufacturing industries. It is an inert gas for cryogenic, heat transfer, shielding, leak detection, analytical and lifting applications. It is the most important element in studying super-cold conditions in low-temperature physics studies. It is a critical component in the manufacturing process, specifically ones which serve unique high-tech applications in MRIs, fibre optics and semiconductor chip manufacturing. More recent uses include hybrid air vehicles, helium filled hard drives and nuclear fusion technology.

Helium is a non-renewable natural resource that is predominantly recovered as a by-product of natural gas production. Globally, helium occurs in economically recoverable concentrations at a limited number of locations, many of which are experiencing progressive depletion. Recent studies of the Virginia gas fields in the Free State Province indicate an unusually high helium concentration, suggesting a geologically distinctive resource when compared to most conventional gas fields. This characteristic presents a notable departure from prevailing global practice, as the proposed D3 Energy development has the potential to prioritise helium as the primary

product, with methane recovered as a secondary by-product. This approach contrasts with the conventional model, where helium recovery is contingent on sustained natural gas production. As international pressures to reduce fossil gas production increase, global helium supply is expected to decline accordingly. In contrast, the Virginia gas fields represent a scenario in which helium recovery is not dependent on large-scale gas production, positioning the resource as a potentially strategic source of helium. The economic need and desirability of the proposed development are underpinned by the current and projected demand for helium, which is widely recognised as strong and enduring due to its critical applications and limited substitutes. Available market indicators suggest that demand for helium is expected to remain robust over the medium to long term, thereby supporting the economic justification and desirability of the proposed production project.

The demand for a product or service is defined as a consumer's desire to purchase goods and services and willingness to pay a price for such goods or services. The processing of helium is a high priority and the demand for this gas is important for the assessment of this expansion. A detailed discussion on what Helium is as well as its many uses is included in **Table 14**. A summary of the commercial uses of Helium is shown in **Figure 18**.

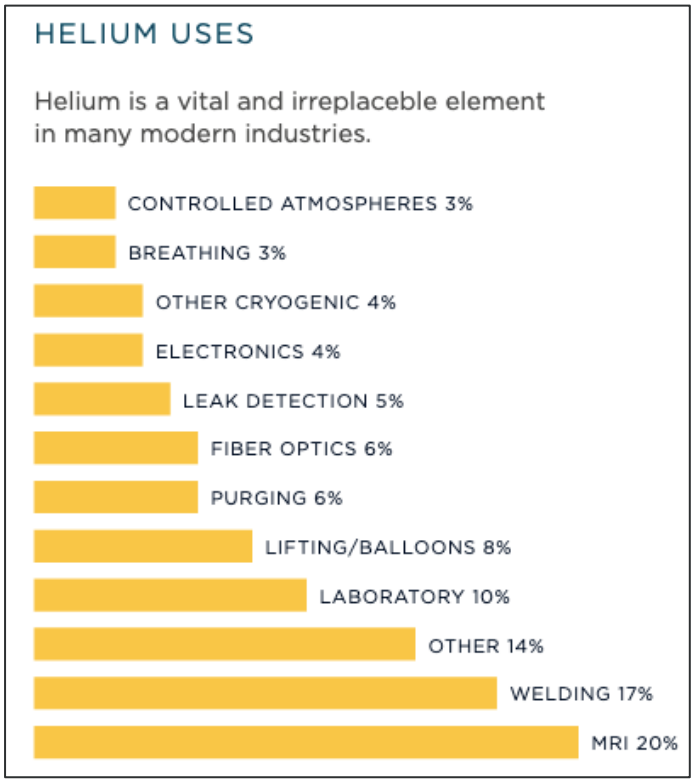


Figure 18: Uses of Helium (Fahrenkamp, 2016).

In the gas fields of Virginia in the Free State, the source of helium for this study is 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 this case, as said, this status quo is reversed, meaning that the Virginia Gas fields may well become a significant strategic helium resource in the world.

When looking at the future uses of helium, there is overwhelming evidence that this element with its rare properties will continue to be in demand. Research is showing that helium is increasingly used in the health industry, and as a coolant in the military and rocket industries. In addition, helium is targeted as a coolant in the potential new nuclear energy generators using fusion, as opposed to fission. In addition, increasing consumption of helium in the electronics and semiconductor industry is expected.

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 expansion.

The global supply and demand for Helium is shown in **Figure 19** was sourced from the Edison Research Group. It shows a possible slight oversupply of helium in next few years, but thereafter demand is likely to outstrip supply (all things being equal). A few independent forecasts for the global growth in demand for helium are mentioned below:

- Energy Industry Review, an energy magazine in Europe, predicts a 4 % CAGR between 2019 and 2027.
- Mordor Intelligence, an independent research company, also predicted growth at 4 % CAGR between 2021 and 2026.
- Global Newswire, an independent market analyst reporting on listed investments, predicts the growth to be 4.5 % to 2030.
- Various other sources put the growth rate of helium much higher than the three sources above - at between 5-11 % CAGR based on the continued increase in scientific and technological innovation.

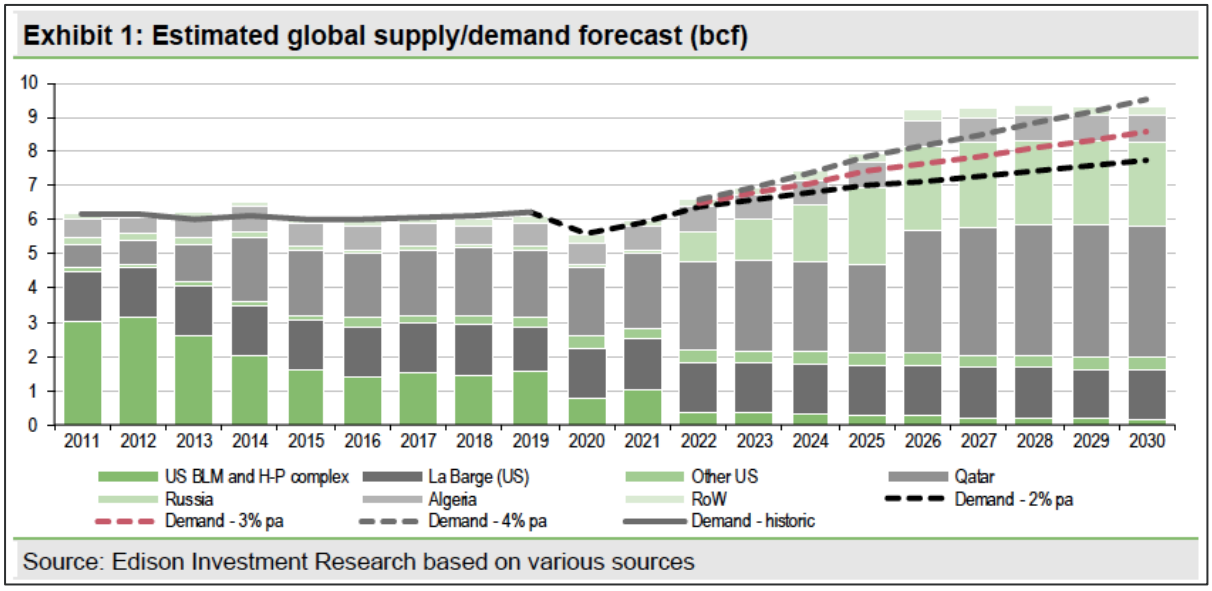


Figure 19: Global demand and supply of Helium in Billion Cubic Feet (Edison Investment Research, 2021).

5.3 DEMAND FOR NATURAL GAS

In this and the section below, the need for natural gas is discussed. Note that natural gas is largely composed of methane, and the gas fields under discussion yields methane as its primary gas. Thus, in discussing natural gas, a discussion of methane is implicit.

The need for natural gas is stated in the list of items below (not an exhaustive list):

- The electric power sector uses natural gas to generate electricity. For example, natural gas accounted for 40% of U.S. electricity generation in 2020, as opposed to 3% in SA.
- The industrial sector uses natural gas as a fuel for heating, as a feedstock to produce chemicals, fertilizer and hydrogen, and many other applications.
- The residential sector uses natural gas for heating, cooking and other applications.

- The commercial sector needs natural gas to heat buildings and water, to operate refrigeration and cooling equipment, to cook, to dry clothes, and to provide outdoor lighting. Some consumers in the commercial sector also use natural gas as a fuel in combined heat and power systems.
- The transportation sector uses natural gas as a fuel to operate compressors that move natural gas through pipelines and as a vehicle fuel in the form of compressed natural gas and liquefied natural gas.

At present gas still plays a significant role in the production of energy in the world. Gas makes up 25% of the world's electricity production and in addition, the growth in the demand for gas appears to be stable.

In South Africa, natural gas plays a relatively small part in contributing to electricity generation. Gas is not regarded as a cleaner energy than "green energy" sources, for example solar, water and wind, but is undoubtedly "cleaner" than coal. As a "bridging" source of energy, there is sufficient cause to rate gas as economically needed and desirable. Gas processing in SA could therefore be favoured in the short and medium term, however, it is very likely that at some future point, targets will be set to reduce gas production (although not Helium) in the same manner as targets are being set to reduce coal production today. The Integrated Resource Plan 2019 (IRP 2019) recognises natural gas as an important component of South Africa's future energy transition and electricity supply strategy. The plan provides for the development of approximately 3,000 MW of new gas-fired generation capacity by 2030 to support system flexibility, energy security and the integration of variable renewable energy technologies. The IRP further identifies gas-to-power as a strategic technology capable of complementing renewable energy generation while contributing to a diversified national energy mix.

Whereas a framework for future power generation in South Africa is set out in the Nationally Determined Contribution, energy policies for South Africa are provided in the Integrated Resource Plan (IRP) as developed by then DMRE), now DMPR These energy policies are based on the demand in electricity and what energy generation types should be procured to meet that demand, along with the generation capacity, timing, and cost. The IRP (2025) acts as the government's roadmap for expanding capacity in the electricity sector, setting targets for all technologies, including renewable energy. The 2025 update of the IRP (IRP-2025) projects more than 105 000MW of new generation capacity by 2039 and of this, 6 000MW of new gas-to-power is projected by 2030 which is identified as "critical for energy security and a stable power system". Out of the total energy mix, the IRP projects 16 000MW from gas, 34 000MW from wind, 25 000MW from solar PV, 5 200MW from nuclear, 8 500MW of energy storage and 16 000MW of distributed generation. Although the aim is to eventually replace fossil fuels completely, there is a strong case to use natural gas in the interim to replace coal for baseload capacity.

A concern with natural gas is around the leaking methane emissions, occurring mainly during the extraction, processing, and transportation of natural gas. The Climate Change Assessment (**Appendix F4**) estimated total Scope 1 greenhouse gas emissions of approximately 29,221 tCO_2e per annum during the operational phase. Of this total, fugitive methane emissions associated with production wells, gathering systems, processing facilities and venting activities contribute approximately 12,179 tCO_2e per annum, equivalent to approximately 530 tonnes of methane per annum, representing around 42% of total Scope 1 greenhouse gas emissions. No Scope 2 greenhouse gas emissions are anticipated as electrical power will be generated on-site using natural gas-fuelled generation systems. Even though CH_4 emissions are 28 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year timescale (US EPA, 2024a), studies show gas has a lower life cycle GHG impact than coal with a lifetime of roughly a decade (PACE, 2015). According to the UK Department for Environment Food & Rural Affairs (DEFRA), natural gas releases 46% less CO_2-eq lifecycle emissions compared to coal-fired facilities and 49% less than diesel-fired facilities for the same electricity generation rate. The IPCC reports, based on the median value, indicate natural gas to result in less than 51% direct- and 40% lifecycle CO_2-eq emissions compared to CO_2-eq emissions from coal (Schlömer S., 2014).

The GHG emissions from the project was calculated to represent 0.009% of the remaining South African annual budget for 2035. The contribution to the South African annual budget will also progressively increase throughout the life of the project as the country's NDCs decrease.

5.4 A SUSTAINABLE AND COMPETITIVE LOCAL GAS AND HELIUM INDUSTRY IN SOUTH AFRICA

A further factor in favour of the D3 Energy PR application is the potential for the development of a sustainable and competitive gas and helium industry in South Africa. When a country has a comparative advantage economically, that advantage has the potential to create economic wealth that then translates into a better quality of life for that country's citizens. Since the advent of the use of oil and gas worldwide, SA has had a comparative disadvantage as it did not possess those natural resources. That meant SA had to (and still does) import most of its oil and gas, which meant that foreign reserves had to be used to pay for such imports. That in itself not only resulted in a decrease in GDP, but it also caused a reduction in the country's foreign reserves.

It can be argued that even though SA had been blessed with significant mineral resources, the lack of oil and gas had been the country's Achilles heel. The historic increase in the cost of gas and oil and weakening of the SA Rand had brought about a persistent "imported" inflation to the SA economy for many decades, and unless SA creates its own less expensive and clean energy, the country will remain less economically competitive than it could be. Ironically, the commodity that SA has in abundance, coal, is today considered as an undesirable commodity because of its effect on warming the earth. Thus, SA faces ominous comparative disadvantages in the generation of future energy - the lack of natural gas, the small amount of energy that can be produced from green energy in the foreseeable future, and the undesirable nature of coal as an energy source. There is thus a strong case to be made for a much stronger natural gas industry in South Africa.

SA historically did not have a helium producer, and to that extent the advent of the D3 Energy and other Gas Producing companies in the Virginia Gas Fields, this can be considered as the establishment of a helium industry in South Africa. Thus, starting from a zero base for helium, one could therefore argue that the need and desirability of the advent of a helium sector in SA is beyond significantly high.

The natural gas sector in SA entails the supply chain of the piped-gas industry is broadly categorised into three levels, namely upstream, mid-stream and downstream. The upstream level of the piped-gas industry includes gas exploration and production activities. The midstream level comprises transmission and distribution of gas, while the downstream level consists of gas reticulation and trading activities. Sasol Gas is the dominant gas enterprise in South Africa, and it plays a major role in production, transmission and distribution. There are not that many rivals in the South Africa gas sector and therefore the sector may not be as efficient a sector as in countries with robust competition.

South Africa's natural gas market is relatively small and regulated by National Energy Regulator of South Africa (NERSA). The major licensed gas traders currently include:

- Sasol Gas
- Spring Light Gas (SLG)
- Egoli Gas
- Novo Energy
- Virtual Gas Network (VGN)
- Kwande Gas
- Tetra4 (producer and supplier in some segments)
- Several smaller licensed traders and distributors operating regionally.

Based on recent NERSA-regulated market structures, there are roughly 10-20 active licensed natural gas traders, distributors, and suppliers, although the exact number changes as licenses are granted, renewed, or become inactive. The proposed application if approved will add to the very small number of downstream gas suppliers in South Africa.

5.5 ALIGNMENT WITH SOUTH AFRICAN ENERGY POLICY FRAMEWORK

The **White Paper on the Energy Policy of the Republic of South Africa (1998)** remains the overarching policy foundation for the energy sector and promotes the development of indigenous energy resources, security of energy supply, economic growth, and private sector participation in energy development. The policy supports the development of South Africa's natural gas resources and recognises the role of private investment and technical expertise in the exploration, production and commercial utilisation of these resources. These principles continue to underpin current energy policy and planning frameworks. The development of domestic gas resources such as the proposed D3 Energy PR is therefore consistent with government's long-standing objective of enhancing energy security, attracting investment, stimulating economic growth and reducing dependence on imported energy sources.

More recently, the **Draft Gas Master Plan (GMP) 2024**, published by then Department of Mineral Resources and Energy (DMRE) now the DMPR, reaffirms the strategic importance of natural gas in South Africa's energy future. The GMP identifies natural gas as an important transition fuel that can support economic development, industrial growth, power generation and energy security while facilitating the country's transition towards a lower-carbon energy system. The plan seeks to ensure security of gas supply through diversification of supply sources, including indigenous gas production, regional pipeline imports and LNG imports. The GMP explicitly recognises the need to develop domestic gas resources and associated infrastructure to address anticipated supply shortages and support long-term energy needs.

The **National Development Plan (NDP) 2030** continues to provide the overarching framework for development in South Africa, with the objectives of reducing poverty, addressing inequality, promoting inclusive economic growth and ensuring reliable access to energy. The NDP identifies energy security as a critical enabler of economic development and supports diversification of the country's energy mix. The NDP recognises the important role that natural gas can play in complementing renewable energy technologies, supporting industrial development and reducing dependence on more carbon-intensive fuels. These objectives are reflected in the Draft Gas Master Plan 2024, which seeks to establish a sustainable gas economy through the development of domestic gas resources, expansion of gas infrastructure and diversification of supply sources.

The policy direction contained in the Draft Gas Master Plan 2024 further recognises that gas demand is expected to exceed available domestic supply and that indigenous gas production will be required to support future economic activity and electricity generation requirements. The plan identifies the development of local gas resources as a strategic priority and acknowledges the role of natural gas in providing flexible generation capacity that can support increased penetration of renewable energy technologies while maintaining grid stability and energy security. Furthermore, government policy promotes the development of a diversified energy mix that balances energy security, affordability, economic growth and environmental considerations.

As such, the development of additional domestic gas resources remains an important national priority. The proposed D3 Energy development supports this policy direction by facilitating the production of indigenous gas resources which could contribute to energy security, economic development and industrial growth. The identification and development of commercial gas reserves within the proposed production area would support government objectives of establishing a sustainable domestic gas industry and reducing reliance on imported hydrocarbons. Potential benefits include increased energy supply, enhanced security of supply, investment in energy infrastructure, stimulation of local and regional economies, employment creation, skills development, procurement opportunities, royalties and tax revenues.

Natural gas is widely recognised as a lower-carbon alternative to coal and other carbon-intensive fossil fuels and is expected to play an important role during South Africa's energy transition. However, natural gas remains a fossil fuel and its production, processing and combustion generate greenhouse gas emissions. Consistent with national environmental legislation and South Africa's climate change commitments, the potential climate and environmental impacts associated with the proposed production activities are thoroughly assessed and appropriately managed through this EIA process and associated mitigation measures.

In summary, successful development of the proposed D3 Energy PR project would be aligned with current national energy policy objectives, including the promotion of indigenous gas resources, enhancement of energy

security, diversification of the energy mix, support for economic development and facilitation of a just and orderly energy transition. Production success could provide long-term benefits through access to domestic energy resources, reduced dependence on imported hydrocarbons, increased investment and regional economic development. It is recognised that South Africa is pursuing a diversified energy future incorporating significant renewable energy deployment together with flexible generation technologies and lower-carbon fuel sources, including natural gas, to support security of supply and sustainable economic growth**. It should be noted that SA is pursuing a diverse energy mix which include significant renewable power generation**. Pursuing natural gas as an energy source does not preclude the continued development of renewable energy. The two are not mutually exclusive and need not be viewed as being in direct competition; rather, they can form part of a diversified energy mix, with natural gas potentially supporting system reliability while renewable capacity continues to expand.

Table 14 below are some features about both helium and LNG, potential project benefits, as well as a brief of the need and desirability of these gases.

Table 14: Helium and LNG properties and uses.

Helium Properties and Uses	LNG Properties and Uses
Helium is one of the most common elements in the universe. It is called a noble gas because it doesn't chemically interact with other elements. Its atomic number is 2 and the weight is 4.002. In its natural state, it doesn't have any smell, taste or colour.	LNG is clear, colourless, and odourless. LNG is non-corrosive and non-toxic. The potential hazards of LNG are the result of its basic properties including its cryogenic nature and dispersion and flammability characteristics.
Occurrence and Discovery	Occurrence and Discovery
Helium can be found all over the universe, although it isn't widely distributed on Earth. Its most frequent form is gas. It shares many characteristics with other noble gases. Helium doesn't form compounds easily with other elements. It is also very stable and has many important uses. Its symbol in the periodic table is "He". Its stability and non-reactive nature make it the perfect tool for handling unstable materials. The element was discovered in 1868 during a solar eclipse. It took scientists 30 years to extract and isolate the gas from the uranium ore clevite.	Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane, but commonly including varying amounts of other higher alkanes, and sometimes a small percentage of carbon dioxide, nitrogen, hydrogen sulphide, or helium. It is formed when layers of decomposing plant and animal matter are exposed to intense heat and pressure supplied by existing under the surface of the Earth over millions of years. The energy that the plants originally obtained from the sun is stored in the form of chemical bonds in the gas.
The gas is not prevalent on Earth. It is usually extracted from natural gas and the typical amount found in natural gas deposits ranges from 0.3 to 7%. It didn't take long for governments to realize its usefulness in military operations. Access to it was restricted during the two World Wars. In its purest form, the element doesn't pose any health risks.	Natural gas is found in deep underground rock formations or associated with other hydrocarbon reservoirs in coal beds and as methane clathrates. Petroleum is another resource and fossil fuel found in close proximity to and with natural gas. Most natural gas was created over time by two mechanisms: biogenic and thermogenic. Biogenic gas is created by methanogenic organisms in marshes, bogs, landfills, and shallow sediments. Deeper in the earth, at greater temperature and pressure, thermogenic gas is created from buried organic material.

Helium Properties and Uses	LNG Properties and Uses
Inhaling excessive amounts has its risks. The danger is the gas functions as an asphyxiate. Inhaling helium from pressure tanks can damage the lungs. The variants found in weather balloons may have other elements that are unhealthy to breathe.	Most natural gas comes from three types of wells namely natural gas and condensate wells, oil wells, and coal bed methane wells.
Helium Properties	LNG Properties
Its atomic number indicates there are two electrons and two protons in a neutral helium atom. Its most vital properties are density, melting and boiling points, state of matter and atomic mass. The density is 101.325 kilopascals (kPa) and 0.1786 grams per litre at 32°F (0.0°C). Its atomic mass is 4.0026 grams per mole.	Quantities of natural gas are measured in normal cubic meters (corresponding to 0 °C at 101.325 kPa) or in standard cubic feet (corresponding to 16 °C and 14.73 psia). The gross heat of combustion of 1m^3 of commercial quality natural gas is around 39 MJ (10.8 kWh), but this can vary by several percent.
Solid and liquid helium can only manifest in high and low temperature settings. Either condition cannot manifest under normal pressures. -272°C (0.95 Kelvin) is the melting point. The boiling point is -268°C (4.22 Kelvin).	The burning of natural gas produces far lower amounts of sulfur dioxide and nitrous oxides than other fossil fuels.
One of the more interesting uses of helium is in cryogenics. This field is concerned with low temperature phenomena and its production. Most of the helium produced today is used for cryogenics.	Gas is an important transitionary fuel as countries around the world look for reliable, affordable, safe and low carbon alternatives to coal and nuclear, and ways of supporting renewable energy sources.
Common uses of Helium	Common uses of LNG
Evidence shows that the human voice can be changed with a bit of helium. The gas is also used as light weight aircraft fuel. The element is usually combined with hydrogen in air balloons. Hydrogen alone is fine, but helium makes the balloon safer to use. The same gas is used by caisson workers too as the divers use oxygen and helium during their dives. The combination provides them with the atmosphere necessary to survive in high pressure environments.	LNG or more specifically CNG is used as a motor fuel instead of petroleum products, since it has a number of advantages, the most important being to provide the industry with cleaner, more environmentally friendly fuel, as well as offering business and consumers a cost-effective alternate energy source. Although vehicles can use natural gas as either a liquid or a gas, most vehicles use the gaseous form compressed to pressures above 200 bar. Tetra4 already has a pilot project whereby busses are powered with gas in the region.
Helium Medical Applications	LNG and Transportation
Helium can also be used for breathing observation. It is essential in treating ailments such as asthma, emphysema and other conditions that affect breathing. The gas is usually used to treat diseases that affect the lungs.	LNG is liquefied natural gas. CNG is compressed natural gas. The key point – and the reason there are two fuels, not one – is that gas has different energy densities in different states. One unit of liquid gas energy takes up 5 times less volume than one unit of compressed gas energy. More fuel can be stored onboard a vehicle using LNG because the fuel is

Helium Properties and Uses	LNG Properties and Uses
Hospital MRI scans reply on liquefied helium. When the element is set at -269°C (the low boiling point), it becomes usable in cooling the MRI magnet.	stored as a liquid, making its energy density greater than that of CNG. This makes LNG well suited for Class 7 and 8 trucks requiring a greater range.
Acute and chronic forms of respiratory ailment treatments have helium components. In almost all cases, oxygen and helium are used together. This combination gets to the lungs much quicker. Helium in different forms and combinations are used in medical instrumentations and nuclear medicine.	Besides use in road vehicles, it is also used in aerial vehicles. Compressed natural gas has been used in some aircraft like the Aviat Aircraft Husky 200 CNG and the Chromarat VX 1 KittyHawk.
Helium in Manufacturing and Cryogenics	LNG in Power Generation
Of the 2014 world helium total production of about 32 million kg (180 million standard cubic meters) helium per year, the largest use (about 32% of the total in 2014) was in cryogenic applications, most of which involves cooling the superconducting magnets in medical MRI scanners and NMR spectrometers (Wikipedia). Helium is used as a shielding gas in arc welding processes on materials that at welding temperatures are contaminated and weakened by air or nitrogen. Helium is used as a protective gas in growing silicon and germanium crystals, in titanium and zirconium production, and in gas chromatography, because it is inert (Wikipedia).	Natural gas is a major source of electricity generation through the use of cogeneration, gas turbines and steam turbines. Natural gas is also well suited for a combined use in association with renewable energy sources such as wind or solar. Particularly high efficiencies can be achieved through combining gas turbines with a steam turbine in combined cycle mode. Natural gas burns more cleanly than other hydrocarbon fuels, such as oil and coal, and produces less carbon dioxide per unit of energy released. For transportation, burning natural gas produces about 30 percent less carbon dioxide than burning petroleum. For an equivalent amount of heat, burning natural gas produces about 45 percent less carbon dioxide than burning coal for power.
Helium in Space Technology	Domestic Uses for LNG
NASA space programs use the gas to fuel their shuttles. Liquid fuels are volatile. They are packed with corrosive material that could destroy a spacecrafts casing. To avoid this problem, a craft is filled with helium gas. The same process is used in blimps and air balloons. It is preferred to hydrogen as it is not flammable. The element is also used to keep nuclear reactors cool.	Natural gas dispensed in a residential setting can generate temperatures in excess of 1100 °C making it a powerful domestic cooking and heating fuel. In much of the developed world it is supplied through pipes to homes, where it is used for many purposes including ranges and ovens, gas heated clothes dryers, heating / cooling, and central heating. Heaters in homes and other buildings may include boilers, furnaces, and water heaters.
Other Helium Applications	Other LNG Applications
Helium neon lasers use the element extensively. These instruments are used for barcode reading. The same element is needed to monitor small fractures in ships and other vehicles.	Natural gas is a major feedstock for the production of ammonia, via the Haber process, for use in fertilizer production.
Helium dating is relied on to date rocks that contain uranium and titanium.	Natural gas is also used in the manufacture of fabrics, glass, steel, plastics, paint, and other products.

Helium Properties and Uses	LNG Properties and Uses
The gas is used for protection during germanium crystal and silicon production. It is valued as a protective gas because of its inert nature.	
Helium's properties also make it ideal for observation in quantum mechanics. Its structure is basic and easy to study. Numerous mathematical processes are used to assess subatomic particle behaviour. Using these techniques, neutrons, electrons and protons can be studied. However, these tests cannot determine their actions 100% accurately. This is due to the nature of quantum mechanics.	Natural gas can be used to produce hydrogen, with one common method being the hydrogen reformer. Hydrogen has many applications: it is a primary feedstock for the chemical industry, a hydrogenating agent, an important commodity for oil refineries, and the fuel source in hydrogen vehicles.

5.6 ARGUMENTS FOR NEUTRALS AND/OR AGAINST THE PROJECT

Stakeholders who are neutral towards or opposed to the proposed D3 Energy PR may acknowledge the potential economic and energy security benefits associated with domestic gas development, while raising concerns regarding its environmental, social and long-term sustainability implications. Such stakeholders may question whether further investment in fossil fuel development is consistent with South Africa's climate change commitments and transition towards a low-carbon economy. Concerns may also relate to potential impacts on biodiversity, water resources, land use, local communities and cumulative greenhouse gas emissions associated with gas production activities.

Neutral stakeholders may support the project subject to the implementation of appropriate mitigation measures, environmental safeguards and ongoing monitoring, while opponents may contend that investment should instead be directed towards renewable energy technologies and other lower-carbon energy alternatives. These differing perspectives are considered below and form an important part of a balanced assessment of the proposed project's potential costs, benefits and overall contribution to sustainable development. Below is discussion around neutrals and/or opposition towards the proposed project and how this is catered for in this EIAr.

There is broad scientific consensus that GHG emissions are a primary driver of global climate change. South Africa has committed, through its Nationally Determined Contributions (NDCs) under the Paris Agreement and subsequent international climate commitments, to progressively reduce its GHG emissions and transition towards a lower-carbon economy. This transition includes reducing reliance on coal-fired power generation and increasing the contribution of renewable energy and other lower-carbon energy sources within the national energy mix.

Within this context, natural gas is regarded by policymakers and energy planners as a transitional or "bridging" fuel that may assist South Africa in achieving energy security while reducing emissions relative to coal. The combustion of natural gas generally produces substantially less carbon dioxide (CO_2) than coal-fired electricity generation, and gas-fired power stations also offer operational flexibility that can support increased integration of renewable energy technologies such as wind and solar power. Consequently, natural gas is considered by many stakeholders to be a potentially important component of South Africa's energy transition in the short to medium term.

However, stakeholders who are neutral towards or opposed to the development of the natural gas facilities in South Africa have raised several concerns regarding the long-term sustainability and climate implications of expanded gas production. Two key concerns are commonly identified:

1. Natural gas remains a fossil fuel. Although natural gas produces lower carbon emissions than coal when combusted, it nevertheless emits carbon dioxide and therefore contributes to climate change. Critics

argue that the continued development of fossil fuel resources may be inconsistent with national and global ambitions to achieve deep decarbonisation and net-zero emissions over the longer term.

2. Potential methane emissions. Natural gas is composed predominantly of methane, a greenhouse gas with a significantly higher warming potential than carbon dioxide over shorter time horizons. Opponents of new gas developments point to the potential for fugitive methane emissions during production, processing, transportation and distribution. They argue that uncontrolled methane losses may reduce some of the climate benefits associated with replacing coal with natural gas.

Some environmental stakeholders therefore advocate that South Africa should accelerate investments directly into renewable energy technologies, including solar, wind, battery storage and other low-carbon alternatives, rather than investing in new fossil fuel developments. From this perspective, concerns are raised that significant investment in gas infrastructure could create long-lived assets that may become economically or environmentally undesirable as climate policies tighten and renewable energy technologies continue to mature and decrease in cost.

These concerns are relevant to the proposed D3 Energy PR Project and have been considered within the broader context of South Africa's evolving energy landscape. Nevertheless, it is also recognised that South Africa continues to face significant electricity supply constraints, energy security challenges and a projected decline in existing domestic and imported gas supplies. The proposed project seeks to develop indigenous gas resources that could contribute to security of supply, reduce dependence on imported hydrocarbons and support economic development during the transition to a lower-carbon economy.

The PCC has acknowledged that natural gas may have a role to play during the country's energy transition but has emphasised that such a role should be limited and supportive rather than dominant. The PCC advocates an energy future centred on renewable energy technologies, supported by storage solutions and limited flexible gas-fired generation to provide system reliability and meet peak demand requirements. In this regard, gas is generally viewed as a complementary fuel that can facilitate renewable energy integration rather than a long-term substitute for renewable energy.

Accordingly, stakeholders who are neutral towards or opposed to the proposed D3 Energy PR Project may argue that any benefits associated with domestic gas production must be carefully weighed against South Africa's long-term decarbonisation objectives and climate commitments. They may also contend that gas development should not delay or displace investment in renewable energy technologies and associated infrastructure. In response to these concerns, it is important to note that the proposed D3 Energy PR Project is not intended to replace the development of renewable energy, nor is it proposed as a permanent long-term solution to South Africa's energy needs. Rather, the project may contribute to the diversification of the country's energy mix during a transitional period, while supporting energy security, economic development and reduced reliance on more carbon-intensive fuels such as coal. Any potential greenhouse gas emissions, including fugitive methane emissions, have been assessed through the EIA process and managed through the implementation of appropriate mitigation, monitoring and regulatory compliance measures, refer to **Section 9**, **Appendix F1**, **Appendix F4** and **Appendix H**.

5.7 NEEDS AND DESIRABILITY ANALYSIS

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.). **Table 15** present the needs and desirability analysis undertaken for the project.

Table 15: Needs and desirability analysis for the proposed production 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.	A number of specialist studies have informed this application and environmental impact assessment and include: • 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; • Geohydrological Assessment; • Hydrological Assessment; • Social Assessment; and • Noise Assessment. These studies assisted in identifying any Threatened Ecosystems, Sensitive and vulnerable ecosystems, Critical Biodiversity Areas, Ecological Support Systems, Conservation Targets and Ecological drivers of the ecosystem. Where sensitive species or ecosystem drivers were identified, relevant mitigation measures were put forward to prevent or minimise the impacts.
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 PR boundary is approximately 14 440ha, however, the permanent surface infrastructure is significantly reduced due to the proposed pipelines being underground. Where infrastructure is to be constructed or installed in natural areas, various measures are put forward to mitigate the impacts on biological diversity. The mitigation measures have been developed in consultation with the relevant specialists as mentioned above. Existing and future alien and invasive species will be controlled which will enhance the opportunities for indigenous and beneficial species in the environment.
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?	
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 project 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

Ref No.	Question	Answer
		adequately stored prior to disposal at a suitably licensed hazardous waste disposal facility. Safe disposal certificates will be obtained from the disposal facility used.
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 and palaeontological impact assessment was conducted as part of the EIA to determine areas of archaeological and/or cultural heritage and associated mitigation measures. The identified sites including suitable buffers have been identified as highly sensitive / no-go areas to prevent adverse impacts in these areas. In addition to the above, a chance find procedure has been put forward by the specialist should any unidentified sites of cultural heritage or palaeontological significance be identified during the construction process.
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?	It is acknowledged that due to the nature of gas resources, an onshore (potentially non-renewable) gas resource will be depleted should the project be authorised. Although gas production will however contribute significantly to the country's economy as well as the transition from dirtier energy production (coal) to renewable energy production in the future. Locally produced gas will also result in a reduced need for these resources to be imported. Therefore, at present, this gas resource is still needed within South Africa. It must be noted that there are a number of renewable energy projects under application and approved from various applicants located within PR area. D3 Energy and the renewable energy applicants will need to discuss the way forward and/or make necessary arrangements to coexist especially within the PR area where there may be infrastructure overlap. Coexisting arrangements can be successfully arranged for the D3 Energy PR footprint, particularly since a majority of the planned infrastructure will be underground. It is therefore, anticipated that this will result in little to no impact on the planned aboveground solar projects.
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 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?	
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 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".
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?	The harvesting of this gas resource (during production) would constitute a better use thereof as it is currently not being harvested in this area (other than by Tetra4) 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). Due to growing global geopolitical uncertainty and increasingly constrained transit of international goods, South Africa would be well positioned to increase local production of gas as opposed to

Ref No.	Question	Answer
		relying on importation thereof. Furthermore, the small spatial extent of the activities allows for the concurrent use of the land for other purposes such as farming etc.
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 project promotes a reduced dependency on the importation of gas resources from other countries as at this stage, a large volume of gas used in the country is imported. 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 13.**
1.8.2	What is the level of risk associated with the limits of current knowledge?	No limits to current knowledge for any potential significant impacts have been identified. The level of risk is therefore deemed to be 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 preferred drilling locations and associated infrastructure such as pipelines cannot be identified at this stage due to the nature of activities (i.e. updated geological model based on initial drilling to inform subsequent drilling), a strategic assessment of transects (100m corridor) and gas infrastructure (1km corridor) and has been undertaken as part of this EIA process in order to identify areas of high sensitivity and no-go areas. The sensitivity planning approach will guide the preferred placement of wells and other infrastructure and will additionally be guided by specific landowner consultations and negotiations. 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 project footprint occur predominantly on properties that are of commercial agricultural concerns. The final infrastructure placement and seismic transects 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 project corridors which allows input from numerous specialist disciplines to identify highly sensitive or no-go areas which can then be excluded from project where necessary. The positive impact of job creation has been identified by the social specialist and
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?	

Ref No.	Question	Answer
		the requirement for local upliftment in the form of employment creation or social programmes put forward.
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.)?	A low 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 will be identified and avoided where possible prior to the final placement of infrastructure.
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 impact on the ecological integrity objectives or targets as consideration of these aspects will be undertaken prior to final placement of infrastructure.
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 6** 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 9** of this report for the identified 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	Details of the IDP's for the Lejweleputswa District Municipality (LDM), as well as the Matjhabeng and Masilonyana Local Municipalities are included in **Section 8.4.2.2.** 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, through the output production of gas.
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.),	
2.1.3	Spatial characteristics (e.g., existing land uses, planned land uses, cultural landscapes, etc.), and	

Ref No.	Question	Answer
2.1.4	Municipal Economic Development Strategy ("LED Strategy").	
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 9** 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, Hennenman, Ventersburg and Theunissen. The project will indirectly assist with increasing the gas production in the area which will ensure that the community projects proposed by D3 Energy under their Social and Labour Plan will be realised. This will complement the local socio-economic initiatives identified for the area.
2.3	How will this development address the specific physical, psychological, developmental, cultural and social needs and interests of the relevant communities?	At this stage of the application process, there has not been specific feedback from the relevant communities on how this project will impact on their physical, psychological, developmental, cultural and/or social needs. While the baseline receiving environment is presented in **Section 8**. Concerns raised by I&APs have been captured, addressed and considered in this report.
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.
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 Virginia, Venterburg and Theunissen (to a limited extent) both locally and regionally. This project is not anticipated to have a material impact on the need for transport of people and goods or impact on access to public transport.
2.5.2	Reduce the need for transport of people and goods.	
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),	
2.5.4	Compliment other uses in the area,	The proposed project is adjacent to the existing Tetra4 production right and will thus compliment the current land us. The nature of the project will also make it possible to coexist with other uses (agriculture) in the area.

Ref No.	Question	Answer
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 project is located within an existing exploration right area where a number of gas exploration wells have been drilled. The 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 will have a minimal impact on the current land uses in the application area as pipeline network is subterranean while the production wells are insignificantly small in area (less than 20m^2 each). This will allow for existing land uses to concurrently with the production activities.
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.),	The proposed D3 Energy production project falls within the approved ER315 area.
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 in 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 agriculture, solar development and gas production 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 is included in this assessment which has identified numerous existing cultural and heritage sites which allows for their protection from negative impacts.

Ref No.	Question	Answer
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 project will have limited temporary and permanent 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 13** 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 limited information relating to the final site-specific location of drill sites and pipeline placement will likely be raised by the solar developments and other mineral right holders in the proposed PR. D3 Energy will continue to engage mineral right holders and the renewable energy developers to provide as much additional information as possible and consultations with landowners and other key I&APs will be held during this EIA phase.
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 9** 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?	

Ref No.	Question	Answer
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, 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 9** 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 9** of this report. The EIA and EMPr also specifies specify 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 7** 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 7** of this report, describing the public participation process undertaken for the proposed project. Advertisement, notification letters and site notices have been made available in English, Afrikaans and Sesotho to assist in understanding of the project. Further public consultation will be held during the review period of this EIAr. Furthermore, public meetings were undertaken during the Scoping phase and will also be undertaken during the current EIA phase.
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,	

Ref No.	Question	Answer
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?	
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. Their right to refuse work (if considered dangerous) must and will be included in the education programme.
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, Venterburg and Theunissen. Details in terms of job figures and employment opportunities will be made available for the EIA-phase report. It is anticipated that workers travelling from the local areas will have to commute approximately 10-30 km to the PR area project.
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.	

Ref No.	Question	Answer
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 impacted 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.
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 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 9** of this report. Addition and detailed mitigation measures have been put forward by the relevant specialists for inclusion in the EMPr (**Appendix H**).
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 and attached as **Appendix F5**.
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 6**, 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 9**.

6 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

For any alternative to be considered feasible, such an alternative must meet the need and purpose of the project proposal without presenting significantly high associated impacts. **Section 5** provides an overview of the project need and desirability.

In this section the various alternatives considered are described and their advantages and disadvantages are presented where applicable. Furthermore, the feasibility of the considered alternatives, from both a technical as well as environmental perspective, is determined and the result thereof are the alternatives that will be investigated further in the EIA phase, towards the selection of preferred alternatives. Essentially, alternatives represent different means of meeting the general purpose and need of the proposed project through the identification of the most appropriate and feasible method of development, all of which are discussed below.

Alternatives can further be distinguished into discrete or incremental alternatives. Discrete alternatives are overall project options, which are typically identified during the pre-feasibility, feasibility and or scoping phases of the EIA process. Incremental alternatives typically arise during the EIA process and are usually suggested as a means of addressing identified impacts. These alternatives are closely linked to the identification of mitigation and management measures and are not specifically identified as distinct alternatives. This section provides information on the Project's location, process, technology and activity alternatives considered and assessed.

6.1 ACTIVITY ALTERNATIVES

Activity alternatives 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 PR project.

The current land uses within the study area and surroundings comprise predominantly of mining and agriculture. The Tetra4 production development is also located adjacent to the proposed D3 Energy PR project. The development of renewable energy facilities for power generation is often seen as a better option than gas production. However, there are numerous renewable energy facilities already in the region and nationally that aim to meet the demand for renewable power. Furthermore, D3 Energy is a natural gas and helium company and doesn't engage in other project activities. Gas utilisation is also specifically included in the IRP2025 as a flexible, dispatchable resource to stabilise the system during a rapid transition away from coal.

Gas production operations, as a land use, is often viewed as directly competing and eventually replacing existing land uses. However, a mixed land use approach consisting of gas production and agriculture as has been demonstrated within the Tetra 4 Cluster 1 project is feasible and achievable. Similarly, current agricultural activities and proposed solar development activities within the proposed study area should be able to coexist within the vicinity of the gas production activities, particularly because the proposed pipeline network is below ground at a depth (750 – 1000mm) that allows for continued agricultural practises. The surface infrastructure of the gas production network is extremely small compared to the overall application area (even on an individual property).

On the other hand, mixed land use consisting of conservation and gas production is unlikely to coexist due to certain land use restrictions within national parks/ nature reserves and buffer areas as per the National Environmental Management: Protected Areas Act (2003) (NEMPPA). However, there are currently no conservation areas (e.g. IBAs, nature reserves, etc.) within the proposed D3 Energy PR, as well as no known plans for the proclamation and/or expansion of any IBAs or nature reserves within or adjacent to the study area. Therefore, the coexistence of the proposed gas production activity in conjunction with current agricultural and mining land uses as well as the renewable development land use is considered feasible. In addition, based on project information, D3 Energy only proposes to undertake production activities for hydrocarbons. Therefore, this alternative is not considered feasible and will not be discussed further.

6.2 LOCATION / PROPERTY AND ROUTE ALTERNATIVES

Location alternatives can apply to the entire D3 Energy PR (e.g. the strategic decision to locate the proposed project in the Free State within the Lejweleputswa District where there is an existing Exploration Right 315 held by D3 Energy), as well as the specific individual components of the proposed developments (e.g. the location of

production wells, pipelines, the helium recovery and gas processing plant including any associated infrastructure within the study area).

While location alternatives can be considered from a macro- or microscale, from a macro location perspective the production is driven by the presence of the target resource and therefore this activity cannot be undertaken in other areas due to the absence of the target resource. No macro or regional location alternatives are therefore deemed feasible.

6.2.1 ACTIVITIES WITHIN PRELIMINARY IDENTIFIED PRODUCTION CORRIDORS

Undertaking the activities within preliminary identified construction corridors would entail a process where the proposed production activities are restricted to within 500m of development corridors and within 25m of the preliminary seismic transects. This would entail undertaking the 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.

6.2.1.1 PRODUCTION WELLS

The proposed activities involve the exploration of up to 48 wells and up to 43 new production wells located along pre-identified 500 m wide corridors within the application area as shown in **Figure 3**. These corridors have been delineated based on underlying geological features (known fractures/fault lines) which are the most suitable location to intercept gas reserves.

Although the final positions of the proposed wells are subject to change during the development campaign as new data becomes available, the final well locations will still remain within the 500 m development corridors as assessed in this application process and will be guided by the sensitivities identified from the specialist assessments to position the well sites in such a manner to avoid sensitivities as far as possible. The sensitivity mapping undertaken during this scoping phase has been updated based on public input as well as final specialist sensitivity mapping (refer to **Section 10**). Based on the sensitivity mapping, areas of high sensitivity as indicated in **Section 10 (Figure 155**) must ideally be avoided, if avoidance is not possible, then impact must be minimized through reduction of activities within the high-sensitive areas. The measures to address landowners' concerns are listed below.

1. Production drilling sites will be negotiated and agreed with the affected landowners and/or approved renewable energy developments prior to final siting and appropriate compensation will be agreed upon contractually where applicable.
2. If the geology allows, then the footprint of more than one drill well can be contained in the same drill site. However, should the same site be used, it cannot be done in parallel but rather in sequence i.e. one well drilled and completed then followed by another thereby extending the time on the property with appropriate compensation adjustments where relevant.

Several specific measures to address safety and security risks have been put forward as recommendations for inclusion in the decision and in order to prevent significant duplication in this report, refer to **Section 12.4**.

6.2.1.2 HELIUM RECOVERY FACILITY AND GAS PROCESSING PLANT

One helium recovery and gas processing plant with the optionality of producing either gaseous or liquified helium and methane will be required. Three options (Options A, B and C) for the plant are currently proposed. The location of the 3 existing wells along the Virginia fault line which will form part of the initial phase of the project were also taken into consideration when deciding on the location of the plant. Based on the sensitivity map in **Section 10 (Figure 155**), Option A and C are recommended while Option B is the least recommended as this option falls within 32m of a wetland and within 1:100-year floodline. In addition, as per the Geohydrological Impact Assessment (**Appendix F7**), processing plant Option B suggest the most potential impact on the riparian zone aquifer with processing plant Option C indicating the least potential impact (**Section 9.3.8.2.6**). **Therefore, Gas Plant Option C is the most recommended, followed by Gas Plant Option A.**

6.2.2 ACTIVITIES WITHIN PRELIMINARY IDENTIFIED CORRIDORS 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 corridors but excluding the directly affected renewable energy developments[8]. It would entail a process where the production activities are restricted to within the 500m corridors and/or within 25m of the preliminary seismic transects but excluding land directly earmarked for renewable energy development infrastructure where the production activities and the planned renewable energy development overlap. This would entail undertaking the production activities within areas assessed in detail, with known sensitivities to be avoided and avoidance of renewable energy developments. This process would reduce the production areas and restrict access to identified resource targets but would allow the renewable energy developments to proceed without any interference.

For this alternative those wells which overlap with the renewable energy facilities footprints are relocated to other areas within the defined production right boundary (**Figure 5** and **Figure 6**). This will allow for the exclusion of those wells that intersect or may interfere with the solar developments in the area.

These location alternatives for development footprint shall be referred to as:

- Production activities within preliminary identified production corridors – L1; and
- Excluding directly affected renewable energy projects – L2.

6.2.3 ADVANTAGES AND DISADVANTAGES OF LOCATION ALTERNATIVES

Preliminary advantages and disadvantages of location alternatives are indicated in **Table 16**.

Table 16: Advantages and disadvantages of undertaking activities within different location alternatives.

ADVANTAGE	DISADVANTAGE
Undertaking the activities within preliminary identified production corridors (L1)	
Activities will be on known site-specific areas whose environmental sensitivities are known and with mitigation controls in place.	Final drilling site/s may fall outside of the assessed area which would limit effective drainage and production 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 (i.e. outside assessed areas).
Restricting activities and subsequent disturbance / impacts to specific locations within the PR.	
Can be undertaken taken with the renewable energy developments through co-existence arrangements.	There may be reduced footprint and/or rescheduling of the gas production development on the affected areas to allow for renewable energy developments which may affect capacity / timing of gas production.
Undertaking activities within preliminary identified production corridors excluding directly affected renewable energy projects (L2)	
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 drainage and production 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

[8] Approved renewable energy projects within the PR.

ADVANTAGE	DISADVANTAGE
Restricting activities and subsequent disturbance / impacts to specific locations within the PR.	Reduced activities on areas already assessed which may negatively affect the outcome of the 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 gas information.
Undertaking the activities outside preliminary production corridors (L3)	
Final drilling site/s may fall outside of the assessed area based on the outcome of the seismic surveys. Strict 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 assessments and specify additional controls.	Activities will be located on areas with little knowledge of specific environmental sensitivities.
	Minimal site-specific controls would be in place for the activities in these areas.
	This would open up the entire exploration footprint for 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 16** above, **it is recommended that the proposed activities ideally be undertaken within the preliminary identified production corridors through co-existence agreements (L1)**, should that not be successful, then the second preferred alternative (L2) would be undertaking activities within preliminary identified production corridors excluding directly affected renewable energy projects. The undertaking of the production activities outside preliminary identified corridors is the least preferred alternative. However, the nature of the 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 (e.g. residence, wetlands and watercourse, etc.) and/or buffers where required provided that the relevant processes to be outlined in **Section 10** and 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 pre-identified corridors (L1 and L2) and outside the corridors (L3) be considered for approval provided that relevant impact management measures are in place.

6.3 ROUTE ALTERNATIVES

Consideration of alternative routes generally applies to linear developments such as power lines, transport, and pipeline routes. Although the proposed D3 Energy PR 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

As indicated in **Figure 5** and **Figure 6**, there are two pipeline route alignments which differ on the basis of the pipeline routes. The proposed and alternative gathering line layouts indicate that the primary route selection consideration from a renewable energy perspective is the degree to which the proposed gas infrastructure may constrain, sterilise, fragment or complicate the future development of existing and planned solar photovoltaic (PV) facilities within the D3 Energy PR. The assessment considered the location of approved and proposed renewable energy developments, including the Quagga Solar Park, Corona Solar Park, the Red Rocket Virginia

Solar Projects (Virginia 1-4) and broader Solar PV EIA application areas, relative to the proposed gathering line alignments and associated 500 m buffer corridors.

6.3.1 PROPOSED PIPELINE ALIGNMENT

The proposed alignment generally follows a central north-south alignment through the PR, connecting the northern and southern well clusters to the proposed gas plant site west of the Corona Solar Park. While the alignment traverses areas that overlap with broader Solar PV application areas, it largely avoids direct encroachment into the core footprints of the approved Quagga and Corona Solar Parks. The proposed alignment runs adjacent to and partially through portions of the Virginia solar development areas and Solar PV application zones. The route particularly passes:

- Between Virginia 1 and Virginia 2 solar development areas;
- Along the western edge of the Virginia 3 assessment area;
- Near Virginia 4;
- Through sections of broader Solar PV application areas.

The route has the potential to create:

- Minor constraints on future solar panel placement immediately adjacent to the gathering corridor;
- Engineering and safety setbacks between gas infrastructure and future electrical infrastructure;
- Additional coordination requirements between developers of the gas and solar projects.

However, the alignment remains relatively concentrated within a single corridor and minimises fragmentation of the renewable energy development footprint. Most of the Virginia solar development areas remain intact and retain flexibility for project design optimisation.

6.3.2 ALTERNATIVE PIPELINE ROUTE ALIGNMENT

The alternative layout introduces a more easterly and northerly gathering line configuration. The route traverses a smaller portion of the renewable energy development corridor before connecting to the proposed gas plant location. Compared with the proposed alignment, the alternative route exhibits substantially smaller overlap with renewable energy development areas.

The alignment:

- Passes directly through portions of the Virginia 2 and Virginia 3 development areas;
- Traverses central sections of Solar PV application areas;
- Creates additional linear infrastructure barriers across land potentially earmarked for future solar expansion;
- Increases the extent of overlap between gathering line buffers and renewable energy planning zones.

However, the more extensive east-west alignment may reduce flexibility in future solar layout design, access road placement, cable routing and electrical infrastructure positioning. Although co-existence remains technically feasible, both routes introduce potential for land-use conflict and future development constraints. The alternative alignment may also increase cumulative effects associated with multiple infrastructure corridors within the renewable energy cluster, resulting in greater land fragmentation relative to the proposed route.

From a renewable energy planning perspective, the proposed route is ideal over the alternative route as indicated in **Table 17**. Although both routes traverse an area subject to significant renewable energy development interest, the proposed route is more consolidated, results in less fragmentation of renewable energy development areas, and has a lower likelihood of constraining the future design and expansion of solar energy facilities. The alternative route introduces greater overlap with the Virginia solar development areas and Solar PV application zones, thereby increasing the potential for land-use conflict and the sterilisation of land that may be required for future renewable energy infrastructure. While these impacts are not necessarily fatal flaws

and can likely be mitigated through detailed engineering design and stakeholder engagement with renewable energy developers, the proposed route represents the lower-impact option from a renewable energy compatibility perspective and is therefore considered the environmentally preferred route alternative.

Table 17: Comparative Route Assessment.

Assessment Criterion	Proposed Layout	Alternative Layout
Direct interaction with approved solar parks	Low	Low to Moderate
Interaction with Solar PV EIA application areas	Moderate	Moderate to High
Fragmentation of renewable development land	Low	Moderate
Future solar layout constraints	Low to Moderate	Moderate to High
Land-use compatibility	High	Moderate
Cumulative impact on renewable energy developments	Low to Moderate	Moderate
Overall impact significance	Low to Moderate	Moderate
Other aspects considered for the layout (deviation section)		
Impacts on soils and agriculture (see **Section 9.3.10**)	Overlaps low-medium sensitive areas	Overlaps medium-high sensitive areas
Impacts on terrestrial biodiversity (see **Section 9.3.11**)	Overlaps low-medium sensitive areas	Overlaps medium-high sensitive areas
Impacts on hydrology (see **Section 9.3.9**)	Overlaps medium-high sensitive areas	Overlaps medium-high sensitive areas
Social impacts (see **Section 9.3.17**)	Overlaps low-medium sensitive areas	Overlaps medium-high sensitive areas

It is important to note that the pipeline routes are largely dependent on the location of the gas-bearing wells in order to connect these wells to the main gas trunklines leading to the compressor stations. The assessed pipeline transects are 500 m wide (**Figure 3**) and within these areas, the final siting of the pipelines will be determined. **The final pipeline routes will be guided by the sensitivities identified from the specialist assessments as well as the concerns raised by the landowners to position the pipelines and above ground inline infrastructure in such a manner to avoid adverse impact as far as possible**. It is therefore recommended that both routes be approved and final route selection during the development phase be guided by the final sensitivity mapping approach detailed in **Section 10** and consultation / agreements with directly affected landowners and/or approved renewable energy developments. Measures to address landowners' concerns are listed below.

1. Pipelines and associated inline infrastructure will be negotiated and agreed with the affected landowners and/or approved renewable energy developments prior to final siting and appropriate compensation will additionally be agreed upon contractually and provided on an annual basis during construction and operations.
2. All pipelines will be buried between 750 – 1000mm below ground (to top of pipe).
3. D3 Energy will investigate alternatives methods for the removal of condensation water in the pipelines with the intention to limit or reduce the number of low point drains in the system which require regular maintenance.

A number of specific measures to address safety and security risks have been put forward as recommendations for inclusion in the decision and in order to prevent significant duplication in this report, refer to **Section 9.3.16**.

6.4 TECHNOLOGY OR PROCESS ALTERNATIVES

6.4.1 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.

6.4.1.1 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 20**). 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.

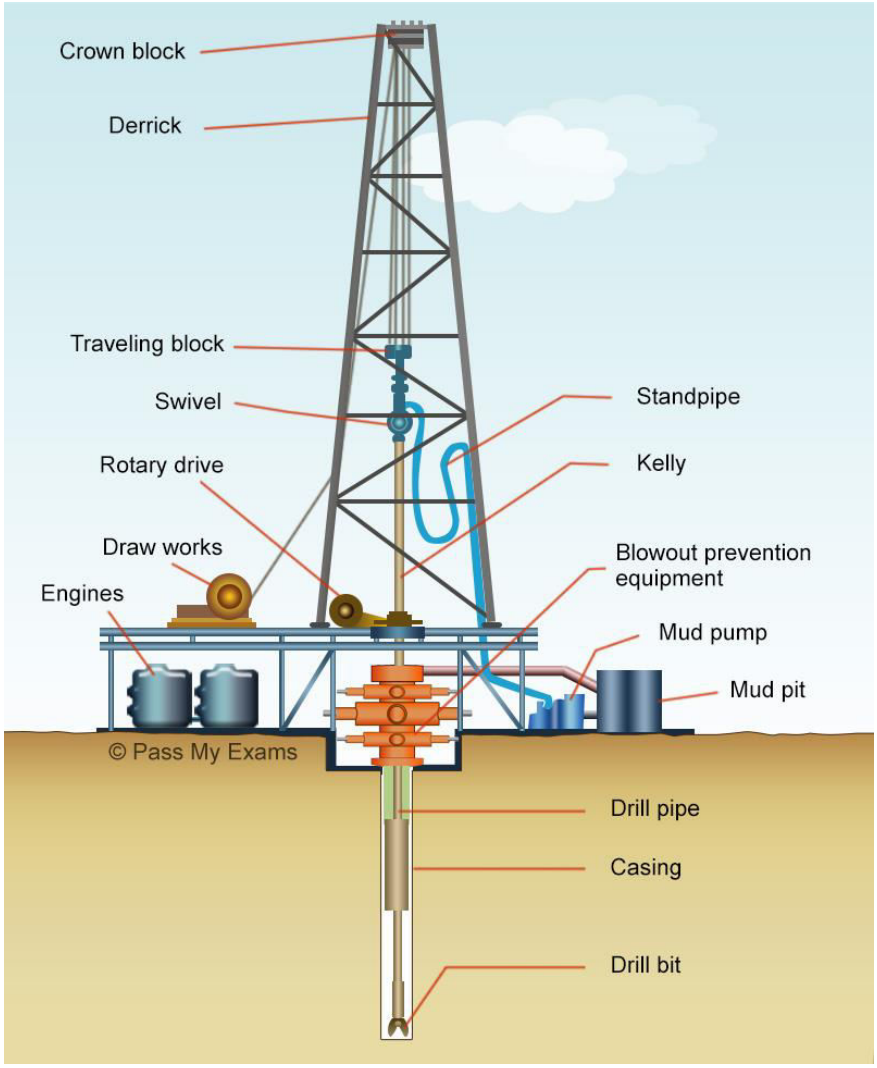


Figure 20: Fully cased drilling with rotary drive (https://www.passmyexams.co.uk/GCSE/chemistry/drilling-crude-oil-1.html).

6.4.1.2 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 21**) 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.

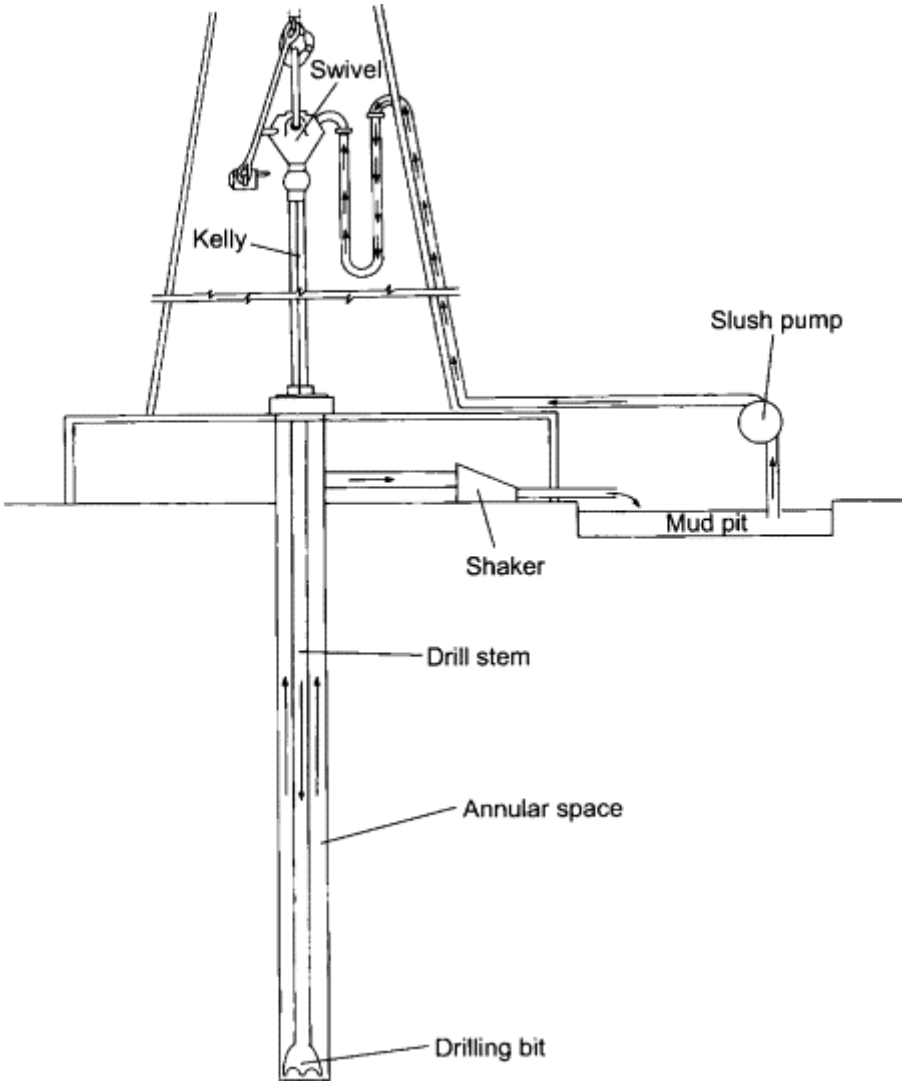


Figure 21: Typical example of percussion drilling technique
(https://www.sciencedirect.com/topics/engineering/percussion-drilling).

6.4.1.3 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 22** 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

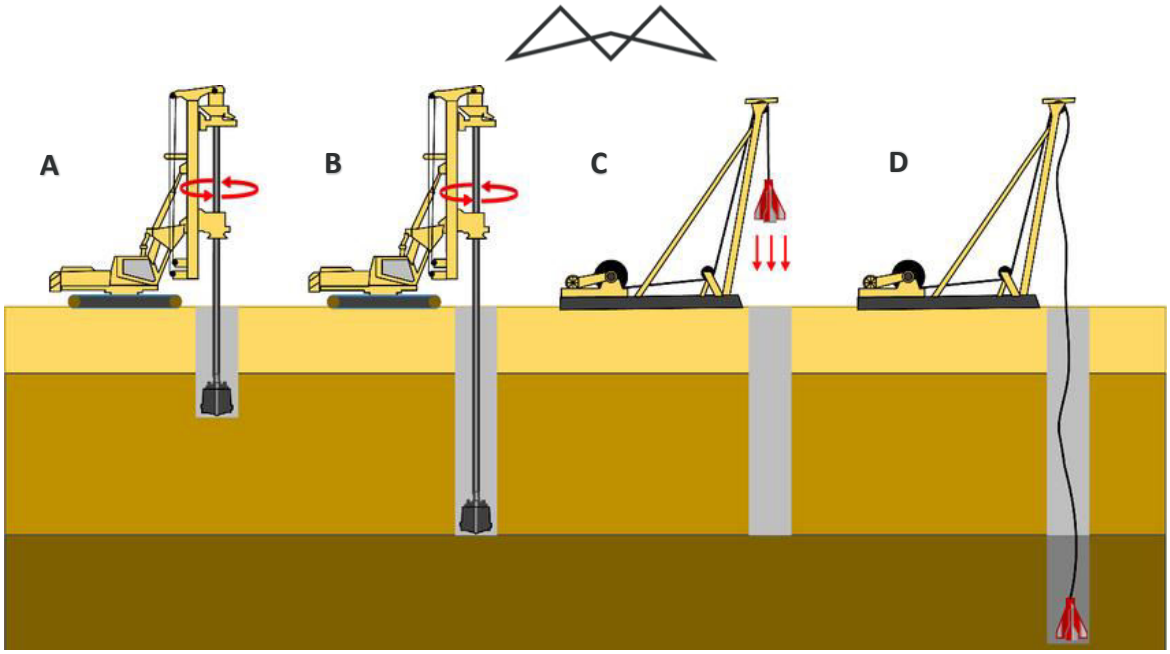


Figure 22: Typical example of rotary-percussion drilling technique (Hu *et al.,* 2023).

6.4.1.4 DIAMOND CORE DRILLING METHOD

Diamond drilling is a type of rotary drilling that uses a diamond studded drill bit (**Figure 23A**) 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 23A**). 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.

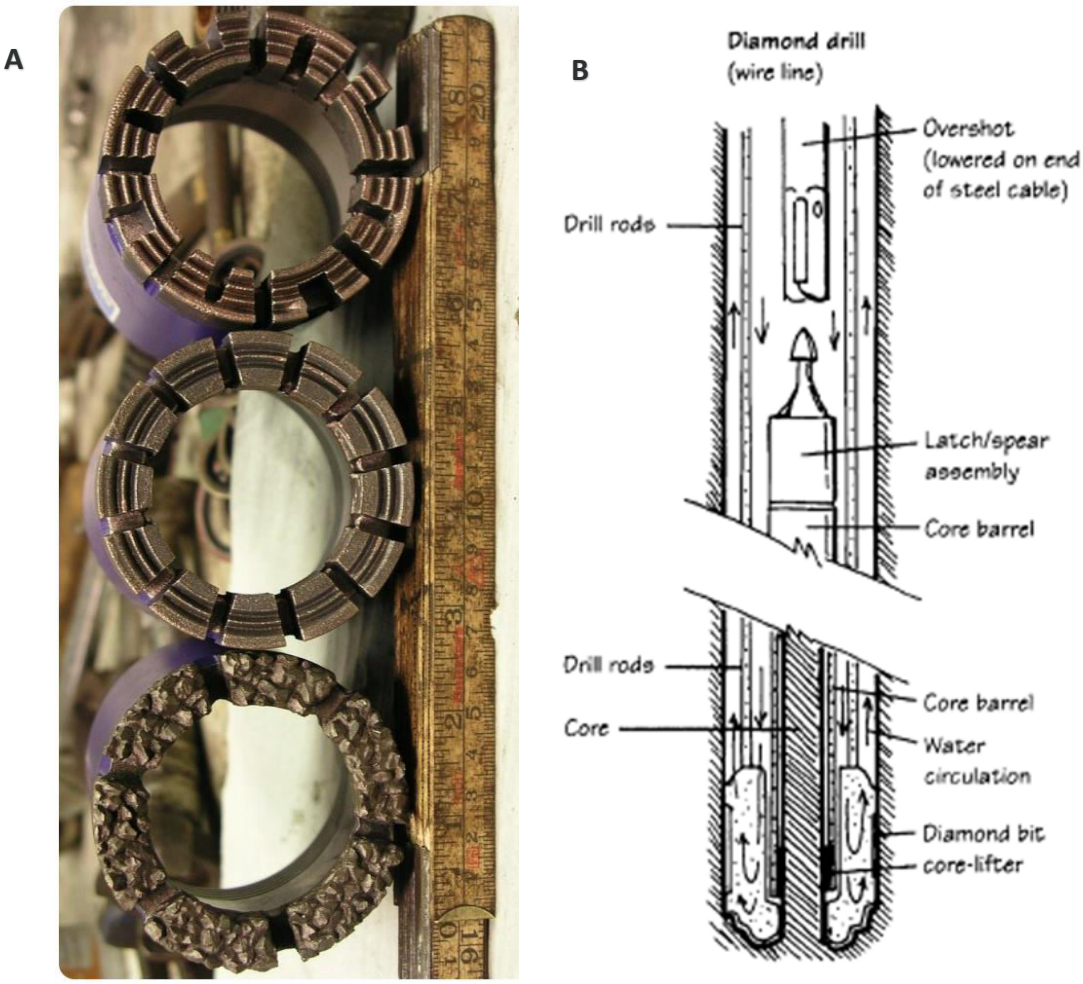


Figure 23: Diamond core drilling technique (Wai: https://www.precisiondrillingaustralia.com.au and Igo: ttps://www.igo.com.au)

6.4.1.5 ROTARY DIRECTIONAL DRILLING

Rotary directional drilling primarily refers to the use of a Rotary Steerable System (RSS), an advanced downhole tool that allows operators to steer a drill bit while the entire drill string rotates continuously from the surface (**Figure 23**). Unlike traditional directional drilling methods (which use a bent-housing mud motor and require stopping string rotation to adjust the well's direction—a process called "sliding"), RSS enables continuous rotation, resulting in a smoother wellbore, faster penetration rates, and easier extraction of cuttings. RSS tools generally fall into two categories:

6.4.1.5.1 Point-the-Bit Systems

These systems use an internal universal joint to point the axis of the drill bit at a slight angle away from the central axis of the tool itself. As the tool rotates, the bit is continuously oriented toward the desired direction of the well path.

6.4.1.5.2 Push-the-Bit Systems

These tools use a system of mechanical pads or ribs that extend outward from the drill collar to push laterally against the wall of the borehole. This continuous lateral pressure deflects the drill string, forcing it to drill a curved or deviated path.

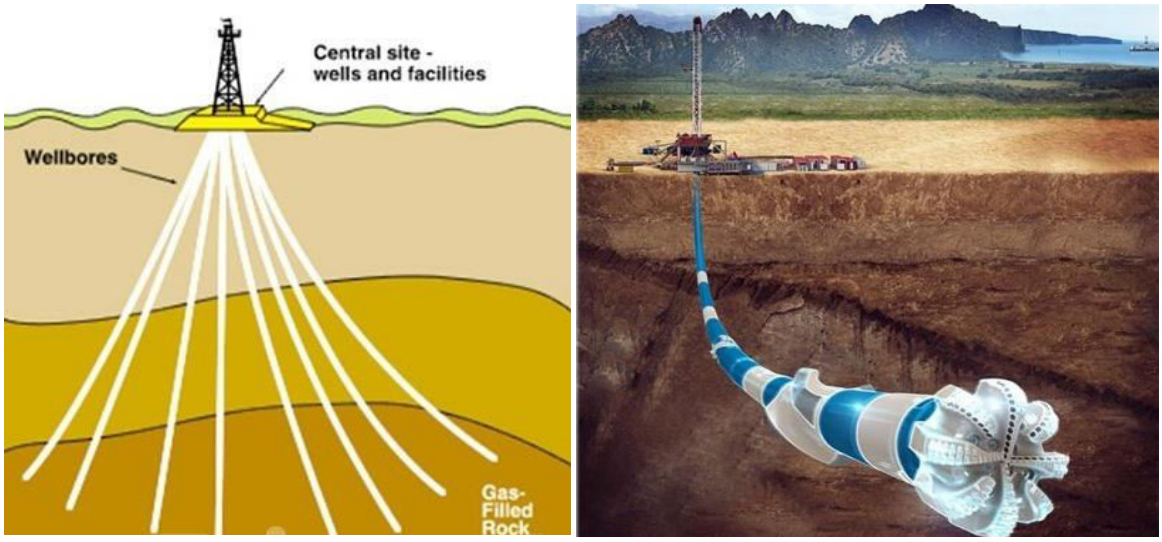


Figure 24: Illustration of rotary directional drilling (https://www.esimtech.com/how-rotary-steerable-systems-revolutionize-directional-drilling-in-the-oil-and-gas-industry and https://www.esimtech.com/how-rotary-steerable-systems-revolutionize-directional-drilling-in-the-oil-and-gas-industry)

6.4.1.6 ADVANTAGES AND DISADVANTAGES OF DIFFERENT DRILLING METHODS

Preliminary advantages and disadvantages of drilling methods are indicated in **Table 18.**

Table 18: Advantages and disadvantages of different 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 pollution from exhaust emissions, and potential soil and water contamination from drilling fluids.
	High penetration rate in hard rock, durable	Expensive, requires specialized equipment

Method	Advantage	Disadvantage
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	Diamond drilling can lead to soil and water contamination if not managed properly. The drilling process can introduce harmful substances into

Method	Advantage	Disadvantage
	to pull a slither of rock delicately from the earth.	the ground, affecting both soil quality and nearby water sources.
	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.
Rotary directional drilling	By drilling multiple wellbores from a single pad, the technology drastically reduces the land clearing, deforestation, and habitat fragmentation required for multiple vertical wells.	The process relies heavily on drilling muds to cool the bit and carry away cuttings. If not managed properly, these fluids can leak or spill, potentially contaminating soil and groundwater.
	The rotating action prevents the drill string from sticking to the side of the wellbore, which is critical for extended-reach and deepwater drilling.	The advanced downhole technologies, real-time logging tools, and surface equipment required are vastly more expensive than conventional systems and require specialised personnel
	It creates a spiral-free, less tortuous wellbore, which makes it significantly easier to run casing and logging tools later in the process.	There is an increased risk on downhole collapse.
	It facilitates the use of closed-loop drilling fluid systems, which minimize	Operating rotary steerable systems and mud pumps requires substantial,

Method	Advantage	Disadvantage
	the discharge of drilling waste into the surrounding environment	continuous power generation at the surface, increasing the short-term carbon footprint during the drilling phase.
	It allows operators to steer drills under sensitive environments like wetlands, ancient woodlands, and rivers without disrupting aquatic life or causing surface soil erosion.	Because of the complex engineering and extended measured depths involved, directional drilling can sometimes take longer to complete than simple vertical drilling, prolonging local noise and operational presence.
	Trenchless methods eliminate the need to dig open trenches, lowering the risk of sediment runoff into waterways and protecting shallow groundwater and shallow utility lines from contamination.	In some soft or highly unconsolidated geological formations, traditional methods like jetting or sliding motors may provide better direct steering control than a rotary steerable system.

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 and production 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 18** 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 and rotary directional drilling could be considered where feasible or where necessary depending on the site specific constraints, and prevailing land uses. However, the rotary directional drilling process requires a weight of vertical drill pipe to enable the horizontal section to be drilled which increases the risks of downhole collapse and the depths that the Applicant is targeting may not even allow this technique to be achievable. Engineering design including torque and drag calculations would be needed to confirm. Directional drilling further assumes one knows exactly what area they are targeting as the drilling is in a horizontal direction, thus only targeting a specific zone. Generally, the first wells in exploration are always vertical to give as much information as possible on all geological properties throughout the sequence. The proposed drilling process is air drilling through percussion method., subject to change based on the geology of the final drilling site.

6.4.2 SEISMIC SURVEYS ALTERNATIVES

A seismic survey is a method used to investigate the subsurface structure, primarily for 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 gas exploration namely, Vibroseis technique, Accelerated Weight Drop (AWD) and Magnetotelluric Survey (MT) (refer to **Section 3.1.1** for detailed information).

6.4.2.1 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.

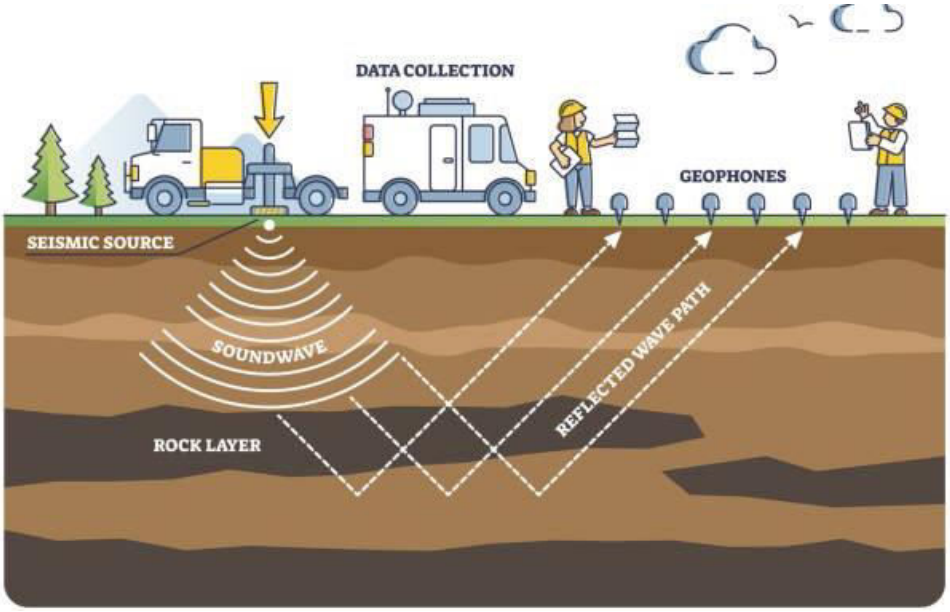


Figure 25: Illustration of Vibroseis technique (Bhardwaj, 2024).

6.4.2.2 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 gas exploration, groundwater studies, and engineering investigations (see **Figure 26**).

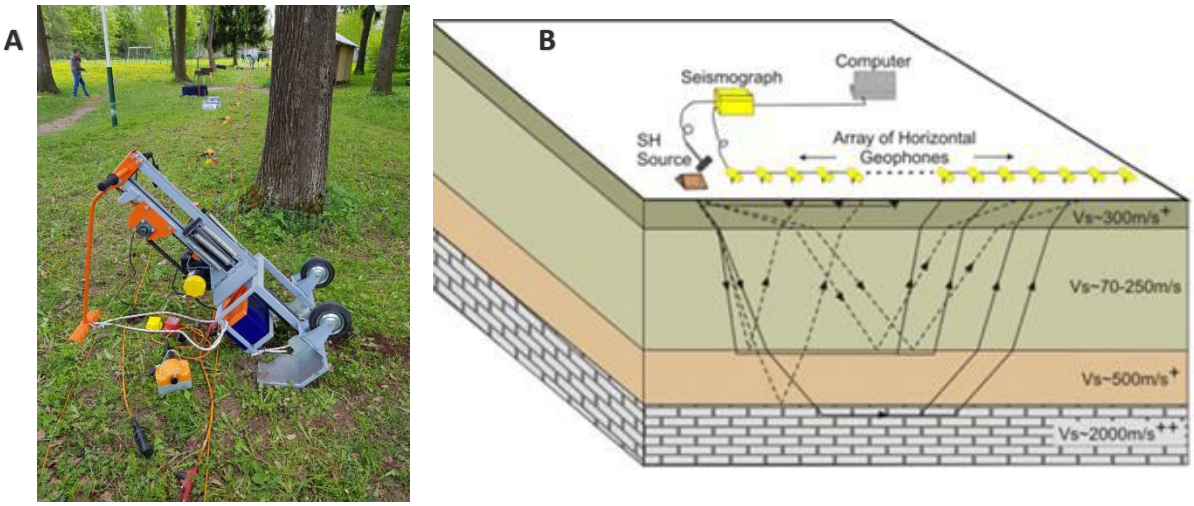


Figure 26: Illustration of AWD technique after Stephenson *et al.,* 2022. (A) AWD on site and (B) illustration of the process.

6.4.2.3 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 27**).

A

B

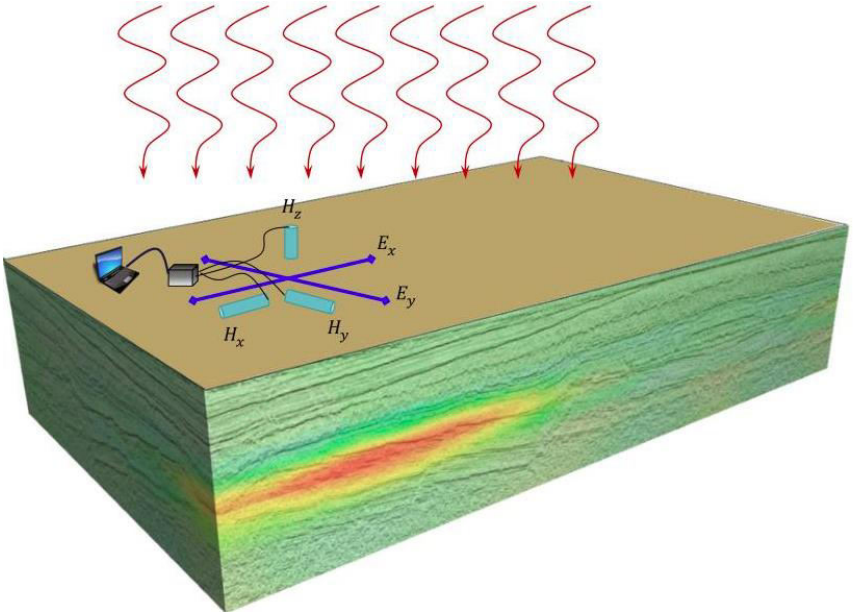


Figure 27: Illustration of MT survey (geopartner: https://geopartner.pl). (A) MT setup on site and (B) illustration of the MT process.

6.4.2.4 ADVANTAGES AND DISADVANTAGES OF DIFFERENT SEISMIC SURVEYS ALTERNATIVES

Preliminary advantages and disadvantages of different seismic survey techniques are indicated in **Table 19**.

Table 19: 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.

TECHNIQUE	ADVANTAGE	DISADVANTAGE
	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 19** above, it can be seen that the suitability for each is based on the nature of the project and the environmental conditions. It can also be seen that where one technique lacks, the other can abound. Therefore, it is **recommended that a multi-survey technique be used based as and when necessary, with the appropriate control measures in place.**

6.4.3 GAS TESTING ALTERNATIVES

During the drilling phase, gas venting (direct release into the atmosphere) and flaring (controlled burning of excess natural gas) may occur intermittently during well clean-up and flow testing or during emergencies. These activities may be required to remove drilling fluids, stabilise the well, and obtain reservoir performance data, including pressure, flow rate, and gas composition. At this stage of development, permanent gas capture or processing infrastructure is not yet installed, necessitating the controlled release or combustion of gas for limited periods.

6.4.3.1 GAS VENTING

Gas venting is the deliberate release of natural gas directly into the atmosphere without combustion. It is typically used to relieve pressure or manage gas during certain operational activities in the gas industry. Gas is released through valves, vents, or piping systems and disperses into the atmosphere. The gas is primarily methane, often with small amounts of other hydrocarbons. Gas venting may occur during:

- Well testing and well clean-up, particularly at low flow rates.
- Equipment commissioning, maintenance, or depressurisation.
- Start-up and shutdown of facilities.
- Situations where flaring is not technically feasible or safe.

6.4.3.2 GAS FLARING

Gas flaring is the controlled burning of excess or unwanted natural gas at a facility or well site, typically through a vertical or horizontal flare stack. It is used to safely dispose of gas when it cannot be captured, processed, or transported. The gas is ignited at the flare tip, where it burns in an open flame. This combustion converts methane (a potent greenhouse gas) primarily into carbon dioxide and water vapour. Gas flaring commonly occurs in various industries during:

- Gas drilling and well testing, before permanent infrastructure is in place.
- Start-up, shutdown, or maintenance of facilities.
- Emergency situations to relieve pressure and prevent equipment failure.
- Operational safety to manage excess gas.

6.4.3.3 ADVANTAGES AND DISADVANTAGES OF DIFFERENT GAS TESTING ALTERNATIVES

Preliminary advantages and disadvantages of different gas testing alternatives are indicated in **Table 20**.

Table 20: Advantages and disadvantages of different gas testing alternatives.

TECHNIQUE	ADVANTAGE	DISADVANTAGE
Gas Venting	Minimal infrastructure and equipment required.	Releases methane (a highly potent greenhouse gas) directly into the atmosphere with a much higher global warming potential than CO_2.
	Practical for small, short-duration releases.	Venting contributes directly to climate change.
	Avoids nitrogen oxides (NO_x) and soot emissions associated with flaring.	Potential for localised air quality impacts.
		Potential for explosive gas accumulation if poorly managed.
Gas Flaring	Controlled combustion reduces the risk of uncontrolled gas accumulation and explosions.	Flame, heat radiation, and noise can affect surrounding communities.
	It emits CO_2, NO_x, and small amounts of other pollutants significantly reducing global warming potential.	Still contributes CO_2 emissions and climate change.

TECHNIQUE	ADVANTAGE	DISADVANTAGE
	Impacts are usually localised and temporary when flaring is well managed.	Gas that could potentially be captured or utilised is destroyed.
	Flaring reduces climate impact compared to venting by burning off methane.	Requires flare systems, safety zones, and monitoring.

Based on the advantages and disadvantages indicated in **Table 20** above, it can be seen that flaring is widely considered preferable to venting from a climate and safety perspective. However, there may be instances where flaring presents a significant safety risk. Therefore, it is **recommended that both alternatives be considered and authorised for the D3 Energy PR, with the relevant impact management controls.**

6.5 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. Two design alternatives are identified and considered; namely drill fluid management alternatives and wellhead placement alternatives.

6.5.1 DRILL FLUID MANAGEMENT ALTERNATIVES

Two options for surface drill fluid management are identified, aboveground tanks 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 project. Subsequently, for purposes of this report, design or layout alternatives are based on the two options for aboveground drill sumps, namely the traditional excavated plastic lined pond (sump pit) or above ground tanks with secondary steel or plastic containment (pit-less drilling).

In exploration/production drilling, a conventional sump pit (or sump) is a contained area usually a pit dug in the ground and lined, used to collect drill cuttings and manage drilling fluids, allowing for water recycling and efficient solids settling. Pit-less drilling sumps on the other hand are aboveground systems often made of steel or plastic tanks. 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.

6.5.1.1 TRADITIONAL EXCAVATED LINED POND (DRILL SUMP PITS)

In this alternative, a sump pit is used to collect drill cuttings and manage drilling fluids, 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 an impermeable barrier material and fenced to prevent animals from entering. The typical lining material used are high density polyethylene sheets (refer to **Figure 28**). 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, backfilling, and restoring the vegetation.

Figure 28: Typical traditional sump pit used for drilling activities in the region.

6.5.1.2 ABOVEGROUND TANKS WITH SECONDARY CONTAINMENT

Above-ground tanks with secondary containment are designed to capture and contain spills or leaks of drill fluids, 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 tanks are often made of materials that are impervious to the stored liquid, such as steel, concrete, asphalt, clay, or plastic. In exploration or production drilling, feasible material includes steel or plastic (**Figure 29**). The sumps are either emptied or disposed by a hazardous waste service provider at a hazardous waste facility.

Figure 29: Examples of aboveground sumps with secondary containment (https://enduramaxx.co.uk/enduramaxx/chemical-storage-tanks-secondary-containment/).

6.5.1.3 ADVANTAGES AND DISADVANTAGES OF DIFFERENT DRILL FLUID 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 21**.

Table 21: Advantages and disadvantages different aboveground drill sumps.

ADVANTAGE	DISADVANTAGE
Traditional excavated 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 tanks 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.
Appropriate liners for the specific activity and site are highly resistant to UV damage, chemicals, and punctures, ensuring long-term durability.	Animals can easily be trapped by the fence and/or fall into the pit.
Potentially fewer truck movements during drilling when on-site containment volume is sufficient.	Lined ponds can suffer from leaks, liner damage, and require sump pumps. Punctures and tears are common, and repairs can be difficult and costly.
Can provide surge capacity and settlement during drilling and testing.	Damage to liner results in immediate contamination and may affect groundwater and/or nearby aquatic systems.
	Larger surface disturbance and visual footprint; typically requires more earthworks and post-drilling rehabilitation.
Aboveground tanks with secondary containment (Pitless / Closed loop)	
Aboveground tanks 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.
Aboveground tanks 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.	Aboveground 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 excavated lined sumps.	Aboveground sumps can be expensive to install, especially if they are large or complex.
Portable allowing for easy transport and setup at different drill sites.	Secondary containment systems, like bunds or containment berms, require additional space around

ADVANTAGE	DISADVANTAGE
	the primary tank or sump, increasing the overall area needed for storage.
Substantially reduced surface disturbance and visual footprint; better alignment with sensitive sites or small pads.	Vehicles can back into them, vandals can deface or damage them, and trespassers can steal their contents. Exposure also increases the chance of leaks.
Reduced risk to soil, groundwater and wildlife by eliminating open pits; improved containment and spill response.	Regular inspections and maintenance are crucial to ensure the integrity of both the primary and secondary containment systems.
Often faster post-drilling demobilisation with minimal rehabilitation.	If the secondary containment fails, the spilled material can contaminate the surrounding soil and water.

Based on the advantages and disadvantages indicated in **Table 21** above, both sump pits and aboveground sumps have noticeable advantages and disadvantages. However, sump pits are 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 production drilling 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.

6.5.2 WELLHEAD PLACEMENT ALTERNATIVES

A wellhead is the surface component of an oil or gas well that serves as the structural and pressure-containing connection between the well and the drilling or production equipment. It typically includes a casing head and a tubing head, which seal the space between the wellbore and the installed casing or tubing. The wellhead also incorporates valves and fittings that allow operators to control the flow of gas from the well.

A key function of the wellhead is to safely contain the pressure and regulate the flow of hydrocarbons from the well. This helps maintain the integrity of the well and reduces the risk of leaks or uncontrolled releases. By enabling controlled production, the wellhead supports the safe and efficient extraction of oil or gas, which is essential for the operational and economic viability of the well. In addition, the wellhead provides a secure access point for monitoring, maintenance, and connection to production infrastructure associated with the well.

The choice between below ground and aboveground gas wellheads involves trade-offs between visibility, security, maintenance access, and installation costs. The main difference between these two setups is where the wellhead equipment (valves, gauges, etc) is located relative to the surface. This section evaluates the environmental and operational implications of these two alternatives in order to determine the preferred option.

6.5.2.1 ABOVEGROUND WELLHEAD

Aboveground gas wellheads are the typical surface level, pressure containing assemblies installed at the top of a natural gas well. They act as the essential interface between the underground geological reservoir and the surface equipment used to extract and transport the gas. These structures, are critical for maintaining well integrity, controlling pressure, and enabling safe production.

6.5.2.2 BELOW GROUND WELLHEAD

Gas wellheads can be placed underground in a chamber or vault, although it is less common than aboveground installations and generally restricted to specific applications like landfills, storage facilities, or specific technical requirements. However, below ground wellhead installations may have certain beneficial applications as discussed below.

6.5.2.3 ADVANTAGES AND DISADVANTAGES OF WELL PLACEMENT OPTIONS

Assessed advantages and disadvantages of different wellheads alternatives are indicated in **Table 22**.

Table 22: Advantages and disadvantages of well placement options.

TECHNIQUE	ADVANTAGE	DISADVANTAGE
Aboveground Wellhead	Easy to monitor, inspect, and maintain because they are fully visible.	Visible, which can be an eyesore.
	Generally, more cost-effective to install as they require no heavy excavation.	Susceptible to vandalism or damage from environmental factors
	Can have a longer lifespan if properly maintained, as they are not subject to soil-related corrosion, although they are exposed to weather.	
	Leaks are detected earlier.	
Below Ground Wellhead	Often used to prevent vandalism and theft.	Expensive and time consuming to install
	Safer from aboveground impacts.	Monitoring for leaks is more difficult
	Can improve the aesthetics of a property.	Leaks can lead to hidden contamination of soil and groundwater
	Generally safer from temperature fluctuations (extreme cold).	

Based on the advantages and disadvantages indicated in **Table 22** above, For the D3 Energy PR, **aboveground wellhead is generally the environmentally preferred alternative** because it allows for:

- easier monitoring,
- earlier leak detection,
- lower risk of hidden contamination,
- simpler maintenance, and
- reduced construction complexity.

A below-ground wellhead will only become the preferred option if security concerns, agricultural operational requirements, or visual sensitivity are demonstrated to outweigh the environmental and operational advantages of an aboveground installation.

6.6 NO GO ALTERNATIVE

The no go alternative would imply that the production 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 production 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 production activities and in turn mining development of an economically viable resource (natural gas including Helium) available in the area.

Production of additional domestic hydrocarbon reserves is considered important, and any available volumes would likely be well received by the local market. D3 Energy PR 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. Gas developments initiatives like D3 Energy are therefore considered essential to identify new domestic supplies that can meet this rising demand. The potential to produce both resources increases economic viability and reinforces the long-term demand-driven rationale for gas production. Overall, the project aligns with national priorities to expand gas supply, meet rising demand, reduce import dependence, and support economic growth.

In addition, as indicated in **Section 12.1**, 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 (with the exception of potential medium-high cumulative impact of GHG emissions and groundwater contamination), it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed D3 Energy PR 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 similar activities.

Considering the above, the detailed need and desirability of the project indicated in **Section 5** and that the proposed actives have generally a small footprint and can be undertaken in parallel with other land uses, **the no go alternative is <u>not</u> considered feasible or reasonable for this application.**

7 STAKEHOLDER ENGAGEMENT

The Public Participation Process (PPP) is a requirement of several pieces of South African legislation and aims to ensure that all relevant Interested and Affected Parties (I&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.

7.1 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.

7.2 PRE-CONSULTATION WITH THE COMPETENT AUTHORITY

A pre-application meeting with the Petroleum Agency of South Africa (PASA) was held on the 30th of October 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.

7.3 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.

7.3.1 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. The I&APs database will continually be updated throughout the duration of the application process.

7.3.2 LIST OF PRE-IDENTIFIED ORGANS OF STATE/ KEY STAKEHOLDERS IDENTIFIED AND NOTIFIED

National, Provincial and Local Government Authorities as well as State Owned Entities (SOE's) were notified of the proposed project and include but not limited to:

Table 23: List of Government Authorities, SOE's and other key I&APs.

Organs of State	Key I&APs
• Council for Scientific and Industrial Research (CSIR) • Department of Mineral and Petroleum Resources: Free State • 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 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 • Masilonyana Local Municipality • Municipal Ward Councillors	• Afgri • Afgri Agri Services • African Conservation Trust • African Carbon Energy • AfriForum • Agri Free State • Agri SA • Air Traffic and Navigation Services (ATNS) • Birdlife South Africa • Botanical Society of Southern Africa • 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 Farmers Union

Organs of State	Key I&APs
• National Department of Agriculture, Land Reform and Rural Development (DALRRD) • 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 (PASA) • Petroleum Oil and Gas Corporation of South Africa (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 • National Transmission Company South Africa (NTCSA)	• Matjhabeng Ratepayers Association • Mining and Environmental Justice Community Network of South Africa (MEJCON-SA) • Mining Affected Communities United in Action (MACUA) • Mulilo Renewable Project Developments (Pty) Ltd • Natural Justice • Tara Wildlife SA • Vaal Environmental Justice Alliance (VEJA) • Vrystaat Landbou/ Free State Agriculture • Warburtons Attorneys • WESSA • Wild Trust

In addition to the above, attempts to consult with directly affected landowners, adjacent landowners, community and farming representatives, occupiers of land, etc. were made.

7.3.3 PROJECT NOTIFICATION AND REQUEST FOR INITIAL COMMENTS

The PPP commenced on the 14th of November 2025 with an initial notification and call to register. The notification was given in the following manner:

7.3.3.1 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 interested or 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 production 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.

7.3.3.2 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 November 2025. Gazette Notice was published in the National Gazette on the 14th of November 2025. The newspaper advert and the Gazette included the following information:

- Project name;
- Applicant name;
- Project location;
- Nature of the activity and application;
- Where additional information could be obtained; and
- Relevant EIMS contact person for the project.

7.3.3.3 SITE NOTICE PLACEMENT

A1 correx site notices in English, Afrikaans and Sesotho were placed at 50 locations within and around the application area between the 17th and 18th of November 2025. 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.

7.3.3.4 POSTER PLACEMENT

A3 posters in English, Afrikaans and Sesotho were placed at local public gathering places in Virginia, Welkom, Ventersburg and Theunissen.

The notices, posters and written notification afforded all I&APs who may be interested in the project with the opportunity to register for the project as well as to submit any issues/queries/concerns 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 (postal).

7.3.4 SCOPING PHASE PUBLIC PARTICIPATION

7.3.4.1 PUBLIC REVIEW AND COMMENT OF SCOPING REPORT

Notification regarding the availability of the Scoping Report for public review was given in the following manner to all registered I&APs (which includes key stakeholders and landowners):

- Registered letters with details on where the scoping report can be obtained and/or reviewed, EIMS contact details as well as the public review comment period;
- Facsimile notifications with information similar to that in the registered letter described above;
- Email notifications with a letter attachment containing the information; and/or
- SMS notifications with the relevant information.

The scoping report was made available for public review and comment from the **23rd of January 2026 to the 23rd of February 2026** for a period of 30 days.

7.3.4.2 SCOPING PHASE PUBLIC 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 18th of February 2026 from 15h00 to 17h30. All registered I&APs were notified of the public meeting on the 13th of February 2026. All attendees were asked to sign the attendance register upon entering the venue 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. Refer to Appendix 7 of the PPR (**Appendix C**) for the Public Meeting Document.

7.4 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 the Scoping Report for review and commenting as well as the EA Application Form. Comments received from PASA have been captured and responded to on the Table of Correspondence (Appendix 8 of **Appendix C**) for the project which have been made available in this EIAr. The authorities have also been afforded another opportunity to review and comment on this EIAr for a minimum period of 30-days.

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 20th of April 2026**.

7.5 EIA PHASE PUBLIC PARTICIPATION

The EIA Phase Public Participation will be undertaken in line with the approved plan of study for the EIA. The public participation for the EIA Phase is indicated below.

7.5.1 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) and **Virginia Public Library** (Corner Civic Ave & Virginia Gardens, Virginia), while a softcopy version has been placed on the EIMS website (https://www.eims.co.za/2025/11/06/1709-motuoane-production-right-eia/). Comments / concerns could be submitted to EIMS the by no later than **29th of October 2026**. The comments / concerns should be directed to EIMS at:

- Contact Person: Mbali Tshabalala
- PASA Reference Number: 12/4/016
- EIMS Reference Number: 1709
- Telephone: (011) 789 7170
- Fax: (086) 571 9047
- E-mail: motuoanepr@eims.co.za

Comments raised during the EIAr public review will be captured, adequately responded to and comments and responses provided to PASA to consider when making a decision on the application.

7.5.2 EIA PHASE PUBLIC / FOCUS GROUP MEETINGS

Notification regarding the EIA phase public meeting will be given in the following manner to all registered I&APs (which includes key stakeholders and landowners):

- Email notifications with a letter attachment containing necessary 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).

During the public review and comment period of this EIAr, the following meetings will be scheduled accordingly:

- Physical Public / Open Day Meeting for all I&APs;
- Focus Group Meeting with Landowners;
- Focus Group Meeting with renewable energy developers;
- Focus Group Meeting with mining right holders within the proposed D3 Energy PR16;
- Virtual Public Meeting for all I&APs

Attendance registers will be signed and collected for each meeting and I&APs 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 can 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 be attached to the Final Public Participation Report and submitted to PASA and DMPR to review and/or consider.

7.6 COMMENTS AND RESPONSES REPORTING

Comments raised to date 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 key comments and responses during the scoping phase is provided in **Table 24** below.

Table 24: Summary of Key Comments and Responses

I&AP	Key Comment(s) Raised	Summary of Response
Paul Lado (CER, MACUA, MEJCON-SA, groundWork, FSEJN, Natural Justice)	Air quality baseline data insufficient; need local monitoring; climate change impacts and Scope 1, 2 and 3 emissions not adequately assessed; hydrogeological studies insufficient; concerns about groundwater contamination, wetlands, biodiversity, social impacts, food security, heritage, need and desirability, and public participation.	EAP indicated detailed Air Quality, Climate Change, Hydrogeological, Social, Agricultural, Heritage and Biodiversity assessments will be undertaken during the EIA phase. Scope 1, 2 and 3 emissions, cumulative impacts, groundwater modelling, climate risks and specialist studies will be assessed in greater detail. Public participation process was considered compliant with NEMA requirements.
Mr Gert Oosthuizen (Optavit Trust)	Need and desirability assessment does not adequately consider downstream climate impacts; concerns regarding impacts on cattle farming, food security, farm security, disease transmission, groundwater contamination, and lack of an Access	EAP committed to further climate change assessment during EIA phase, including downstream emissions. Agricultural impacts, livestock impacts, biosecurity measures, groundwater impacts, access protocols and emergency response

I&AP	Key Comment(s) Raised	Summary of Response
	Protocol and Emergency Response Plan.	plans will be assessed and incorporated into the EMPr and EIA process.
Celine Oates (Red Rocket SA)	Potential conflict between gas infrastructure and approved solar PV facilities; inadequate need and desirability assessment; insufficient climate, biodiversity, agricultural and freshwater assessments; concerns about cumulative impacts on renewable energy developments and public participation.	EAP stated that coexistence between renewable energy projects and gas developments is being pursued. Additional specialist studies will assess climate change, biodiversity, water, agriculture, air quality, noise, traffic, and cumulative impacts. Alternatives and land-use compatibility will be further assessed during the EIA phase.
Ms Phumla Ngesi	Requested clarification on Water Use Licence (WUL) and Atmospheric Emission Licence (AEL) requirements; queried exploration well numbers, facility descriptions, wastewater management, and exclusion of IsiXhosa in participation materials.	EAP clarified that an AEL is not required, while WUL applications will be submitted where applicable. Exploration well numbers and survey lengths were clarified. Additional facility diagrams were added to the report. Language choices were justified based on dominant local languages.
Nthabiseng Mahlumba (MACUA)	Requested transport for community members and suggested meeting venues be moved closer to affected communities to improve participation.	EAP indicated transport could not be provided but virtual participation options were offered. Future EIA phase engagements may include venues closer to communities.
Taole Mavious Mokhele (Goldfields Community Forum)	Concerns over public participation accessibility; requested reports be placed in township libraries; requested transport assistance. Expressed support for project due to anticipated employment and skills development benefits.	Additional hard-copy report locations were arranged. Virtual participation was offered. EAP acknowledged future venue considerations. Support comments were recorded for submission to authorities.
Tshepo Moloto	Requested coordinates and polygon information for the proposed production right area to prepare comments.	Coordinates and project KMZ information were provided.
Tinashe Maramba	Requested KML/KMZ files for the Production Right and Exploration Right areas and registration as an I&AP.	KMZ files were supplied and the requester was added to the I&AP database.
Kahmani Gounden (Sibanye Gold)	Requested KMZ files, project layouts and information to determine overlap with Sibanye mining rights and associated infrastructure.	KMZ files, locality maps and preliminary infrastructure layouts were provided; additional stakeholders were registered as I&APs.

I&AP	Key Comment(s) Raised	Summary of Response
Elmar Roberg	Requested registration, project presentation material and various KMZ/locality map files to understand project boundaries and spatial relationships.	Requested documentation and spatial files were provided.
Natasha Thomas	Could not access Baseline Specialist Reports online.	Website issue was resolved and working links were provided.
Luka Van Der Merwe	Reported inaccessible Appendix F documents and requested extension of the public comment period.	Website issue was corrected. Comment period could not be extended due to regulatory timelines, but late comments could be considered during the EIA phase.
Paul Lado, Natasha Thomas and Luka Van Der Merwe	Raised concerns regarding inaccessible specialist studies on the EIMS website.	EAP acknowledged technical issues, restored access and distributed direct links to documents.
DFFE Biodiversity Conservation (Lekalakala)	Advised that biodiversity-related submissions must be directed to the Directorate: Biodiversity Conservation and identified responsible officials.	EAP acknowledged and noted the contact requirements.
Transnet Pipelines (Thami Hadebe)	Confirmed Transnet Pipelines is not affected by the proposal.	Comment noted by EAP.
PASA (Ms. Mnyaka)	Submitted technical comments on the Draft Scoping Report.	EAP acknowledged receipt and advised that formal responses would be provided.

All comments that have been received throughout the application process have been captured and adequately 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 and EIAr during the respective public review and commenting periods. The PPR and comments and responses documents will be updated as and when comments are received during the public review of this EIAr. Refer to see **Appendix C** for all Public Participation related documents.

7.7 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.

It must however be noted that, a municipal council may extend or condone a failure by a person to comply with the timeframes in regulations 4(1) and 5. In addition, despite regulation 7(1), the appeal authority may decide an appeal within (a) 70 calendar days of the expiry of the time period in regulation 5 or (b) 50 calendar days of the appeal administrator receiving the appeal panel or expert's recommendations, where an appeal is complex. An appeal is complex where it requires:

a) the appointment of an advisory appeal panel or an expert to assist the appeal authority to decide an appeal;

b) the appeal administrator to undertake a site inspection to properly advise the appeal authority; or

c) more than one appeal administrator to process the appeal due to the volume of its documents or the technical nature of its subject matter.

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.

8 ENVIRONMENTAL ATTRIBUTES AND BASELINE ENVIRONMENT

This section of the EIAr 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 project 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**.

8.1 PROJECT LOCATION AND LAND USES

The proposed Production Right is located within an existing ER area (ER315) over an area of approximately 14 440 hectares (ha), covering various farms approximately 15 km to the southeast of the town of Virginia in the Free State Province of South Africa. The local municipalities in which the proposed production area is located are Matjhabeng and Masilonyana Local Municipalities of the Lejweleputswa District Municipality. The site boundary is ~15km southeast of the town of Virginia, ~28km southeast of the town of Welkom, ~13km southwest of the town of Ventersburg and ~21km northeast of the town of Theunissen. The geographic coordinates at the approximate centre of the application area are 28°14'38.37"S and 26°57'54.97"E

The land cover/use of the proposed study area is mostly grassland with scattered areas that are disturbed and degraded due to anthropogenic activities, such as clearing of vegetation for agricultural and solar developments. Some parts to the north and south of the proposed PR area are cultivated, there are areas with intact natural vegetation while some areas have evidence of alien species. Similar land use was observed in areas directly adjacent to the PR area. Associated photographic evidence is depicted in **Table 25** below.

Table 25: Site photographs.

View of vegetation in the northeastern portion of the PR

Existing farm road noted in the northeastern portion of the PR

Equipment storage container used during the exploration activities in ER315

Northern landscape view within the PR area

Rill erosion noted on one of the farm access roads within the PR area

View of the Maselspruit River tributary within the PR area

Erosion noted within the Maselspruit River tributary

Existing gas well within the PR boundary

View of the R73 within the PR boundary

Eskom transmission line noted crossing the R73 within the PR boundary

Farm dam noted along the R73

Bare and rocky patches noted within the PR area

Fire breaks and farm roads noted along some fence lines

Some farm dwellings / houses noted within the PR area

Roads works (filling of potholes) noted along the R73

Agricultural lands noted in the northern and southern portions of the PR area

Solar PV development by Red Rocket noted in the northeastern section of the PR area

Vegetation clearing for Solar PV development noted within the PR area

View of an unnamed road along the northeastern area of the PR area

View of the Maselspruit River tributary crossing the unnamed road in the northeastern area of the PR area

8.2 TOPOGRAPHY

Information on the area's topography was obtained from the Geohydrological Impact Assessment Report undertaken by Gradient Groundwater Consulting (**Appendix F7**). The topography of the greater study area has a generally flat to gently undulating topography becoming more undulating and hillier towards the east and can be classified as a lowland with hills. 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 far northern and western perimeters and 30 – 450.0m to the south and east. The landscape gradually flattens out towards the lower laying drainage system towards the northwest (approximate elevation low of 1260.0mamsl), while the southern and southwestern perimeters are shaped by ridges also forming the surface water catchment water divide (approximate elevation high of 1695.0mamsl) (based on elevations extracted from the SRTM DEM raster interpolation). Elevations generally increase towards the southern and central parts of the study area, with the highest on-site elevation recorded as 1467.0mamsl also shaping the local water divide. The lowest on-site elevation is recorded as 1320.0mamsl forming part of the drainage system situated on the northern edge of the study area. On-site gradients are variable, especially towards the south zone of the study area, however the gradient is gentle to moderate. The average slope is calculated at ~-2.50% to +3.50% with an elevation loss of approximately 140.0m over a lateral distance of 7.0km in a general northeastern orientation. **Figure 30** shows the regional topographical contours and setting.

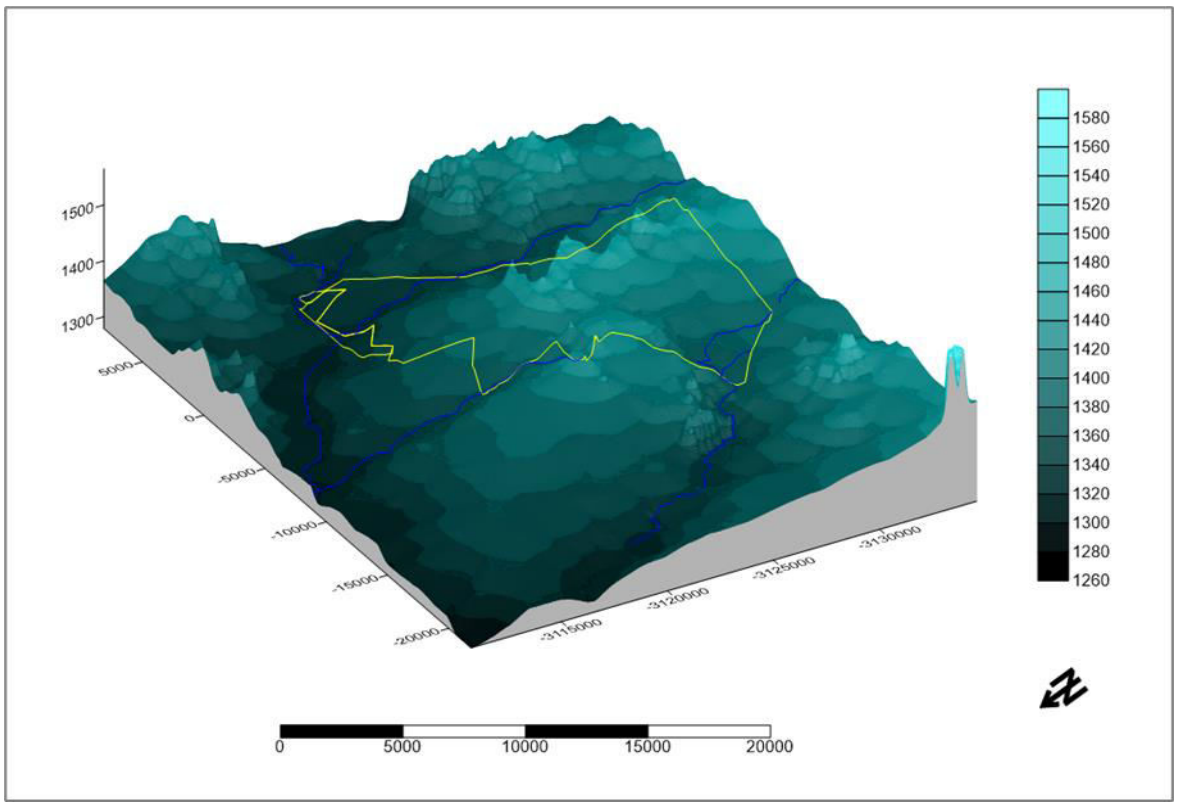


Figure 30: General topography of the study area (Gradient Groundwater Consulting, 2026).

8.3 GEOLOGY

This section summarizes the regional and local geology as per the information obtained from the Geohydrological Impact Assessment Report undertaken by Gradient Groundwater Consulting (**Appendix F7**).

8.3.1 REGIONAL GEOLOGY

According to the Council for Geoscience (CGS) 1:250 000 geological maps (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 as well as sediments of the Beaufort Group within the Karoo Supergroup; dolerite dykes, sheets, and sills associated with the Karoo Dolerite Suite; and post-Karoo kimberlite pipes and dykes. Refer to **Table 26** for a summary of the lithostratigraphy of the study area while **Figure 31** depicts the regional geology and stratigraphy.

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.

A vast network of dolerite dykes, sheets, and sills associated with the Karoo Dolerite Suite occurs throughout the region and is especially prominent in the southern and central parts of the 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).

8.3.2 LOCAL GEOLOGY

Based on the Council for Geoscience (CGS) 1:250 000 geological maps (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 Group within the Karoo Supergroup; dolerite dykes, sheets, and sills associated with the Karoo Dolerite Suite; and post-Karoo kimberlite pipes and dykes **Figure 30** depicts the regional geology and stratigraphy.

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).

8.3.3 STRUCTURAL GEOLOGY

According to the CGS 1:250 000 geological maps (Geological Map Sheet 2826 Winburg) large dolerite intrusions in the form of dykes and sills are observed throughout the study area. The Karoo sediments in this portion of the WMA are much intruded by sub accordant sheets, and to a lesser extent by near-vertical dykes of Karoo dolerite (DWAF, 2004). The Karoo Basin is characterised by a vast network of post-Karoo intrusive dolerite (Jd) sills and dykes that rapidly intruded at 183.0 to 182.3Ma (Svensen et al., 2012). The intrusive Karoo dolerite suite

represents a shallow feeder system which occurs as an interconnected network of dykes, sills as well as sheets which typically form resistant caps of hills compromising softer sedimentary strata (Chevallier and Woodford, 1999). A high resolution airborne magnetic survey identified various southwest-northeast as well as southeast-northwest striking magnetic lineaments inferred as dolerite dykes towards the western and central zones of the production right area. Regional fault zones include the known fault Virginia and Ventersburg fault lines. Structural analysis also suggests a potential east-west striking fault zone towards the central zone of the production right area. The latter may have an impact on the local hydrogeological regime as it can serve as potential mechanisms and preferred pathways for groundwater flow and contaminant transport.

Table 26: Simplified lithostratigraphy of the greater study area (Gradient Groundwater Consulting, 2026)

Age (Mya)	Supergroup	Group	Subgroup	Formation	Intrusions	Lithology
< 0.01	-	-	-	Quaternary Deposits	-	Aeolian sand, alluvium, calcrete and surface limestone
130 to 70	-	-	-	-	Kimberlite	-
180	-	-	-	-	Karoo Dolerite Suite	-
248 to 239	Karoo	Beaufort	Adelaide	-	-	Mudstone with subordinate sandstone
				Normandien	-	Mudstone, siltstone, shale, rhythmite, sandstone
290 to 248		Ecca	-	Volksrust	-	Mudstone, siltstone, shale
300 - 280		Dwyka	-	-	-	Mudstone, shale
Unconformity						
~2.7 Ga	Ventersdorp Supergroup	Klipriviersberg Group	-	-	-	Lavas and volcaniclastics
Unconformity						
2.9–2.7 Ga	Witwatersrand Supergroup	Central Rand Group	-	Virginia Formation	-	Quartzite and conglomerate

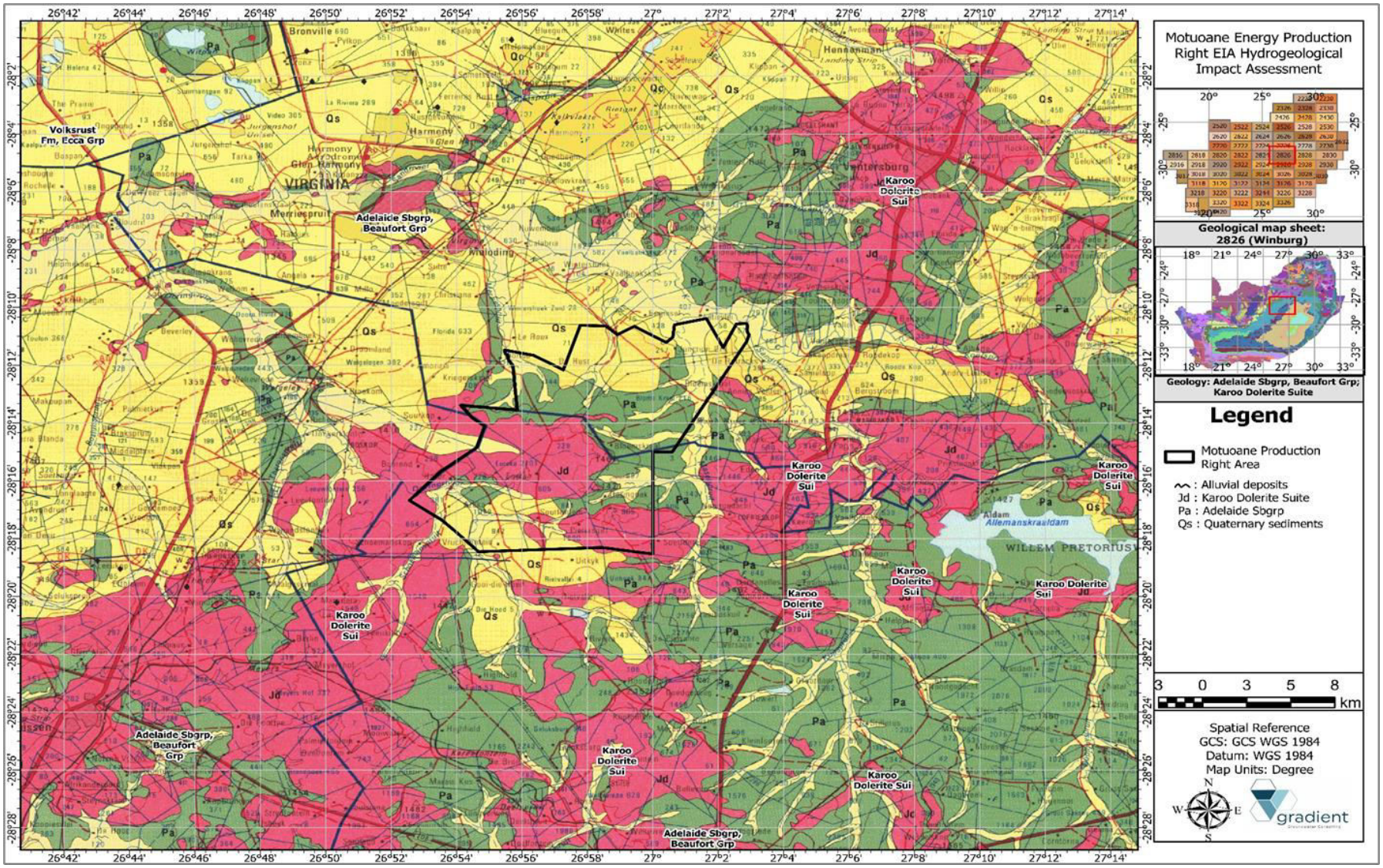


Figure 31: Regional geology and stratigraphy from Geological map sheet 2826: Winburg at 1:250 000 scale (Gradient Groundwater Consulting, 2026).

8.3.4 NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM/TENORM)

Naturally Occurring Radioactive Material (NORM) refers to naturally occurring radionuclides present in geological formations, soils, groundwater, and gases. During exploration, production, processing, and transportation of natural gas and helium, these radionuclides may become concentrated through industrial activities, thereby creating Technologically Enhanced Naturally Occurring Radioactive Material (TENORM). The PR is situated within the Karoo-age sedimentary and dolerite-intruded geological sequence associated with the Virginia helium province, a region recognized for elevated natural helium concentrations and natural gas accumulations.

8.3.4.1 REGULATORY CONTEXT

The NNR requires that activities involving radioactive materials demonstrate that radiation exposures to workers and the public remain As Low As Reasonably Achievable (ALARA). TENORM management in South Africa is regulated principally through:

- National Nuclear Regulator Act (Act No. 47 of 1999).
- National Environmental Management Act (NEMA, Act No. 107 of 1998).
- Occupational Health and Safety Act (Act No. 85 of 1993).
- National Nuclear Regulator (NNR) Radiation Protection Requirements.
- IAEA Safety Standards relating to NORM industries.

The extraction, processing and handling of natural gas may result in the mobilisation, concentration or accumulation of NORM within process equipment, pipelines, separators, filters, scales, sludges, produced-water management systems and other operational infrastructure. While NORM is naturally present within geological formations, operational processes can in some cases result in TENORM through the concentration of naturally occurring radionuclides, particularly those associated with uranium, thorium and radium decay series.

At the current stage of project design and environmental assessment, no evidence is available to indicate that NORM or TENORM will occur at concentrations requiring specific radiological management measures. However, given the nature of hydrocarbon production activities and recognising that radionuclide concentrations can only be reliably determined once production operations commence and representative operational samples become available, a precautionary monitoring and characterisation approach will be adopted during the operational phase.

Accordingly, D3 Energy will implement a NORM/TENORM monitoring and management programme, where applicable, during production operations. This programme will include the periodic inspection, monitoring and characterisation of produced water, scales, sludges, sediments, process residues, maintenance wastes and any other materials identified as having the potential to contain elevated concentrations of naturally occurring radionuclides. Monitoring requirements and sampling frequencies will be informed by operational experience, production characteristics, regulator requirements and recognised industry good practice.

Should NORM or TENORM be identified during operational monitoring, appropriately qualified specialists will be engaged to undertake detailed radiological characterisation and risk assessment of the affected materials and infrastructure. The findings of such investigations will be used to determine whether any specific management measures, exposure controls, waste-management requirements, transport controls, storage requirements or disposal procedures are necessary.

The results of operational monitoring and radiological characterisation will further be used to determine the applicability of any regulatory requirements administered by the National Nuclear Regulator (NNR) or any other competent authority. Where monitoring identifies radionuclide activity concentrations or operational circumstances that trigger regulatory obligations, D3 Energy will engage with the relevant authorities and obtain any required authorisations, registrations, permits or approvals prior to undertaking the regulated activity.

No operational activity involving the handling, storage, transport, treatment or disposal of NORM/TENORM will be undertaken outside the requirements of applicable legislation and regulatory standards. Where radioactive

residues are identified, these materials will be managed in accordance with the recommendations of suitably qualified specialists and any requirements prescribed by the relevant competent authorities.

Given the uncertainty regarding the occurrence and concentration of NORM/TENORM prior to production, a performance-based management approach is considered appropriate. This approach ensures that operational monitoring is undertaken to establish actual site-specific conditions, while providing a mechanism to implement additional controls and obtain any required authorisations should elevated radionuclide concentrations be encountered during the life of the project.

8.3.4.2 REGIONAL GEOLOGICAL SETTING

The D3 Energy PR is located within the Free State Helium Province, immediately adjacent to the Tetra4 gas producing project. The area is associated with major fault-controlled structures, particularly the Virginia Fault System and associated fractures that act as migration pathways and storage zones for methane-rich natural gas and helium.

The regional stratigraphy includes:

- Karoo Supergroup sediments.
- Ecca and Beaufort Group shales and sandstones.
- Dolerite intrusions.
- Underlying Witwatersrand and Ventersdorp Supergroups.
- Deep groundwater circulation systems associated with major fault zones

These lithologies can naturally contain low concentrations of:

- Uranium-238
- Thorium-232
- Radium-226
- Radium-228
- Radon-222
- Potassium-40

Previous investigations in South African sedimentary basins indicate that radionuclide concentrations are generally low to moderate and consistent with natural background levels, except where groundwater and hydrocarbons interact with uranium-bearing strata (Hobday & Galloway, 1999; Botha, 2017; Cole, 2020; Makubulo, 2020).

8.3.4.3 EXISTING RADIOLOGICAL ENVIRONMENT

8.3.4.3.1 REGIONAL BACKGROUND RADIATION

The Free State Province generally exhibits natural terrestrial gamma radiation levels typical of sedimentary terrains. Background external gamma dose rates are expected to range from:

- 0.05 to 0.15 microsieverts per hour (µSv/h)
- Equivalent annual external doses of approximately 0.4 to 1.3 millisievert (mSv)/year

These levels fall within normal global natural background radiation ranges as reported by the International Atomic Energy Agency (IAEA) and UNSCEAR. No licensed radioactive waste facilities or uranium mining operations occur within the immediate D3 Energy PR footprint, although historic gold mining districts occur elsewhere within the broader Free State Goldfields region.

8.3.4.3.2 SOILS

Baseline soils in the project area are dominated by:

- Sandy loams.
- Clay-rich agricultural soils.
- Residual weathering products derived from Karoo sediments.

Table 27: Expected radionuclide concentrations in undisturbed soils (UNSCEAR, 2000)

Parameter	Anticipated Background Range
U-238	10 – 50 Bq/kg
Th-232	10 – 60 Bq/kg
Ra-226	10 – 50 Bq/kg
K-40	100 – 800 Bq/kg

No evidence currently indicates elevated radioactivity associated with surface soils within the proposed wellfield areas.

8.3.4.3.3 GROUNDWATER

Groundwater occurs within fractured sedimentary formations and fault-controlled aquifers. Deep groundwater circulation is considered instrumental in the generation and migration of methane and helium within the Virginia gas province. Naturally occurring radionuclides potentially present in groundwater include:

- Radium-226.
- Radium-228.
- Uranium isotopes.
- Dissolved radon gas.

Under pre-development conditions, radionuclide concentrations are expected to remain below South African and World Health Organization drinking-water screening levels. However, radionuclide concentrations may increase with depth and proximity to major fault structures.

8.3.4.3.4 AIR QUALITY AND RADON

Radon (Rn-222) is generated naturally through uranium decay in rocks and soils. Baseline radon concentrations in outdoor environments across the Free State are generally low due to:

- Open terrain.
- Moderate wind speeds.
- Lack of uranium-rich surface geology.

Typical outdoor radon concentrations are expected to be:

- <10 Bq/m³

No significant public exposure pathways currently exist.

Based on current regional geology and the nature of the gas resource, the pre-development radiological environment is considered to be low risk. Available information does not indicate the presence of significant naturally radioactive geological formations within the proposed D3 Energy development area. The principal radiological concern is therefore not ambient radiation but the potential generation of TENORM through operational concentration processes associated with produced water, scale deposition, sludge accumulation and radon-bearing gas streams. The project area lies within the same helium-producing structural corridor as the Virginia Gas Project, where gas migration occurs along major fault systems and fractured reservoir zones.

Without mitigation, localized TENORM accumulation may occur within production equipment over the operational life of the project. However, implementation of a NORM Management Plan, routine monitoring, worker training, waste characterization, and compliance with National Nuclear Regulator requirements are expected to reduce residual risks to low levels.

8.4 CLIMATE

This section provides the climatic conditions as per the Climate Impact Assessment by Airshed Planning Professionals (**Appendix F4**).

8.4.1 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 greater study area ranges between 11.5 °C in the winter (July) and 24.4 °C in the summer (January), while the mean annual temperature is 18.8 °C (Climate-Data, 2021). Refer to **Figure 32** for the Mean Yearly Temperature Distribution of the greater study area. Based on the Climate Change Impact Assessment by Airshed Planning Professionals (**Appendix F4**), Baseline annual average temperature was in the range 15.9°C three very hot days per year and seven heat wave days per year.

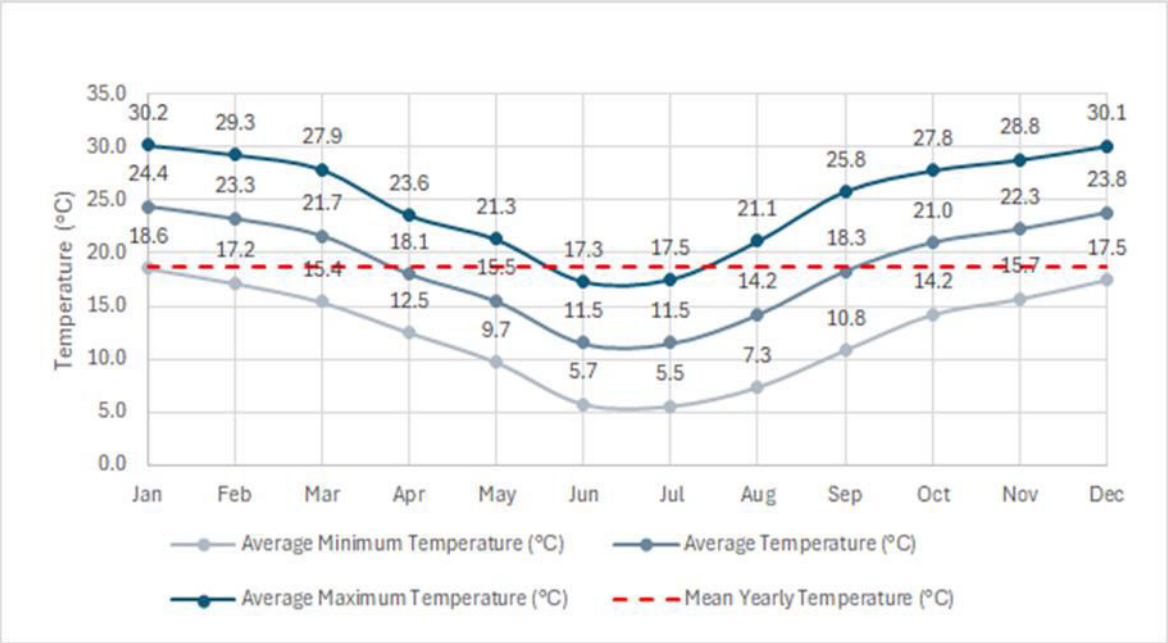


Figure 32: Mean Yearly Temperature Distribution of the greater study area, 1991 – 2024 (Climate-Data, 2021).

Recent change in climatic conditions near the project site were accessed from MeteoBlue[9] 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 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 33**– 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 34**), where the difference

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

from long-term average for each year in the data set is visualised by the stripes in the lower panel of (**Figure 33** (brown stripes indicate lower than average rainfall and green stripes above average rainfall).

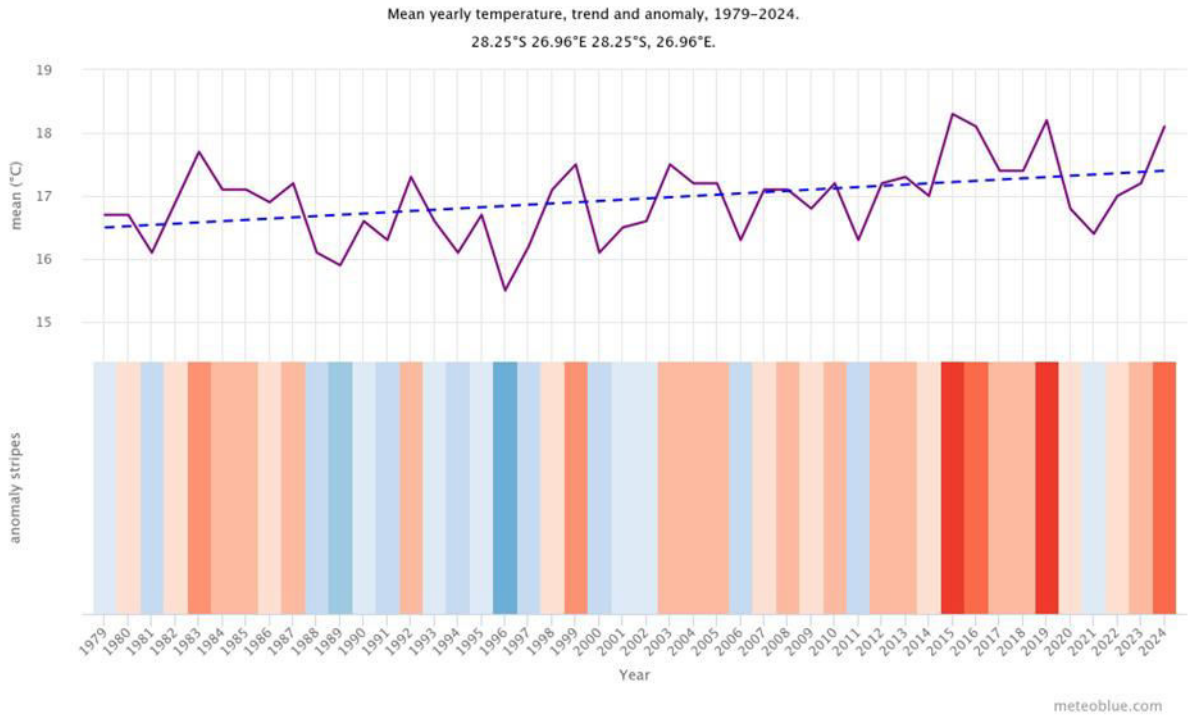


Figure 33: Annual average temperature (top panel) and temperature anomaly (lower panel) between 1979 and 2024 (Meteoblue, 2025).

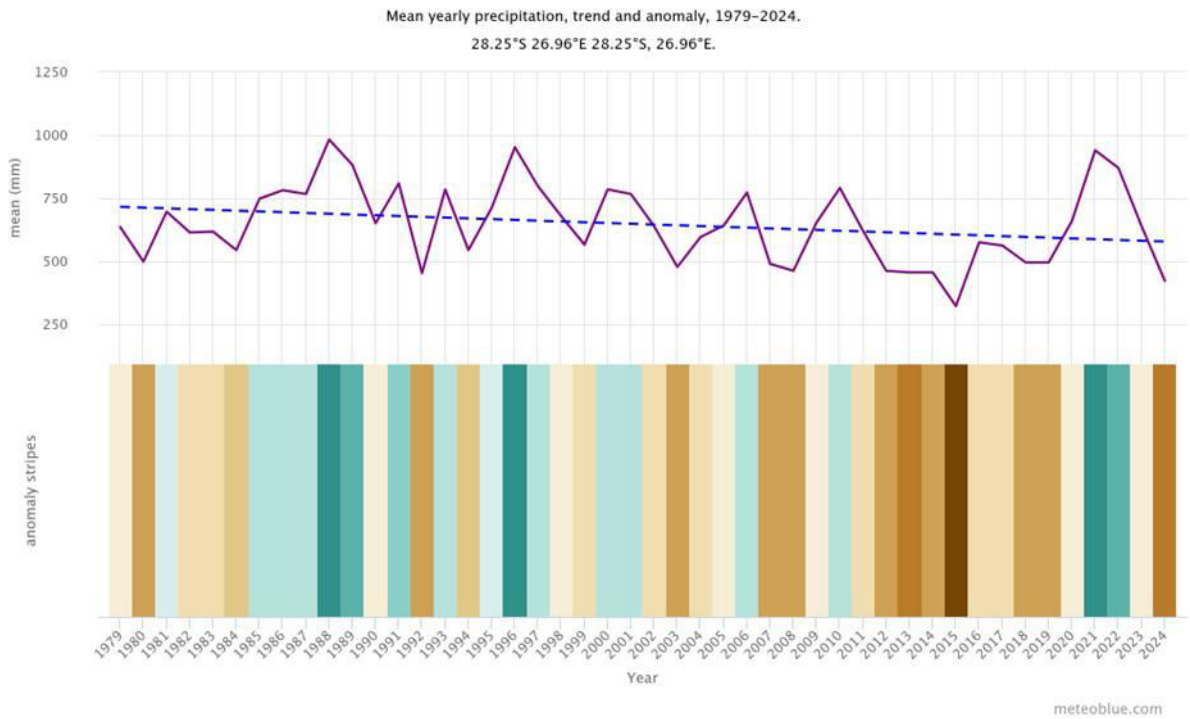


Figure 34: Annual average rainfall (top panel) and rainfall anomaly (lower panel) between 1979 and 2024 (Meteoblue, 2025).

The mean annual precipitation (MAP) for the study area is estimated at approximately 535.98 mm/a, based on patched monthly precipitation data (ranging from 1920 to 2009), obtained from the WR2012 database (WRC,

2016). The 5th percentile of the dataset, which approximately represents a 1:20 year drought, is calculated as 353.24 mm/a. The 95th percentile of the dataset, which approximately represents the 1:20 year flood, is calculated as 774.02 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 (~80.0%) as high intensity thunderstorms, while the winter months, June to August, are particularly dry. Refer to **Figure 35** for graphical representations of the monthly precipitation distributions for the study area. The study area falls within evaporation zone 19C with the mean annual evaporation (MAE), measured by Symons Pan, ranging between 1 560 and 1 600 mm/a (WRC, 2016).

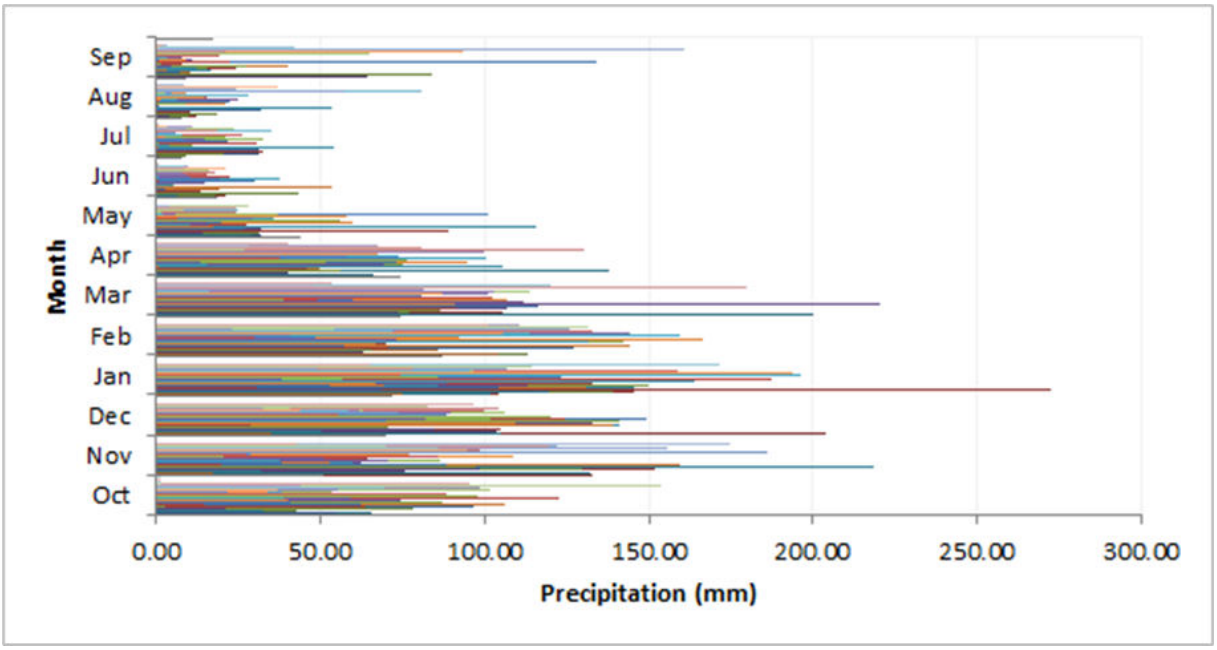


Figure 35: Monthly Precipitation Distribution (WRC, 2016).

8.4.2 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/m2 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 CO2 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

8.4.2.1 RCP4.5 TRAJECTORY

The Green Book projected temperature changes in the near future (up to 2050) indicate an average increase of 2.3°C (**Figure 36**, Engelbrecht, et al., 2019). The number of very hot days are expected to increase by 8.5 days per year (**Figure 37**). Between 2021 and 2050 the annual rainfall near the project site was projected to increase

by 163 mm (**Figure 38**, Engelbrecht, et al., 2019), with extreme rainfall days potentially increasing by 2.2 days in the near future (**Figure 39**, Engelbrecht, et al., 2019).

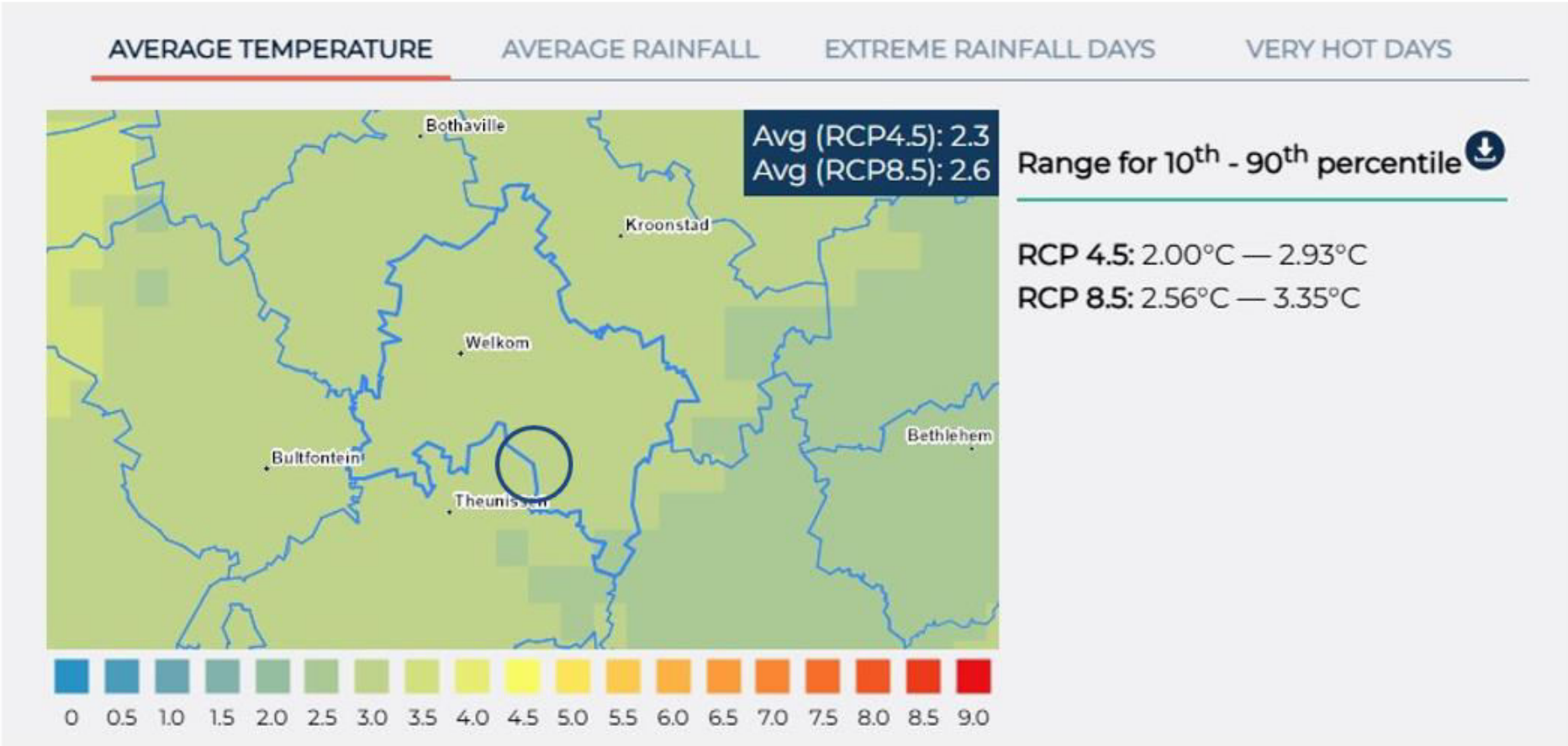


Figure 36: Projected change in annual average temperature for the near future (2021 – 2050) (dark blue marker indicates approximate location of the project) (Airshed, 2026)

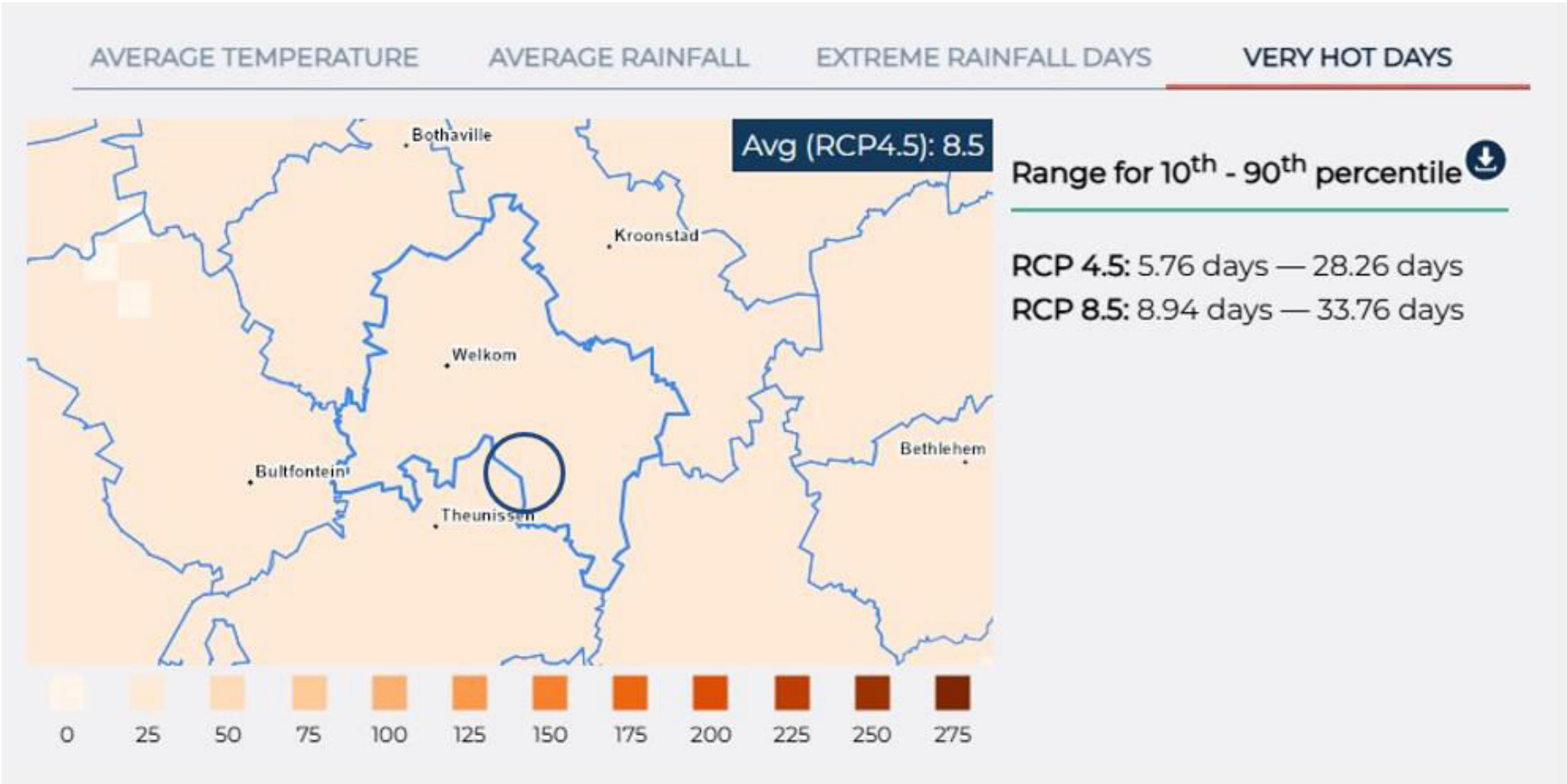


Figure 37: Projected change in annual average number of very hot days for the near future (2021 – 2050) (dark blue marker indicates approximate location of the project) (Airshed, 2026)

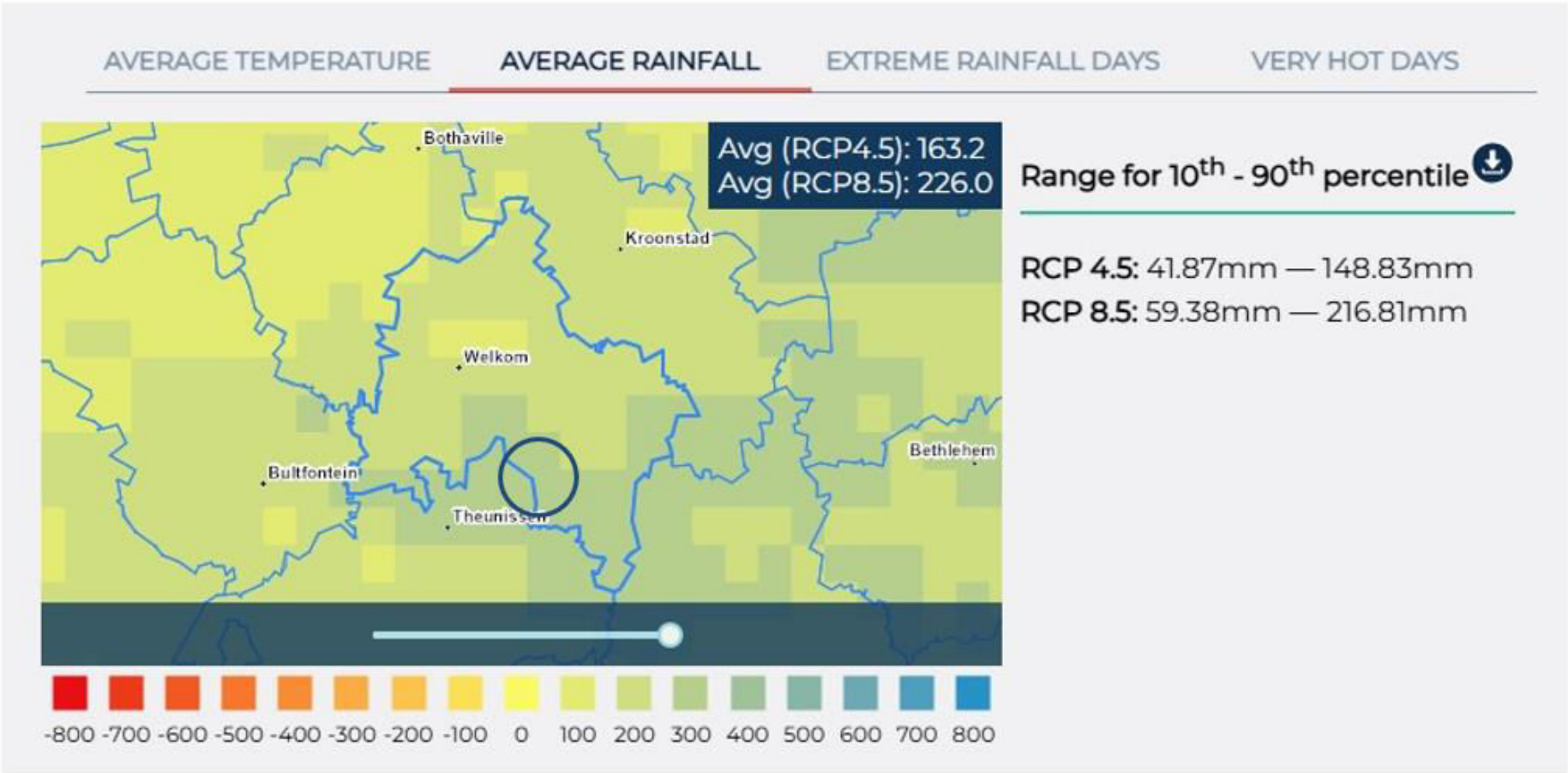


Figure 38: Projected change in annual average rainfall for the near future (2021 – 2050) (dark blue marker indicates approximate location of the project) (Airshed, 2026)

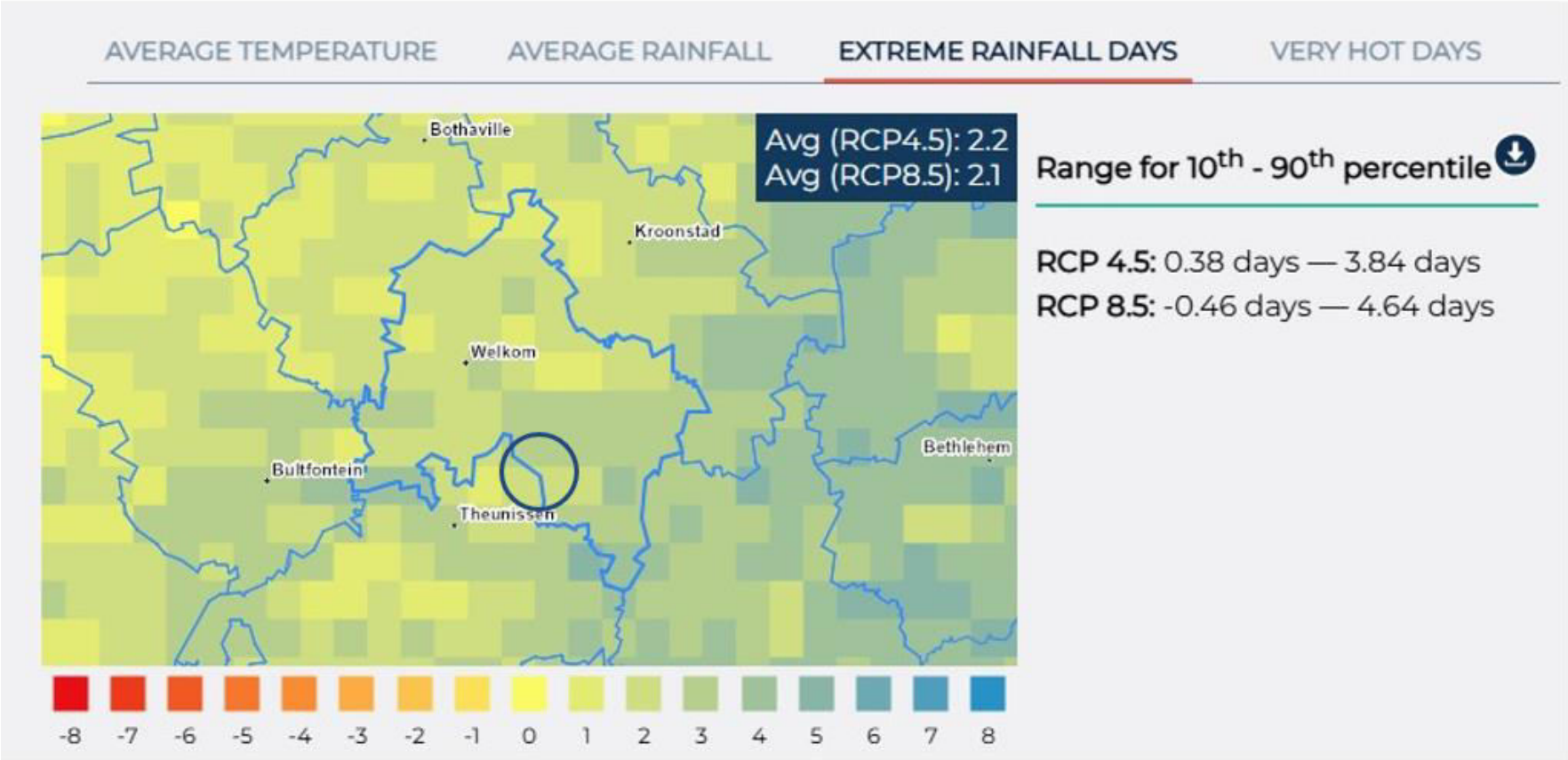


Figure 39: Projected change in annual average number of extreme rainfall days (>20 mm in <24 hours) for RCP4.5 trajectory (dark blue marker indicates approximate location of the project) (Airshed, 2026)

8.4.2.2 RCP8.5 TRAJECTORY

The Green Book projected temperature changes in the near future (up to 2050) indicate an average increase of 2.6°C (**Figure 36**, Engelbrecht, et al., 2019). The number of very hot days are expected to increase to between 9 and 34 days per year. Between 2021 and 2050 the annual rainfall near the project site was projected to increase by 226 mm (**Figure 38**, Engelbrecht, et al., 2019), with extreme rainfall days potentially increasing by 2.1 days in the near future (**Figure 39,** Engelbrecht, et al., 2019).

8.4.2.3 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 2.3°C for the period 2081 to 2100. The projections for the RCP8.5 indicate an increase in annual average temperatures of 2.7°C for the period 2041 to 2060, to 5.3°C for the period 2081 to 2100 (IPPC, 2022). The AR5 projections, for comparison, estimate an increase in annual average temperatures (50th percentile) of 2.3°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 5% for the period 2041 to 2060, to 6% for the period 2081 to 2100. The projections for RCP8.5 indicate a decrease in rainfall of 6% for the period 2041 to 2060, to 10% for the period 2081 to 2100 (IPPC, 2022).

It should be noted that the difference in precipitation projections between the various models (for e.g. Green Book and AR6) vary primarily by spatial resolution, geographic scope, forecast time horizon, and underlying physical or statistical physics.

8.5 SOCIAL

Information on the area's topography was obtained from the Social Impact Assessment Report undertaken by Equispectives Research and Consulting Services (**Appendix F11**). The proposed project is located in Wards 1, 3, and 4 of the Matjhabeng Local Municipality and Ward 6 of the Masilonyana Local Municipality that both forms part of the Lejweleputswa District Municipality in the Free State Province (2016 municipal boundaries). The baseline description of the environment will include these areas. **Figure 40** 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.

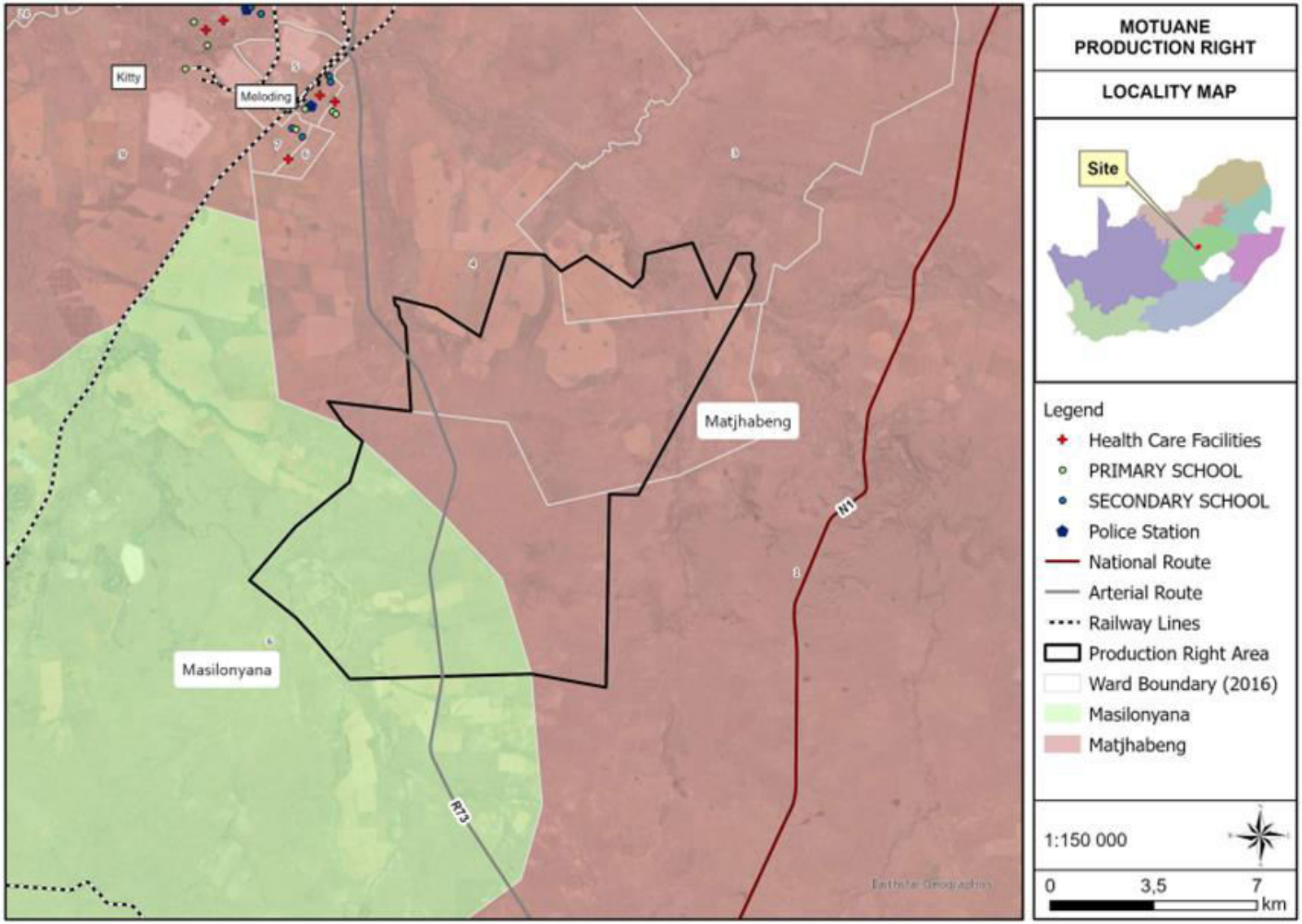


Figure 40: Location of the proposed D3 Energy PR in relation to local municipal boundaries (Equispectives Research and Consulting Services, 2026).

8.5.1 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 makes 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.

8.5.1.1 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).

8.5.1.2 MASILONYANA LOCAL MUNICIPALITY

The main towns in the Masilonyana Local Municipality are Theunissen, Brandfort, Winburg, Verkeerdevlei, and Soutpan. It is a semi-rural municipality whose economy is primarily driven by mining and agriculture. Mining remains the largest contributor to economic output, accounting for about 40.2% of Gross Value Added (GVA) in 2022, although it provides only around 8% of local employment due to its capital-intensive nature (Masilonyana Local Municipality IDP 2024/2025). Agriculture dominates land use and contributes significantly to rural livelihoods, but its overall economic value is modest. The largest sources of employment are trade, community services, agriculture, and private households, which together absorb the bulk of the workforce. While the municipality continues to recognise the potential of tourism linked to its central location and heritage assets, its current development focus is on infrastructure upgrades, improving financial sustainability, and fostering partnerships with the mining sector to support inclusive growth.

8.5.2 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 are different from 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.

8.5.2.1 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 28**), 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 28: 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
Masilonyana LM	6,618	59,895	63,800	9.05	9.64	6.52

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 29**), 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 Masilonyana 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 29: 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
Masilonyana LM	5.3	41.8	0.022	6.5	41.8	0.027

8.5.2.2 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, of Matjhabeng LM and Ward 6 of Masilonyana LM (**Figure 41**).

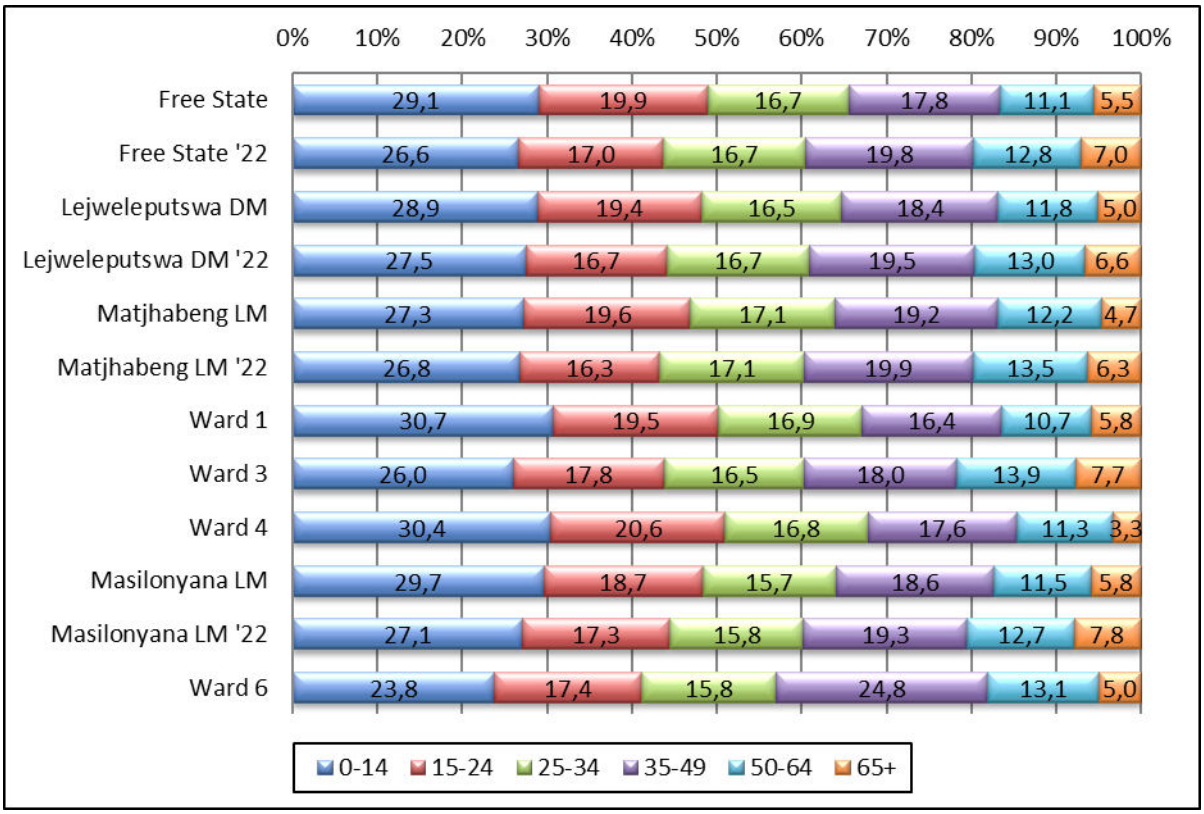


Figure 41: Age distribution (shown in percentage, source: Census 2011), Census 2022.

8.5.2.3 LANGUAGE

The majority of people in the area under investigation have Sesotho as home language. Ward 3 has 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**).

8.5.2.4 ACCESS TO WATER AND SANITATION

Ward 3 of the Matjhabeng 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 a borehole (**Figure 42**). 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 production to prevent groundwater seepage as per the proposed drilling procedure.

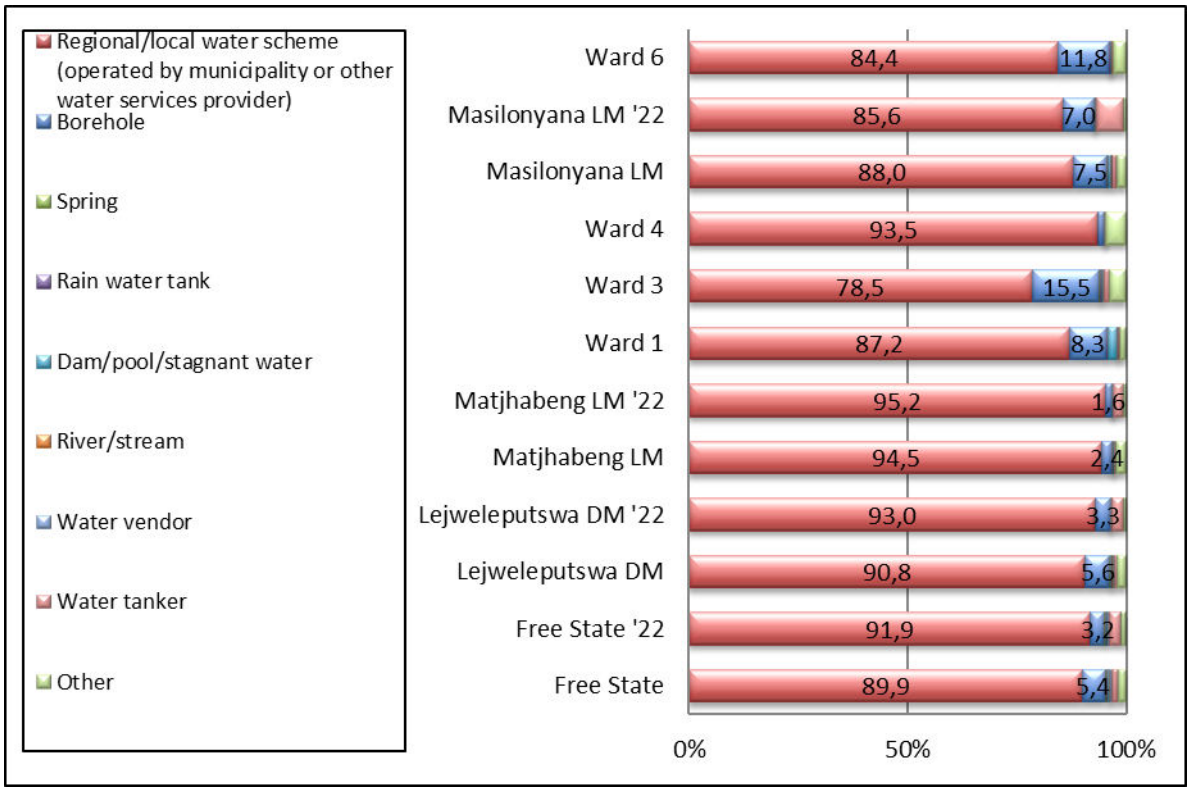


Figure 42: Water source (shown in percentage, source: Census 2011, Census 2022).

Access to piped water, electricity and sanitation relate to the domain of Living Environment Deprivation as identified by Noble et al (2006). Almost half of households in Ward 4 has access to piped water inside the dwelling (**Figure 43**). The proportion of households in the other wards with access to water inside their dwellings are lower than on local and district level.

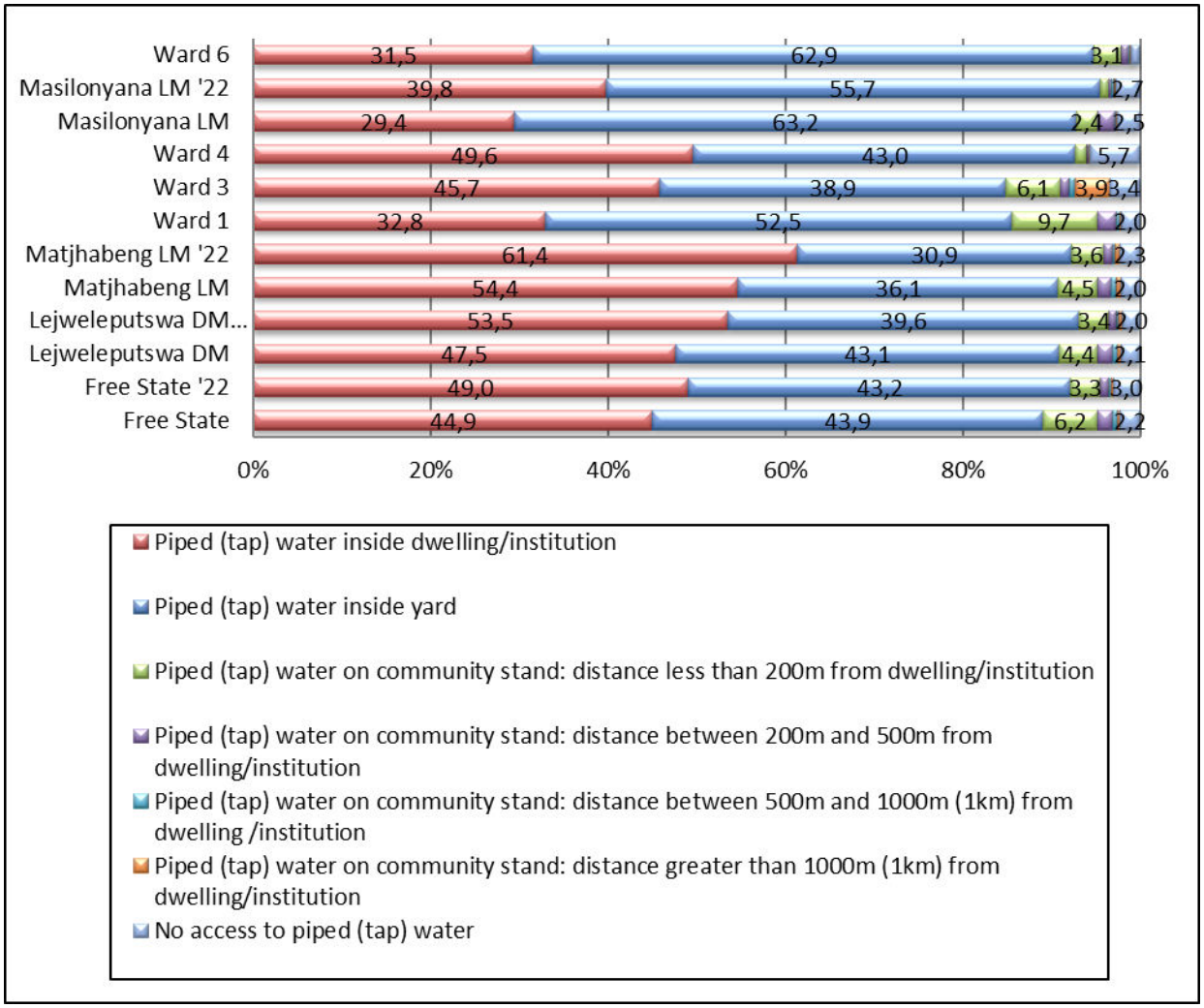


Figure 43: Piped water (shown in percentage, source: Census 2011, Census 2022).

The level of access to flush toilets that are connected to a sewerage system varies between the wards. Ward 1 had the highest incidence of households that don't have access to sanitation (**Figure 44**). The level of access to flush toilets that are connected to a sewerage system varies between the wards.

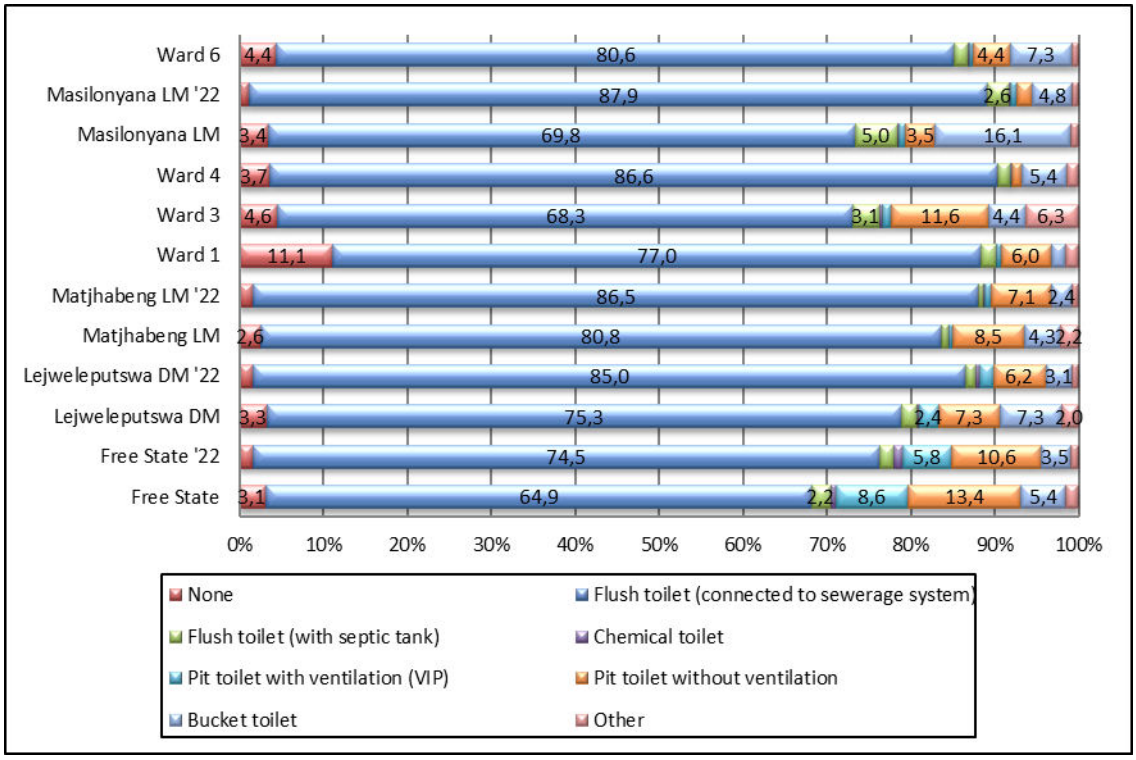


Figure 44: Sanitation (shown in percentage, source: Census 2011).

8.5.2.5 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 1 and 3 of Matjhabeng LM have the lowest proportion of households with access to electricity as energy source for lighting (**Figure 45**). It is evident from the energy source usage that gas is underutilized in the area although there is direct evidence of gas-emitting boreholes, nearby commercial gas production, gas encountered during drilling and underground mining operations in the region.

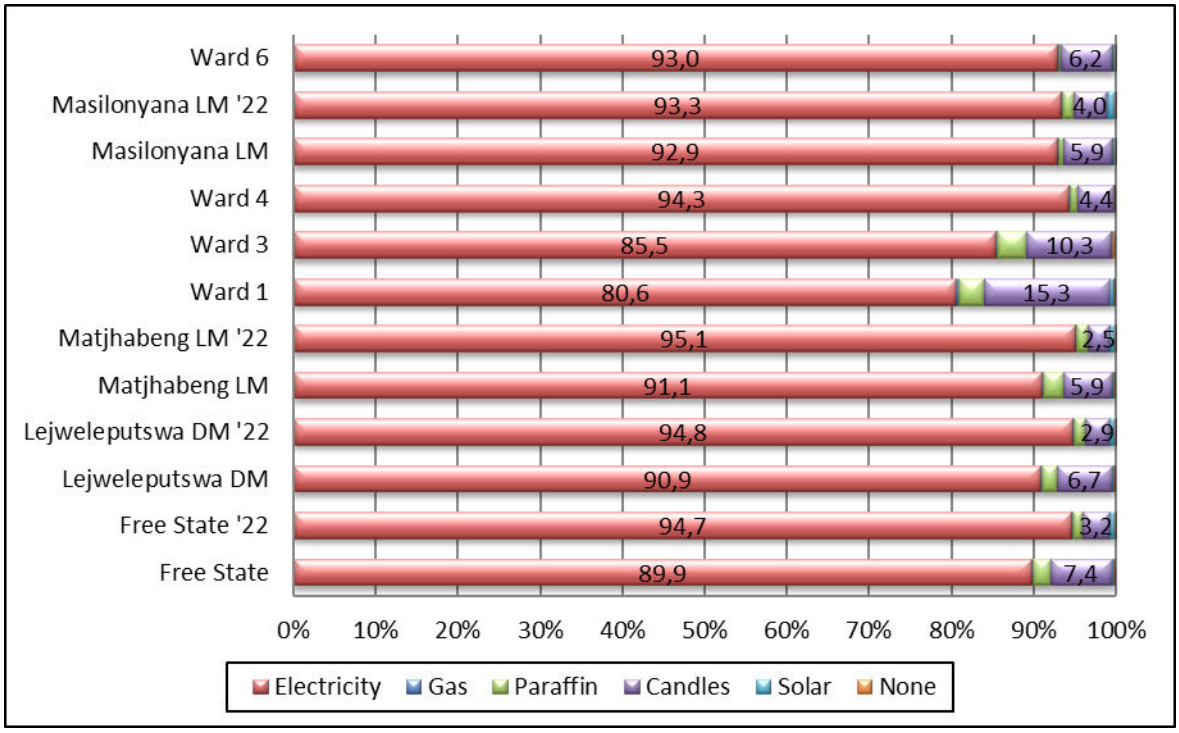


Figure 45: Energy source for lighting (shown in percentage, source: Census 2011, Census 2022).

8.6 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 Production Right area in Virginia Free State Province.

According to the Baseline Heritage Impact Assessment Report undertaken by Dr Lucien James (EIMS, 2025), 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).

8.6.1 RELATIVE ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME SENSITIVITY

According to the DFFE Screening Tool Report, the proposed study area is located within an area of *low* relative archaeological and cultural heritage theme sensitivity (see **Figure 46**). An assessment of the NHRA and preliminary project information revealed that the proposed project triggers Section 38(1) of the NHRA. Therefore, a Heritage Impact Assessment is required and will be undertaken in the EIA Phase. The South African Heritage Resources Agency (SAHRA), the Free State Heritage Resources Authority (FSPHRA) and Association of Southern African Professional Archaeologists (ASAPA) are I&APs in the project and will be provided with a copy of the report for review and comment.

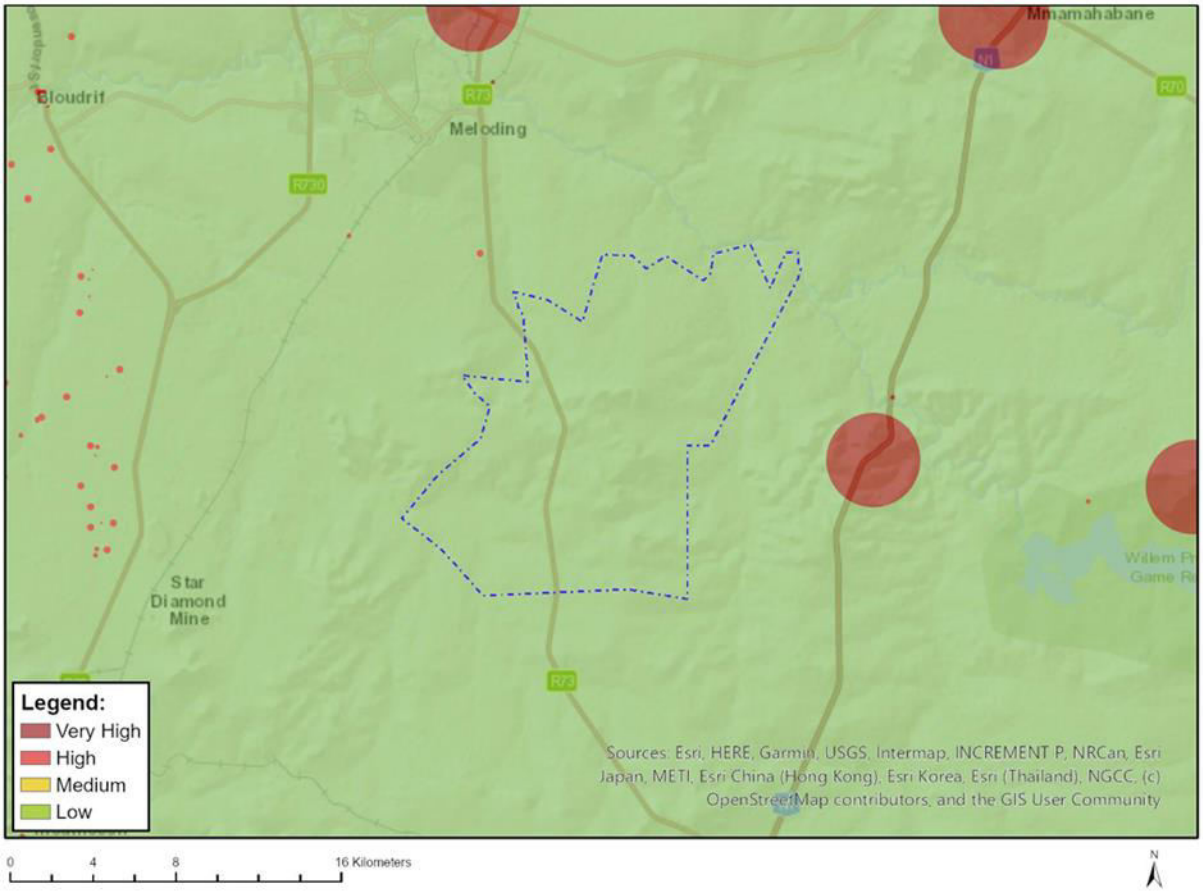


Figure 46: Map of relative archaeological and cultural heritage theme sensitivity (DFFE, 2025).

Based on the Heritage Impact Assessment Report undertaken by Dr Lucien James (**Appendix F2)**, the proposed PR area 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 (2826BB, 2827AA, 2826BD and 2827AC) 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. An assessment of the maps revealed that the area in question has included several features such as settlements. The earliest map (2826BB dated 1945) indicates the presence of such settlements or "native huts" along a proposed PR5 seismic transect (**Figure 47**). The features can be seen in aerial photographs from as early as 1944 (**Figure 48**). The features seem to have been disturbed and destroyed since, as they do not appear in current satellite imagery.

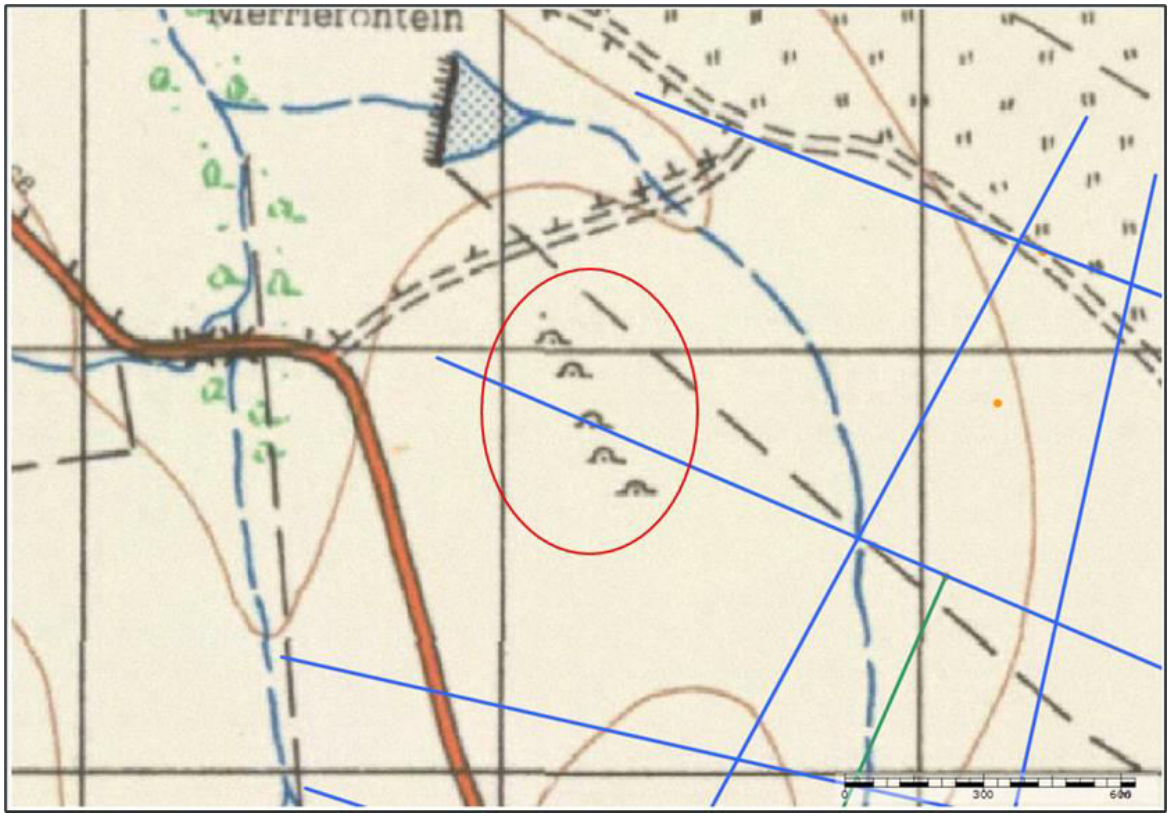


Figure 47: Extract of the First Edition Topographic map 2826BB dated 1945 indicating the presence of settlements (circled in red). Blue lines = seismic transects, green lines = gas line, orange dots = wells. (EIMS, 2025).

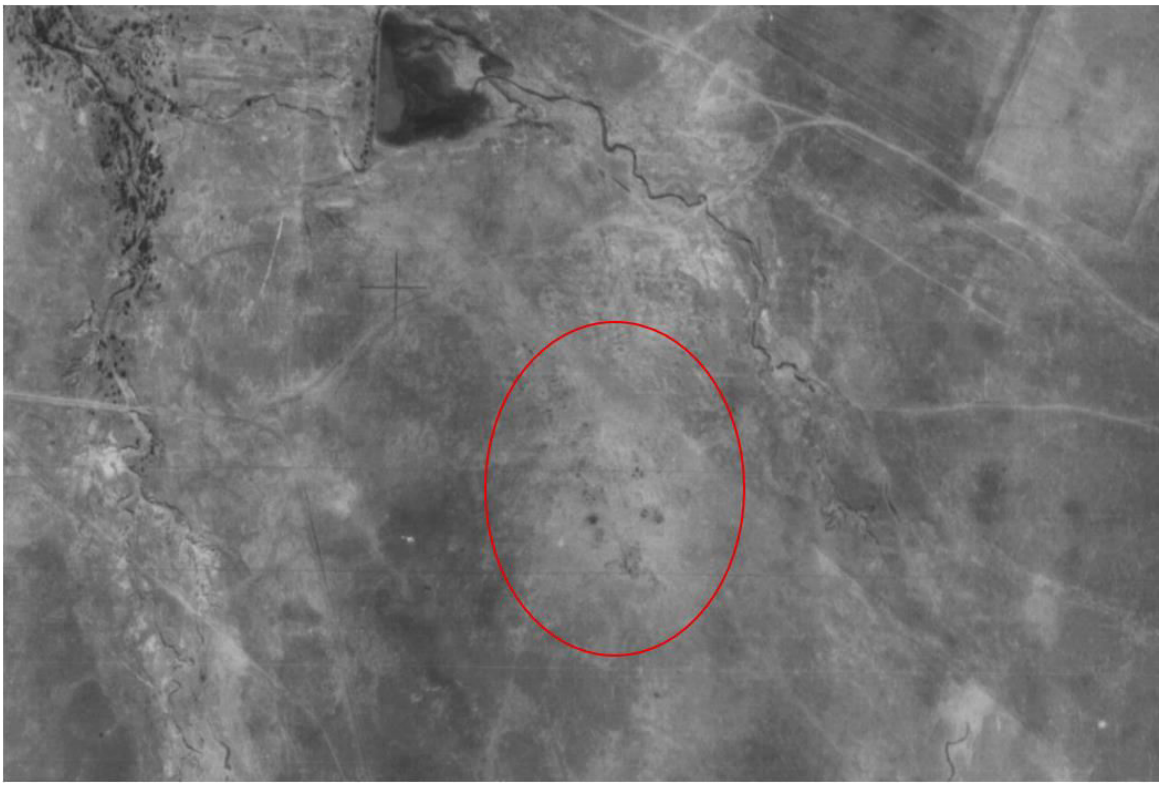


Figure 48: Aerial photograph of 1944. Note the presence of features (circled in red) corresponding with observations made in the First Edition Topographic maps along PR5 seismic transect.

To corroborate the above observation, the impact of agriculture and similar activities on heritage features is noted in examples illustrated below. For example, settlements were noted near the historical farm complex Azeka (**Figure 49**). The complex has since been demolished and the settlement destroyed making way for cultivated land as depicted in **Figure 50**.

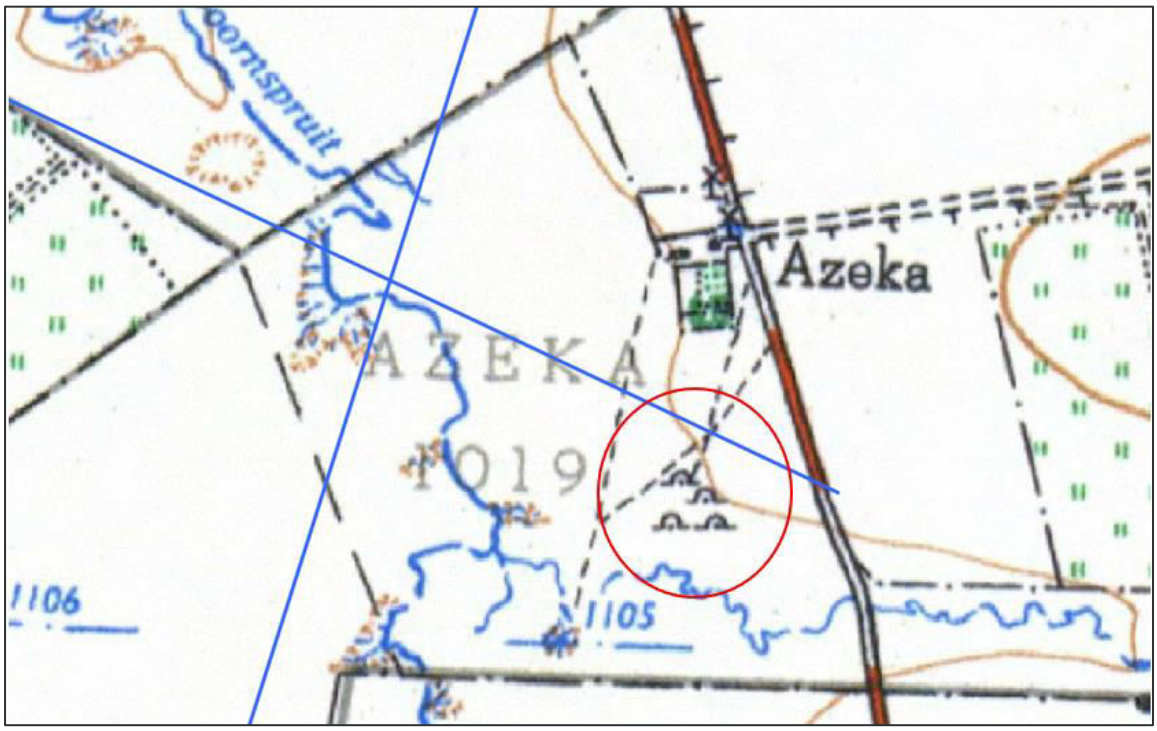


Figure 49: Extract of the First Edition Topographic map 2826BD dated 1947 indicating the presence of settlements (circled in red). Blue lines = seismic transects.

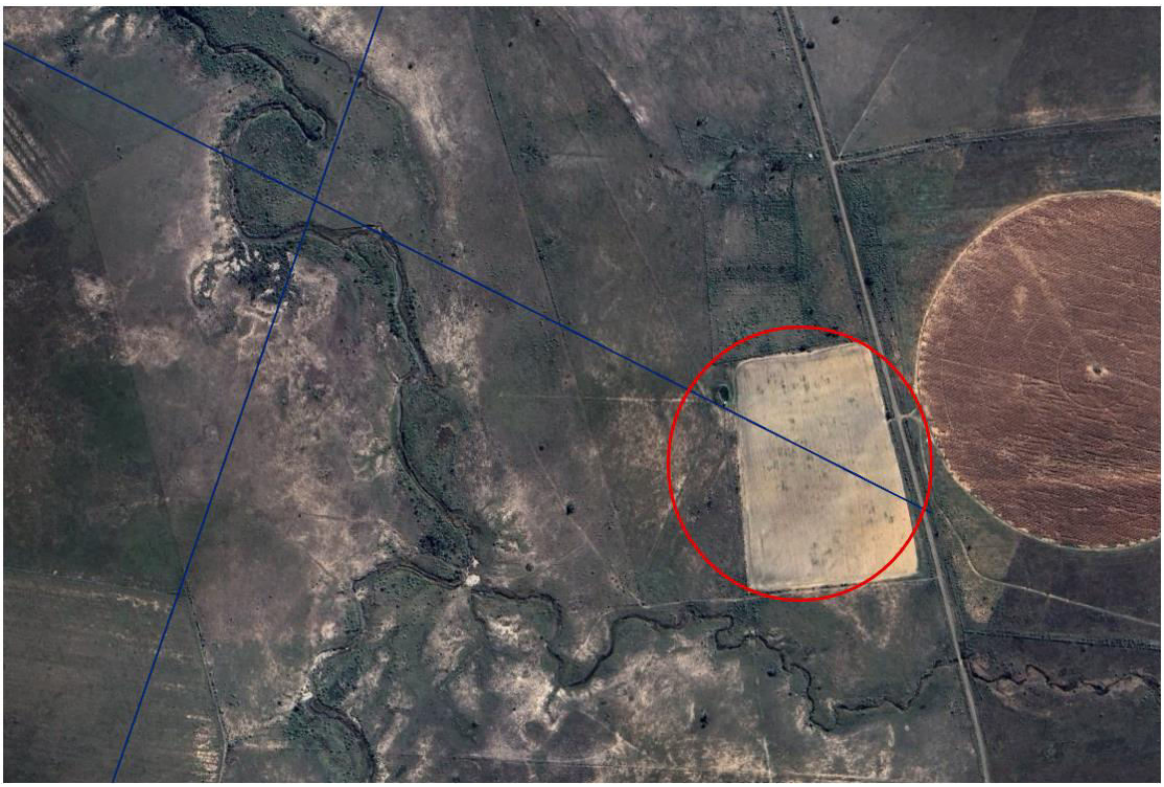


Figure 50: Google Earth imagery of a disturbed area which once held settlements (general location circled in red) as heritage features along the proposed PR3 seismic transect (illustrated in blue).

Another important feature noted through the desktop assessment was the farm complex Siberiasfontein, which appeared on first edition topographic maps, and is still present and in use (**Figure 51**). The complex includes, not only historical buildings, but also a graveyard which fall along PR7 seismic transect.

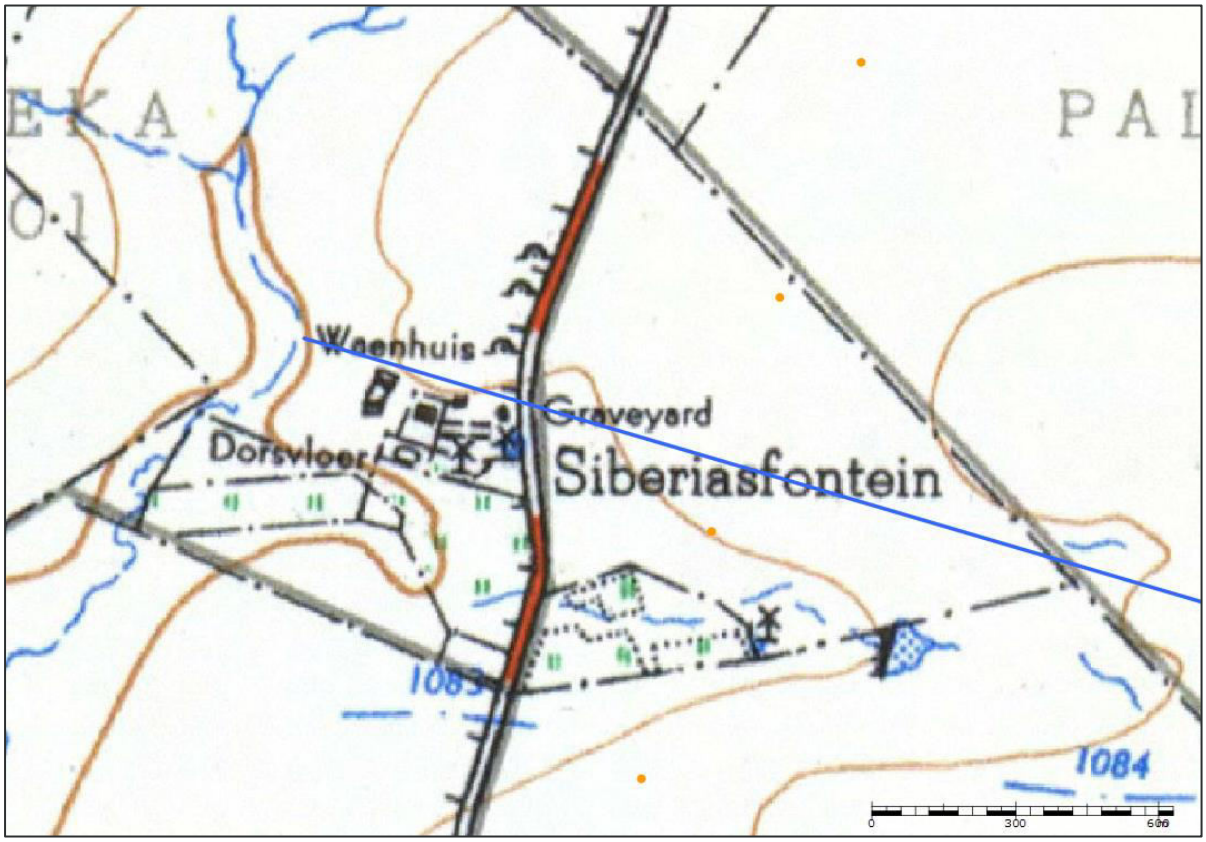


Figure 51: Extract of the First Edition Topographic map 2826BD dated 1947. Map includes the farm complex, Siberiasfontein. Note the grave and historical structures which fall along the proposed PR7 seismic transect (blue line).

8.6.2 SUMMARY OF BASELINE HERITAGE FINDINGS

Following a desktop assessment and field survey, a total of 18 potential heritage features were identified within the area, of which 13 Were identified in proximity and intersecting the project footprint including, burials and cemeteries, historical period remains, historical farmsteads and structures, and a potential iron age/colonial settlement. **Table 30** provides a summary of the different features identified, a description of the feature, as well as the coordinates of where the feature are located or associated relative central points.

Table 30: Summary of different finds identified (EIMS, 2025).

Feature No.	Description	Rating and Significance	Coordinate
MPR001	Historical Farmstead or farm complex known as Bloemskraal identified by Kruger (2021).	Grade IIIC Medium	28°14'46.46"S 26°58'35.47"E
MPR002	Historical Period remains including an ash midden and material culture of metal and plastic. Identified by Kruger (2021).	Grade IIIC Medium	28°12'30.85"S 27° 0'17.46"E
MPR003	Historical Period burial site including at least two graves. Identified by Kruger (2021).	Grade IIIA High	28°14'40.01"S 26°58'28.38"E
MPR004	Burial site holding a large number of graves. Some graves include headstones dating as far back as 1976. Site was identified by Kruger (2023).	Grade IIIA High	28°13'55.72"S 26°59'2.22"E
MPR005	Potential Historical Period Settlement. Identified by Kruger (2022).	Grade IIIC Medium	28°13'27.13"S 26°56'41.00"E
MPR006	Burial site holding at least 4 graves. Identified most recently by Angel (2024).	Grade IIIA High	28°15'44.99"S 26°56'23.73"E
MPR007	Kraal Structure which may not be older than 60 years. Identified by Angel (2024). – Verified through site survey.	NCW	28°15'49.82"S 26°56'42.76"E
MPR008	Historical structures part of old farmstead or complex.	Grade IIIC Medium	28°15'42.27"S 26°56'16.51"E
MPR009	Historical Farmstead and associated structures.	Grade IIIC Medium	28°17'0.54"S 26°59'17.14"E
MPR010	Historical Farmstead and associated structures.	Grade IIIC Medium	28°11'25.25"S 27° 0'33.82"E
MPR011	Potential historical settlement identified through archival study	N/A	28°12'22.01"S 26°56'11.30"E
MPR012	Grave site including 15-18 graves. Identified by Angel (2024).	Grade IIIA High	28°12'31.02"S 26°56'20.19"E
MPR013	Foundation of stone-built structure identified by Angel (2024).	Grade IIIA High	28°12'26.10"S 26°56'15.43"E
MPR014	Burial or grave site including 1-2 graves. No headstones included. Identified by Angel (2024).	Grade IIIA High	28°12'25.70"S 26°56'14.50"E

Feature No.	Description	Rating and Significance	Coordinate
MPR015	Midden including ash, glass and metal cultural material remains. Identified by Angel (2024).	Grade IIIA High	28°12'24.80"S 26°56'16.58"E
MPR016	Possible grinding stone identified by Angel (2024).	Grade IIIC Medium	28°12'20.66"S 26°56'15.04"E
MPR017	Foundation of stone-built structure identified by Angel (2024).	Grade IIIA High	28°12'27.65"S 26°56'39.95"E
MPR018	Foundation of stone-built structure identified by Angel (2024). – Verified through site survey.	Grade IIIA High	28°15'45.68"S 26°56'41.75"E
MPR019	Later Stone Age Site – included examples of different lithic types of material not of the area.	Grade IV B Medium	28°15'52.32"S 26°57'55.11"E
MPR020	Farm Infrastructure which may not be older than 60 years.	NCW	28°16'28.90"S 26°58'48.41"E
MPR021	Grave site including 10-15 identifiable headstones.	Grade IIIA High	28°16'50.92"S 26°58'44.80"E

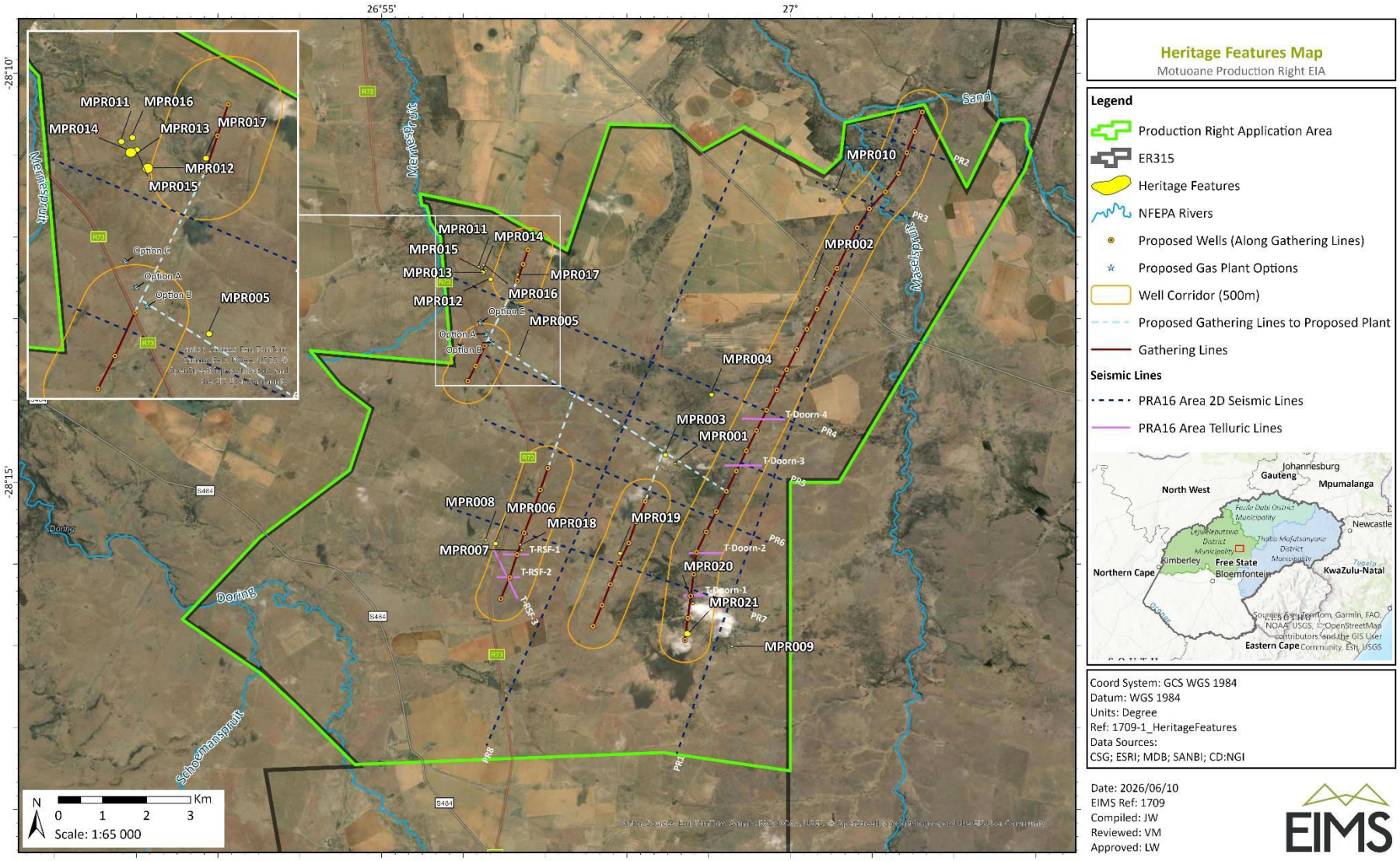
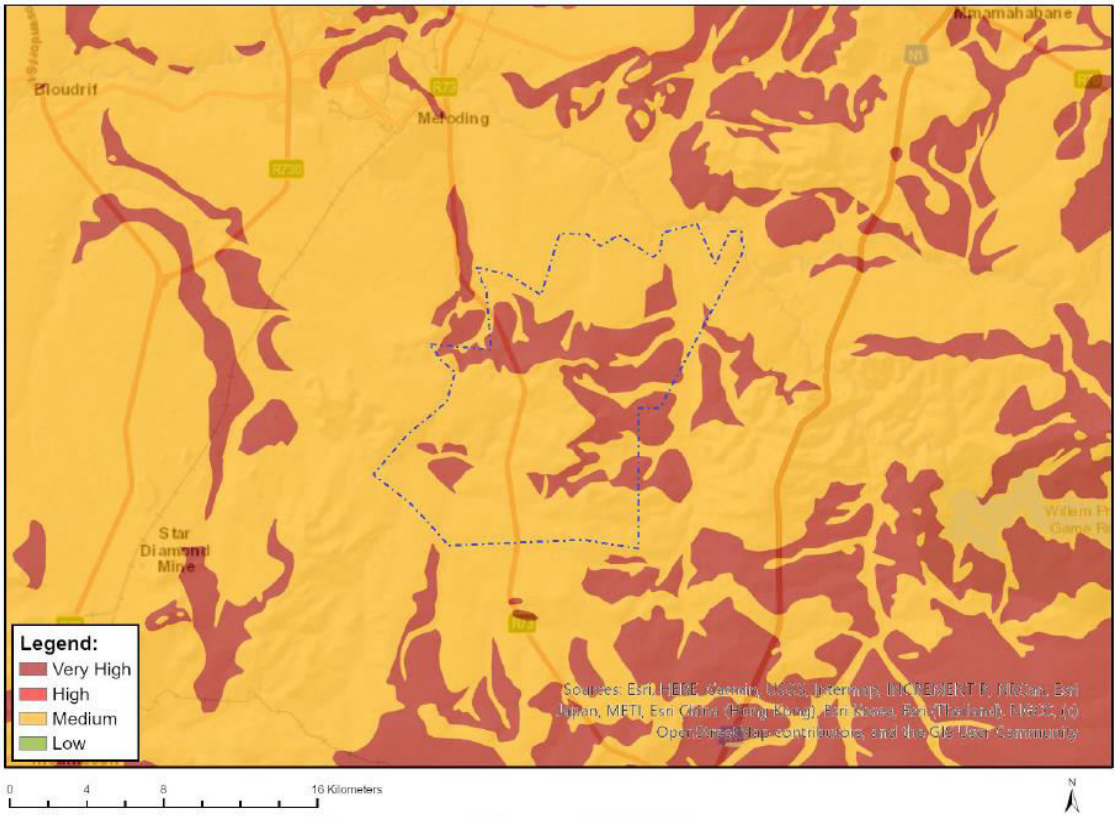


Figure 52: Map of potential heritage features across the PR Area (EIMS, 2026).

8.7 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 53**). The study area is located on an area which has largely been transformed by mining and agriculture, but the proposed project entails deep excavations (650m production wells). A Palaeontological Impact Assessment (PIA) was undertaken by Banzai Environmental (**Appendix F9**) for the project to identify fossil resources and the potential impact by the proposed project as well as mitigation measures.



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

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

Figure 53: Map of relative palaeontology theme sensitivity (DFFE, 2025).

According to the Palaeontological Impact Assessment Report for the ER (**Appendix F9**), the PR is underlain by Quaternary sands (Qs) and alluvium, (yellow single bird figure), unfossiliferous Jurassic dolerite (Jd, red), and the Adelaide Subgroup (Pa, Beaufort Group, Karoo Supergroup). The PalaeoMap of the South African Heritage Resources Information System (SAHRIS) indicates that the Palaeontological Sensitivity of the Adelaide Subgroup is Very High, that of the Quaternary sediments is Moderate, and that of the that of the Jurassic Dolerite is Zero (Almond and Pether, 2009; Almond et al., 2013, Groenewald et al 2014).

According to the Council for Geoscience (CGS) 1:250 000 geological maps (Geological Map Sheet 2826 Winburg), the surface geology of the study area is characterized by a variety of lithologies, formations, and intrusions. The Beaufort Group, the third major subdivision of the Karoo Supergroup, overlays the Ecca Group and consists mostly of mudrocks alternating with sandstones, deposited in the Karoo Basin from the Middle Permian to the Early Triassic (Viglietti et al., 2016; Li et al., 2017). This constitutes the first entirely continental period within the Karoo Supergroup, with an extensive outcrop area of 140,000 km² in South Africa (Linol et al., 2021). The group is separated into two subgroups: the Tarkastad Subgroup and the Adelaide Subgroup.

The Adelaide Subgroup reaches a maximum thickness of 3,500 m in the southern region of the basin but significantly diminishes to under 200 m towards the north (Linol et al., 2021). Deposition occurred under humid circumstances conducive to expansive floodplains with elevated water tables, often considered to be fluvio-lacustrine environments (Viglietti et al., 2018). The lithologies consist of alternating greyish-red, bluish-grey, and greenish-grey mudrocks interspersed with fine- to medium-grained sandstones. Sandstones often display multi-storey formations, characterised by cut-and-fill structures, internal ripple lamination, horizontal lamination, and sporadic trough cross-bedding, whereas mudrocks erode into blocky profiles and may retain desiccation fractures or raindrop imprints (Li et al., 2017).

The Beaufort Group floodplains are globally recognised for their preservation of the early diversification of terrestrial vertebrates, offering one of the most comprehensive fossil records of the evolutionary shift from reptiles to mammals (Rubidge, 1995; Smith et al., 2020). Vertebrate assemblages serve as the basis for biostratigraphic subdivision (Kitching, 1977; Keyser & Smith, 1977; Viglietti et al., 2016).

The Very High Palaeontological Sensitivity of the DFFE Screening Tool is supported by the SAHRIS PalaeoMap, which similarly indicates a Very High Palaeontological Sensitivity for the Adelaide Subgroup underlying the majority of the footprint (**Figure 54**). A field-based site investigation was conducted on 9 June 2026, no fossiliferous outcrops were identified within the development footprint. It is therefore, currently considered that the proposed project will not lead to detrimental impacts on the palaeontological reserves of the area and construction of the project may be authorised in its whole extent.

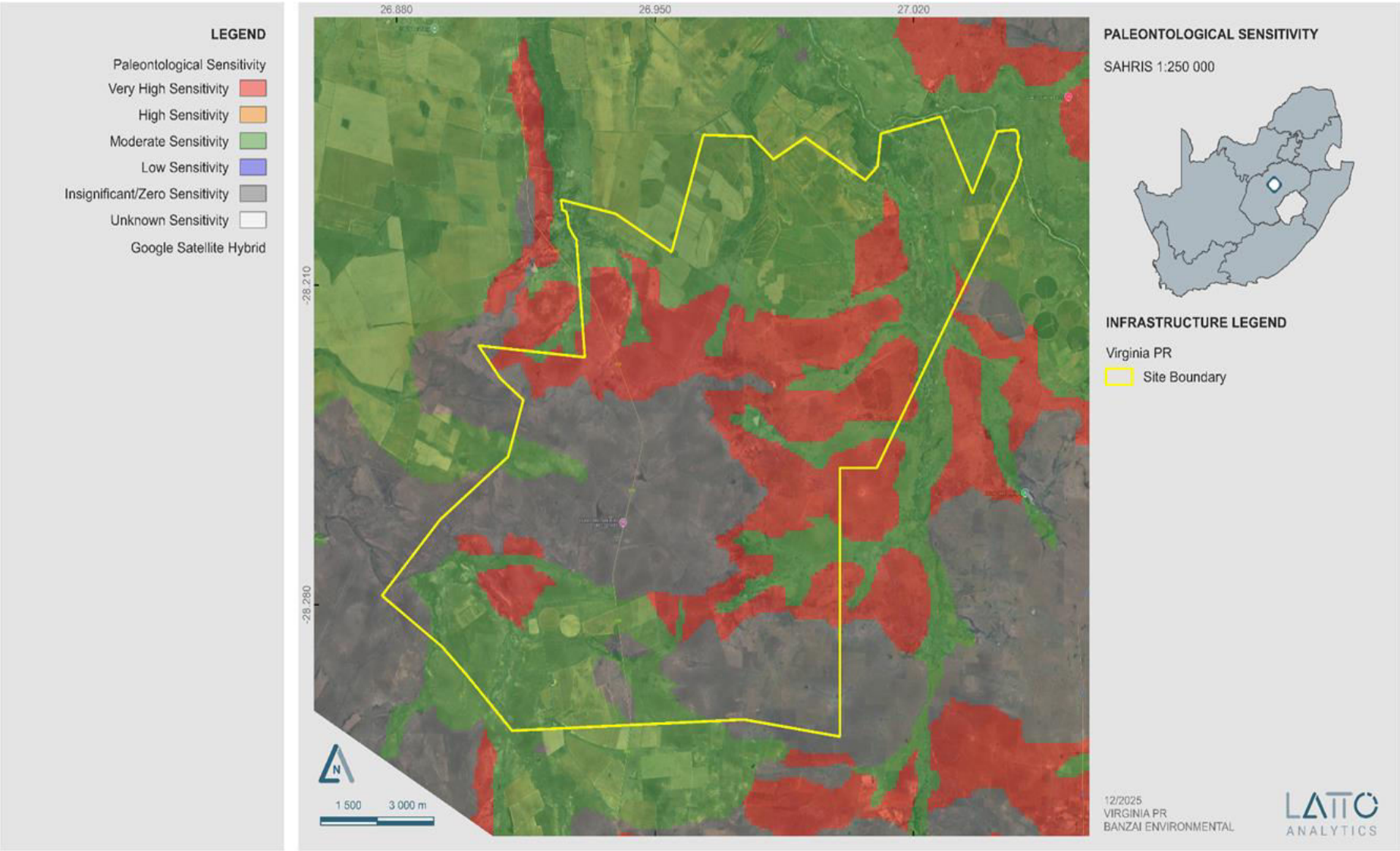


Figure 54: Extract of the SAHRIS PalaeoMap map (Banzai, 2026).

8.8 SOILS AND AGRICULTURAL POTENTIAL

As Soils and Agricultural Impact Assessment (**Appendix F12**) undertaken by The Biodiversity Company (2026), 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.

8.8.1 LAND CAPABILITY

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. The baseline soil land capability classes were compared to the National Land Capability data (DAFF, 2017), respectively. According to the land type database (Land Type Survey Staff, 1972 – 2006), the study area is characterised by land type Bd 20, Dc 12 and Dc 8 (**Figure 55**). **Figure 56** illustrates the respective terrain units relative to the proposed project area. The dominant Dc 12 land type is characterised by Mispah, Mayo, Swartland and Rensburg soil forms, with the possible occurrence of other soil forms throughout the landscape. The Bd 20 land type is characterised by the Clovelly, Avalon, Hutton and Valsrivier soil forms; while the Dc 8 land type is characterised by the Arcadia, Valsrivier, Rensburg, Oakleaf and Fernwood soil forms, with the possible occurrence of other soil forms throughout the landscape.

The land capability sensitivity is evenly dominated by the "Moderate to High" and the "Low to Moderate", with few isolated areas associated with the "Very Low to Low" sensitivity. If the crop fields found within the study area are active, the production activities will have an overall high residual impact on the agricultural production ability of the land. However, if the crop fields within the study area are inactive, the production activities will have an overall low to medium residual impact on the agricultural production ability of the land.

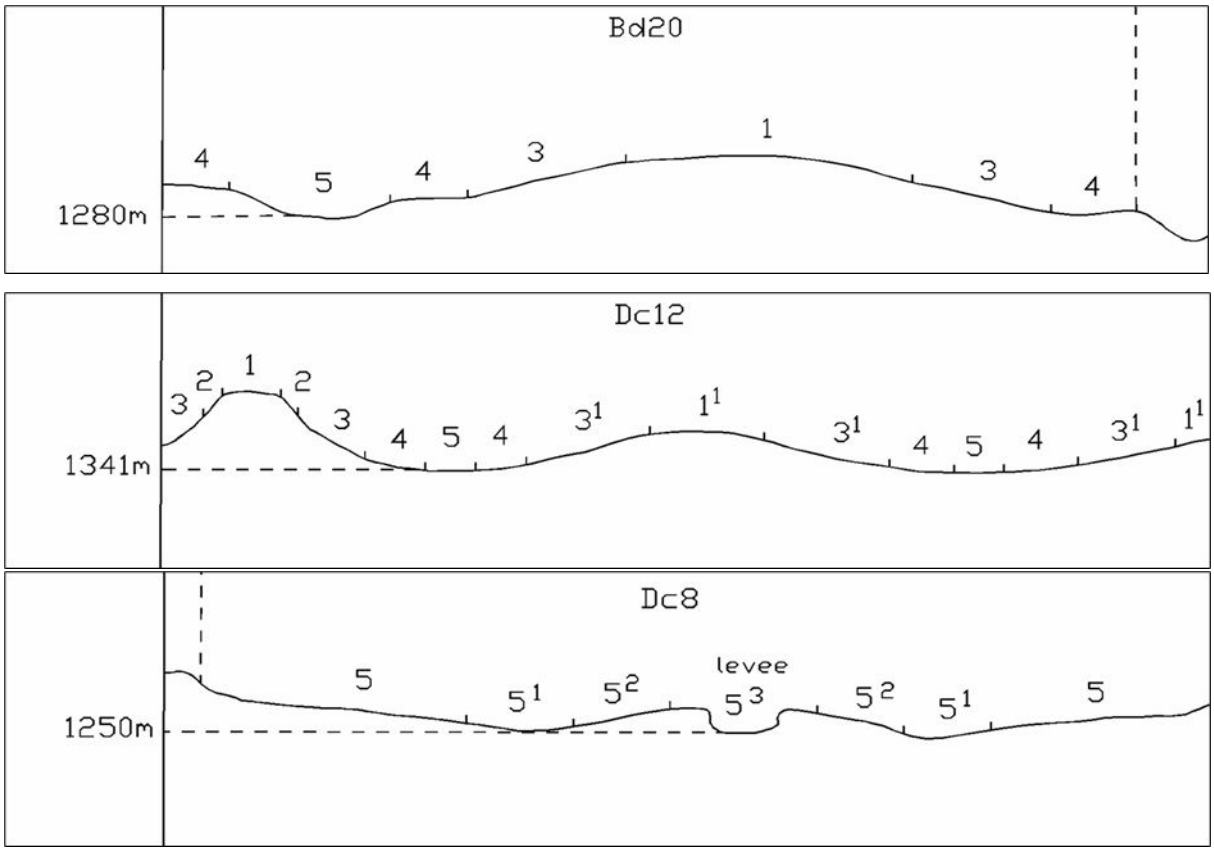


Figure 55: Illustration of the Bd 20, Dc 12 and Dc 8 land type terrain units (Land Type Survey Staff, 1972 – 2006) (The Biodiversity Company, 2026).

Thirteen (14) representative soil forms were identified in the proposed Project Area namely, Dundee, Ermelo, Hutton, Griffin, Clovelly, Cartref, Rensburg, Swartland, Glen, Arcadia, Rustenburg, Glenrosa, Mispah and Grabouw soil forms (**Figure 57**).

The most sensitive soil forms suitable for crop production identified within the seismic transects includes the Dundee, Griffin, Hutton and Clovelly soil forms. The Dundee soil form consists of an orthic topsoil horizon on top of a thick alluvial horizon. 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.

Two (2) hydromorphic soils with signs of wetness identified within the proposed target areas includes the Rensburg and Cartref soil forms. The Rensburg soil form consists of a vertic topsoil horizon underlain with a gley horizon. The Cartref soil form consists of an orthic topsoil horizon on top of an albic horizon underlain with a lithic horizon.

Three clayey soils also identified within the proposed seismic transects includes the Swartland, Glen, Arcadia and Rustenburg soil forms. The Swartland soil form consists of an orthic topsoil horizon on top of a pedocutanic horizon underlain with a lithic horizon. The Glen soil form consists of a vertic topsoil on top of a thick pedocutanic horizon. The Arcadia soil form consists of a vertic topsoil on top of a lithic horizon. The Rustenburg soil form consists of a vertic topsoil horizon on top of a hard rock substratum horizon. These soils are characterised by high clay content which may impede drainage, aeration, and root penetration.

The less sensitive soil forms identified within the seismic transacts with severe with to very severe limitations to crop production includes the Glenrosa, Mispah and Grabouw soil forms. The Glenrosa consists of an orthic topsoil horizon on top of a lithic horizon. The Mispah soil form consists of an orthic topsoil horizon on top of a hard rock substratum horizon. These soils have limited soil profile which in turn restrict their soil water holding capacity, root penetration and aeration. The Grabouw physically disturbed Anthrosols is characterised as the land which is physically disturbed by anthropogenic actives for agricultural purposes. This soil form is characterised by extremely severe limitation for crop production and is more suitable for wildlife practices.

The desktop assessment database (Land Type Survey Staff, 1972 – 2006) for the areas forming the entire production right area excluding the site verified proposed Project area indicates that the areas are characterised with the Clovelly, Hutton, Valsrivier, Rensburg, Oakleaf, Dundee, Swartland, Bonheim, and Mispah soil forms. The Dundee, Hutton, Clovelly and Oakleaf soil forms are mostly suitable for cropping practices. The Rensburg soil form is characterised by hydromorphic conditions associated with watercourse and wetlands areas. The Valsrivier, Swartland, and Bonheim soil forms have high clay contents which can limit most cropping practices. The Mispah soil form have restrictive limitations and therefore less suitable for crop production. Some of the identified soil horizons within the proposed Project Area, as well as the current land uses are illustrated in **Figure 58** to **Figure 59**, and **Figure 60,** respectively.

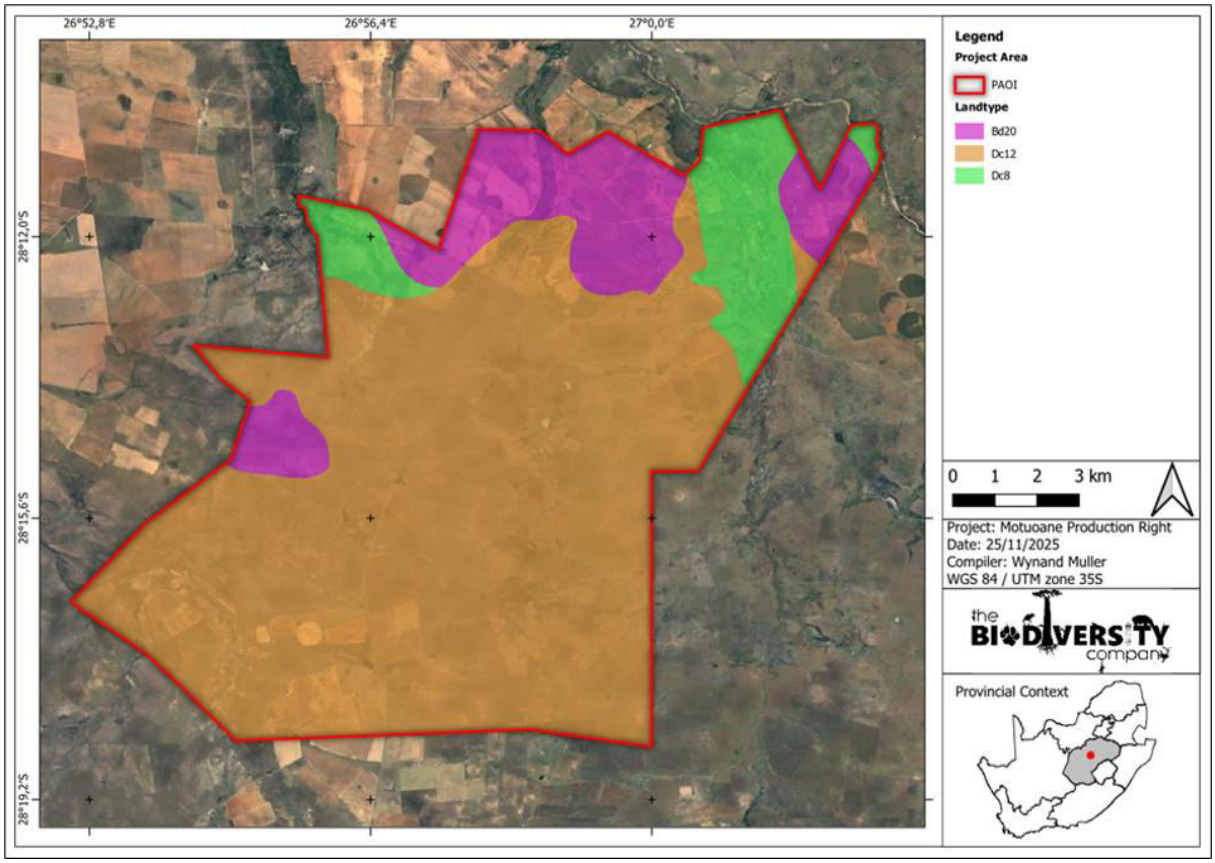


Figure 56: The land type associated with the production right (The Biodiversity Company, 2026)

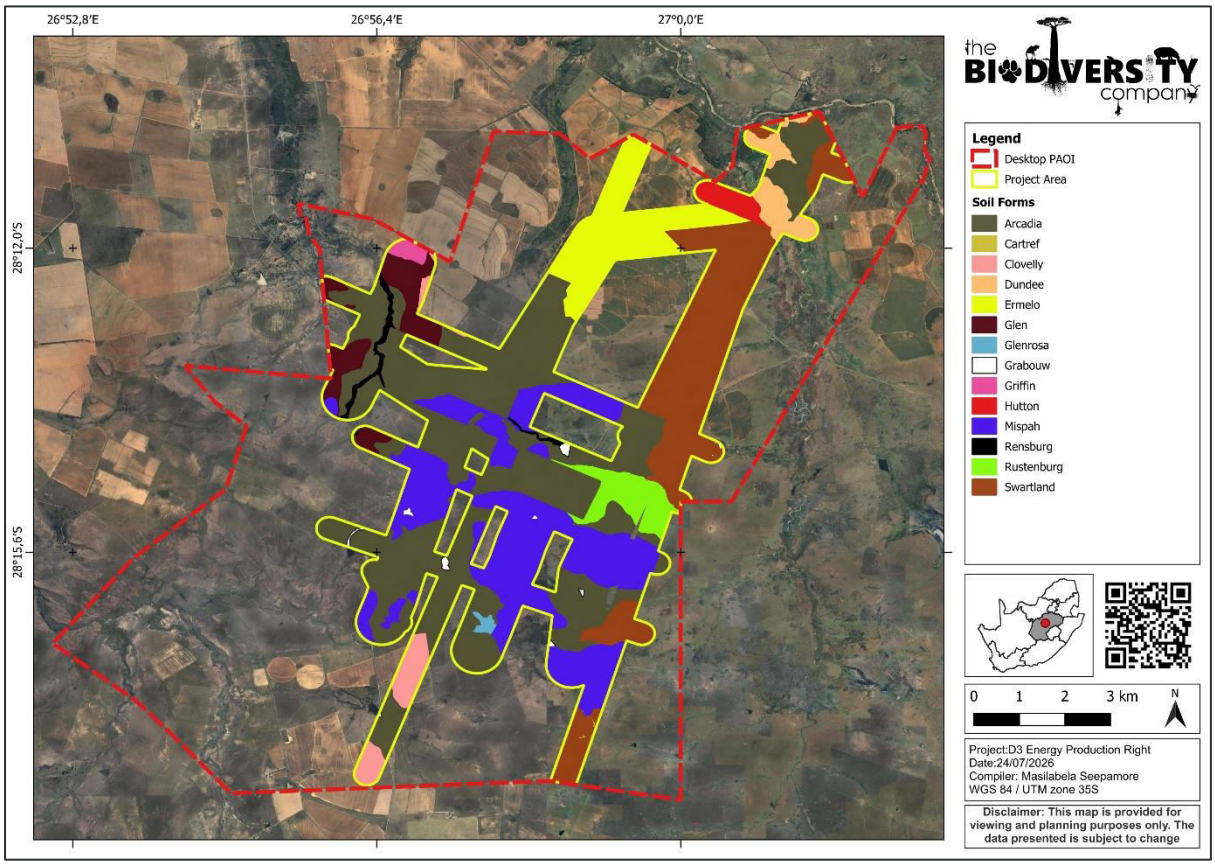


Figure 57: Soil forms found within the proposed PR (The Biodiversity Company, 2026)

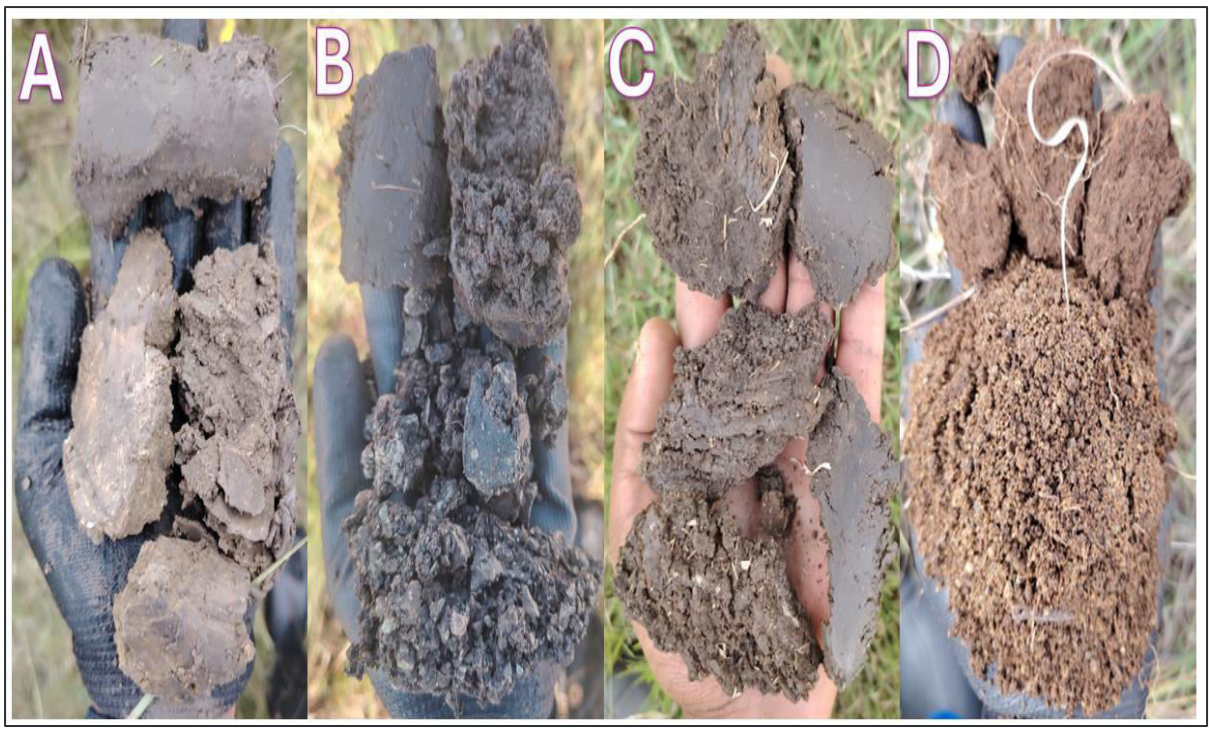


Figure 58: Diagnostic soil horizons identified on-site: A) Glen soil form; B) Arcadia soil form; C) Rustenburg soil form; and D) Glenrosa soil form (The Biodiversity Company, 2026)

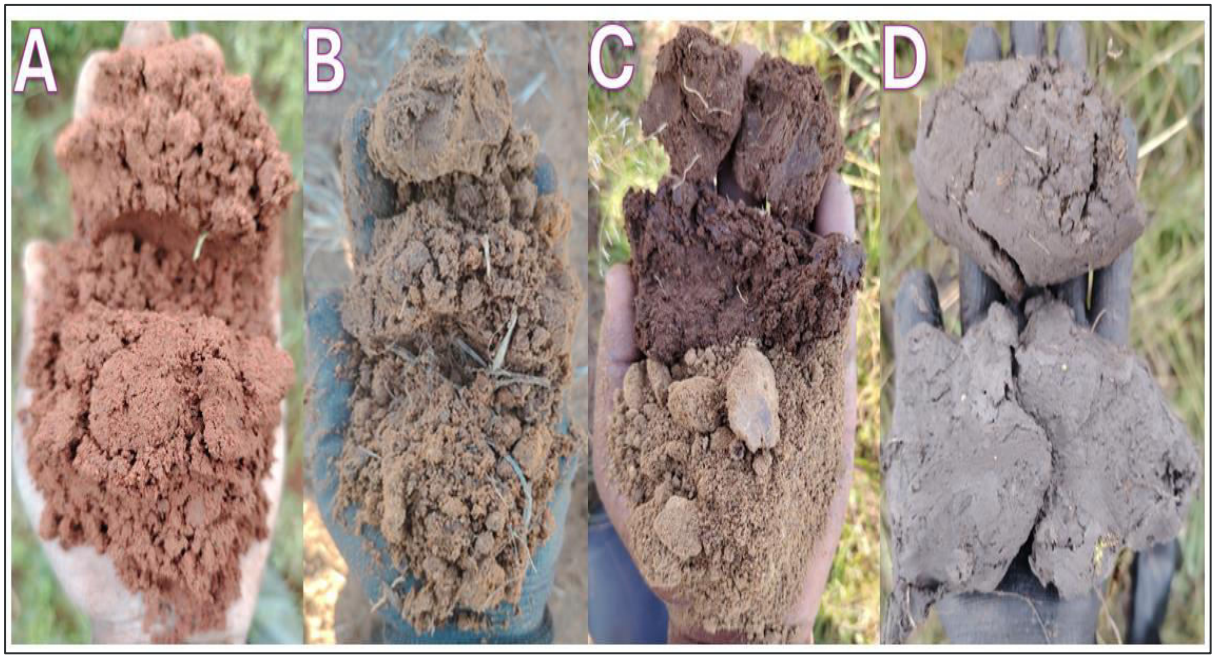


Figure 59: Diagnostic soil horizons identified on-site: A) Hutton soil form; B) Clovelly soil form; C) Swartland soil form; and D) Rensburg soil form (The Biodiversity Company, 2026)

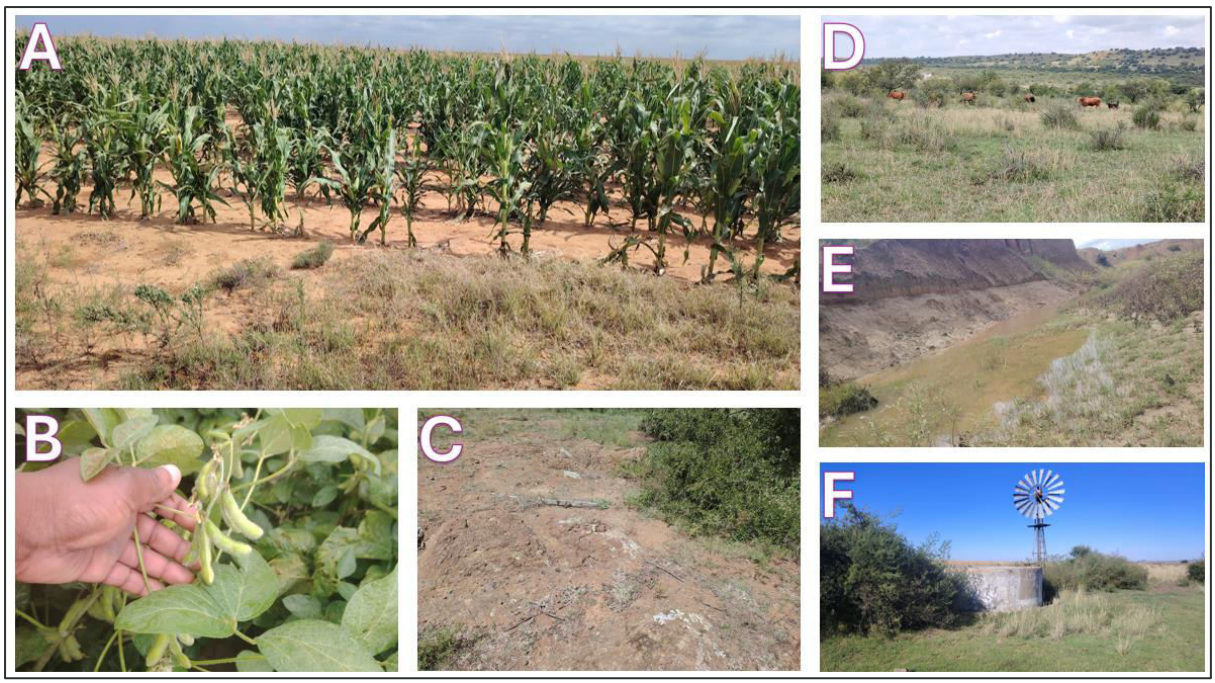


Figure 60: Current land use found within the proposed Project Area; A) & B) Active crop fields; C) Rocky areas; D) Livestock grazing; E) River; and F) Windmill (The Biodiversity Company, 2026)

8.8.2 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 land capability 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. Griffin, Hutton, Dundee and Clovelly soil forms), land capability "III" (i.e. Swartland, Glen, Arcadia and Rustenburg soil forms), land capability "V" (i.e. Rensburg and Cartref soil forms), land capability "VI" (i.e. Glenrosa and Mispah soil forms) and land capability "VIII" (i.e. Grabouw soil form).

Land capability is defined as the combination of the slope class and soil morphological properties (i.e. topsoil texture, profile depth and permeability class of the upper soil layers). Accordingly, following Smith, (2006) which the national DAFF, (2017) land capabilities protocols were further expanded from, the above-mentioned identified Ermelo and Clovelly 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. Dundee, Clovelly, Griffin, Hutton soil forms) categorised by LC 6-7 (Low-Moderate); land capability "III" (i.e. Swartland, Glen, Arcadia and Rustenburg soil forms) categorised by LC 1-5 (Very Low to Low), land capability "V" (i.e. Rensburg and Cartref soil forms) categorised by LC 6-7 (Low-Moderate), land capability "VI" (i.e. Glenrosa and Mispah soil forms) categorized by LC 1-5 (Very Low to Low), and land capability "VIII" (i.e. Grabouw soil form) categorized by LC 1-5 (Very Low to Low). The baseline soil land capability was aligned and - compared to the National Land Capability data (DAFF, 2017). Refer to **Table 31** and **Figure 61**.

Table 31: Land capability for the soils within the project area (The Biodiversity Company, 2026)

Land Capability Class	Definition of Class	Conservation Need	Use-Suitability	Land Capability 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
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
VIII	Extremely severe limitations. Not suitable for grazing or afforestation.	Total protection from agriculture.	Wildlife	Non-Arable	Low

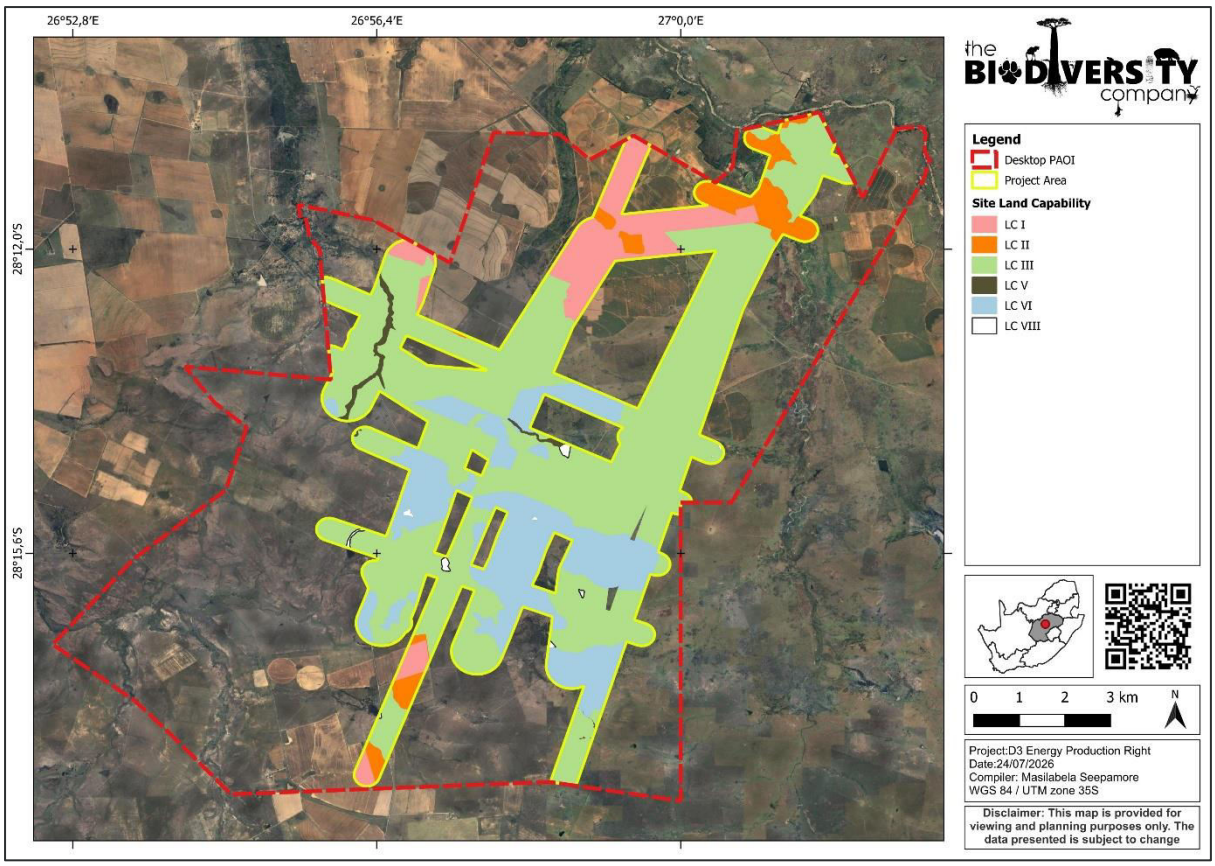


Figure 61: Site land capability of the dominant soil forms identified in the proposed PR (The Biodiversity Company, 2026)

8.9 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 study area are discussed below as per the Terrestrial Biodiversity Impact Assessment undertaken by The Biodiversity Company (**Appendix F13**).

8.9.1 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 32: Desktop and background spatial features examined (The Biodiversity Company, 2026).

Desktop Information Considered	Relevance	Reasoning	Section
Ecosystem Threat Status (Red List of Ecosystems (RLE, 2022; RLE, 2025)	Relevant	Overlaps with 'Endangered' and 'Least Concern' ecosystems	**8.9.5.1**
Ecosystem Protection Level (NBA, 2018)	Relevant	Overlaps with 'Not Protected', 'Poorly Protected' and 'Moderately Protected' Ecosystems	**8.9.5.2**
Provincial Conservation Plan (Free State Biodiversity Plan 2024)	Relevant	Overlaps with CBA 1, CBA 2, ESA1, ESA 2, Other Natural Areas and Degraded Areas	**4.3.3**
National Protected Areas Expansion Strategy (NPAES, 2018)	Relevant	Overlaps with NPAES Priority Focus Areas	**8.9.3**
South Africa Protected Areas Database (SAPAD,2025) and South Africa Conservation Areas Database (SACAD, 2025)	Relevant	According to the protected area spatial datasets from SAPAD and SACAD, three SACADs occur within 10 km, Tara Wildlife Safaris, H.J. Joel Private Nature Reserve and LM Safaris Nature Reserve. No SAPADs occur within 5 km.	**8.9.2**
South African Inventory of Inland Aquatic Ecosystems (SAIIAE)	Relevant	A Seep Wetland can be found within the D3 Energy PR development area, while a Depression Wetland can be found within the 500 m regulated area. Additionally, three rivers- Sand, Merriespruit and Maselspruit- overlaps with the D3 Energy PR development area.	**8.10.2**
National Freshwater Ecosystem Priority Area (NFEPA)	Relevant	Several wetland types were identified within the D3 Energy PR development area. A CVB Wetland, a Flat Wetland, a Floodplain Wetland, and a Seep Wetland are present within the Seismic Transect, with the CVB Wetland, Floodplain Wetland, and Seep Wetlands also extending into the 500 m regulated area. An UVB Wetland was identified within the 500 m regulated area. Additionally, three rivers—Sand, Maselspruit, and Merriespruit—overlap with the D3 Energy PR development area.	**8.10.3**
Strategic Water Source Areas (SWSA)	Irrelevant	Does not overlap with any relevant areas	-
Key Biodiversity Areas (KBA, 2024)	Irrelevant	Not within range of any relevant areas	-

8.9.2 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 study area falls within >5 km of H. J. Joel Private Nature Reserve, Tara Wildlife Safaris, and LM Safaris Nature Reserve (**Figure 62**).

8.9.3 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). The study area overlaps with NPAES Priority Focus Areas (**Figure 63**).

8.9.4 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 study area overlaps with the Vaal-Vet Sandy Grassland, Central Free State Grassland, Highveld Alluvia Vegetation and the Winburg Grassy Shrubland vegetation types (**Figure 64**).

8.9.4.1 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 of Bloemfontein. The altitude ranges from 1220 – 1560 meters, generally between 1260 -1360 meters. The landscape is plains-dominated with some scattered, slightly irregular undulating plains and hills. Mainly low-tussock grasslands with an abundant karroid element.

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 *Stachys spathulata (d), Barleria macrostegia, Berkheya onopordifolia var. onopordifolia, Chamaesyce inaequilatera, Geigeria aspera var. aspera, Helichrysum caespititium, Hermannia depressa, Hibiscus pusillus, Monsonia burkeana, Rhynchosia adenodes, Selago densiflora, Vernonia oligocephala,*

Bulbine narcissifolia, Ledebouria marginata, Tripteris aghillana var. integrifolia, Felicia muricata (d), Pentzia globosa (d), Anthospermum rigidum subsp. pumilum, Helichrysum dregeanum, H. paronychioides, 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).

8.9.4.2 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 characterised 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).

8.9.4.3 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*.

8.9.4.4 BLOEMFONTEIN KARROID SHRUBLAND

The Bloemfontein Karroid Shrubland is a unique vegetation type found as an archipelago of isolated patches on koppies, butts, and ridges, mainly within dry highveld grasslands. It extends over large distances between Bloemfontein in the southwest, Verkeerdevlei and Lindley in the southeast, Standerton in the northeast, and Heilbron and Bultfontein in the northwest. The altitude ranges from 1,320 to 1,840 m, mostly between 1,400 and 1,440 m. This vegetation type is found on plateaus or slightly sloping flanks of dolerite outcrops, supporting low shrubland dominated by dwarf small-leaved karroid and succulent shrubs. Grasses are restricted to depressions and crevices filled with fine soils.

Important Plant Taxa includes Tall Shrubs such as *Diospyros austro-africana, Euclea crispa subsp. ovata, Rhus burchellii, R. erosa, R. tridactyla.* Low Shrubs: *Eriocephalus ericoides (d), Euryops empetrifolius (d), Anthospermum rigidum subsp. pumilum, Asparagus suaveolens, Felicia muricata, Helichrysum dregeanum, Heliophila suavissima, Jamesbrittenia pristisepala, Nenax microphylla, Pentzia globosa, Phyllanthus parvulus, Selago albida.* Succulent Shrubs: *Chasmatophyllum musculinum (d), Euphorbia mauritanica (d), Ruschia spinosa (d), Stomatium mustellinum (d), Cotyledon orbiculata var. dactylopsis, Euphorbia rectirama, Kalanchoe paniculata, Othonna protecta, Pachypodium succulentum, Ruschia hamata, R. unidens, Sarcocaulon salmoniflorum, Stapelia grandiflora.* Succulent Woody Climber: *Sarcostemma viminale.* Graminoids: *Aristida diffusa (d), Eragrostis nindensis (d), Heteropogon contortus (d), Oropetium capense (d), Aristida adscensionis, A. congesta, Cymbopogon caesius, C. pospischilii, Cyperus rupestris var. rupestris, Digitaria eriantha, Enneapogon scoparius, Eragrostis chloromelas, E. obtusa, E. superba, E. trichophora, Eustachys paspaloides, Melinis repens subsp. repens, Microchloa caffra, Themeda triandra, Tragus koelerioides, T. racemosus.* Herbs: *Berkheya onopordifolia var. onopordifolia, B. rigida, Chamaesyce inaequilatera, Commelina africana, Gazania linearis var. linearis, Geigeria aspera var. aspera, G. filifolia, Hermannia coccocarpa.* Geophytic Herbs: *Cheilanthes eckloniana (d), Albuca setosa, Dipcadi ciliare, D. viride, Nerine laticoma, Pellaea calomelanos, Trachyandra saltii.* Succulent Herbs: *Senecio radicans (d), Adromischus trigynus, Aloe grandiden-tata, Anacampseros telephiastrum, Avonia*

ustulata, Crassula nudicaulis, Duvalia corderoyi, Orbea cooperi, Orbeopsis lutea, Tripteris aghillana var. integrifolia. Endemic Taxon Geophytic Herb: *Brachystelma glenense.*

The Bloemfontein Karroid Shrubland is classified as "Least threatened." The conservation target is 28%. Almost 2% is statutorily conserved in the Willem Pretorius Nature Reserve. More than 10% has been transformed for cultivation and by urban sprawl. Erosion is generally low (57%), very low (24%), and moderate (18%) (Mucina & Rutherford, 2006).

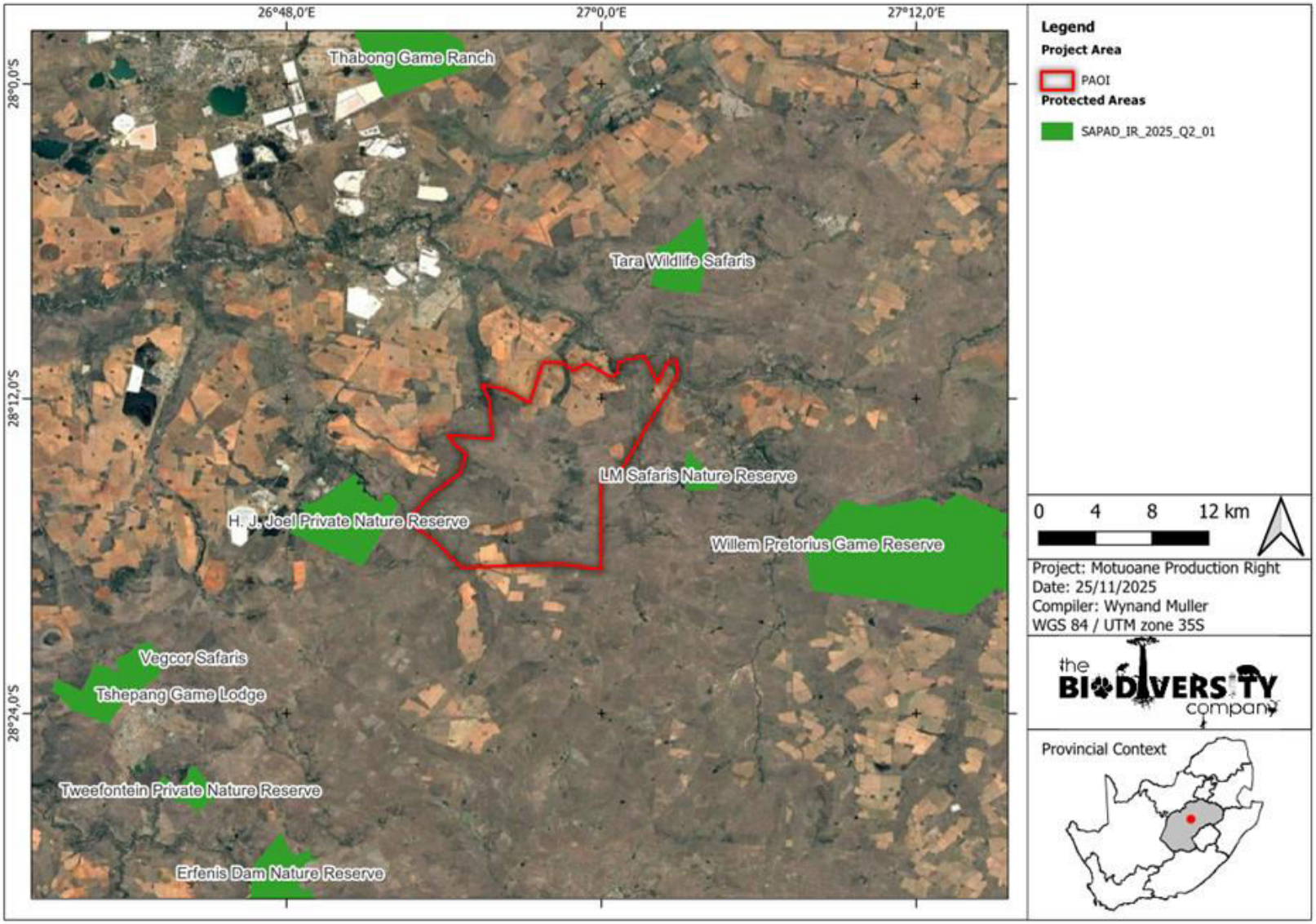


Figure 62: Map illustrating the PR in relation to the SAPAD areas (The Biodiversity Company, 2026).

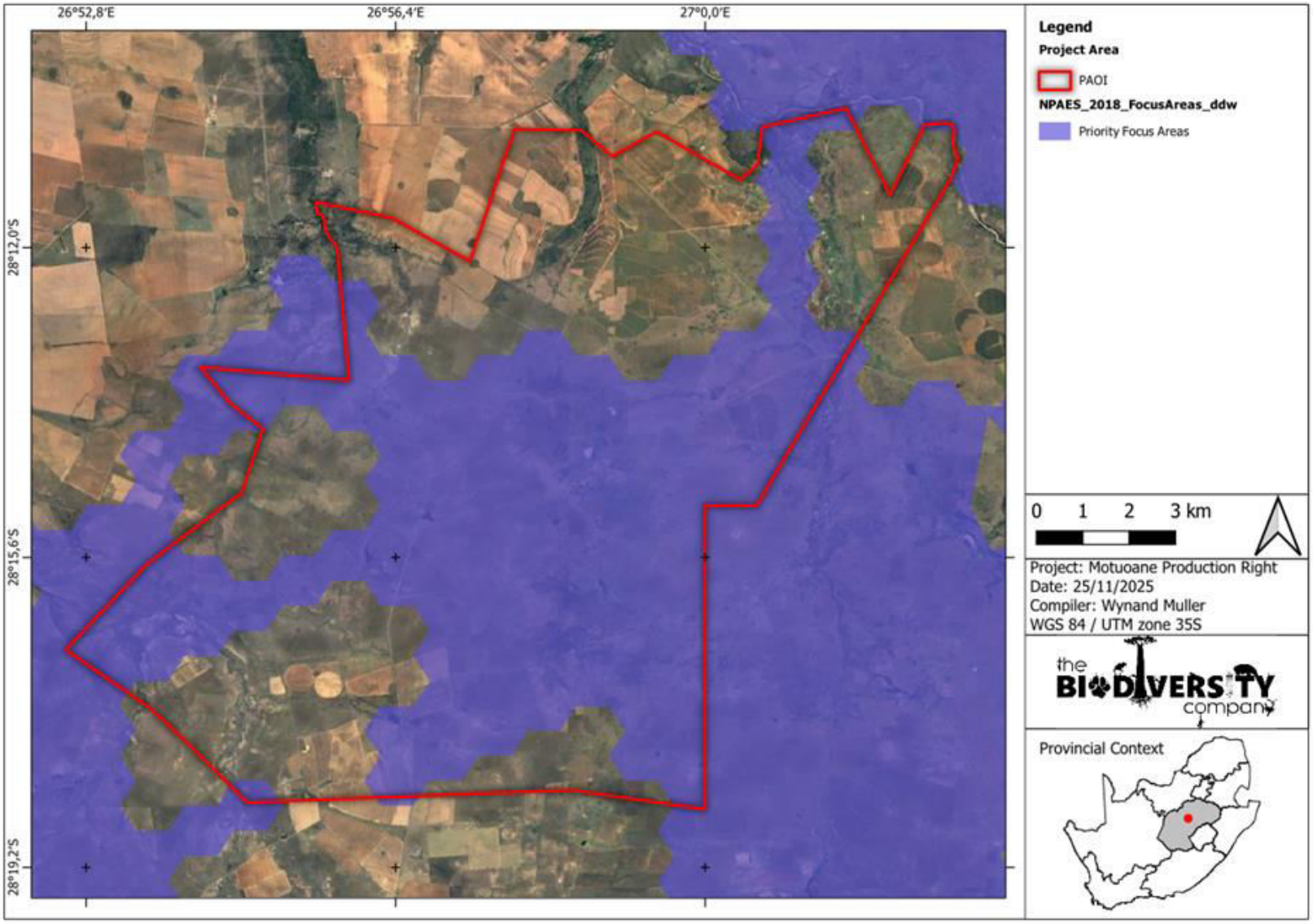


Figure 63: Map illustrating the PR in relation to the NPAES areas (The Biodiversity Company, 2026).

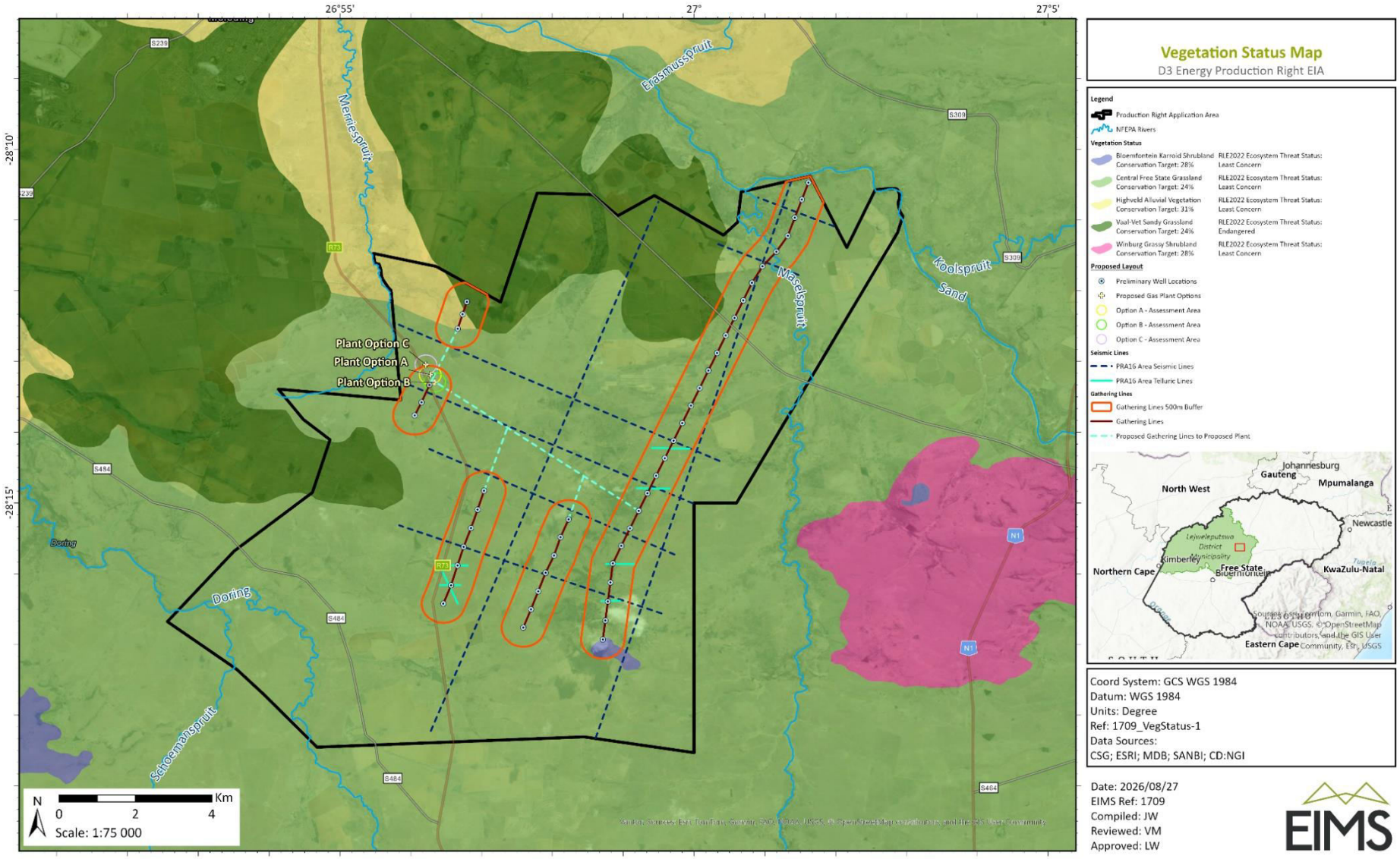


Figure 64: Vegetation types and status associated with the study area.

8.9.5 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).

8.9.5.1 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 PR overlaps with EN and LC ecosystems (**Figure 65**).

8.9.5.2 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 is 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 PR overlaps with NP, MP and PP ecosystems (**Figure 66**).

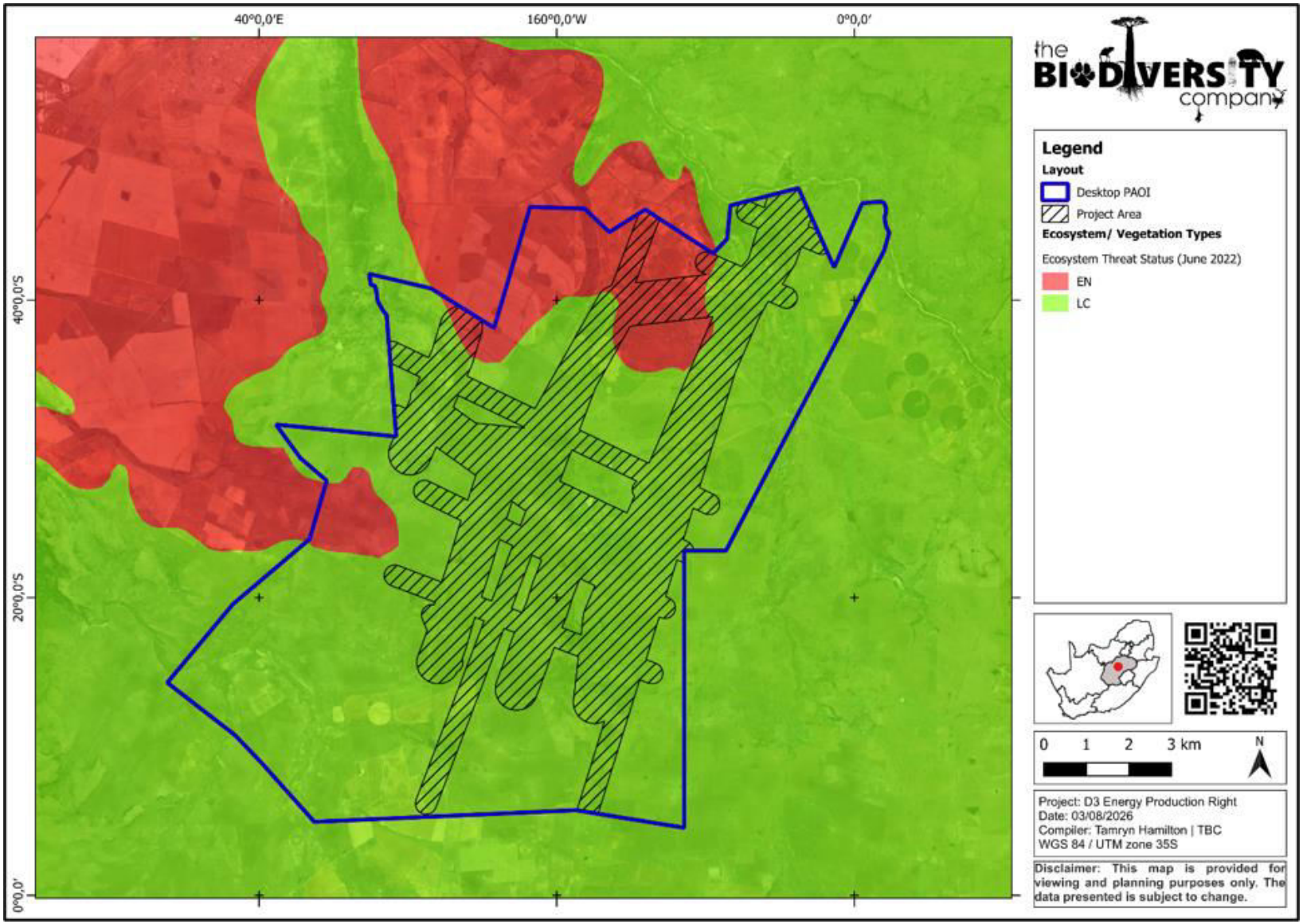


Figure 65: Map illustrating the ecosystem threat status associated with the study area (The Biodiversity Company, 2026).

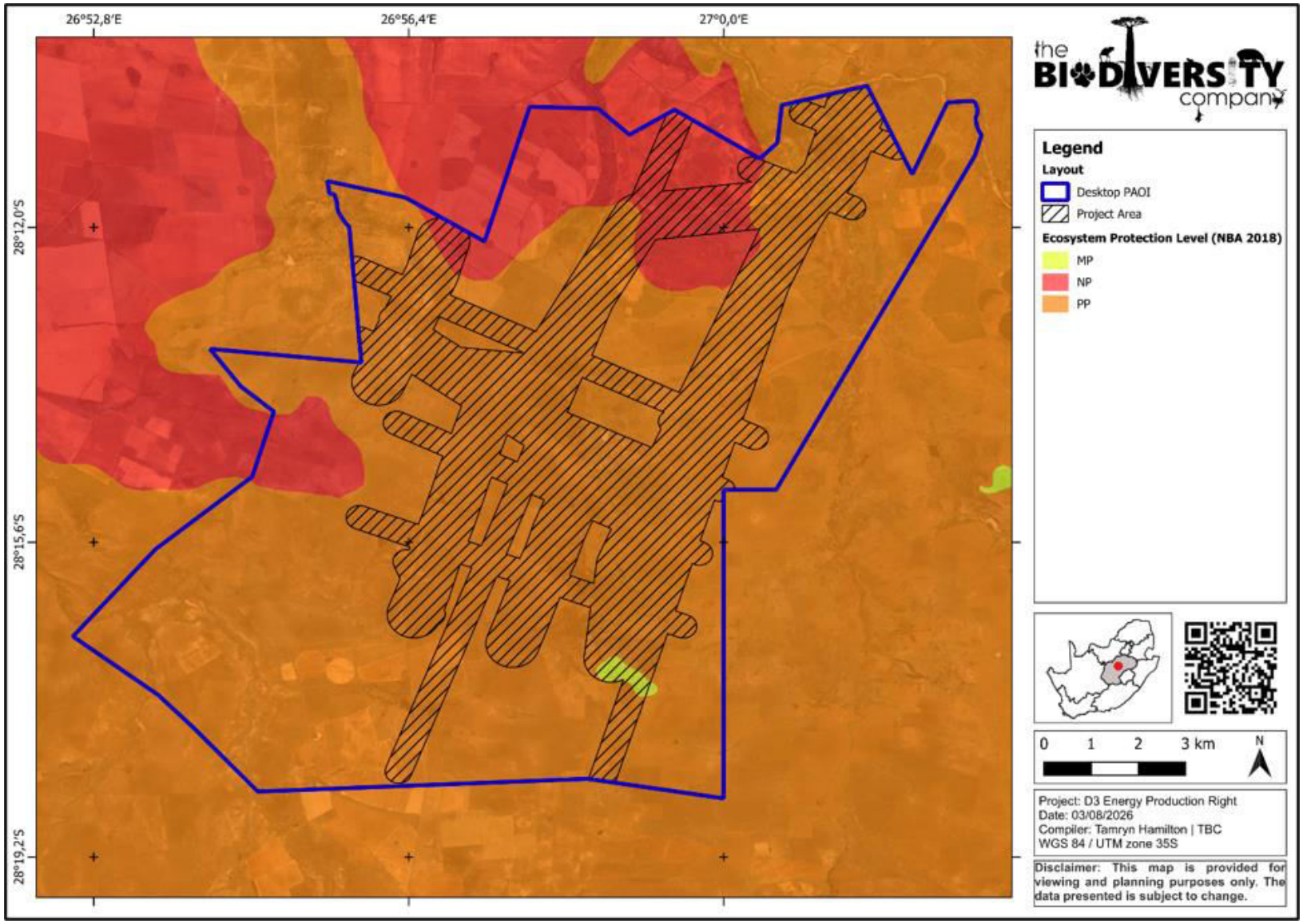


Figure 66: Map illustrating the ecosystem protection level associated with the study area (The Biodiversity Company, 2026).

8.9.5.3 FLORA

According to the Terrestrial Biodiversity Impact Assessment undertaken by the Biodiversity Company (**Appendix F13**), the Plants of southern Africa (POSA) database indicates that 463 species of plants are expected to occur within the study area, of which 215 are indigenous. As per the field assessments undertaken by The Biodiversity Company, three categories of floral species were identified as follows:

- Indigenous flora;
- Protected flora; and
- Alien Invasive Plants (AIPs)

Indigenous flora and Protected flora are discussed below while AIPs are discussed in **Section 4.1.7.2**.

8.9.5.3.1 INDIGENOUS FLORA

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 PR and Project Area. 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 PR. Nevertheless, the floristic analysis completed thus far is considered a reliable representation of the local flora for the PR.

8.9.5.3.2 PROTECTED FLORA

Nine (9) species of provincially protected plant were recorded for the Project Area: *Ammocharis coranica* (Berg Lily), *Anacampseros papyracea* (Karoo Gansmis)*, Anacampseros subnuda subnuda, Boophone disticha* (Bushman Poison Bulb)*, Eucomis autumnalis* (Pineapple Lily)*, Euphorbia clavarioides* (Lion's Spoor)*, Gladiolus permeabilis edulis, Helichrysum nudifolium* (Hairy Everlasting) and *Helichrysum zeyheri* (Vaalbergkaroo). These species occurred in various habitat units within the Project Area. All are protected under Schedule 6 in 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). Given the presence of suitable grassland habitat on site, additional protected species may occur within the PR. A site walkdown should therefore be undertaken prior to development, with any protected species identified on site to be marked and avoided, if not possible to avoid, then relocated to a nearby area of similar habitat outside the project impact area.

8.9.5.4 FAUNA

Mammal, herpetofauna and avifauna observations and recordings fall under this section.

8.9.5.4.1 MAMMALS

The mammal species recorded for the Project Area during the field survey are presented in **Table 33** below. No SCC was observed during the assessment. Additional common mammal species are expected for the PR, along with some SCC. Fauna will most likely use broader area as movement corridor for general habitat (refuge, hunting/feeding, etc). To yield a higher species count, long-term surveys over multiple temporal periods would be required.

Table 33: Mammal species recorded within the PR (The Biodiversity Company, 2026)

Scientific Name	Common Name	Conservation Status	
		SANBI	IUCN
Canis mesomelas	Black-Backed Jackal	LC	LC
Cynictis penicillata	Yellow Mongoose	LC	LC
***Felidae* spp.**			
Felis lybica	African Wildcat	LC	LC
Kobus ellipsiprymnus	Lechwe	LC	NT
Phacochoerus africanus	Warthog	LC	LC
Orycteropus afer	Aardvark	LC	LC
Raphicerus campestris	Steenbok	LC	LC
Tragelaphus strepsiceros	Kudu	LC	LC
Note: LC = Least Concern and NT = Near Threatened			

8.9.5.4.2 HERPETOFAUNA

Reptile and amphibian species recorded within the PR during the field survey are presented in **Table 34** below. Additional common herpetofauna species are expected for the PR.

Table 34: Reptile and amphibian species recorded within the PR (The Biodiversity Company, 2026)

Scientific Name	Common Name	Conservation Status	
		SANBI	IUCN
Reptile			
Stigmochelys pardalis	Leopard Tortoise	LC	LC
Amphibian			
Poyntonophrynus vertebralis	Southern Pygmy Toad	LC	LC
Sclerophrys capensis	Ranger's Toad	LC	LC
Note: (LC = Least Concern)			

8.9.5.4.3 AVIFAUNA

Thirty (30) species of bird were recorded within the PR during the survey based on either direct observation, vocalisations, or the presence of visual tracks and signs (**Table 35**). Four (4) species are SCC. These species are likely to make use of the water resource and the surrounding grassland habitats.

Table 35: Avifauna species recorded within the PR (The Biodiversity Company, 2026)

Species	Common Name	Conservation Status		Free State Nature Conservation Ordinance 8 of 1969
		Regional	IUCN	
Afrotis afraoides	Northern Black Korhaan	Unlisted	LC	Schedule 1
Anas undulata	Yellow-billed Duck	Unlisted	LC	Schedule 2
Ardea ibis	Western Cattle Egret	LC	LC	-
Asio capensis*	Marsh Owl	NT	LC	-
Bostrychia hagedash	Hadada Ibis	Unlisted	LC	Schedule 1
Centropus burchellii	Burchell's Coucal	Unlisted	LC	-
Colius colius	White-backed Mousebird	LC	LC	-
Corvus albus	Pied Crow	Unlisted	LC	-
Dendrocygna viduata	White-faced Whistling Duck	Unlisted	LC	Schedule 1
Elanus caeruleus*	Black-winged Kite	NT	LC	Schedule 2
Estrilda astrild	Common Waxbill	LC	LC	-
Fulica cristata	Red-knobbed Coot	LC	LC	Schedule 2
Gallinago nigripennis	African Snipe	LC	LC	-
Grus paradisea*	Blue Crane	VU	VU	Schedule 2
Lanius collaris	Southern Fiscal	Unlisted	LC	Schedule 2
Macronyx capensis	Cape Longclaw	Unlisted	LC	Schedule 1
Merops apiaster	European Bee-eater	Unlisted	LC	-
Myrmecocichla formicivora	Ant-eating Chat	LC	LC	-
Numida meleagris	Helmeted Guineafowl	LC	LC	-
Plocepasser mahali	White-browed Sparrow-Weaver	LC	LC	-
Pternistis swainsonii	Swainson's Spurfowl	Unlisted	LC	Schedule 2

* Species of Conservational Concern

Species	Common Name	Conservation Status		Free State Nature Conservation Ordinance 8 of 1969
		Regional	IUCN	
Scopus umbretta*	Hamerkop	NT	LC	Schedule 1
Tachybaptus ruficollis	Little Grebe	Unlisted	LC	Schedule 2
Tadorna cana	South African Shelduck	LC	LC	Schedule 2
Threskiornis aethiopicus	African Sacred Ibis	Unlisted	LC	-
Trachyphonus vaillantii	Crested Barbet	Unlisted	LC	-
Tricholaema leucomelas	Acacia Pied Barbet	Unlisted	LC	Schedule 1
Upupa epops* spp. *africana	African Hoopoe	Unlisted	LC	-
Uraeginthus angolensis	Blue Waxbill	LC	LC	-
Vanellus armatus	Blacksmith Lapwing	Unlisted	LC	Schedule 1
Vanellus coronatus	Crowned Lapwing	Unlisted	LC	Schedule 1
Note: LC = Least Concern and NT = Near Threatened				

8.9.5.5 HABITAT ASSESSMENT

The habitat assessment for the PR was completed in the following way:

- Desktop habitat delineation for the extended PR (**Table 36**);
- Extrapolation of habitats observed within the D3 Energy PR development area; and
- Habitat delineations based on the field observation for the Project Area (these can be seen in **Table 36** and **Figure 68**).

Descriptions of the habitat units can be found in **Table 36**.

Table 36: Descriptions of the habitat types within the PR (The Biodiversity Company, 2026)

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Modified	Modified areas are regions that have undergone significant anthropogenic disturbance, including major roads, cultivated fields, urban infrastructure, and other artificial surfaces. These landscapes are dominated by non-natural land cover, such as asphalt, concrete, and intensively managed agricultural land, with indigenous vegetation largely absent and often replaced by crops, exotic plants, or AIP. The structure and composition of these areas are heavily influenced by ongoing human activities, resulting in a highly altered ecological state. The ecosystem has been entirely modified, resulting in the near-total loss of its original composition and structure. Most or all ecological functions have been eliminated. The presence of AIP is common and further contributes to the modified character of these areas. Due to the intensive nature of agricultural practices, the dominance of artificial surfaces, and the lack of indigenous vegetation, the ecological services provided by these habitats are significantly limited. Key natural processes such as soil stabilization, water infiltration, nutrient cycling, and support for indigenous biodiversity are greatly reduced or absent compared to more natural or semi-natural habitats. The absence of natural vegetation restricts opportunities for foraging, breeding, and refuge for indigenous flora and fauna, and the habitat does not provide viable conditions for their persistence. The dominance of AIP can further disrupt ecosystem functioning by outcompeting indigenous species and altering habitat structure. No fauna or flora SCC were observed during the field survey, and none are expected to occur within these modified areas due to the lack of suitable habitat and resources. However, certain features within the modified landscape, such as field margins, irrigation channels, or uncultivated strips, may still function as movement corridors or temporary refuges for locally common fauna, particularly small mammals, birds, and invertebrates adapted to disturbed environments. These features can facilitate limited ecological connectivity across the landscape, albeit at a much-reduced level compared to more intact habitats. The habitat is not considered a viable CBA 1, CBA 2, ESA 1 or ESA 1, nor is it representative of the Vaal-Vet Sandy Grassland (EN), Central Free State Grassland (LC), Highveld Alluvial Vegetation (LC) or Bloemfontein Karroid Shrubland (LC) ecosystems. This habitat unit will not recover without active human intervention.	Irreversibly and Severely Modified	**Very Low**	679.04

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Alluvial Vegetation	Alluvial vegetation refers to plant communities that grow on soils deposited by rivers, streams, or other running water. These soils, known as alluvium, are typically found in floodplains, riverbanks, and deltas. Alluvial vegetation is adapted to periodic flooding, fluctuating water tables, and nutrient-rich, often loose or sandy soils. This type of vegetation plays a crucial role in stabilizing riverbanks, filtering water, and providing habitat for wildlife. Although the alluvial habitat is classified as semi-natural, it has been subject to various disturbances, including fragmentation, livestock grazing, and erosion. Despite these pressures, the alluvial habitat generally retains intact ecological functioning, largely due to the faunal communities it continues to support. However, the ecological condition across the unit is not uniform; it fluctuates in response to differing land uses and the intensity of disturbances. Certain sections have been impacted by both historical and ongoing grazing, while others are more affected by the proliferation of AIP and edge effects on floral communities, resulting in reduced habitat integrity. The overall variation in habitat condition is therefore closely linked to the degree of disturbance, with some areas experiencing more pronounced overgrazing. Importantly, these alluvial areas remain connected to, and play a vital role in supporting, adjacent water resource habitats. Indigenous species observed within the habitat include *Vachellia karroo, Gymnosporia buxifolia, Ziziphus mucronata, Panicum maximum, Felicia muricata, Chloris virgata*, and *Eragrostis plana*. Dominant AIP present in more disturbed areas are *Salix babylonica, Populus* alba, and *Melia azedarach*. In addition, one (1) Provincial Protected Flora species - *Ammocharis coranica* - was observed, as listed in Schedule 6 of the Free State Nature Conservation Ordinance 8 of 1969. Section within the habitat is considered viable ESA 1 and ESA 2. No fauna or flora SCC were observed during the field survey. Nevertheless, this habitat provides refuge, grazing, and foraging resources for both indigenous fauna and livestock, and contributes to water filtration as it percolates through the soil into drainage areas. Serving as an important ecological corridor, the alluvial habitat facilitates fauna dispersion and movement across the landscape. It is utilised by faunal species throughout various life stages and may support multiple SCC. While flora SCC are not anticipated, fauna SCC, particularly avifauna , are likely to make use of this habitat.	Disturbed	**Medium**	242.65

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Central Free State Grassland and Central Free State Grassland (No Access)	This habitat is characterised by a predominance of grassy ground layers, with *Heteropogon contortus, Eragrostis curvula*, and *Eragrostis chloromelas* identified as the dominant grass species. Scattered patches of Themeda triandra were also observed within the unit. Noticeable encroachment by *Vachellia karroo* is evident, primarily as a result of historical and ongoing overgrazing. Additionally, several AIP, including *Verbena officinalis* and *Xanthium strumarium*, are present within the habitat. Sections of the habitat have experienced historical agricultural activities, with species such as *Aristida adscensionis, Aristida congesta*, and *Sporobolus fimbriatus* observed in more disturbed areas. Despite these disturbances and ongoing transformation, the habitat retains certain structural and floristic elements characteristic of the Central Free State Grassland (LC) and is considered representative of this vegetation type (RLE, 2022). In addition, two Provincial Protected Flora species: *Boophone distachia* and *Helichrysum nudifolium,* were observed, as listed in Schedule 6 of the Free State Nature Conservation Ordinance 8 of 1969. No fauna or flora SCC were observed during the field survey. Sections within the habitat are considered viable CBA 1, CBA 2, ESA 1, ESA 2, and representative of the Central Free State Grassland (LC). However, it should be noted that some areas (approximately 429.35 ha) within the habitat unit were not assessed due to access restrictions. Ecologically, this habitat provides a range of important services. It offers refuge, grazing, and foraging resources for indigenous fauna and livestock, and serves as a movement corridor for fauna between areas. The habitat aids in the filtration of water as it permeates through the soil into drainage areas, provides erosion control, and contributes to pollination and seed dispersal processes. Additionally, the presence of diverse grass and forb species supports soil fertility and nutrient cycling, while the structural complexity of the vegetation enhances microhabitat availability for a variety of invertebrates and small vertebrates.	Semi-natural and Disturbed	**Medium**	923.21 and 283.37

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Disturbed Central Free State Grassland	The habitat is primary in nature, with some levels of anthropogenic disturbance, particularly from AIPs and mismanagement of the field. The vegetation structure is dominated by indigenous grasses such as *Themeda triandra*, *Eragrostis superba*, *Bromus catharticus*, *Paspalum dilatatum*, *Trichoneura grandiglumis*, *Eragrostis plana*, *Elionurus muticus*, *Melinis repens*, and *Heteropogon contortus*. The grassland is interspersed with forbs and herbs, supporting a diverse assemblage of indigenous flora. Bush encroachment by woody and shrubby species is evident in certain sections, with species such as *Vachellia karroo*, *Seriphium plumosum*, *Diospyros austro-africana*, *Lycium cinereum*, and *Rosa rubiginosa* present. Two (2) Provincial Protected Flora*, Ammocharis coranica* (Berg Lily) and *Eucomis autumnalis* (Pineapple Lily), were observed in terms of Schedule 6 of the Free State Nature Conservation Ordinance 8 of 1969. AIPs are present within this habitat, with notable species including *Verbena officinalis, Agave americana*, *Datura ferox*, *Eucalyptus sideroxylon* and *Eucalyptus camaldulensis*. These AIPs are particularly prevalent in disturbed or overgrazed patches and contribute to the ongoing transformation of the ecosystem. Sections within the habitat are considered viable, CBA 2, ESA 1, ESA 2, and representative of the Central Free State Grassland (LC; RLE, 2022). These areas retain certain structural and floristic elements characteristic of their respective vegetation types, despite the presence of disturbance and ongoing transformation. No fauna or flora species of conservation concern were observed during the field survey. While the likelihood of fauna SCC occurring in this habitat unit is considered low, there remains a possibility that flora SCC may be present. Despite the presence of disturbance and ongoing transformation, this habitat unit continues to provide important ecosystem services. These include forage and grazing for indigenous fauna and livestock, soil stabilisation, water filtration, and support for pollinators and other ecosystem functions. The habitat also offers refuge and movement corridors for locally common fauna. However, the ecological	Disturbed	**Medium**	1795.97

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
	integrity and functioning of the habitat are compromised by the presence of AIPs, bush encroachment, and mismanagement, which reduce the overall provision of ecosystem services and threaten the persistence of indigenous biodiversity. Active management is required to control AIPs, prevent further encroachment, and support the recovery of indigenous species and ecosystem processes.			
Degraded Grassland	This habitat is secondary in nature due to historic and ongoing anthropogenic activities. The most notable impacts on this habitat are the presence of AIPs, and encroachment of woody species. Alien invasive plants such as *Tagetes minuta, Solanum campylacanthum* and *Xanthium spinosum* are common, often forming dense stands in some areas. Despite the disturbance, a diverse assemblage of indigenous flora persists, including grasses such as *Themeda triandra*, *Eragrostis curvula*, *Heteropogon contortus*, and *Digitaria eriantha.* No fauna or flora SCC were observed during the field survey. Despite fragmentation and ongoing degradation, this habitat continues to provide important ecosystem services, including foraging and grazing for indigenous fauna and livestock, refuge and movement corridors for fauna, soil stabilisation, water filtration, and support for pollinators and other ecosystem functions. The habitat is not considered a viable CBA 2, ESA 1 or ESA 2, nor is it representative of the Vaal-Vet Sandy Grassland (EN), Highveld Alluvial Vegetation (LC) or Central Free State Grassland (LC) ecosystem. The habitat provides limited grazing and foraging resources for indigenous fauna and livestock, aids in the filtration of water permeating through the soil into drainage areas and serves as an important corridor for fauna dispersion within the landscape. In many cases, these areas may function as movement corridors and form a barrier between more degraded and modified areas.	Degraded	**Low**	138.12

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Winberg Grassy Shrubland	This habitat is primary in nature, with some levels of anthropogenic disturbance. and is characterised by grass and woody layers. Dominant grasses observed in the unit are *Aristida adscensionis, A. congesta, A. diffusa, Cymbopogon pospischilii, Cynodon dactylon, C. incompletus, Eragrostis chloromelas* and *E. lehmanniana.* Dominant tree species were *Vachellia karroo, Celtis africana* and *Ziziphus mucronata.* No fauna or flora SCC were observed during the field survey. However, fauna SCC, particularly avifauna, are likely to make use of the habitats for foraging. The habitat is considered viable constitutes of CBA 2, ESA 1, and ESA 2. Provides refuge, grazing and foraging resources for indigenous fauna and livestock. Aids in the filtration of water permeating through the soil into the drainage areas and provides erosion control. Contributes to the processes of pollination and seed dispersal. Provides movement corridors and natural habitat in an area largely disturbed by mining activities.	Semi-natural	**Medium**	609.59

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Secondary Central Free State Grassland	This habitat unit is classified as secondary grassland, having developed on land previously used for agriculture and subsequently abandoned, which has allowed for partial natural regeneration. The vegetation is characterised by a mix of indigenous grassland species, including grasses such as *Eragrostis curvula, Eragrostis plana, Elionurus muticus, Aristida congesta, Cymbopogon pospischilii, Setaria sphacelata*, and *Themeda triandra*. The dominant shrub present is Seriphium plumosum. Despite the persistence of indigenous flora, the habitat exhibits significant levels of disturbance, most notably from AIPs such as *Opuntia cespitosa, Opuntia lasiacantha, Tagetes minuta, Verbena incompta, Datura ferox, Argemone ochroleuca, Solanum sisymbriifolium, Plantago lanceolata, Trichocereus spachianus, Curium vulgare, Bidens pilosa* and *Verbena officinalis*. No fauna or flora SCC were observed during the field survey. However, fauna SCC, particularly avifauna, are likely to make use of the habitats for foraging. The habitat is not considered a viable ESA 1 and ESA 2 nor is it representative of the Central Free State Grassland LC ecosystem. Despite fragmentation and ongoing degradation, this secondary grassland habitat continues to provide important ecosystem services. These include foraging and grazing opportunities for indigenous fauna and livestock, refuge and movement corridors for fauna, soil stabilisation, water filtration, and support for pollinators and other ecosystem functions. Active management is required to control AIPs with restoration efforts focusing on promoting indigenous species recovery, maintaining habitat connectivity, and supporting the continued provision of ecosystem services.	Disturbed	**Low**	124.03

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Rocky Grassland	This habitat is primary in nature, with moderate levels of anthropogenic disturbance, particularly from overgrazing and the presence of AIPs. The habitat unit is comprised of a rocky outcrop, supporting a mosaic of grass and woody layers. Characteristic species observed within this habitat unit include *Vachellia karroo*, *Searsia erosa*, *Searsia dentata*, *Euclea crispa* and *Gymnosporia buxifolia* among others. The grass layer is represented by species such as *Digitaria eriantha*, *Eragrostis plana*, *Elionurus muticus*, *Aristida congesta*, and *Melinis repens*. This habitat type is regarded as a disturbed rocky outcrop grassland due to visible signs of overgrazing by cattle, as well as the widespread occurrence of AIP such as *Eucalyptus camaldulensis, Opuntia cespitosa*, *Tagetes minuta*, *Verbena officinalis*, *Gleditsia triacanthos*, *Datura ferox* and others. While the structural diversity of the habitat remains relatively intact, ongoing grazing pressure and alien plant invasion have resulted in moderate degradation. Thie habitat is a representative of the Central Free State Grassland (LC) and Bloemfontein Karroid Shrubland Bioregion (LC; RLE, 2022). No fauna or flora SCC were observed during the field survey; however, there is a possibility that SCC could occur in this habitat unit. The ecosystem processes and services are affected by the current disturbances present within this habitat unit. The overgrazing and habitat destruction associated with mechanical excavation and dumping has driven a decrease in the overall functionality and integrity of this habitat. The habitat does, however, benefit the surrounding areas with seed dispersal and plant recruitment. This habitat also acts as a movement corridor for local faunal species.	Intact	**High**	513.69

Habitat	Description and Ecological Processes	Condition	SEI	Size (~ha)
Water Resources	This is a non – terrestrial habitat and are permanently to seasonally wet portions of land as delineated by the wetland specialists. These include different natural wetland/aquatic systems but also artificial water resources with different sensitivity levels. These include Artificial Drainage Channel, Artificial Wet Area, Depression Wetland, UVB Wetland, Seep Wetland, CVB Wetland, Drainage lines, Dams and Reservoirs. Common species observed along watercourses include *Combretum* spp., *Ziziphus mucronata, Cyperus* spp. and *Typha capensis.* For more details pertaining to Water Resources please refer to the Wetland Assessment Report (TBC, 2026). Although no fauna or flora SCC were observed during the field survey, some suitable habitat is present within this unit and may support SCC, particularly in less disturbed or more structurally diverse areas. Even though it is somewhat disturbed the ecological integrity, importance and functioning of these areas play a crucial role as a water resource system locally and regionally, and an important habitat for various fauna and flora. These systems also provide movement corridors, refuge and foraging resources.	Artificial, Disturbed and Natural	**Low – High**	520.44

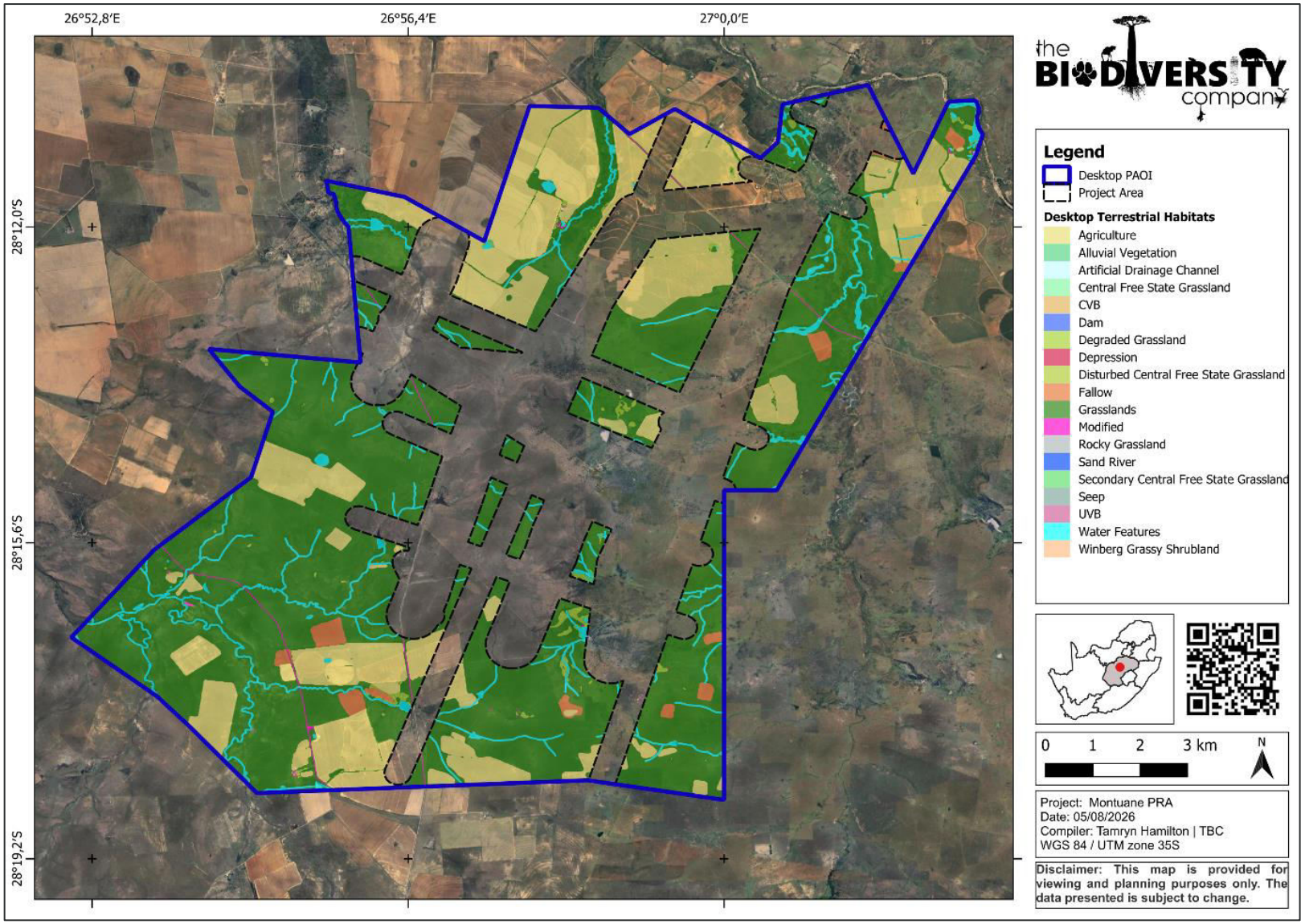


Figure 67: Desktop habitat units delineated for the PR (The Biodiversity Company, 2026)

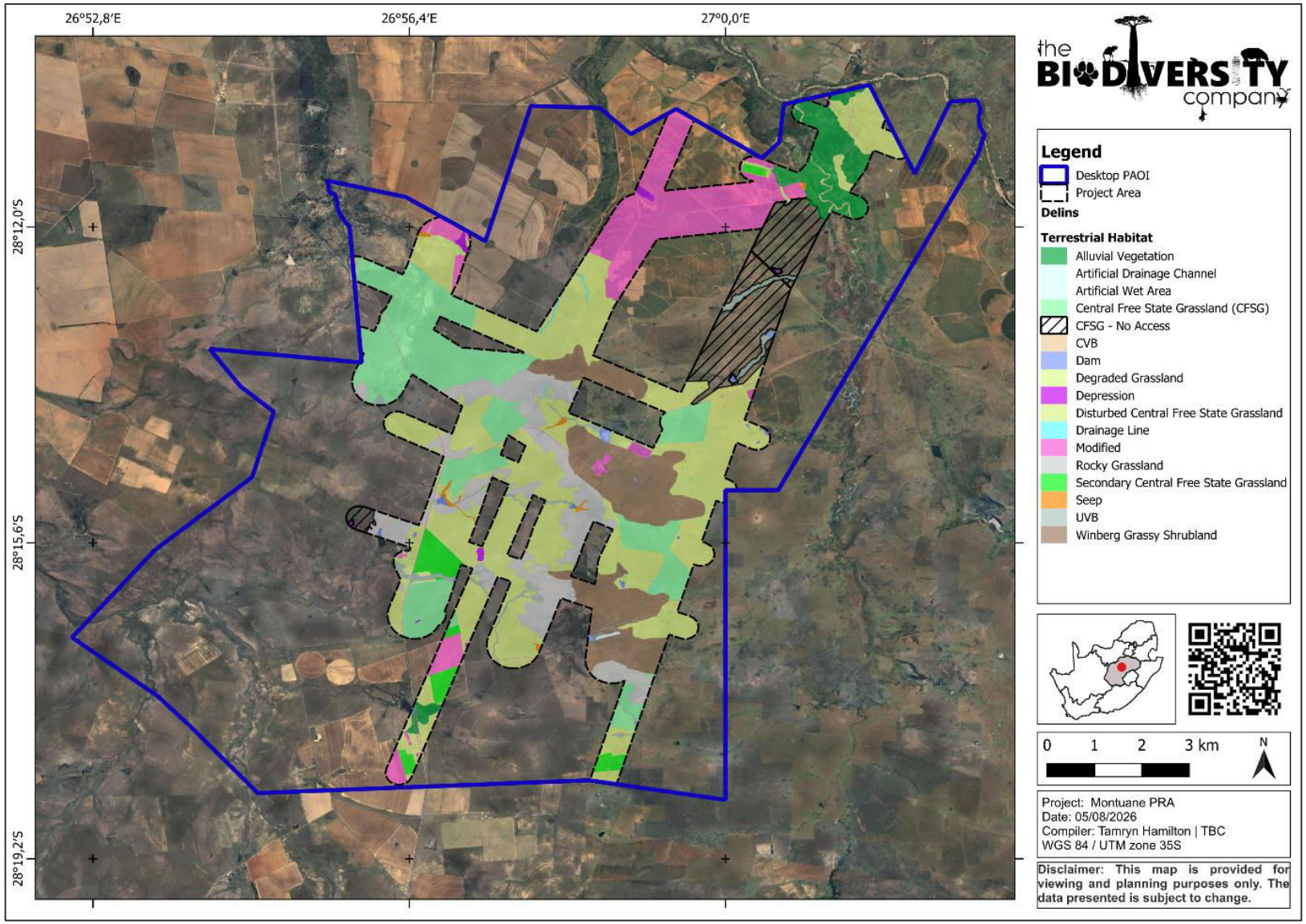


Figure 68: Habitat Units Delineated for the Project Area (The Biodiversity Company, 2026)

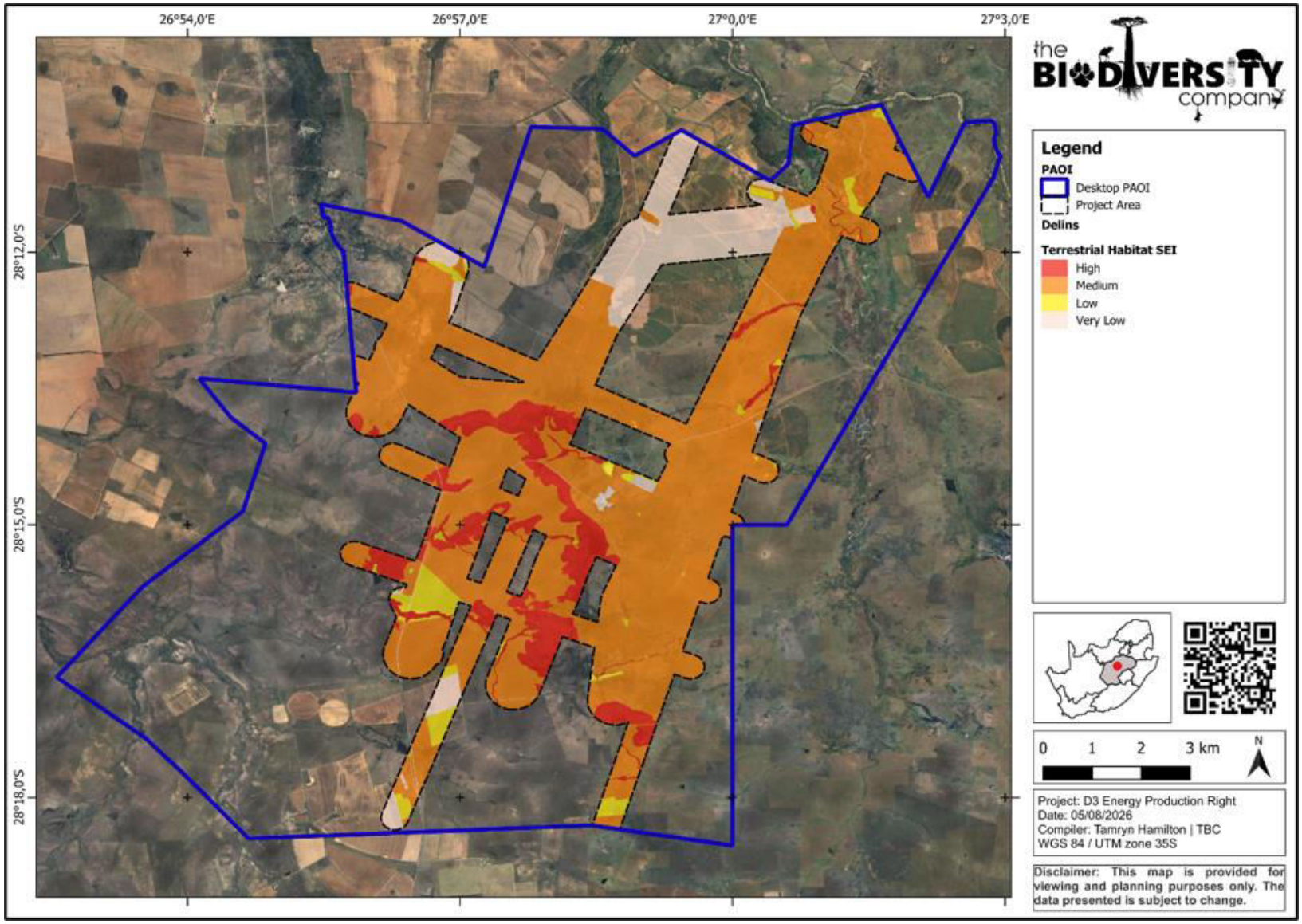


Figure 69: Site Ecological Importance of the PR development area (The Biodiversity Company, 2026)

8.10 FRESHWATER ECOLOGY - SURFACE WATER AND WETLAND

8.10.1 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 Hydrological Assessment undertaken by Smec South Africa (**Appendix F6**) and the Geohydrological Impact Assessment undertaken by Gradient Groundwater Consulting (**Appendix F7**) as well as the Aquatics and Wetland Impact Assessment undertaken by the Biodiversity Company (**Appendix F3**).

South Africa was originally divided into nineteen Water Management Areas (WMAs) which were later consolidated to nine. 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 area is situated in primary catchment (C) of the Vaal River drainage system which covers a total area of approximately 598.0km^2. The resource management falls under the Vaal Water Management Area (WMA5) (previously Middle Vaal WMA[10]) which spans portions of the North West Province, northern Free State as well as northern sections of the Northern Cape. The study area encompasses several quaternary catchments of the Vaal WMA. These include Quaternary Catchments C42G, C42H and C42K. The main watercourses within the Middle Vaal WMA are the Mooi, Vet, Sand 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 hydrology of the region is characterised by predominately perennial watercourses with primary rivers in and around the study area the Merriespruit, Steenbokspruit and Maselspruit, draining the northern section of the production right area in a general northwestern direction, forming a confluence with the Sand River flowing on the northern perimeter in a general southwestern direction. The southern section of the production right area is drained by the Doringspruit as well as Schoemanspruit flowing in a general western direction.

Major surface water bodies in close proximity to the greater study area include the Allemanskraal Dam (a surface area of approximately 28.64 km^2), which is situated approximately 13.0 km due east and located within the Sand The mean annual runoff (MAR) for the study area is estimated at approximately 12.34 Mm^3/a, based on MAR data obtained from WR2012 (WRC, 2016). **Table 37** provides a summary of relevant climatological and hydrogeological information for the relevant quaternary catchments. Refer to **Figure 70** for the hydrological conditions.

Table 37: Study Area Catchment and Hydrological Properties (Gradient Groundwater Consulting, 2026).

Quaternary Catchment	Area (km^2)	% Covered by Study Area	MAP (mm/a)	MAE (mm/a)	MAR (Mm^3/a)	Rainfall Zone	Evaporation Zone
C42G	555.01	38.92	549.39	1560	13.83	C4C	19C
C42H	445	25.24	540	1 590	10.16	C4C	19C
C42K	668.01	35.66	521.15	1 600	13.02	C4C	19C

[10] 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.

8.10.2 SOUTH AFRICAN INVENTORY OF INLAND AQUATIC ECOSYSTEMS

The South African Inventory of Inland Aquatic Ecosystems spatial dataset is part of the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) which was released as part of the National Biodiversity Assessment (NBA 2018). National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE, 2018). Ecosystem threat status (ETS) of river and wetland ecosystem types are based on the extent to which each river ecosystem type has been altered from its natural condition. Ecosystem types are categorised as CR, EN, VU or LT, with CR, EN and VU ecosystem types collectively referred to as 'threatened' (Van Deventer *et al.,* 2019; Skowno *et al.,* 2019). The study area overlaps with multiple wetlands and river ecosystems identified by the dataset. The wetlands identified include numerous LC depressions and one CR seep. The identified river lines are CR (**Figure 72**).

8.10.3 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 National Environment Management Biodiversity Act's (NEM:BA) biodiversity goals (Nel *et al.,* 2011). **Figure 73** shows that the study area overlaps numerous non-priority wetlands and multiple NFEPA rivers.

8.10.4 WETLANDS DELINEATION

The delineated wetlands were grouped into Hydrogeomorphic (HGM) units based on their topographic similarity, shared exposure to comparable threats, and the expectation that they provide similar ecological benefits. This approach ensures that wetlands with analogous landscape positions, hydrological regimes, and vulnerability to anthropogenic pressures are assessed collectively.

Forty-two (42) HGM units were identified and delineated within the PR (**Figure 74**). These features were classified as channelled valley-bottoms, unchannelled valley-bottoms, seeps, depressions, and floodplain systems (refer to **Figure 70**). In addition, three riparian systems and several non-perennial drainage features and dams were identified. Furthermore, several artificial wet areas were delineated, which have resulted from stormwater management and land-use practices such as agricultural activities.

The buffer requirements for the wetlands were calculated using the Site-Based Tool: Determination of buffer zone requirements for wetland ecosystems (Macfarlane *et al.,* 2014). The recommended post-mitigation buffers were calculated to be 15 m.

A summary of the wetland area and percentage covers of wetland within the PR is provided in **Table 38**.

Table 38: Summary of wetland area within the PR (The Biodiversity Company, 2026)

Feature	Area (Ha)	Area (%)
HGM 1 – Unchannelled Valley-Bottom	49.19	11.40
HGM 2 – Seep	7.67	1.78
HGM 3 – Channelled Valley-Bottom	39.32	9.11
HGM 4 – Depression	3.41	0.79
HGM 5 – Seep	4.63	1.07
HGM 6 – Unchannelled Valley-Bottom	1.39	0.32
HGM 7 – Unchannelled Valley-Bottom	15.10	3.50

Feature	Area (Ha)	Area (%)
HGM 8 – Channelled Valley-Bottom	2.13	0.49
HGM 9 – Unchannelled Valley-Bottom	5.78	1.34
HGM 10 – Depression	36.98	8.57
HGM 11 – Unchannelled Valley-Bottom	52.43	12.15
HGM 12 – Depression	2.14	0.50
HGM 13 – Channelled Valley-Bottom	36.0	8.34
HGM 14 – Seep	1.29	0.30
HGM 15 – Channelled Valley-Bottom	15.23	3.53
HGM 16 – Unchannelled Valley-Bottom	9.56	2.22
HGM 17 – Seep	4.36	1.01
HGM 18 – Depression	3.60	0.83
HGM 19 – Depression	2.59	0.60
HGM 20 – Floodplain	11.05	2.56
HGM 21 – Seep	6.47	1.50
HGM 22 – Unchannelled Valley-Bottom	0.5	0.12
HGM 23 – Depression	1.64	0.38
HGM 24 – Channelled Valley-Bottom	7.46	1.73
HGM 25 – Seep	2.80	0.65
HGM 26 – Depression	0.6	0.14
HGM 27 – Seep	5.39	1.25
HGM 28 – Depression	2.80	0.65
HGM 29 – Unchannelled Valley-Bottom	4.12	0.95
HGM 30 – Seep	11.53	2.67
HGM 31 – Unchannelled Valley-Bottom	6.04	1.40
HGM 32 – Floodplain	11.01	2.55
HGM 33 – Seep	3.70	0.86

Feature	Area (Ha)	Area (%)
HGM 34 – Unchannelled Valley-Bottom	14.64	3.39
HGM 35 – Seep	32.12	7.44
HGM 36 – Seep	12.27	2.84
HGM 37 – Depression	2.88	0.67
HGM 38 – Seep	0.27	0.06
HGM 39 – Depression	0.75	0.17
HGM 40 – Depression	0.07	0.02
HGM 41 – Depression	0.11	0.03
HGM 42 – Channelled Valley-Bottom	0.54	0.12

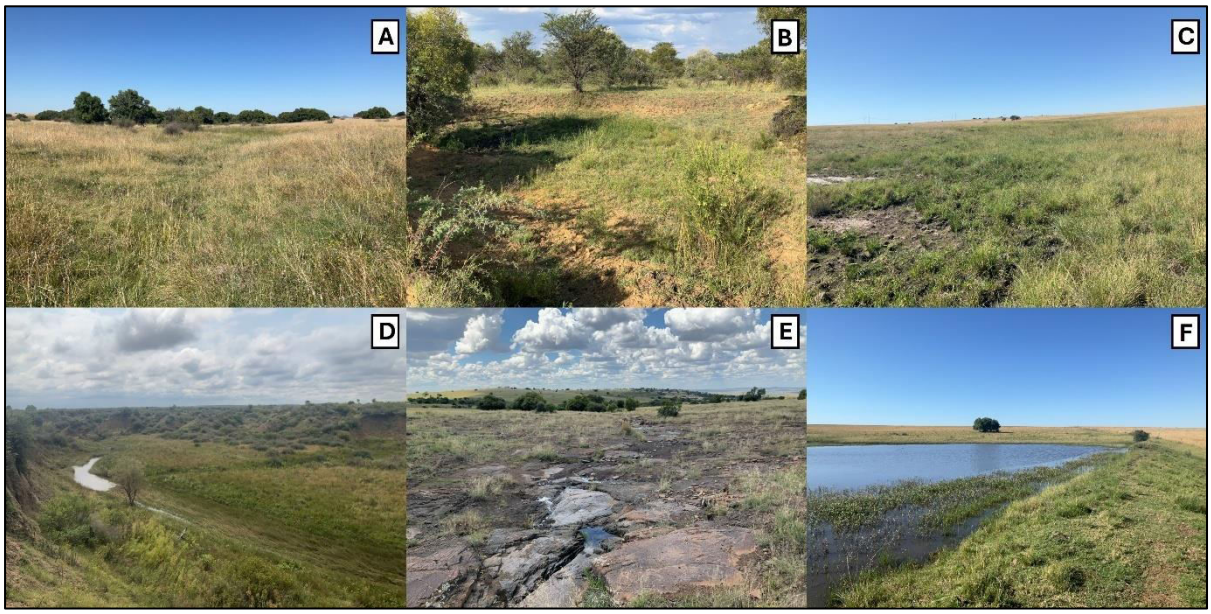


Figure 70: Representative photographs of the different water features within the project area of interest. A) Seep; B) Depression; C) UVB; D) CVB; E) Non-perennial Drainage Line; F) Dam (The Biodiversity Company, 2026).

8.10.5 PRESENT ECOLOGICAL STATUS

The wetlands identified within the project area have exhibited a limited degree of modification resulting from natural physical changes, as well as anthropogenically induced impacts at both the local and catchment level. Resultingly, the wetlands scored average Present Ecological State (PES) scores within the "C – Moderately Modified" and "D – Largely Modified" PES classes. The results of the wetland health and integrity assessment is provided in **Table 39**.

Table 39: Average Present Ecological State scores for the assessed wetland units (The Biodiversity Company, 2026).

C – Moderately Modified	D – Largely Modified
Channelled Valley-Bottoms (HGM 1; HGM 6; HGM 7; HGM 9; HGM 11)	Unchannelled Valley-Bottoms (HGM 3; HGM 8; HGM 13; HGM 15)
Seeps (HGM 2; HGM 5; HGM 14)	Depressions (HGM 4; HGM 10; HGM 12)

The list below refers to the present-day local impacts observed within the assessed wetland areas:

- Agricultural disturbance and associated edge effects;
- Localised soil compaction in and around wetland areas;
- Erosion and sediment deposition from disturbed surfaces and access routes;
- Altered runoff pathways caused by existing roads, tracks, and crossings;
- Disturbance of wetland-edge vegetation and reduced buffer integrity;
- Alien and invasive and disturbance-associated plant encroachment;
- Habitat fragmentation and reduced ecological connectivity; and
- Localised disturbance associated with existing access and exploration activities

8.10.6 ECOLOGICAL IMPORTANCE AND SENSITIVITY

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. Various components pertaining to the protection status of a wetland is considered for the EIS, including Strategic Water Source Areas (SWSA), the NFEPA Wetveg protection status and the protection status of the wetland itself considering the NBA wetland dataset. The results of the assessment are shown in the **Table 40**. The wetlands average EIS scores present within the “B – High”, and “C – Moderate” classes.

Table 40: Aspects considered in the Ecological Importance and Sensitivity assessment (The Biodiversity Company, 2026).

HGM Type	NFEPA Wet Veg			Wetland Condition	NBA Wetlands		SWSA (Y/N)	CBA / ESA (Y/N)	EIS Class
	Type	Ecosystem Threat Status	Ecosystem Protection Level	(Field Survey)	Ecosystem Threat Status 2018	Ecosystem Protection Level			
Unchannelled Valley-Bottoms (HGM 3; HGM 8; HGM 13; HGM 15)	Dry Highveld Grassland Group 3 /Dry Highveld Grassland Group 4	Least Threatened / Critically Endangered	Not Protected	D – Largely Modified	Critically Endangered	Not Protected	N	Y (CBA, ESA)	B – High
Seeps (HGM 2; HGM 5; HGM 14)		Endangered / Critically Endangered		C – Moderately Modified	Critically Endangered	Not Protected		Y (CBA, ESA)	B - High
Channelled Valley-Bottoms (HGM 1; HGM 6; HGM 7; HGM 9; HGM 11)		Least Threatened / Critically Endangered		C – Moderately Modified	Critically Endangered	Not Protected		Y (CBA, ESA)	B – High
Depressions (HGM 4; HGM 10; HGM 12)		Least Threatened		D – Largely Modified	Least Threatened	Poorly Protected		Y (CBA, ESA)	C – Moderate

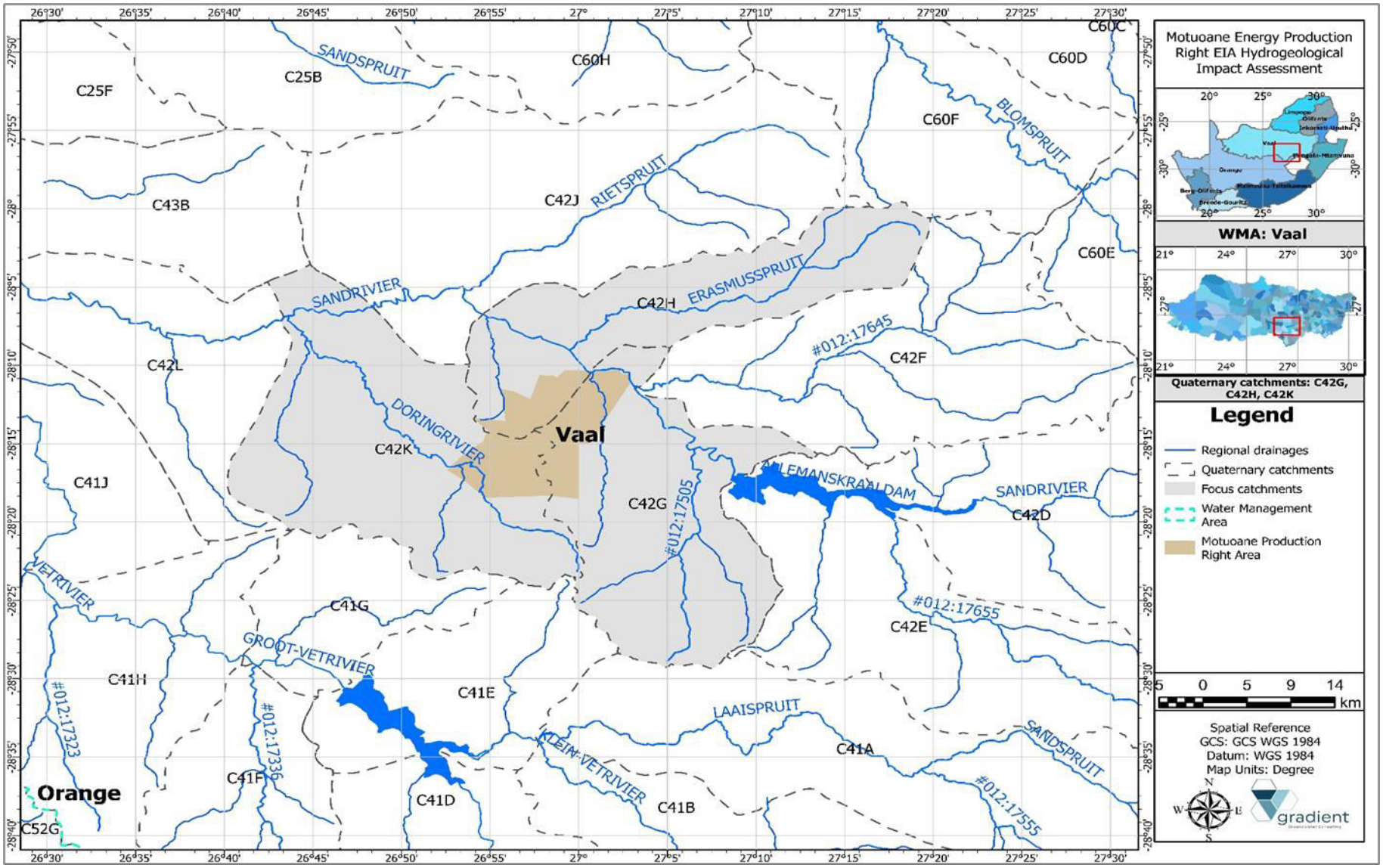


Figure 71: Quaternary catchments and water management area (Gradient Groundwater Consulting, 2025).

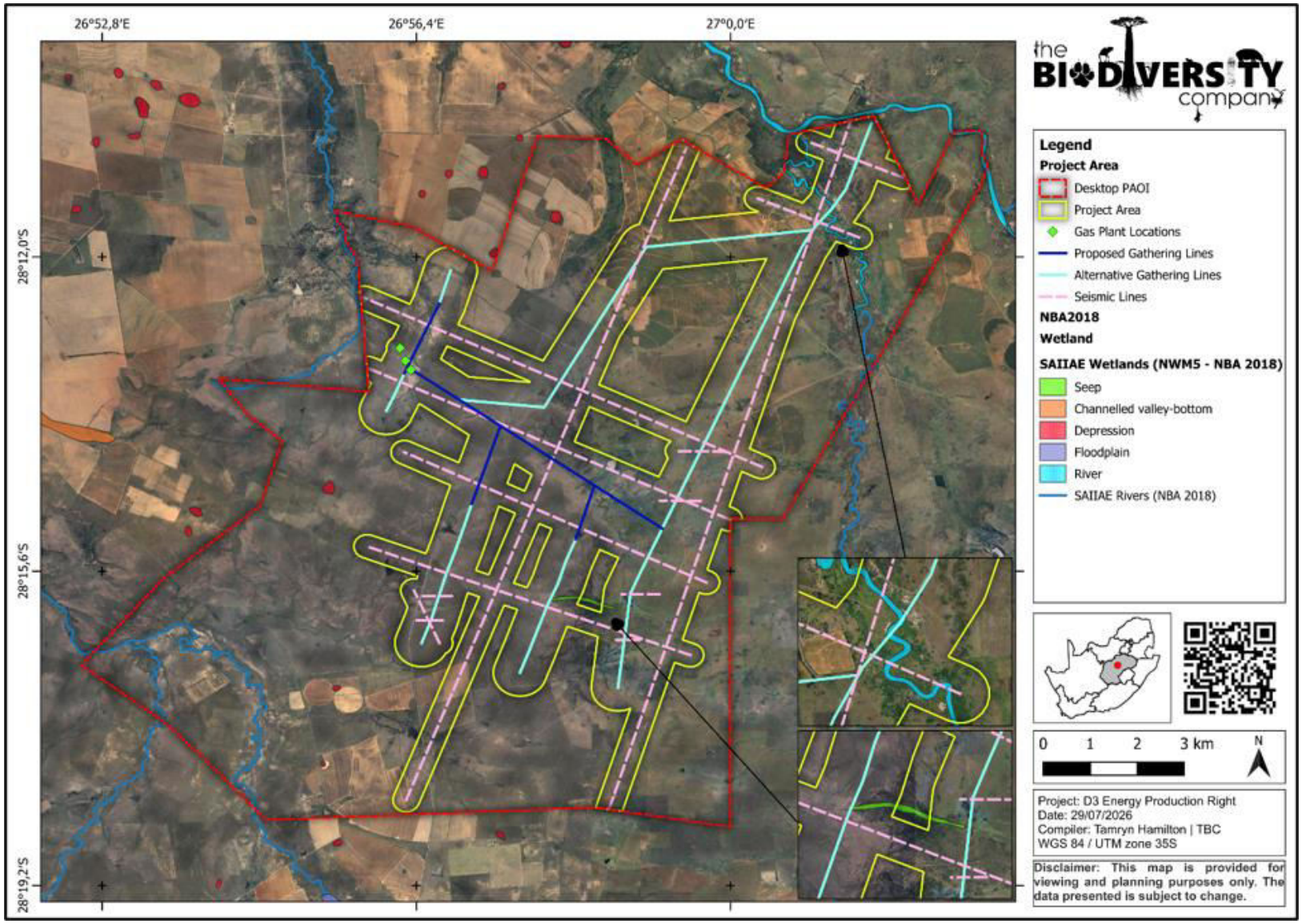


Figure 72: Map illustrating ecosystem threat status of rivers and wetlands in the PR (The Biodiversity Company, 2026).

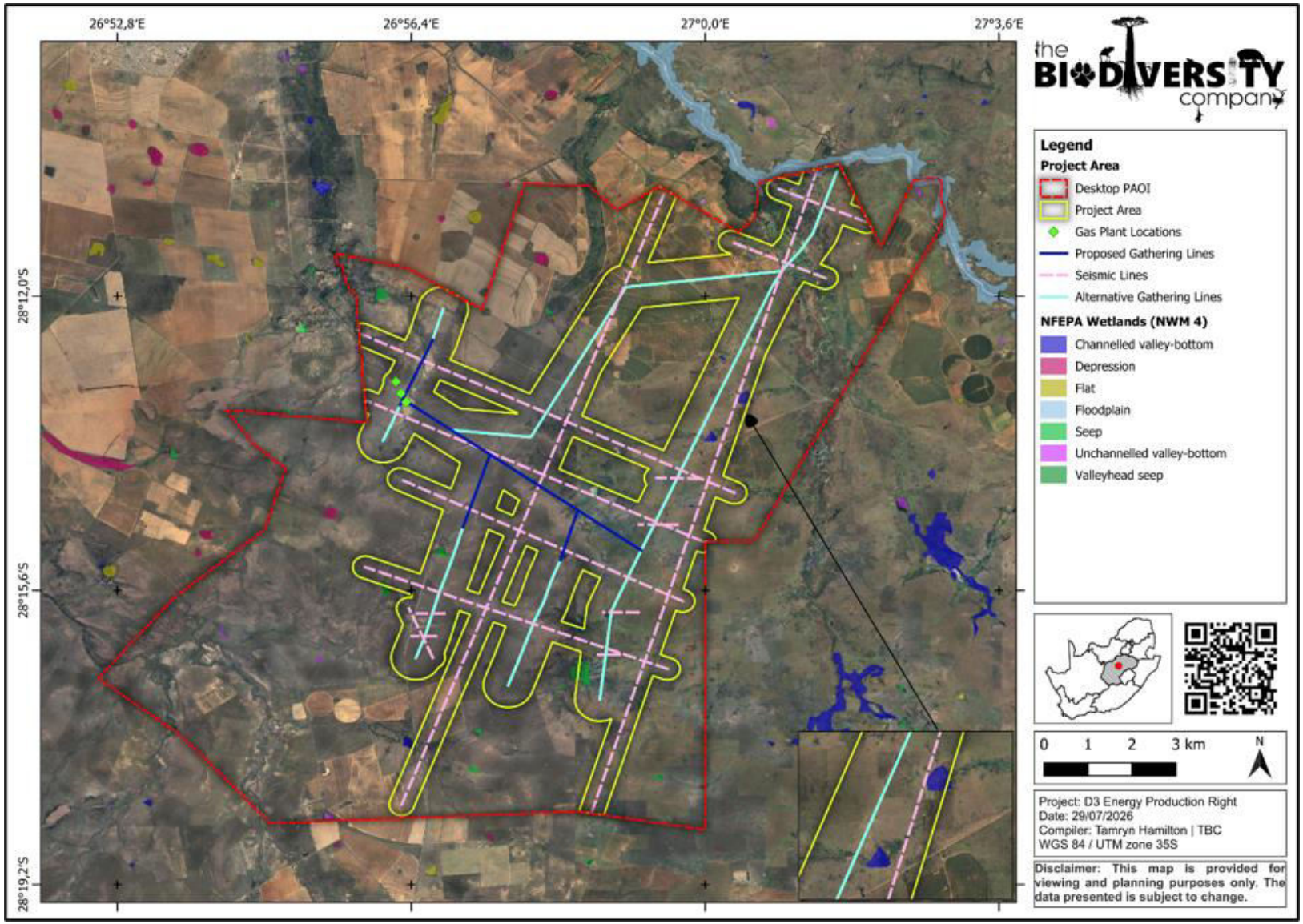


Figure 73: The PR in relation to the National Freshwater Ecosystem Priority Areas (The Biodiversity Company, 2026).

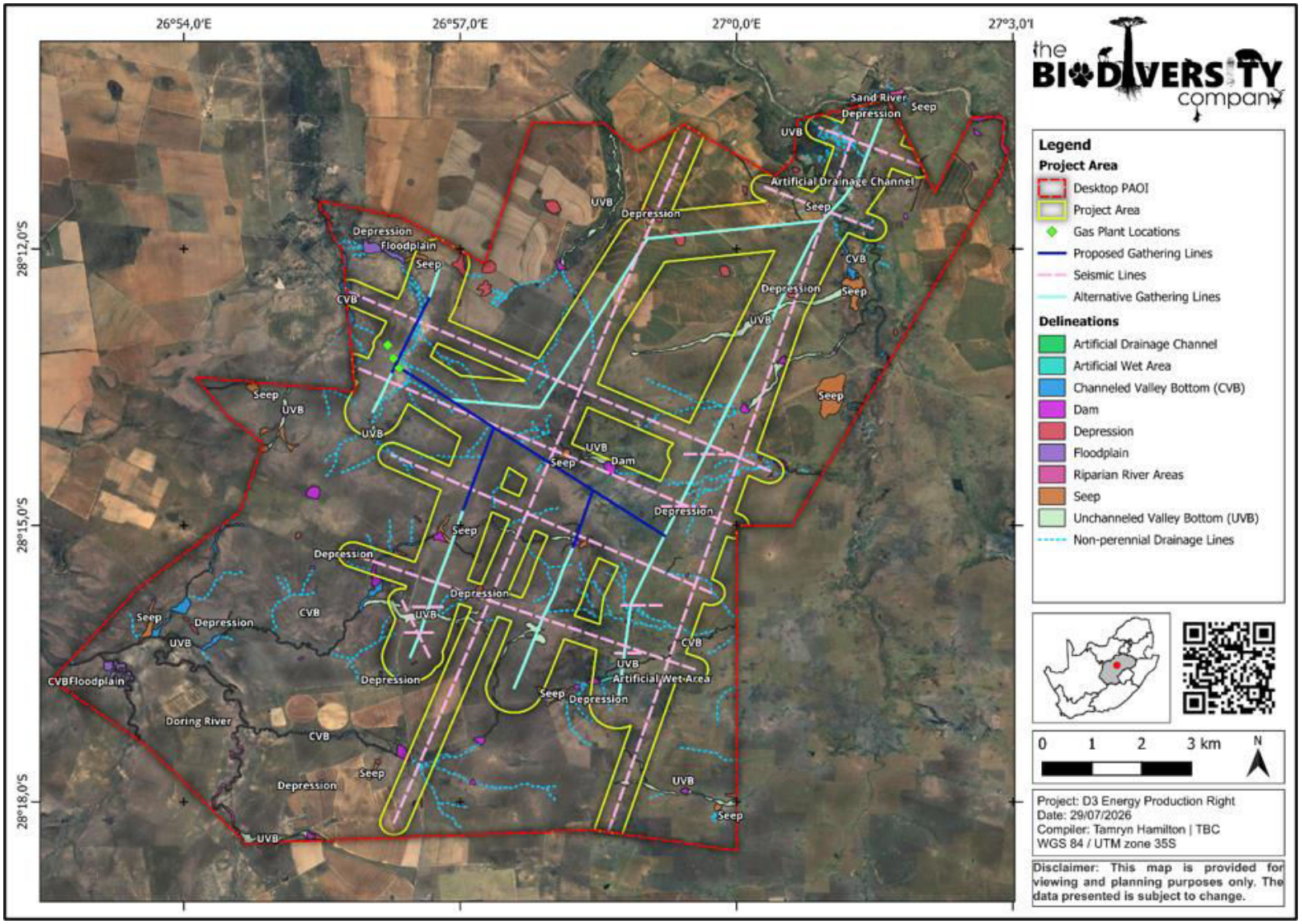


Figure 74: Delineation of water resources within the PR (The Biodiversity Company, 2026).

8.10.7 FLOODLINES

This section provides the flood baseline information for the PR as per the Hydrological Assessment undertaken by Smec South Africa (**Appendix F**6). This section must be read in conjunction with the Climatic Conditions (**Section 8.4**), Aquatics and Wetlands (**Section 8.10**) and Geohydrological (**Section 8.10.7**) sections.

8.10.7.1 CURRENT CLIMATIC CONDITIONS

The climate of the study area is characterised by dry winters and wet summers. The warmest months in the region occur between November and February and the coldest months occur between May and August. Average annual maximum temperature is approximately 28 ^{o}C per annum, according to the National Centre for Environmental Information (NCEI). In order to avoid repetition of information, refer to **Section 8.4.1** for the detailed baseline climatic conditions.

8.10.7.2 FUTURE CLIMATIC CONDITIONS

The baseline (1961 to 1990) annual averages for these metrics were accessed for the area near the project site from the South Africa 'Green Book' (CSIR, 2019). The metrics include three percentiles (10th, 50th, and 90th) as an indication of the variability within the measured data set. The baseline annual average temperature was in the range 16.1°C (10th percentile) and 16.3°C (90th percentile)) with the number of very hot days varying between 2 (10th percentile) and 4.5 (90th percentile) days per year. The annual average rainfall range between the 10th and 90th percentiles is 1 079 mm and 1 168 mm. Extreme rainfall days varied between 12.4 (10th percentile) and 13.8 (90th percentile) days per year.

The projected climate change is modelled using Representative Concentration Pathways (RCP). The Green Book projected temperature changes in the near future (2021 to 2050) indicate a 50th percentile increase of 2.3°C and a 90th percentile increase of 2.8°C (Engelbrecht, et al., 2019). Between 2021 and 2050 the annual rainfall near the project site is projected to increase by 180 mm (50th percentile) (Engelbrecht, et al., 2019), with extreme rainfall days potentially increasing by 1.7 days (50th percentile) in the near future (Engelbrecht, et al., 2019). Between 2021 and 2050 the **annual rainfall near the project site was projected to increase by 200 mm** between 2021 and 2050 (50th percentile) (Engelbrecht, *et al.*, 2019), with extreme rainfall to increase by 1.5 days (Engelbrecht, *et al.*, 2019). Refer to **Section 8.4.2** for the detailed projected future climatic conditions.

8.10.7.3 ADJUSTMENT FOR CLIMATE CHANGE

To understand what the likely impact of climate change on the peak flow rates generated by rainfall events for the PR it is then important to understand the main parameters that impact the value of peak flows/runoffs as determined using rainfall/runoff models.

The most common and widely accepted rainfall/runoff model used in South-Africa and Internationally as well, is the Rational Method, which also forms the basis of the SDF method used and selected for the design case on this project.

The Rational Method is a simple formula stating that the peak flow/runoff (Q-value) is a function of three main parameters, i.e. the catchment characteristics or C-value, the rainfall intensity or I-value and the area of the catchment or A-value. When these are multiplied (using appropriate units), the peak flow rate Q is determined, refer to Equation 5-1: Rational Method Formulae

for the Rational Method Formulae.

$$Q = C\,i\,A$$

Equation **Fehler! Kein Text mit angegebener Formatvorlage im Dokument.**-1: Rational Method Formulae

For South-Africa, the Rational Method has been calibrated whereby the catchment characteristic (C-value) is a function of the MAP of the catchment. Since the climate change studies discussed earlier, suggest an increase in the MAP for the Project Area, there is therefore an expected increase in the catchment characteristic C-value for the catchment too. For example, higher MAP areas have typically higher soil moisture content and therefore

higher runoff resulting from rainfall. Higher runoff means an increase in stream flow rates and therefore floodlines of larger extent.

Over and above the relationship between the MAP and the C-value, the Consultant has illustrated that there is also a relationship between the MAP and the rainfall depth and thus rainfall intensity (I-value) in the Rational Formulae. This relationship means a relationship between the runoff/peak flow (Q-value) and climate change through the MAP rainfall depth/intensity relationship.

8.10.7.4 MAP VS 100 YEAR 24-HOUR RAINFALL DEPTH

8.10.7.4.1 INCREASE IN RAINFALL DEPTH

In a recent study by Airshed Planning Professionals (2026) for a nearby gas development located within the same major catchment, rainfall data was analysed for approximately 20 rainfall stations in the area. The conclusion drawn was that a direct relationship exists between the rainfall depth and the mean annual precipitation of the area. The relationship showed that for an anticipated increase in MAP of 200mm as per the adopted climate change model, the rainfall depth will increase by about 4% as the catchment becomes wetter on average (larger MAP). The same 4% increase in rainfall depth is proposed for the D3 Energy PR being adjacent to the said nearby gas development and being in the same hydrological catchment.

8.10.7.4.2 INCREASE IN RUN-OFF COEFFICIENT

Three factors namely surface slope, ground permeability and vegetation cover and density determine how much of rain is retained on the surface during and after a rainfall event. Separate coefficients are assigned to these three factors as shown in Figure 98 below (Table 3C.1 – SANRAL Drainage Manual) making up the combined C-factor as explained earlier with the Rational Method Formulae. The higher coefficients indicate that less of the rainfall is retained and that more rainfall runs off and enters the streams or rivers.

For the Rational Method application, the run-off or catchment characteristic coefficients (C-values) are separated into columns representative of three rainfall ranges. Project areas with a MAP of 600mm and less will be drier, and the ground is expected to absorb more of the initial rainfall than in the higher rainfall area where the ground surface is expected to be already partially saturated at the start of the rain event, resulting in larger runoff and therefore increase runoff/peak flow rates.

Table 3C.1				
Rural (C_1)				
Component	**Classification**	**Mean annual rainfall (mm)**		
		600	**600 - 900**	**900**
Surface slope (C_S)	Wetlands and pans (<3%)	0,01	0,03	0,05
	Flat areas (3 to 10%)	0,06	0,08	0,11
	Hilly (10 to 30%)	0,12	0,16	0,20
	Steep areas (>30%)	0,22	0,26	0,30
Permeability (C_P)	Very permeable	0,03	0,04	0,05
	Permeable	0,06	0,08	0,10
	Semi-permeable	0,12	0,16	0,20
	Impermeable	0,21	0,26	0,30
Vegetation (C_V)	Thick bush and plantation	0,03	0,04	0,05
	Light bush and farm-lands	0,07	0,11	0,15
	Grasslands	0,17	0,21	0,25
	No vegetation	0,26	0,28	0,30

Figure 75: Table 3C.1 extracted from SANRAL Drainage Manual

The MAP for the project area is between 518 mm and 625 mm before application of climate change and falls mostly within the 600mm range but when considering the future up to the year 2050 the MAP increases to a value corresponding with the 600 – 900 mm MAP range. The run-off / catchment characteristic coefficient increases consequently. Total run-off coefficient (C-value or C_1) was adjusted from the 600mm MAP range to the 600-900mm range by applying the Surface Slope (C_S), Permeability (C_P), and Vegetation (C_V) in area proportional ratios to arrive at an overall combined C-factor for the increased MAP under Climate Change Conditions.

Again, for the neighbouring gas development facility, the increase in C-factor as a result of the MAP increasing by 200mm per year resulted in a value of 40%. This means that 40% more flow as a combined impact of wetter climate (higher MAP) on the topography in question, the permeability of soils and the vegetation for the project will likely be seen. Combining the 4% increase in rainfall depth and estimated 40% increase in runoff results in an overall increase in runoff of 46% for the PR.

Rainfall and runoff coefficients were modified to reflect the estimated 46% increase in runoff to obtain the most relevant floodlines for the project. All flood estimation methods considered for the project rely on rainfall data and some form of catchment runoff or catchment response parameter, both of which are predicted to increase under climate change conditions, for this reason all flood estimation methods are recommended to be adjusted for climate change impacts as assessed and quantified in the Hydrological Assessment.

8.10.7.4.3 PEAK FLOW RATES WITH CLIMATE CHANGE

The peak flows as reflected in **Table 41** include for the impacts of climate change as quantified in the Hydrological Assessment.

Table 41: 1:100year Peak Flow Rates (m^3/s) - Projected Climate Change (Smec South Africa, 2026).

Flood Estimation Method	Peak Flowrates (m^3/s)						
	C_NW2	**C_SW1**	**C_SW1a**	**C_SW1b**	**C_N3**	**C_N3a**	**C_N3b**
Standard Design Flood (SDF)	**404**	**888**	**378**	**682**	**3731**	**577**	**3589**
Rational Method 2	201	362	166	277	1417	242	1362
Rational Method 3	127	309	129	237	1748	221	1680
Unit Hydrograph (UHG)	187	510	176	369	1846	318	1792
Empirical - Midgley and Pitman	160	445	178	337	2766	298	2670
Empirical – Regional Maximum Flood	254	601	326	485	3923	482	3851

The climate change SDF peak flow rates as tabulated above were accordingly implemented into the hydraulic model for assessing the most relevant floodlines for the project.

8.10.7.5 FLOODLINE MODELLING

The river hydraulics were modelled using the GeoHEC-RAS software suite, developed by CivilGEO Engineering Software. The software utilises the widely used one-dimensional HEC-RAS river hydraulics engine, developed by the US Army Corps of Engineers. The floodlines are based on static flow conditions and do not reflect any additional water rise, due to possible dam break events, in the upstream catchment area. Flood modelling was undertaken for the sections of the above-mentioned rivers that lie within or near the project area boundary.

8.10.7.5.1 CHANNEL ROUGHNESS

Channel roughness values are physical parameters describing the irregularity of the surface within a particular stream/river that impacts the water depth, velocity and therefore energy and momentum of water moving from upstream to a downstream location. Manning's Roughness coefficient/values (n) were estimated using a visual assessment of Google Earth aerial photograph maps and site photographs and interpreted from the Composite Table and Diagram extracted from SANRAL Drainage manual, 6th Edition.

Table 42: Manning's Roughness Coefficient/values (Smec South Africa, 2026

River Reaches	Left Bank	Channel	Right Bank
Sand River	0. 045	0.040	0.045
Doring River	0.045	0.040	0.045

The values above represent the average Manning's roughness values across the rivers inside the project area. Generally, every section along a natural river has a different manning's roughness due to its irregular nature. The following figures indicate the channel characteristics at each of the rivers.

8.10.7.5.2 RIVER HYDRAULIC MODEL

There were no bridges identified in the project area, but there were a few culverts. Most of the culverts were small, which is expected, based on the type of roads found in the vicinity. There are two larger roads which have slightly more robust culverts, and these were assessed more closely. An HY8 model (a culvert capacity analysis software) was created to assess the hydraulic capacity of these culverts and compare that to the peak flowrate in the relevant streams. In all cases it was seen that the culvert capacity could not pass the 1:100-year flowrate, and the roads would therefore be overtopped. Based on this assessment it was decided not to include the culverts in the GeoHEC-RAS model, which results in the software routing floodwater over the road surface (picked up from the surveyed DEM), rather than through the culvert. This is a conservative approach and is deemed a reasonable assumption for this level of floodline study. The same level of flooding of the roads would be seen if the culverts were blocked with debris, which is quite possible.

The normal depth condition was used as the downstream and upstream hydraulic controls / boundaries for all river sections modelled.

8.11 HYDROGEOLOGY - GROUNDWATER

This section summarises the regional and site-specific hydrogeology as obtained from the Geohydrological Impact Assessment by Gradient Groundwater Consulting (2026) attached as **Appendix F7**. 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; and
- Hydraulic parameters.

8.11.1 REGIONAL HYDROGEOLOGY INFORMATION

The Department of Water and Sanitation 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), with host aquifers consisting primarily of arenaceous and argillaceous strata. 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). 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.

According to Vegter's groundwater regions delineated (2000) the study area can be classified as falling under the Northeastern Upper Karoo Region (Region 30). Groundwater Region 30 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 Upper Karoo Region is 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. Refer to **Figure 77** for a map illustrating the typical groundwater occurrence for the greater study area while **Figure 78** depicts the hydrogeological map of the greater study area.

8.11.2 LOCAL HYDROSTRATIGRAPHIC UNITS

For the purposes of this investigation, three main hydrostratigraphic units/aquifer systems can be inferred in the saturated zone[11]:

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 and Karoo Dolerite Suite**: 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 Beaufort Group and Karoo Dolerite Suite formations**: 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,

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

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.

8.11.3 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 76** (Fetter and Kreamer, 2023). According to the 1.0×1.0 km groundwater level grid obtained from WR2012 (WRC, 2016), the thickness of the unsaturated zone i.e., depth to groundwater ranges between ~30.0 m to >55.0 m.

8.11.4 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.

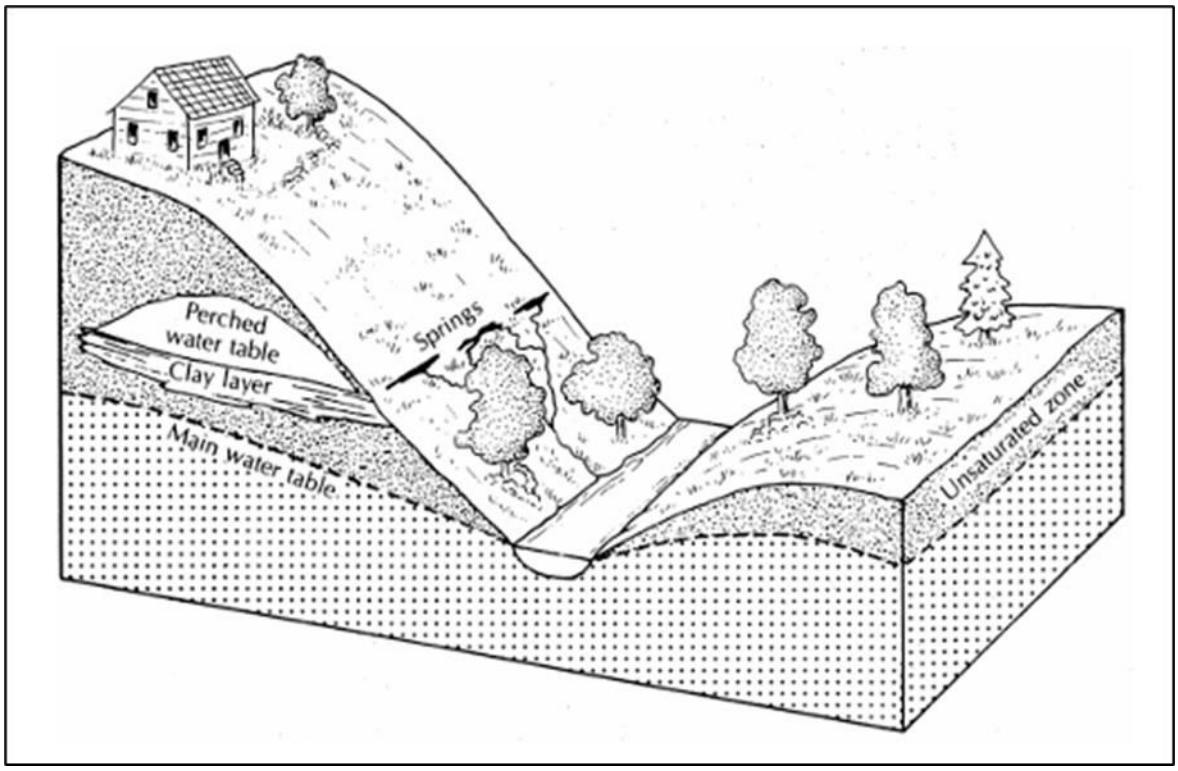


Figure 76: Illustration of the Unsaturated Zone (Fetter and Kreamer, 2023).

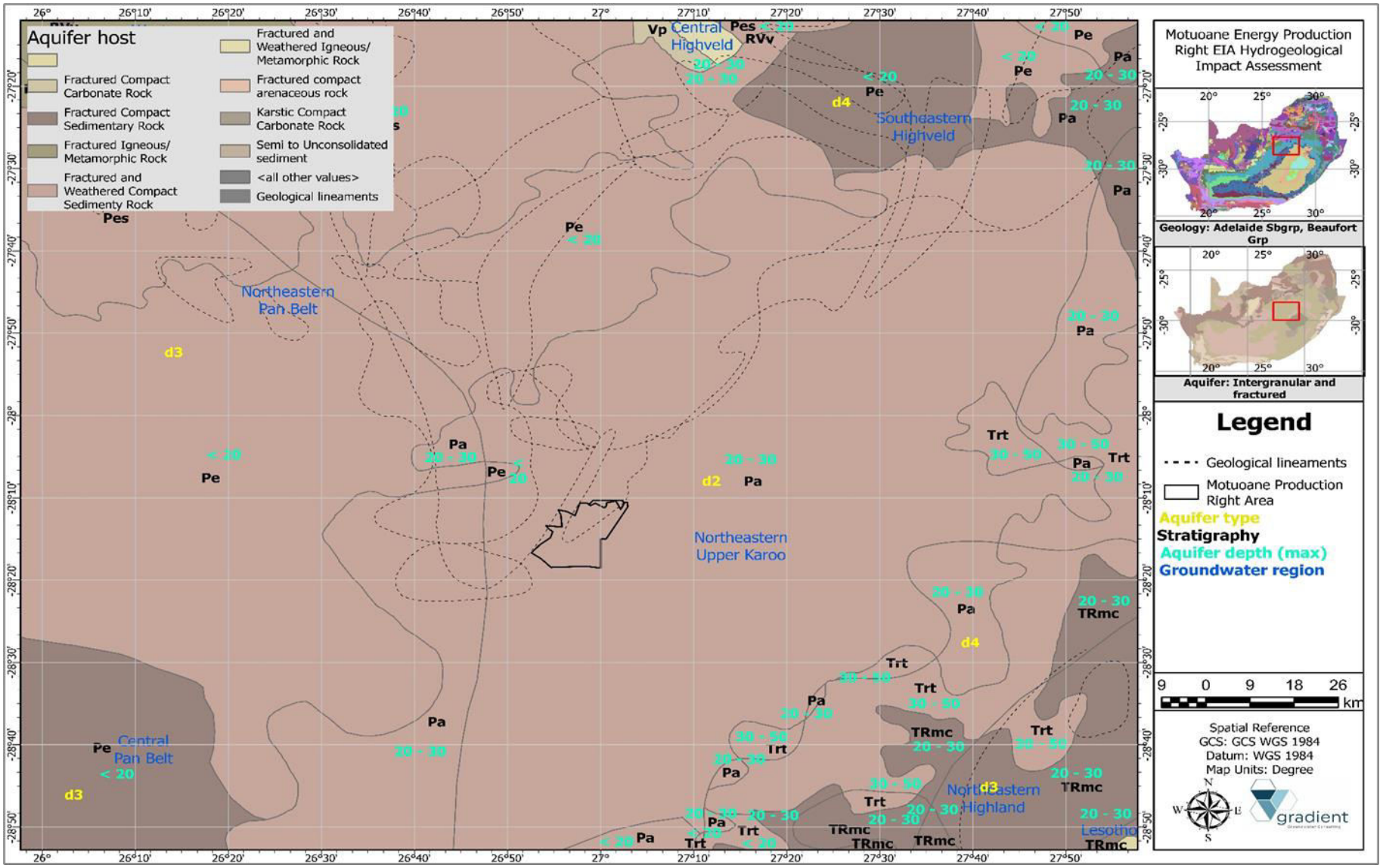


Figure 77: Typical aquifer hosts and groundwater occurrence for the study region (Gradient Groundwater Consulting, 2026).

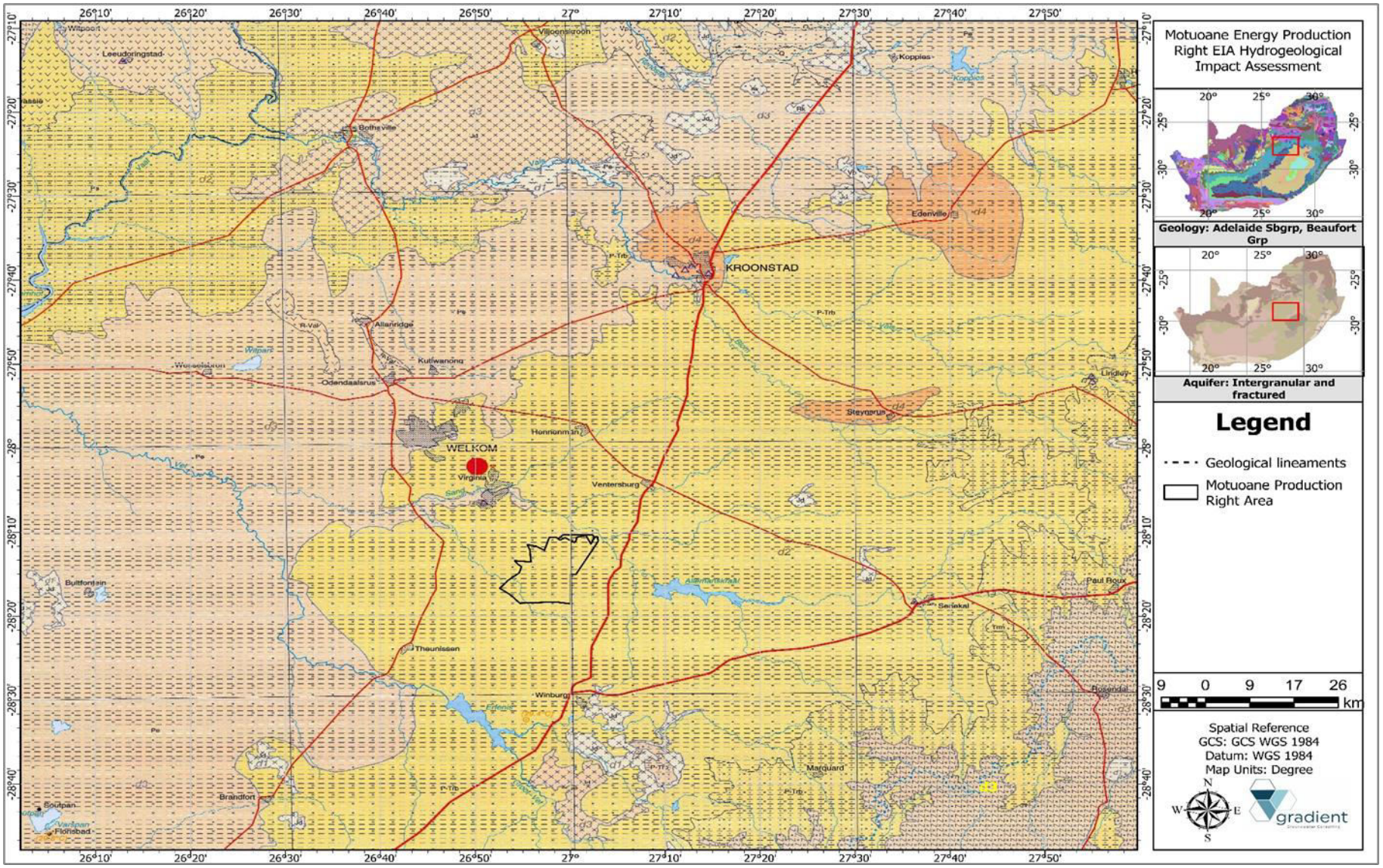


Figure 78: Hydrogeological map of the greater study region (Gradient Groundwater Consulting, 2026).

8.11.5 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.

8.11.5.1 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 77** 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)[12].

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

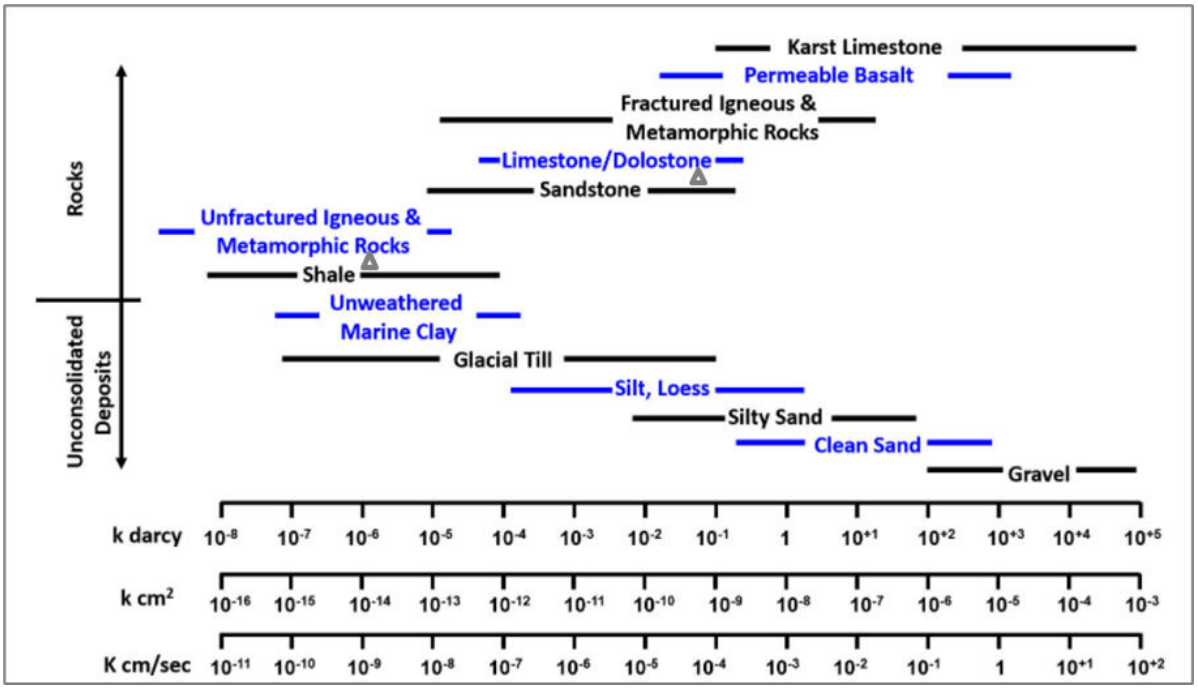


Figure 79: Typical hydraulic conductivity values for on-site hydrostratigraphical units (Gradient Groundwater Consulting, 2026).

8.11.5.2 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., $10E^{-2}$.

8.11.5.3 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).

8.11.5.4 RECHARGE

An approximation of recharge for the study area is estimated at at ~3.27% of MAP i.e. ~17.52 mm/a as summarised in **Table 43**. According to the 1 × 1 km recharge grid obtained from WR2012, the average recharge in the greater study area ranges is approximately 1% (5.0 mm/a) whereas the upper limit is approximately 5.0% (26.50mm/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 80**) (iii) Harvest Potential (**Figure 81**) (iv) Baseflow as a minimum of recharge (v) Qualified opinion and, (vi) Literature review.

Table 43: Recharge estimation (after van Tonder and Xu, 2000) (Gradient Groundwater Consulting, 2026).

Recharge method/ Reference	Recharge (mm/a)	Recharge (% of MAP)	Weighted Average (High = 5; Low = 1)
Geology	22.00	4.10	1.00
Vegter	20.00	3.73	4.00

Recharge method/ Reference	Recharge (mm/a)	Recharge (% of MAP)	Weighted Average (High = 5; Low = 1)
Harvest Potential	15.00	2.80	3.00
Baseflow	15.00	2.80	3.00
Qualified Opinion	17.50	3.27	3.00
Literature	17.80	3.32	3.00
Weighted average	**17.52**	**3.27**	**17.00**
Notes: Recharge per annum were calculated using a MAP of 535.98 mm/a.			

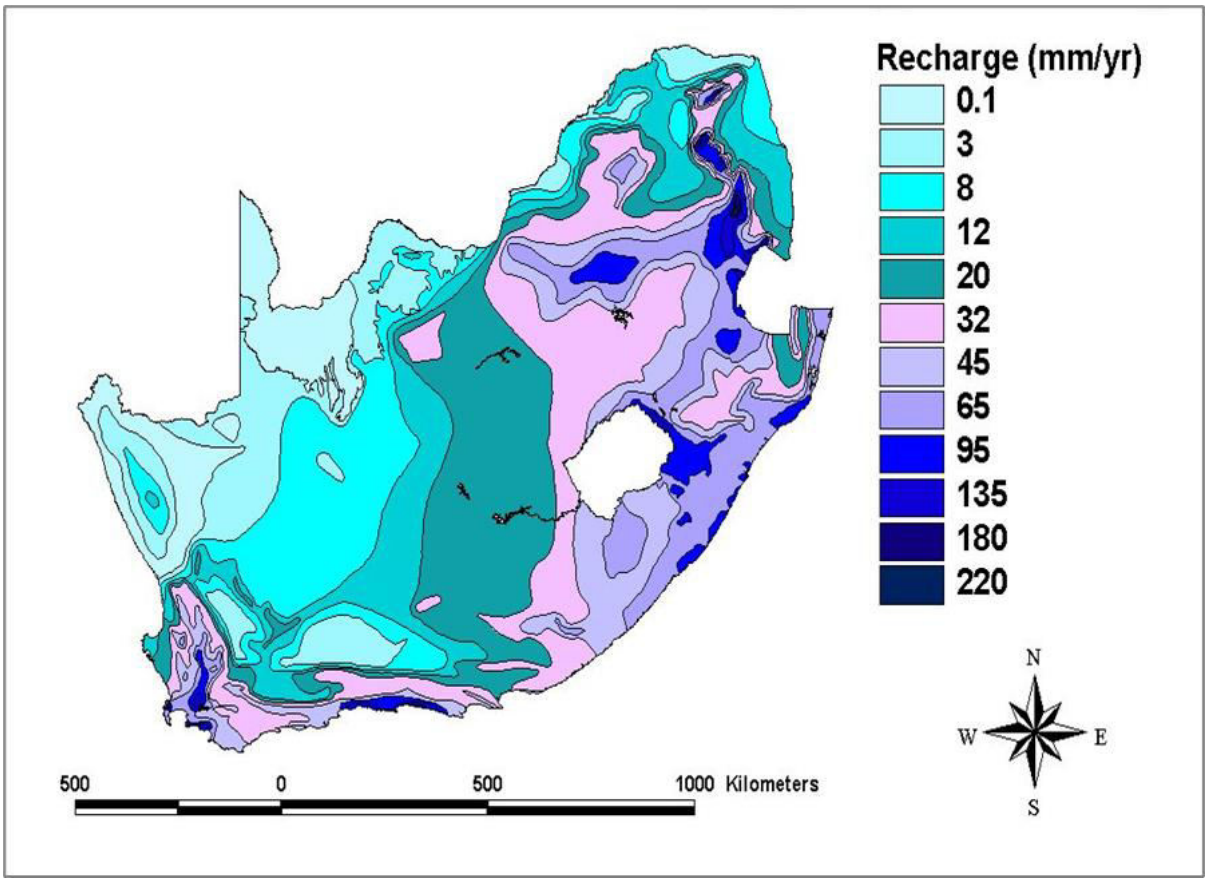


Figure 80: Groundwater recharge distribution in South Africa (After Vegter, 1995).

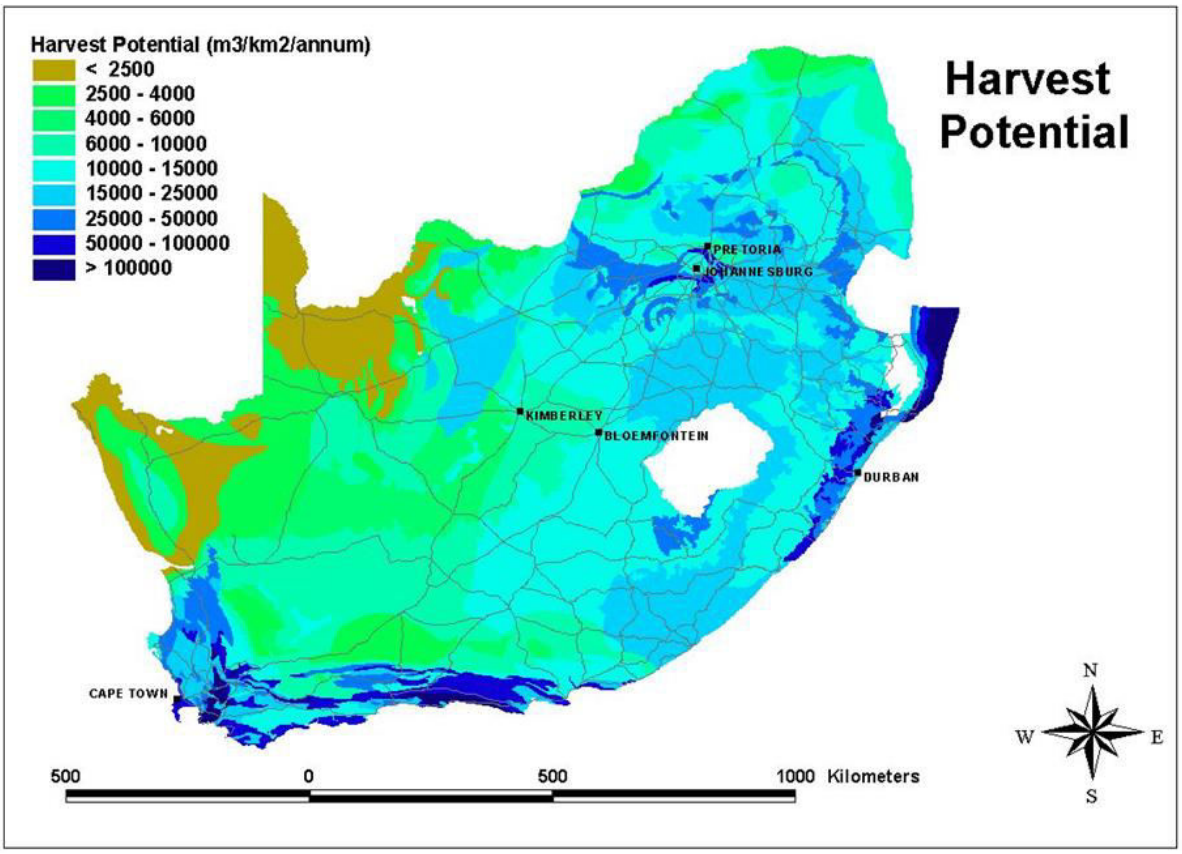


Figure 81: Harvest potential distribution in South Africa (DWS, 2013).

8.11.6 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.

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

8.11.6.1 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 systems. 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**".

8.11.6.2 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.

8.11.6.3 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 44**.

Table 44: Groundwater Quality Management Index (Gradient Groundwater Consulting, 2026).

Aquifer system		Aquifer vulnerability	
Management qualification		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		

Aquifer system		Aquifer vulnerability	
Management qualification		**Classification**	
Special Aquifer System	0-6		
GQM INDEX	**Level of protection**		
<1	Limited Protection		
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**

8.11.7 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 82** 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 83**[13] depicts a west- east cross section of the study area for the pre-operational scenario while **Figure 84** indicates the same cross section for the post-operational scenario with relevant groundwater information included.

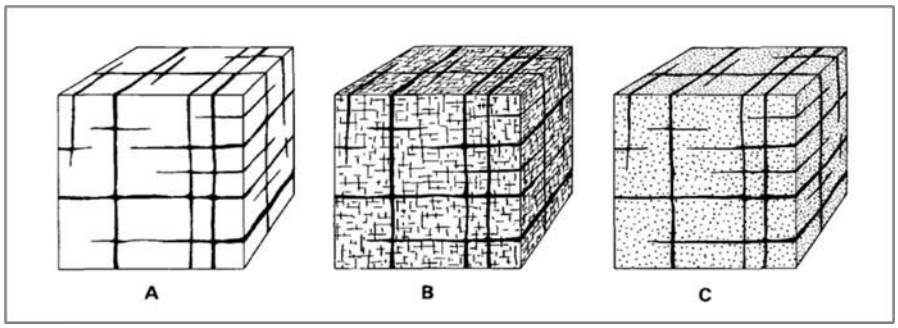


Figure 82: Generalised conceptual hydrogeological model (after Kruseman and de Ridder, 1994).

[13] Kindly note HP on **Figure 83** and **Figure 84** refers to pressure head.

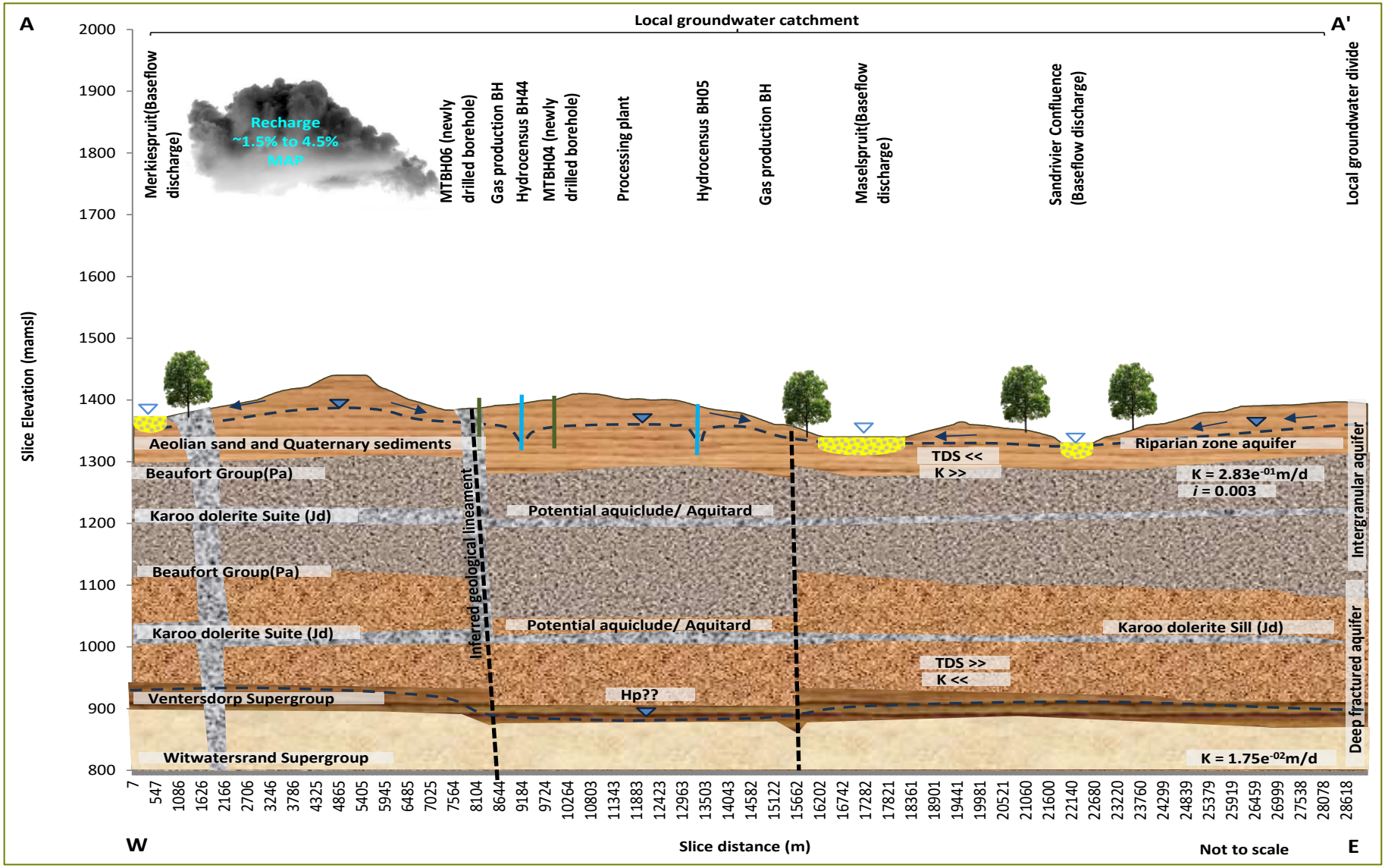


Figure 83: Hydrogeological conceptual model: West- East cross section (A-A')(Pre-operational) (Gradient Groundwater Consulting, 2026).

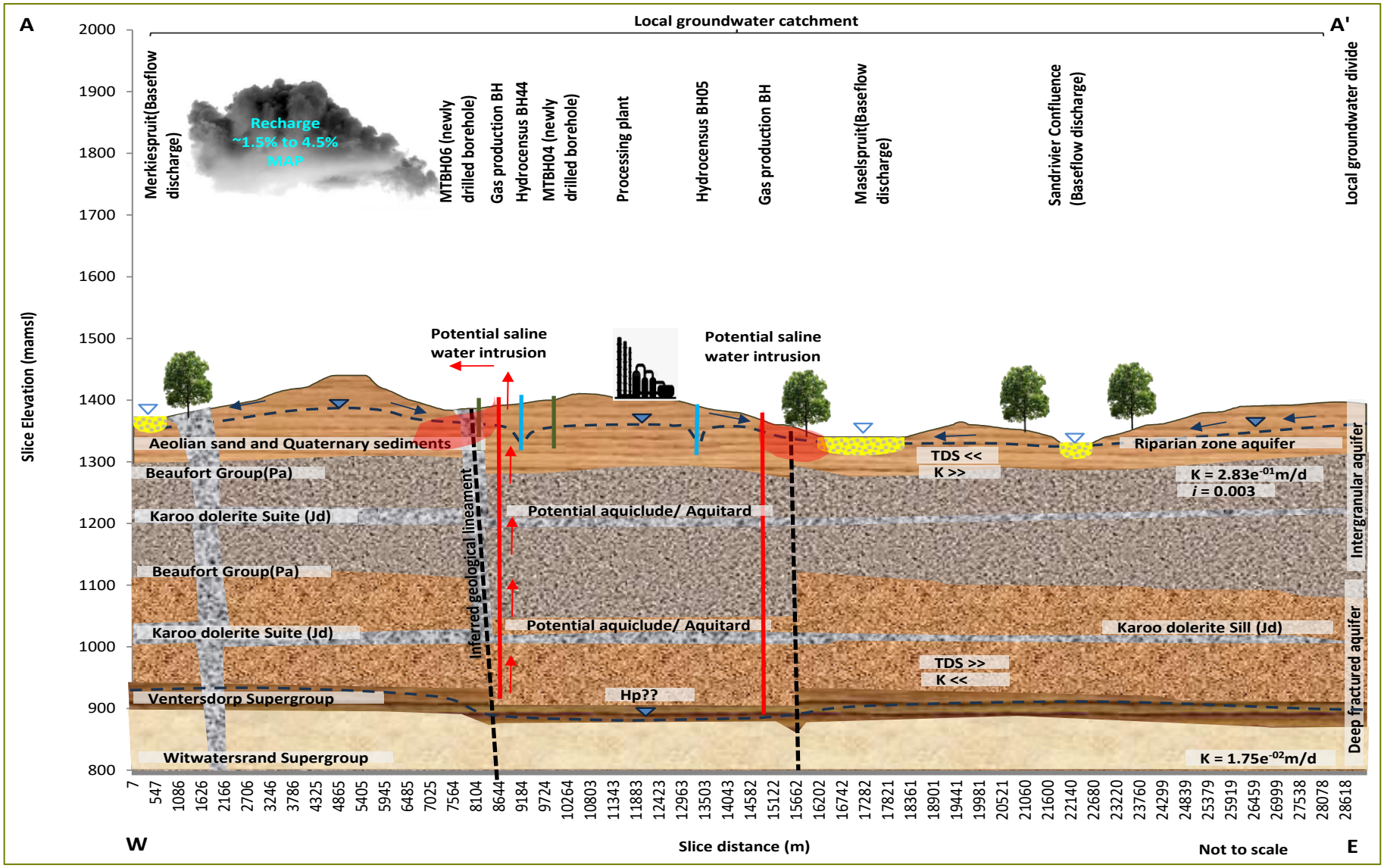


Figure 84: Hydrogeological conceptual model: South- North cross section (A'-A') (Post-operational) (Gradient Groundwater Consulting, 2026).

8.11.8 SITE INVESTIGATION

8.11.8.1 HYDROCENSUS USER SURVEY

A hydrocensus user survey within the greater study area was conducted during November and December 2025[14] 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 gas production activities. A total of 62 geosites were visited and recorded as part of the hydrocensus user survey which includes 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. Relevant hydrocensus information is summarised in **Table 45** while **Figure 89** depicts a spatial distribution map of geosites visited as part of the hydrocensus user survey with **Figure 90** indicating the various groundwater status and applications.

8.11.8.1.1 GROUNDWATER STATUS

Of the boreholes recorded, the majority are in use (74.14%) while 25.86% are not currently being utilized. Refer to **Figure 86** for a summary of the groundwater status quo.

8.11.8.1.2 GROUNDWATER APPLICATION

Most boreholes recorded are being applied for livestock watering purposes (34.25%) while water being applied for either domestic and household or domestic and livestock purposes account for 42.47%. A small number of boreholes are also being applied for wildlife watering (1.37%) or monitoring purposes (1.37%). Boreholes which do not have an application and are not currently being utilized account for 20.55% of the total geosites visited. Refer to **Figure 87** for summary of groundwater applications. According to the Middle Vaal ISP (DWAF, 2004), most boreholes are being applied for irrigation and small-town water supply.

8.11.8.1.3 BOREHOLE EQUIPMENT

Most boreholes visited are equipped with submersible pumps and account for 42.86%, while 37.50% of boreholes were fitted with a wind pump. An average of 19.64% of boreholes are not equipped as indicated in **Figure 88**.

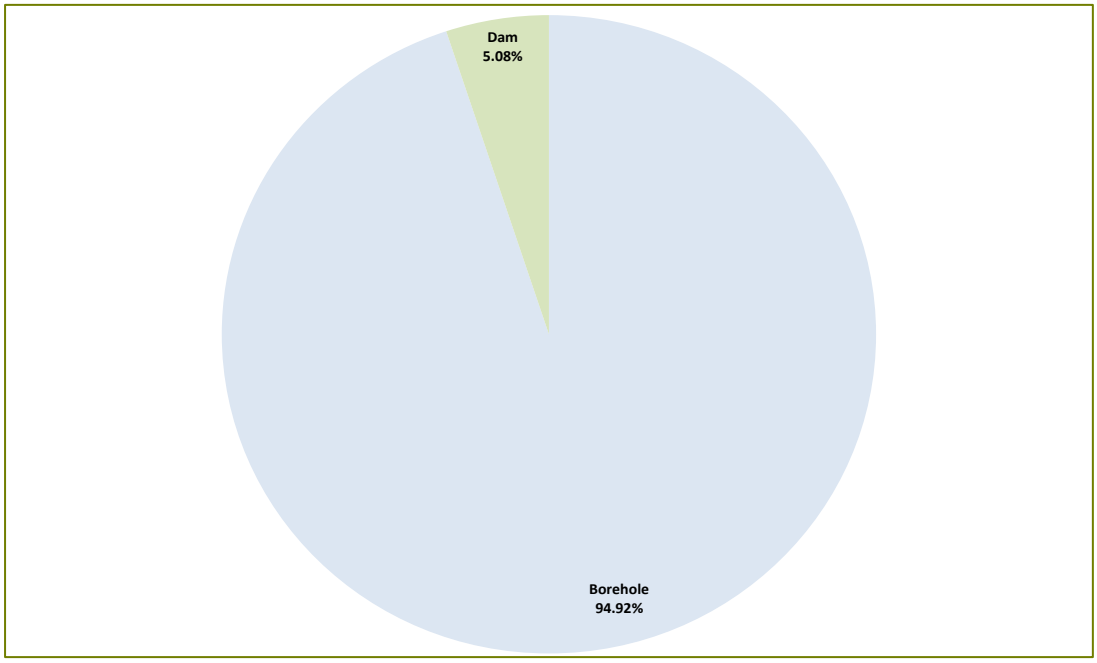


Figure 85: Hydrocensus user survey: Geosite type (Gradient Groundwater Consulting, 2026).

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

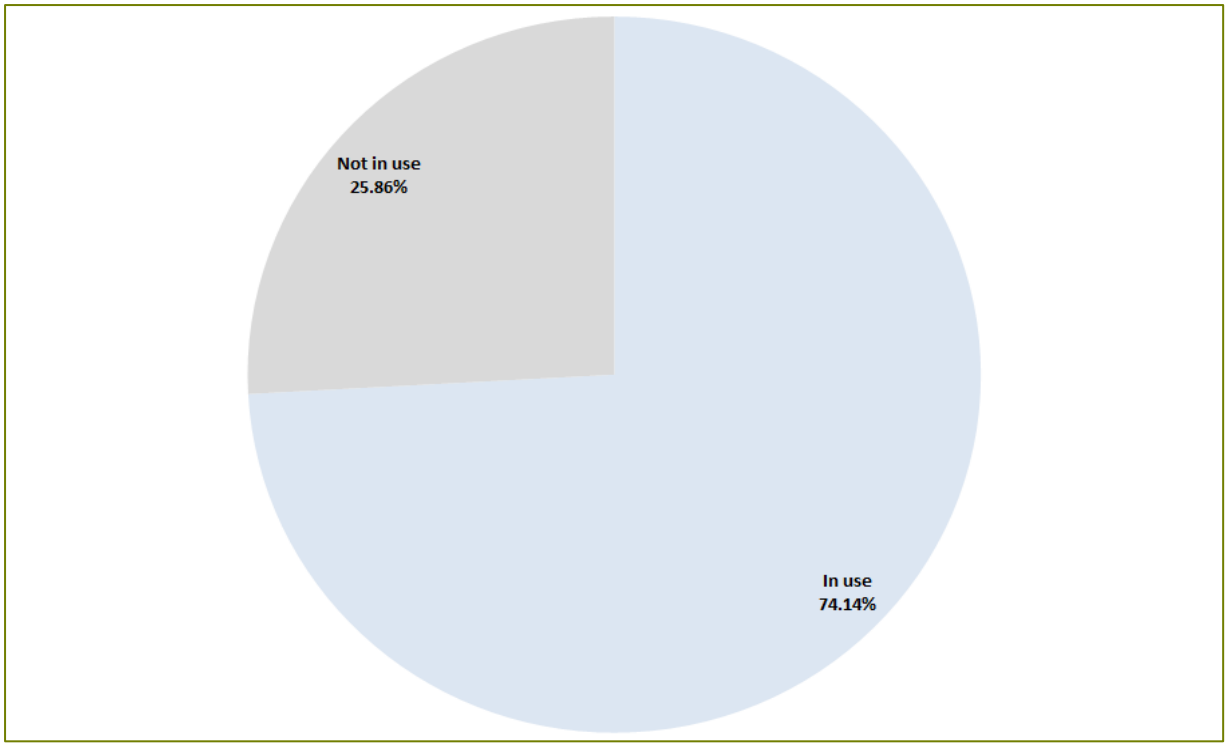


Figure 86: Hydrocensus user survey: Geosite status (Gradient Groundwater Consulting, 2026).

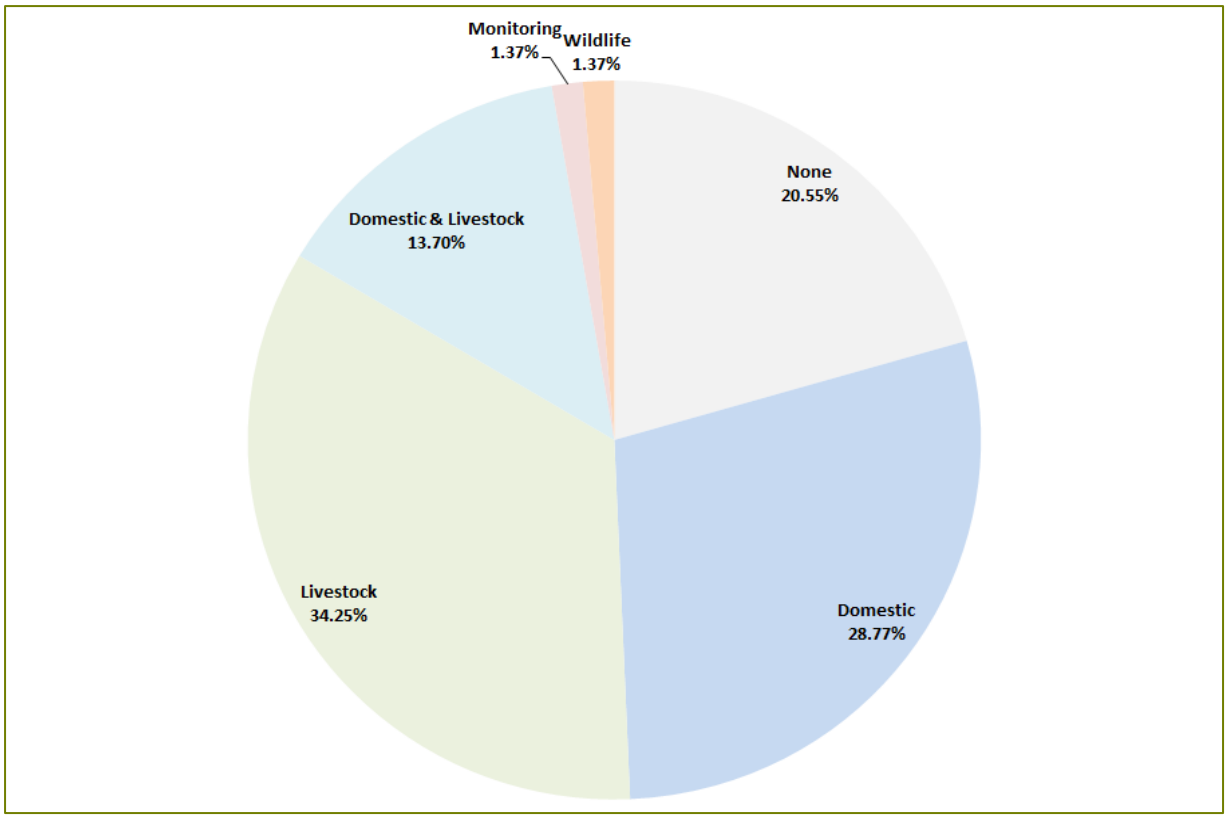


Figure 87: Hydrocensus user survey: Groundwater application (Gradient Groundwater Consulting, 2026).

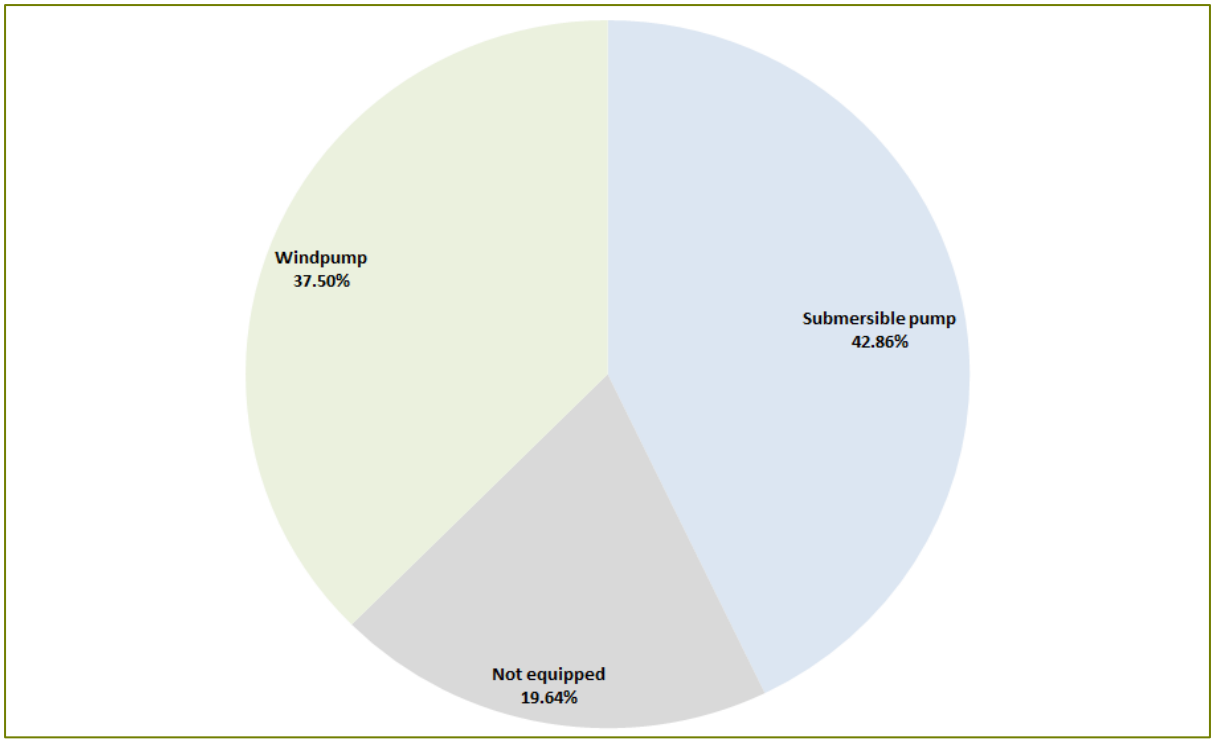


Figure 88: Hydrocensus user survey: Equipment type (Gradient Groundwater Consulting, 2026).

Table 45: Hydrocensus user survey: relevant information for geosites visited (Gradient Groundwater Consulting, 2026).

Geosite ID	Latitude	Longitude	Measured water level (mbch)	Collar height (m)	Water level (mbgl)	Borehole depth (mbgl)	Water level status	Site type	Site status	Equipment	Water application
BH 01	-28.1961	26.9720	3.48	0.00	3.48		Static	Borehole	In Use	Submersible pump	Domestic
BH 02	-28.1962	26.9723	3.00	0.42	2.58		Static	Borehole	Not in use	Not Equipped	None
BH 03	-28.1592	26.9787	0.16	0.00	0.16	24.22	Static	Borehole	Not in use	Not Equipped	None
BH 04	-28.2030	26.9670	3.13	0.00	3.13	48.07	Static	Borehole	Not in use	Not Equipped	None
BH 05	-28.2088	26.9761			NAWL		Obstructed	Borehole	Not in use	Windpump	None
BH 06	-28.1917	26.9654	1.77	0.25	1.52	18	Static	Borehole	Not in use	Not Equipped	None
BH 07	-28.1918	26.9460	5.07	0.37	4.70		Static	Borehole	In Use	Submersible pump	Livestock
BH 08	-28.1795	26.9402	4.44	0.00	4.44		Static	Borehole	Not in use	Windpump	None
BH 09	-28.2056	26.9120	5.00	0.29	4.71		Recovering	Borehole	In Use	Submersible pump	Domestic
BH 10	-28.2055	26.9139	7.00	0.32	6.68	7.22	Static	Borehole	Not in use	Not Equipped	None

Geosite ID	Latitude	Longitude	Measured water level (mbch)	Collar height (m)	Water level (mbgl)	Borehole depth (mbgl)	Water level status	Site type	Site status	Equipment	Water application
BH 11	-28.2071	26.9137	1.23	0.00	1.23		Static	Borehole	Not in use	Windpump	None
BH 12	-28.2233	26.9175	4.69	0.00	4.69	4.82	Static	Borehole	Not in use	Not Equipped	None
BH 13	-28.1928	26.9117	12.25	0.00	12.25		Pumping	Borehole	In Use	Windpump	Livestock
BH 14	-28.1749	26.9037	10.77	0.00	10.77		Static	Borehole	In Use	Submersible pump	Domestic
BH 15	-28.1913	27.0083	10.65	0.26	10.39		Recovering	Borehole	In Use	Submersible pump	Domestic & Livestock
BH 16	-28.1915	27.0086	5.04	0.00	5.04		Static	Borehole	In Use	Submersible pump	Domestic & Livestock
BH 17	-28.1908	27.0088	6.83	0.00	6.83		Static	Borehole	In Use	Submersible pump	Domestic & Livestock
BH 18	-28.1924	27.0070	11.01	0.00	11.01		Recovering	Borehole	In Use	Submersible pump	Domestic
BH 19	-28.1721	26.9940	2.70	0.00	2.70		Static	Borehole	In Use	Submersible pump	Domestic & Livestock
BH 20	-28.2882	26.9404			NAWL		Obstructed	Borehole	In Use	Windpump	Livestock
BH 21	-28.2883	26.9397	5.70	0.00	5.70		Pumping	Borehole	In Use	Windpump	Domestic & Livestock
BH 22	-28.2907	26.9444	9.43	0.00	9.43		Pumping	Borehole	In Use	Windpump	Livestock

Geosite ID	Latitude	Longitude	Measured water level (mbch)	Collar height (m)	Water level (mbgl)	Borehole depth (mbgl)	Water level status	Site type	Site status	Equipment	Water application
BH 23	-28.2956	26.9415	4.78	0.00	4.78	29.03	Static	Borehole	Not in use	Not Equipped	None
BH 24	-28.2996	26.9185	9.37	0.00	9.37		Static	Borehole	In Use	Windpump	Domestic & Livestock
BH 25	-28.3035	26.9199	5.83	0.00	5.83		Static	Borehole	In Use	Submersible pump	Domestic
BH 26	-28.3066	26.9258		0.00	NAWL		Obstructed	Borehole	In Use	Windpump	Livestock
BH 27	-28.2896	26.9261	9.19	0.00	9.19		Pumping	Borehole	In Use	Windpump	Domestic & Livestock
BH 28	-28.2702	26.9550	15.88	0.21	15.67		Static	Borehole	In Use	Windpump	Livestock
BH 29	-28.2759	26.9733	27.59	0.00	27.59		Recovering	Borehole	In Use	Submersible pump	Domestic & Livestock
BH 30	-28.2787	26.9749	3.97	0.23	3.74		Static	Borehole	In Use	Windpump	Livestock
BH 31	-28.2811	26.9768	13.41	0.22	13.19		Static	Borehole	In Use	Windpump	Livestock
BH 32	-28.2899	26.9719	13.94	0.25	13.69		Static	Borehole	In Use	Windpump	Livestock
BH 33	-28.2749	26.9802	10.36	0.23	10.13		Static	Borehole	In Use	Windpump	Wildlife
BH 34	-28.2927	26.9631	9.71	0.12	9.59		Pumping	Borehole	In Use	Windpump	Domestic & Livestock
BH 35	-28.2923	26.9618	25.94	0.24	25.70		Static	Borehole	In Use	Submersible pump	Domestic

Geosite ID	Latitude	Longitude	Measured water level (mbch)	Collar height (m)	Water level (mbgl)	Borehole depth (mbgl)	Water level status	Site type	Site status	Equipment	Water application
BH 36	-28.2840	26.9882	13.13	0.36	12.77	38.2	Static	Borehole	Not in use	Not Equipped	None
BH 37	-28.2837	26.9961	12.50	0.20	12.30		Pumping	Borehole	In Use	Windpump	Livestock
BH 38	-28.2788	26.9998			NAWL		Obstructed	Borehole	In Use	Windpump	Livestock
BH 39	-28.2755	26.9885	13.49		13.49		Static	Borehole	Not in use	Windpump	None
BH 40	-28.2341	26.9748	9.10	0.18	8.92		Static	Borehole	In Use	Submersible pump	Livestock
BH 41	-28.2277	26.9581	19.97	0.26	19.71		Static	Borehole	In Use	Submersible pump	Livestock
BH 42	-28.2304	26.9462	13.00	0.14	12.86		Static	Borehole	In Use	Submersible pump	Domestic & Livestock
BH 43	-28.2114	26.9459			NAWL		Obstructed	Borehole	In Use	Windpump	Livestock
BH 44	-28.2171	26.9405	10.54	1.01	9.53	37.24	Static	Borehole	In Use	Not Equipped	Monitoring
BH 45	-28.2481	26.9496			NAWL		Obstructed	Borehole	In Use	Submersible pump	Livestock
BH 46	-28.2457	26.9612	14.20	0.00	14.20		Potentially affected by Pumping	Borehole	In Use	Submersible pump	Livestock
BH 47	-28.2454	26.9612			NAWL		Obstructed	Borehole	In Use	Submersible pump	Livestock

Geosite ID	Latitude	Longitude	Measured water level (mbch)	Collar height (m)	Water level (mbgl)	Borehole depth (mbgl)	Water level status	Site type	Site status	Equipment	Water application
BH 48	-28.2466	26.9670	5.77	0.40	5.37		Static	Borehole	Not in use	Submersible pump	None
BH 49	-28.2529	26.9630	1.46	0.10	1.36		Static	Borehole	In Use	Submersible pump	Livestock
BH 50	-28.2529	26.9645	1.16	0.31	0.85		Static	Borehole	In Use	Submersible pump	Livestock
BH 51	-28.2697	26.9781	13.30	0.30	13.00		Static	Borehole	Not in use	Not Equipped	None
BH 52	-28.2669	26.9781	10.85	0.22	10.63		Static	Borehole	In Use	Windpump	Livestock
BH 53	-28.2658	26.9884	11.89	0.21	11.68	11.89	Static	Borehole	Not in use	Not Equipped	None
BH 54	-28.2531	26.9908	20.29	0.18	20.11		Static	Borehole	In Use	Submersible pump	Livestock
BH 55	-28.2523	26.9912	52.79	0.35	52.44		Recovering	Borehole	In Use	Submersible pump	Livestock
BH 56	-28.2403	26.9833	10.46	0.10	10.36		Pumping	Borehole	In Use	Submersible pump	Livestock
MTBH03	-28.2411	26.9738	13.08	0.20	12.88	120	Static	Borehole	In Use	Not Equipped	Monitoring
MTBH04	-28.2110	26.9577	8.14	0.20	7.94	120	Static	Borehole	In Use	Not Equipped	Monitoring
MTBH05	-28.2863	26.9701	13.29	0.20	13.09	120	Static	Borehole	In Use	Not Equipped	Monitoring
MTBH06	-28.2244	26.9389	4.86	0.20	4.66	120	Static	Borehole	In Use	Not Equipped	Monitoring

Geosite ID	Latitude	Longitude	Measured water level (mbch)	Collar height (m)	Water level (mbgl)	Borehole depth (mbgl)	Water level status	Site type	Site status	Equipment	Water application
SW 01	-28.2072	26.9173	n/a	n/a	n/a	n/a	n/a	Dam	In Use	n/a	Livestock
SW 02	-28.2901	26.9397	n/a	n/a	n/a	n/a	n/a	Dam	In Use	n/a	Livestock
SW 03	-28.2785	26.9750	n/a	n/a	n/a	n/a	n/a	Dam	In Use	n/a	Livestock
N/A: Not applicable											
NAWL: No access to water level											
****Contact details for relevant landowners have been recorded; however this information will be made available on request as it is protected by the Protection of Personal Information Act, 2013 (POPIA)**											

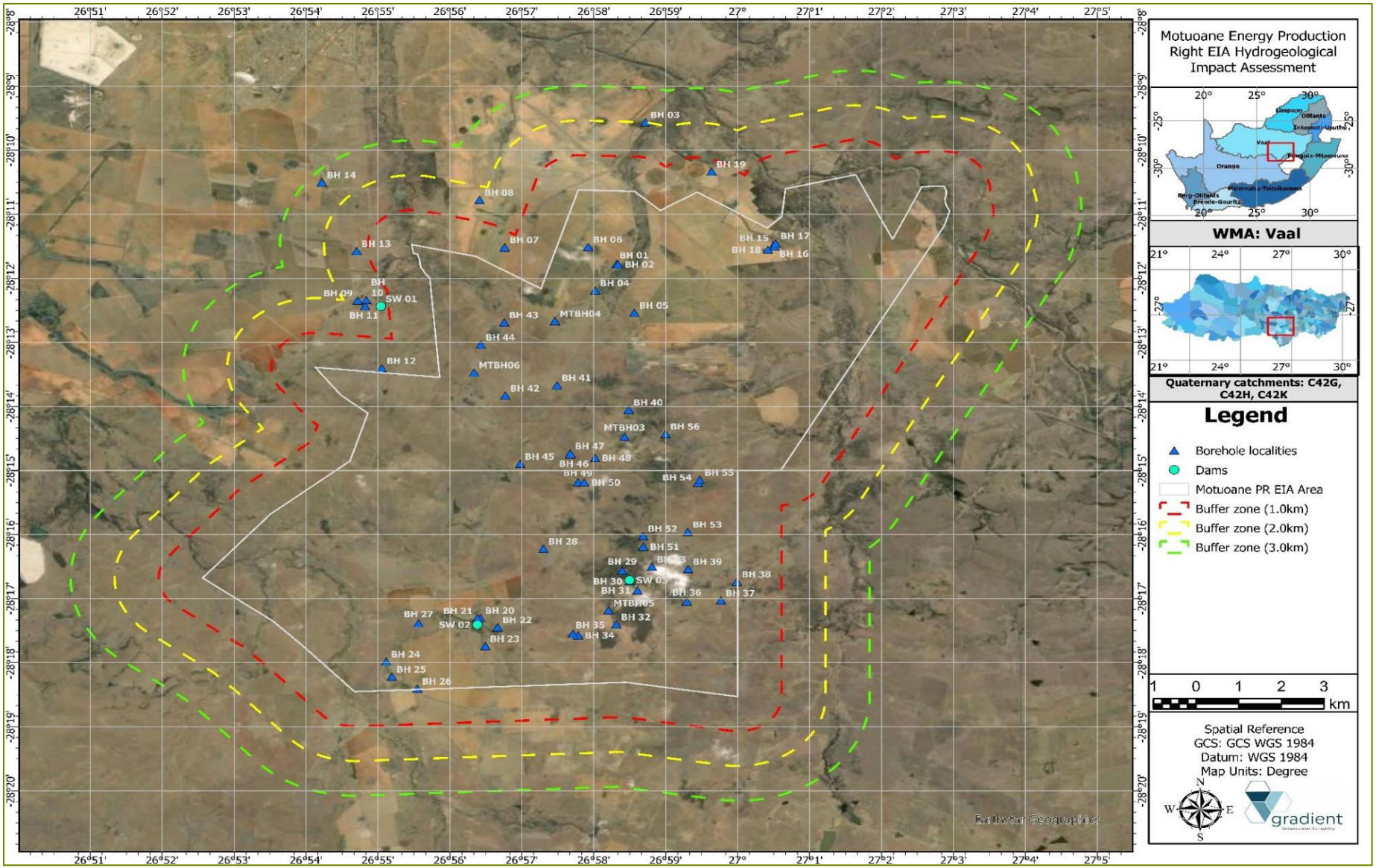


Figure 89: Spatial distribution map of the hydrocensus geosites surveyed (Gradient Groundwater Consulting, 2026).

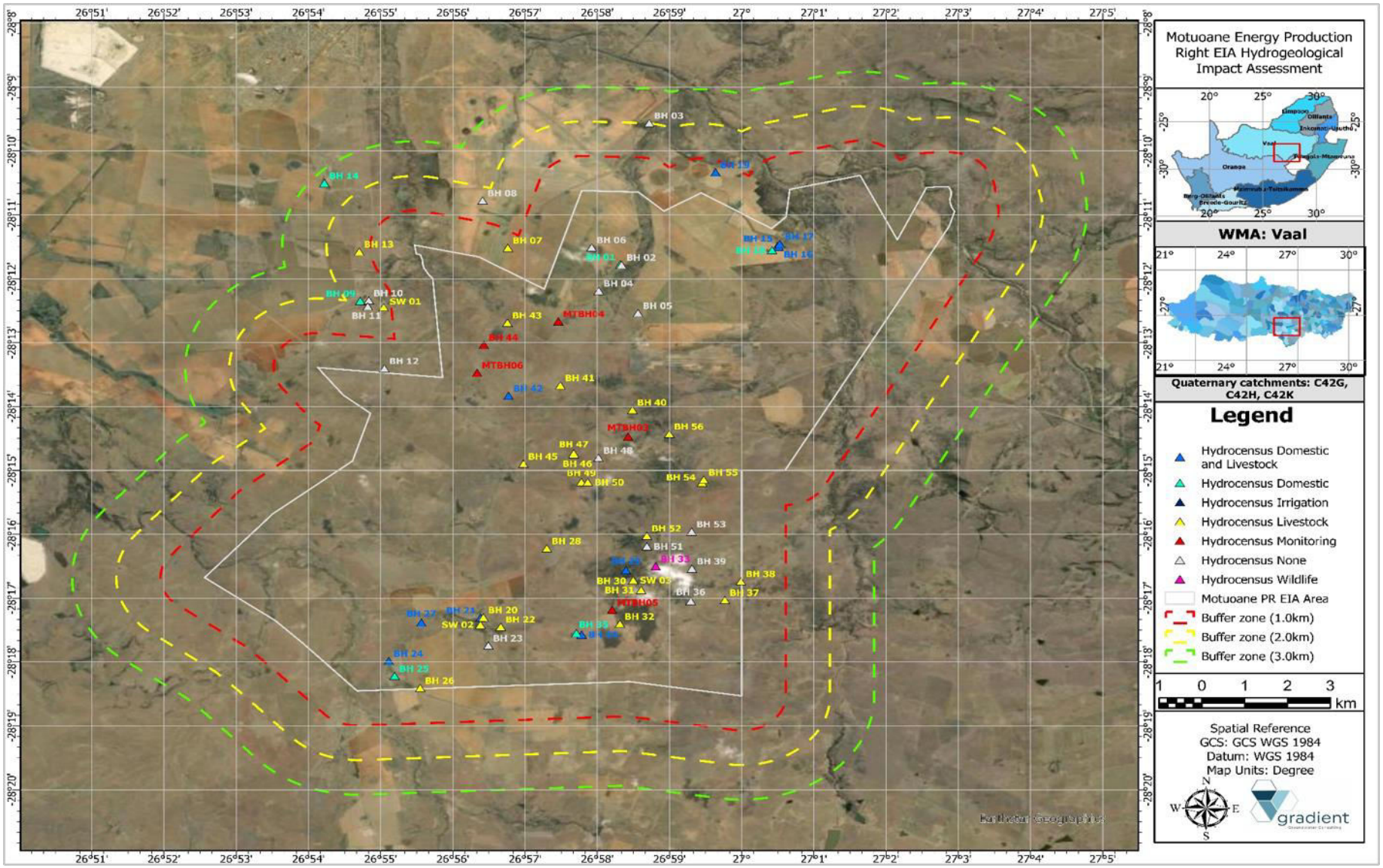


Figure 90: Spatial distribution map indicating groundwater status and application (Gradient Groundwater Consulting, 2026).

8.11.8.2 AQUIFER CHARACTERISATION

In order to gather representative on-site aquifer data and relevant information a site characterisation phase was conducted where new monitoring boreholes i.e., site characterisation boreholes were established and subjected to aquifer tests to obtain site representative aquifer parameters and hydraulic properties. The latter was incorporated into the numerical groundwater flow model development and calibration process. The aim of the site characterization was to target various on-site lithologies and hydrostratigraphical units in order to estimate representative hydraulic parameters. All site characterisation work was performed in accordance with

SANS 10299-4:2003 standards: Development, maintenance and management of groundwater resources. The following sub-sections summarises the site characterisation and fieldwork conducted.

8.11.8.2.1 GEOPHYSICAL SURVEY

A geophysical survey was conducted during 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 91** 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 46** for a summary of geophysical traverse coordinates, traverse lengths, station spacings as well as approximate orientations and potential targets. **Figure 92** indicates the geophysical traverse array in relation to earmarked site characterisation gaps identified as well 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 **Appendix F7**.

Table 46: Geophysical traverse summary (Datum: WGS84) (Gradient Groundwater Consulting, 2026).

Traverse ID	Start		Approximate Length (m)	Potential target	Station spacing (m)	Drilling target	Approximate orientation
	Latitude	Longitude					
Traverse 6	-28.236595	26.981723	400.00	NE-SW as well as NW-SE striking lineaments	10.00	n/a	E-W
Traverse 7	-28.235741	26.981927	600.00	NW-SE striking lineament	10.00	n/a	SE-NW
Traverse 8	-28.244154	26.977983	750.00	Various SW-NE striking lineaments	10.00	MTBH03	SE-NW
Traverse 9	-28.252679	26.993750	1450.00	NW-SE 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 ID	Start		Approximate Length (m)	Potential target	Station spacing (m)	Drilling target	Approximate orientation
	Latitude	Longitude					
Traverse 12	-28.200461	26.941426	800.00	NE-SW striking lineament	10.00	n/a	NW-SE
Traverse 13	-28.280721	26.939537	650.00	NE-SW striking lineament	10.00	n/a	S-N
Traverse 14	-28.293376	26.974412	700.00	Various NW-SE striking lineaments	10.00	n/a	SW-NE
Traverse 15	-28.287420	26.968337	750.00	NW-SE striking lineament	10.00	MTBH05	SW-NE
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

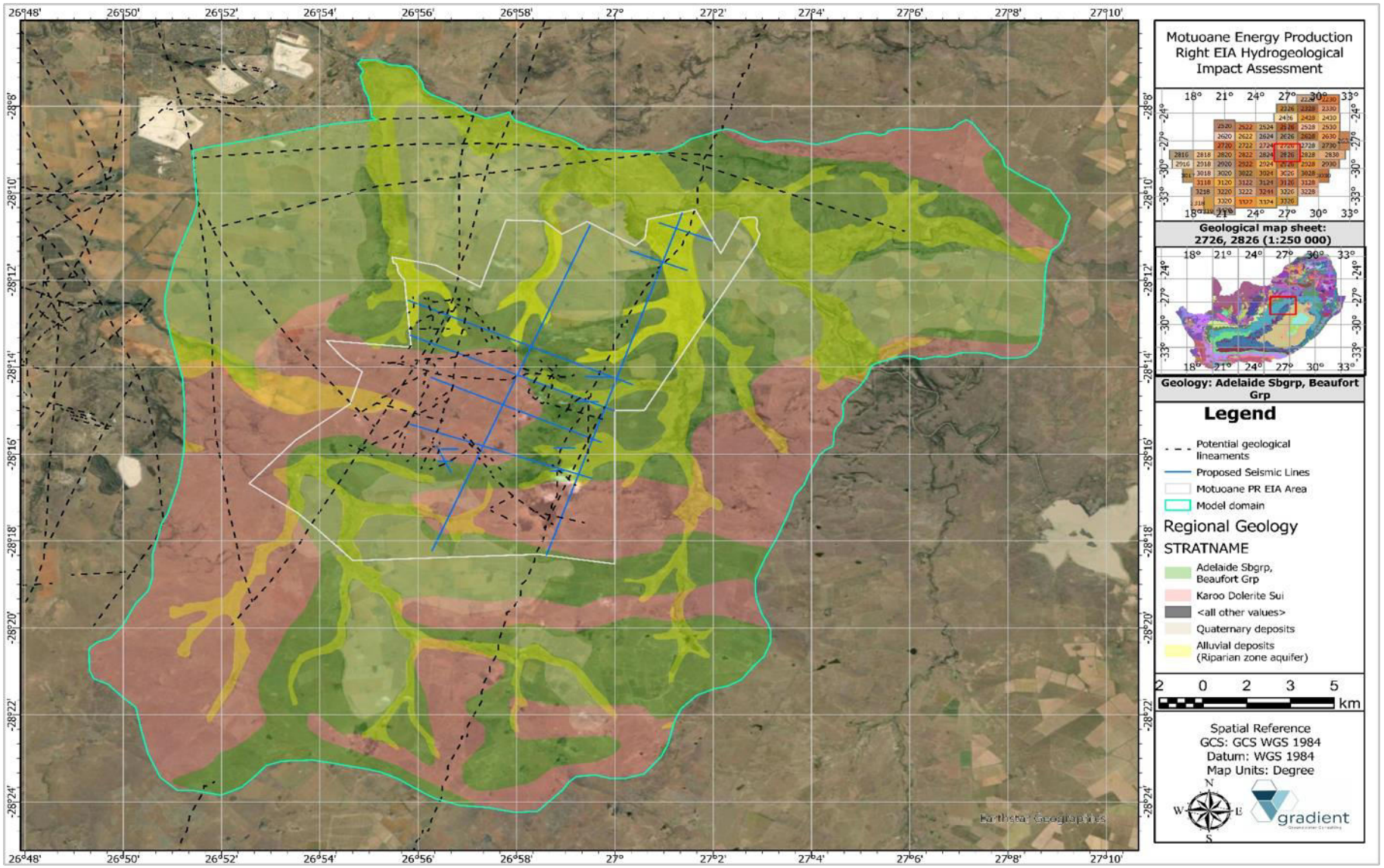


Figure 91: Map indicating potential reginal geological lineaments in relations to proposed infrastructure and activities (Gradient Groundwater Consulting, 2026).

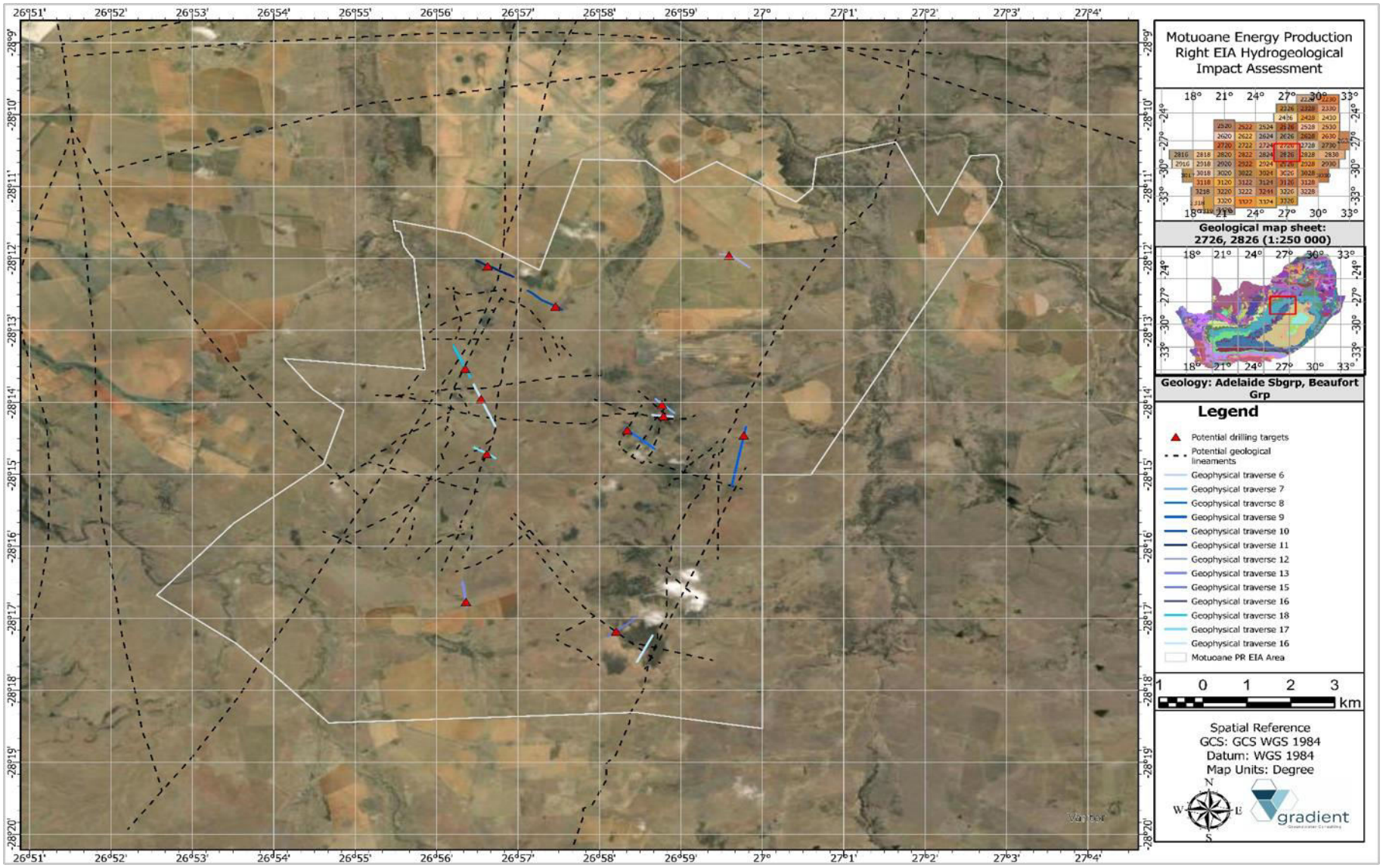


Figure 92: Geophysical traverse array in relation to regional geology as well as potential geological lineaments (Gradient Groundwater Consulting, 2026).

8.11.8.2.2 TRAVERSE 08

Traverse 08 was surveyed over a lateral distance of 750.0m (10 m-station spacing) and was conducted in an approximate southeast-northwest orientation targeting various southwest-northeast striking lineaments. A prominent magnetic low zone can be observed between stations 100.0-120.0m which can be attributed to interference caused by a high voltage power line and, as such, was not considered. The electro-magnetic profiles indicate a decrease in the vertical dipole reading with an increase in the horizontal dipole reading at station 250.0m as well as 580.0 which may suggest conductance at these segments. Accordingly, the second anomaly was identified as drilling position MTBH03, targeting a potential structure and preferred groundwater flow pathway which may act as contaminant transport mechanism. Refer to **Figure 93** for the magnetic curve and electro-magnetic profile summarising relevant information.

8.11.8.2.3 TRAVERSE 10

Traverse 10 was surveyed over a lateral distance of 800.0m (10 m- station spacing) and was conducted in an approximate northwest-southeast orientation targeting a northeast-southwest striking geological lineament. A magnetic low is observed just before station 200.0m, however this is caused by interference of a nearby windmill. Another magnetic anomaly can be observed between station 610.0-640.0m which is also associated with an increase in the electro-magnetic vertical dipole reading and a decrease in the vertical dipole reading. The latter can be inferred as a potential dyke structure and preferred groundwater flow pathway which may act as contaminant transport mechanism. Accordingly, station 630.0m was identified as drilling position MTBH04. Refer to **Figure 94** for the magnetic curve and electro-magnetic profile summarising relevant information.

8.11.8.2.4 TRAVERSE 15

Traverse 15 was surveyed over a lateral distance of 750.0m (10 m- station spacing) and was conducted in an approximate southwest-northeast orientation targeting a northwest-southeast striking geological lineament. A slight magnetic anomaly is observed just before station 200.0m with a magnetic low observed at station 550.0m. The first magnetic anomaly is associated with a sharp decrease in the vertical dipole reading while an increase in the horizontal dipole reading is noted. Accordingly, this anomaly was identified as drilling position MTBH05, targeting a potential structure and preferred groundwater flow pathway which may act as contaminant transport mechanism. Refer to **Figure 95** for the magnetic curve and electro-magnetic profile summarising relevant information.

8.11.8.2.5 TRAVERSE 18

Traverse 18 was surveyed over a lateral distance of 1.0km (10 m- station spacing) and was conducted in an approximate northwest-southeast orientation targeting a northeast-southwest striking geological lineament. The traverse is characterised by two prominent magnetic highs and anomalies i.e., 380.0m and 510.0m. The electro-magnetic profiles associated with this section indicate a decrease in the vertical dipole reading with an increase in the horizontal dipole reading which may suggest conductance on the edges. Accordingly, station 500.0m was identified as drilling position MTBH06, targeting the weathered perimeter of a potential dyke structure which may act as a preferred groundwater flow pathway and mechanism for contaminant transport. Refer to **Figure 96** for the magnetic curve and electro-magnetic profile summarising relevant information.

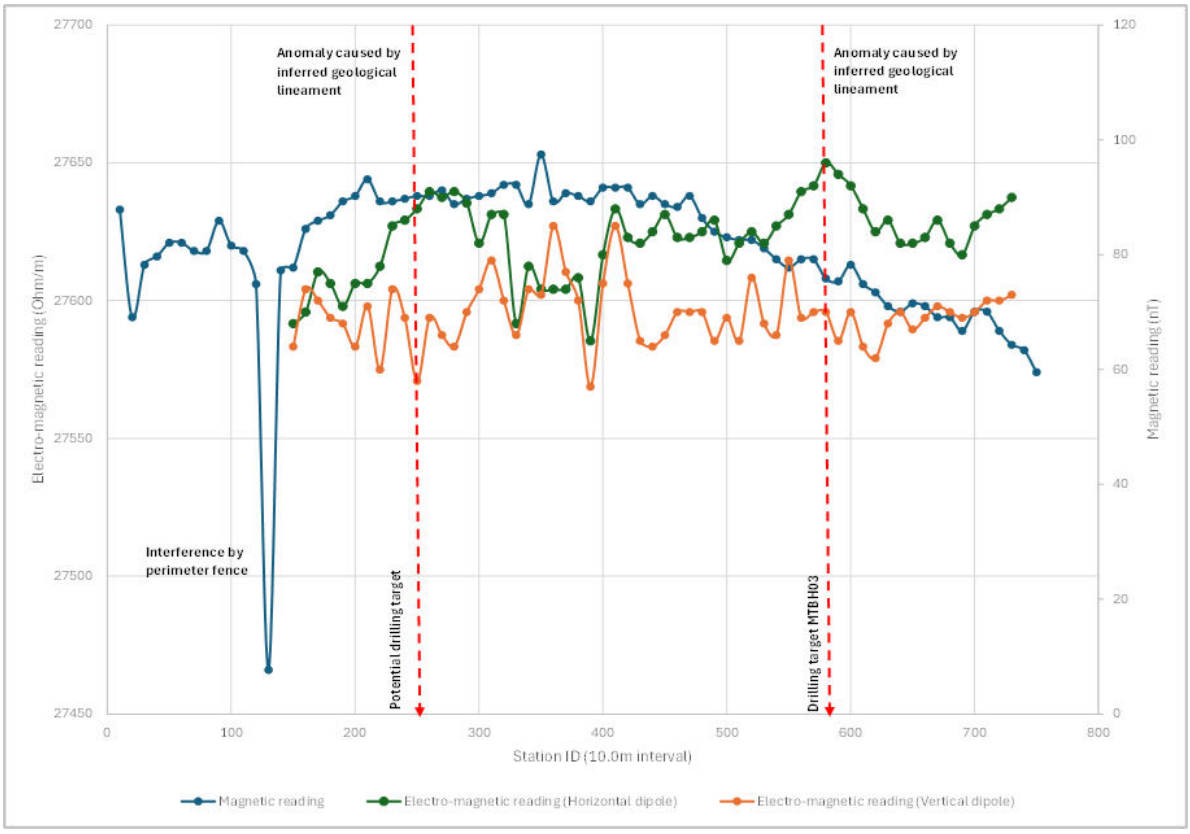


Figure 93: Geophysical traverse 08: Magnetic curve as well as electro-magnetic profile with relevant information (Gradient Groundwater Consulting, 2026).

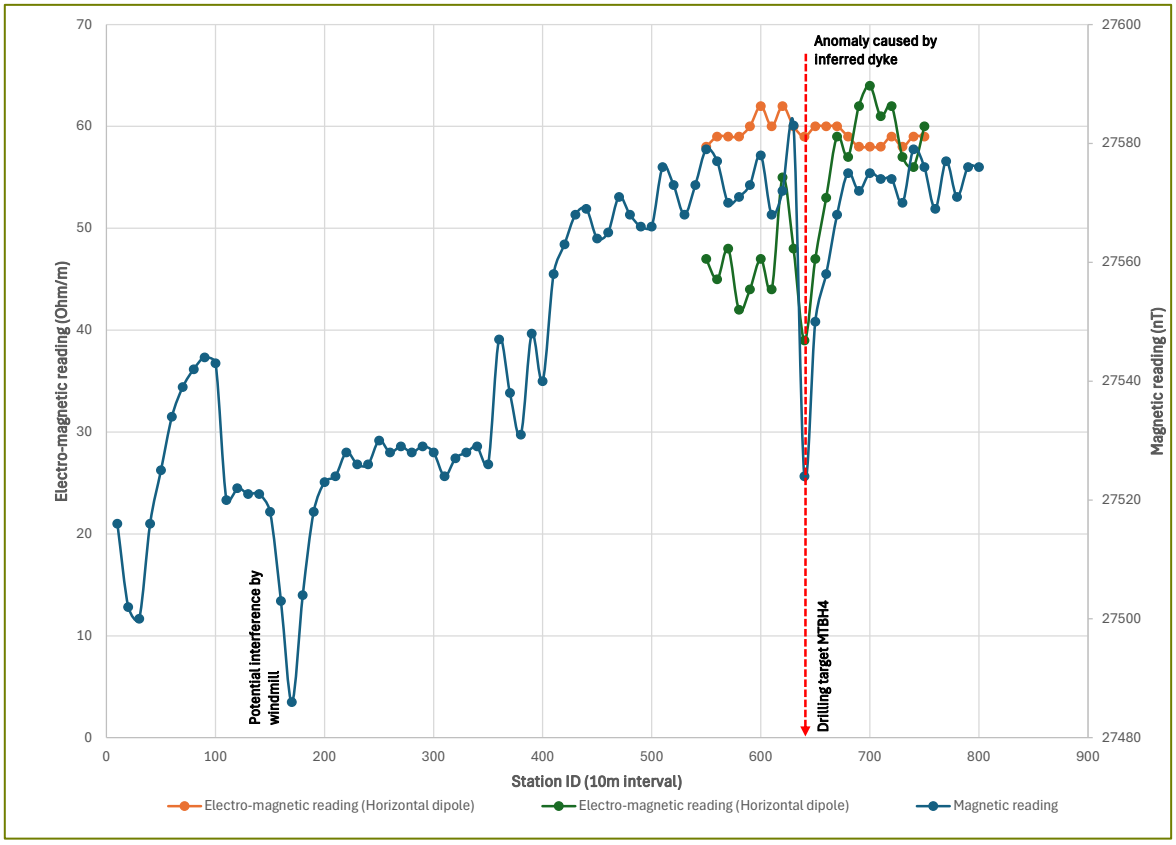


Figure 94: Geophysical traverse 10: Magnetic curve as well as electro-magnetic profile with relevant information (Gradient Groundwater Consulting, 2026).

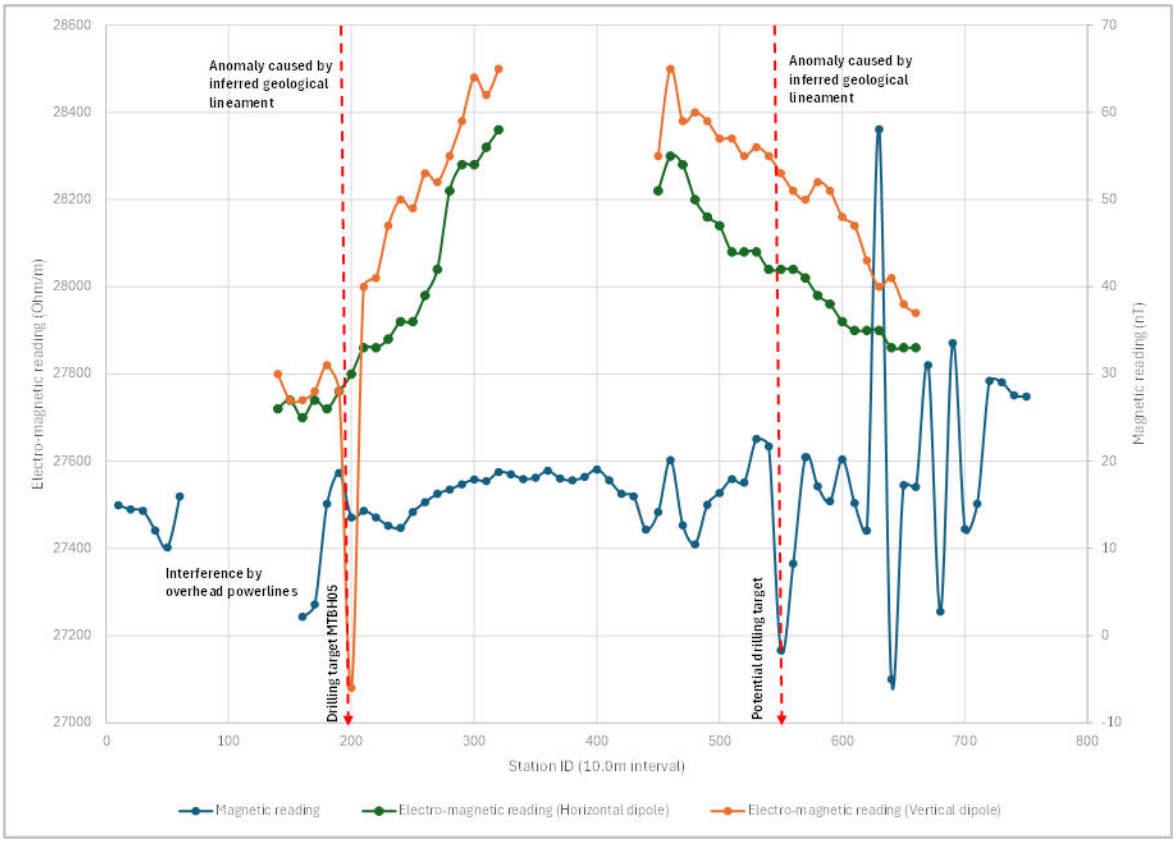


Figure 95: Geophysical traverse 15: Magnetic curve as well as electro-magnetic profile with relevant information (Gradient Groundwater Consulting, 2026).

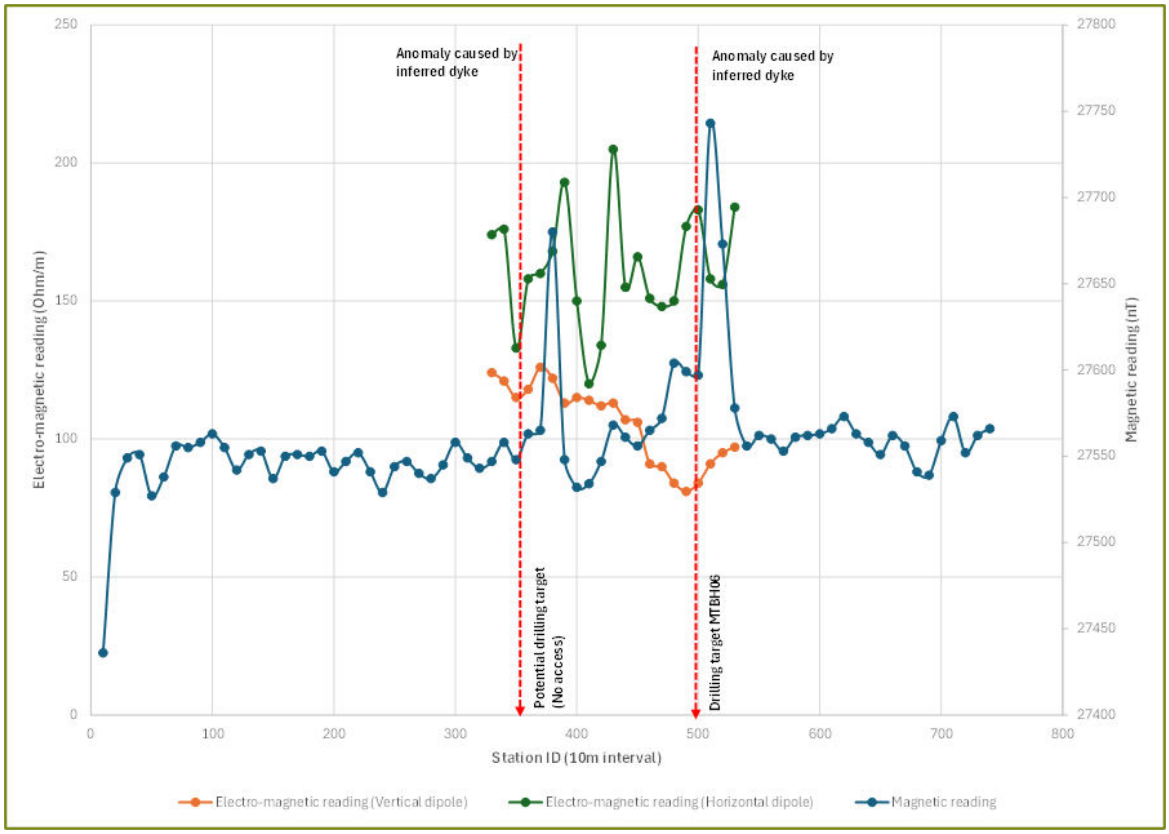


Figure 96: Geophysical traverse 18: Magnetic curve as well as electro-magnetic profile with relevant information (Gradient Groundwater Consulting, 2026).

8.11.8.2.6 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 47** whereas borehole technical information is tabulated in **Table 48**. **Figure 97** 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.

Table 47: Drilling targets and objectives (Gradient Groundwater Consulting, 2026).

BH ID	Latitude	Longitude	Aquifer target	Borehole purpose
MTBH03	-28.241076	26.973778	Intergranular and fractured aquifers	Site characterisation and monitoring
MTBH04	-28.211000	26.957670	Intergranular and fractured aquifers	Site characterisation and monitoring
MTBH05	-28.286273	26.970084	Intergranular and fractured aquifers	Site characterisation and monitoring
MTBH06	-28.224400	26.938920	Intergranular and fractured aquifers	Site characterisation and monitoring

Table 48: Relevant borehole information summary (Gradient Groundwater 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)
MTBH03	120	1.05	219.0mm(0-6m); 165.0mm (6m-EOH)	Steel (starter = 6m) uPVC (EOH)	165.0mm (0-EOH)	200	58	0.06
MTBH04	120	12.88	219.0mm(0-6m); 165.0mm (6m-EOH)	Steel (starter = 6m) uPVC (EOH)	165.0mm (0-EOH)	200	Seepage (60)	0.33
MTBH05	120	7.94	219.0mm(0-12m); 165.0mm (6m-EOH)	Steel (starter = 12m) uPVC (EOH)	165.0mm (0-EOH)	200	Seepage (30, 60)	None
MTBH06	120	13.09	219.0mm(0-6m); 165.0mm (6m-EOH)	Steel (starter = 6m) uPVC (EOH)	165.0mm (0-EOH)	200	16/30/60/ 102	0.33
Notes: EOH = End of Hole.								

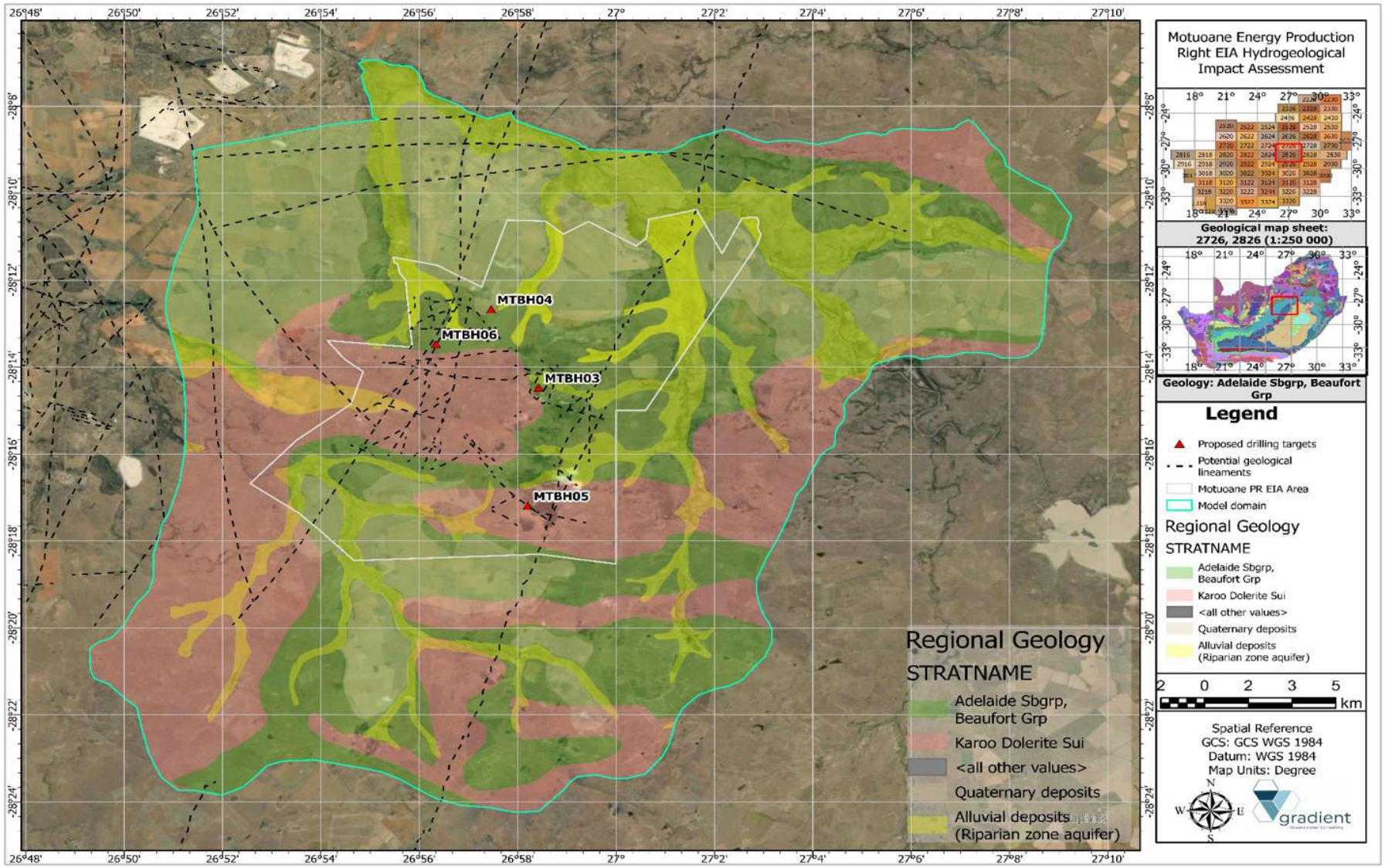


Figure 97: Map depicting new drilled site characterisation borehole positions in relation to regional geology and inferred geological lineaments (Gradient Groundwater Consulting, 2026).

8.11.8.2.6.1 DRILLING LOCALITY MTBH03

Borehole locality MTBH03 was drilled at a 165.0mm (6.50”) diameter to a depth of 120.0 meters below ground level (mbgl). The borehole was reamed to a diameter of 219.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 6.0mbgl followed by uPVC for the entire length of the hole. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of a clay layers followed by highly weathered to moderately weathered sandstone to a depth of approximately 96.0mbgl followed by black shale of the Beaufort Group formations to the end of hole (EOH). Only one major water strike was encountered at depths of 58.0m with a final blow yield of 0.06l/s measured. After borehole development, the static water level was recorded at 1.05mbgl.

8.11.8.2.6.2 DRILLING LOCALITY MTBH04

Borehole locality MTBH04 was drilled at a 165.0mm (6.50”) diameter to a depth of 120.0 meters below ground level (mbgl). The borehole was reamed to a diameter of 219.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 6.0mbgl followed by uPVC for the entire length of the hole. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of a sand layer followed by highly weathered, yellowish shale of the Beaufort Group formations up to a depth of 36.0mbgl followed by sandstone to a depth of 114mbgl. Dolerite was encountered at a depth of 114-120mbgl. A seepage zone was encountered within the weathered shale at a depth of approximately 60.0mbgl (final blow yield = 0.33l/s) After borehole development, the static water level was recorded at 12.88mbgl.

8.11.8.2.6.3 DRILLING LOCALITY MTBH05

Borehole locality MTBH05 was drilled at a 165.0mm (6.50”) diameter to a depth of 120.0 meters below ground level (mbgl). The borehole was reamed to a diameter of 219.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 6.0mbgl followed by uPVC for the entire length of the hole. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of shallow, highly weathered dolerite, followed by weathered, blue to greenish shale of the Beaufort Group formations up to a depth of 66.0mbgl followed by sandstone to a depth of 120.0mbgl. Dolerite was encountered at a depth of 66.0-90.0mbgl. A seepage zone was encountered within the weathered shale at a depth of approximately 30.0mbgl as well as 60.0mbgl, however seepage rates were not adequate to perform blow yields on. The static water level was recorded at 7.94mbgl.

8.11.8.2.6.4 DRILLING LOCALITY MTBH06

Borehole locality MTBH06 was drilled at a 165.0mm (6.50”) diameter to a depth of 120.0 meters below ground level (mbgl). The borehole was reamed to a diameter of 219.0mm (8.50”) and the unsaturated, vadose zone was cased using a steel casing (177.0mm) up to a depth of 6.0mbgl followed by uPVC for the entire length of the hole. A 3.0mm silica gravel-pack was used to fill the borehole annulus surrounding the saturated sediments. Drilling chips collected confirmed the presence of a relatively thin clay layer followed by yellow and blueish shale of the Beaufort Group formations to the end of the hole (EOH). Major water strikes were encountered at depths of 30.0m and 60.0m with seepage zone at 16.0m and 102.0m (final blow yield = 0.33l/s) After borehole development, the static water level was recorded at 13.09mbgl.

8.11.8.2.7 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:

Equation Fehler! Kein Text mit angegebener Formatvorlage im Dokument.**-1** **Transmissivity (Cooper-Jacob).**

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

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 49** for a technical summary of hydraulic testing conducted while **Table 50** provides the aquifer hydraulic parameter estimations. Borehole specific drawdown and recovery data are included in Appendix D of **Appendix F7**.

8.11.8.2.7.1 CONSTANT RATE TEST BOREHOLE MTBH03

Only one calibration step tests of 0.15l/s was conducted on borehole MTBH03 followed by a constant rate test at a yield of 0.15l/s for a duration of three hours. A maximum drawdown depth of 93.59 mbgl was reached during the pump test duration, representing all the available drawdown utilised. Borehole recovery observed was not good with the borehole not reaching pre-testing water levels within the recovering time. An average transmissivity of 0.05m^2/d was calculated for this site characterisation borehole.

8.11.8.2.7.2 CONSTANT RATE TEST BOREHOLE MTBH04

One calibration step test of 0.15l/s was conducted on borehole MTBH04 followed by a constant rate test at a yield of 0.20l/s for a duration of eight hours. A maximum drawdown depth of 47.77 mbgl was reached during the pump test duration, representing >58.0% of available drawdown utilised. Borehole recovery observed was not good with the borehole not reaching pre-testing water levels within the recovering time. An average transmissivity of 0.26m^2/d was calculated for this site characterisation borehole.

8.11.8.2.7.3 CONSTANT RATE TEST BOREHOLE MTBH05

One calibration step test of 0.15l/s was conducted on borehole MTBH05 followed by a constant rate test at a yield of 0.15l/s for a duration of five hours. A maximum drawdown depth of 87.06 mbgl was reached during the pump test duration, representing all the available drawdown utilised. Borehole recovery observed was not good with the borehole not reaching pre-testing water levels within the recovering time. An average transmissivity of 0.09m^2/d was calculated for this site characterisation borehole.

8.11.8.2.7.4 CONSTANT RATE TEST BOREHOLE MTBH06

Borehole MTBH06 was subjected to three calibration step tests of 0.15l/s, 0.30l/s and 0.75l/s followed by a constant rate test at a yield of 0.15l/s for a duration of 2 hours after which the pump inlet (PI) was reached. The recovery following the step tests was very poor and the borehole did not return to the pre-testing water level. Consequently, a new water level had to be applied as the revised datum water level. After the constant rate tests, the borehole recovery was very poor again. An average transmissivity of 0.04m^2/d was calculated for this site characterisation borehole.

Table 49: Constant discharge aquifer tests summary (Gradient Groundwater 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)
MTBH03	0.06	CR	0.15	180.00	1.05	95.00	93.95	93.95	100.00	0.15	-	-	-
MTBH04	0.33	CR	0.20	480.00	12.88	95.00	82.12	47.77	58.17	0.15	-	-	-
MTBH05	None	CR	0.15	300.00	7.94	95.00	87.06	87.06	100.00	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 50: Aquifer tests: Hydraulic parameter estimation (Gradient Groundwater 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)**
MTBH03	Beaufort Group formation	0.03	0.02	0.09	0.03	0.05	0.00
MTBH04	Quaternary deposits	0.12	0.11	0.58	0.08	0.27	0.03
MTBH05	Karoo Dolerite Suite	0.05	0.04	0.18	0.07	0.09	0.01
MTBH06	Geological lineament	0.04	0.03	0.05	0.04	0.04	0.004

8.11.9 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 98** 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.

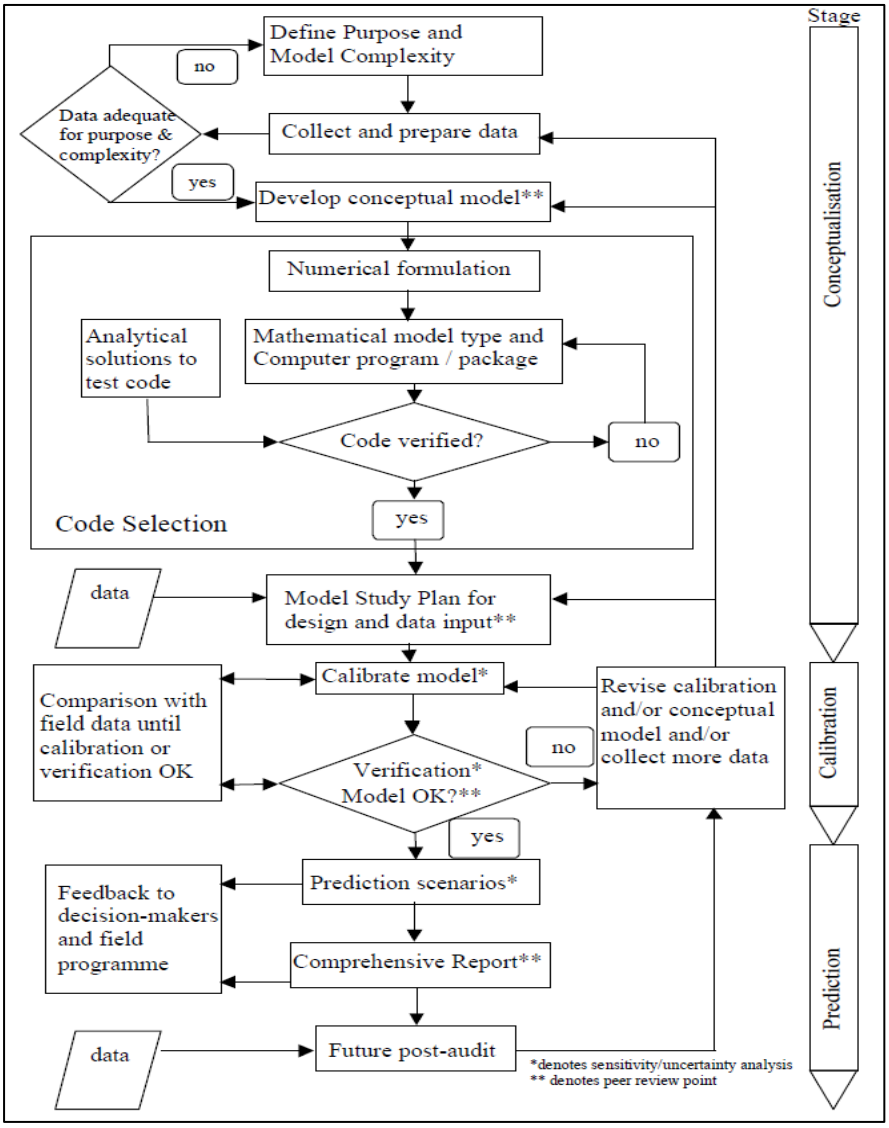


Figure 98: Workflow numerical groundwater flow model development (Groundwater Consulting, 2026).

The mass balance equation (Bear and Verruijt, 1992) (advection-dispersion equation) of a pollutant can be expressed as follows:

Equation Fehler! Kein Text mit angegebener Formatvorlage im Dokument.**-4** **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[15];

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 production boreholes (TDS = 7 832.0 mg/l - based on hydrochemical analysis of water samples representing this aquifer unit). 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 production boreholes. The drilling of gas production 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 gas production zone(s) is separated from the shallow and potable Karoo aquifer by very low permeability shale formations which

[15] 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.

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 51**:

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 production phase.

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

iv. **Scenario 03:** Migration of stray methane (CH_4) gas emanating from the production zone to the overlying, potable aquifer(s) during the operations gas production 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 production zone to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

vii. **Scenario 06:** Gas processing plant alternative evaluation and site selection.

Table 51: Summary of model stress-periods (Groundwater Consulting, 2026).

Stress period	Description
Year01 – Year30	Gas production operational phase
Year 30 – Year 80	50-years post closure
Year 80 – Year 130	100-years post closure

8.12 AIR QUALITY

The information presented in this section was obtained from the Air Quality Impact Assessment Report undertaken by Airshed Planning Professionals (**Appendix F1**). Air quality sensitive receptors (AQSRs) refer to places where humans reside. Ambient air quality guidelines and standards, as discussed under **Section 4.1.6**, 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., Virginia (suburbs of Meloding and Calabria) as well as surrounding mines (Beatrix and Harmony Joel) residential areas).

8.12.1 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 & 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 & Tyson, 1988). The atmospheric processes at macro- and meso-scales need, therefore, to be taken into account in order to accurately parameterise the atmospheric dispersion potential of a particular area. A qualitative description of the synoptic systems determining the macro-ventilation potential of the region may be provided based on the review of pertinent literature. These meso-scale systems may be investigated through the analysis of meteorological data observed for the region.

Data from the Welkom SAWS station for the period 2023 to 2025 was used for the assessment**.**

8.12.2 LOCAL WIND FIELD

The 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 99**. 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%.

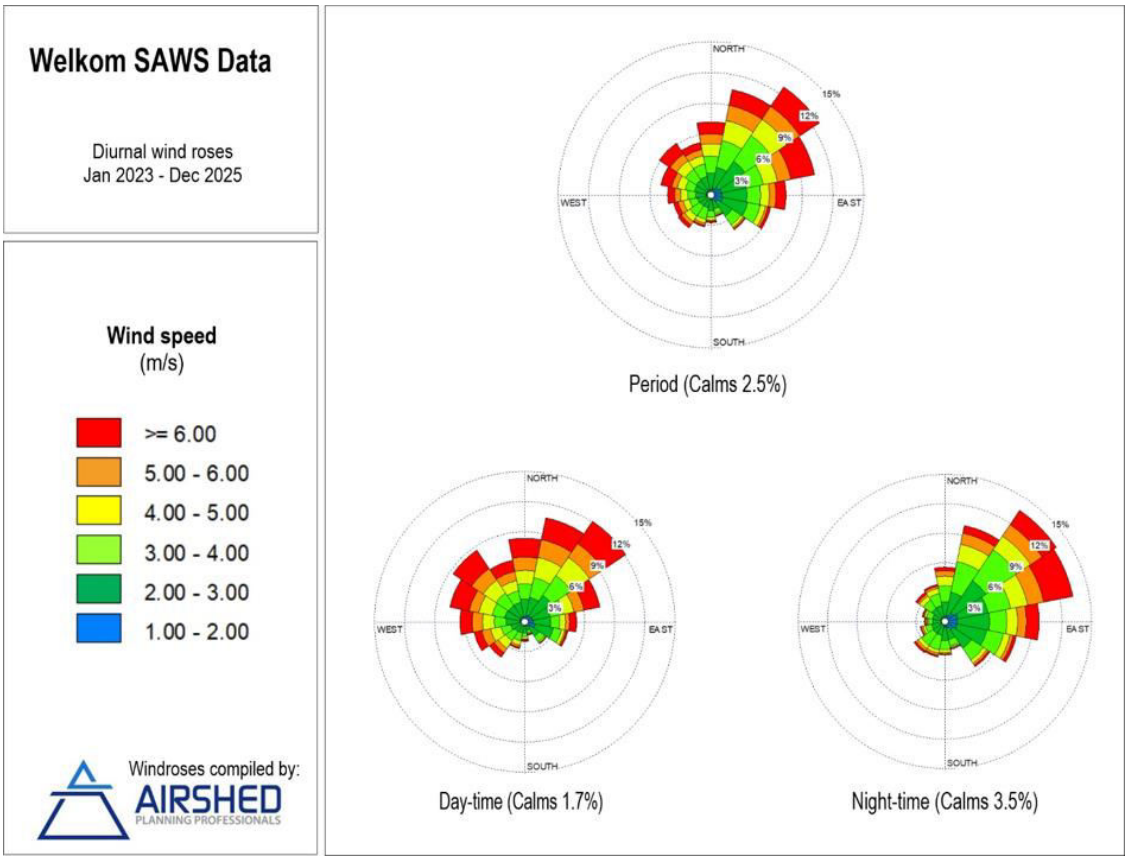


Figure 99: Period average, daytime and night-time wind roses (measured data; January 2023 to December 2025; SAWS Welkom monitoring station (Airshed Planning Professionals, 2026)

8.12.3 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.

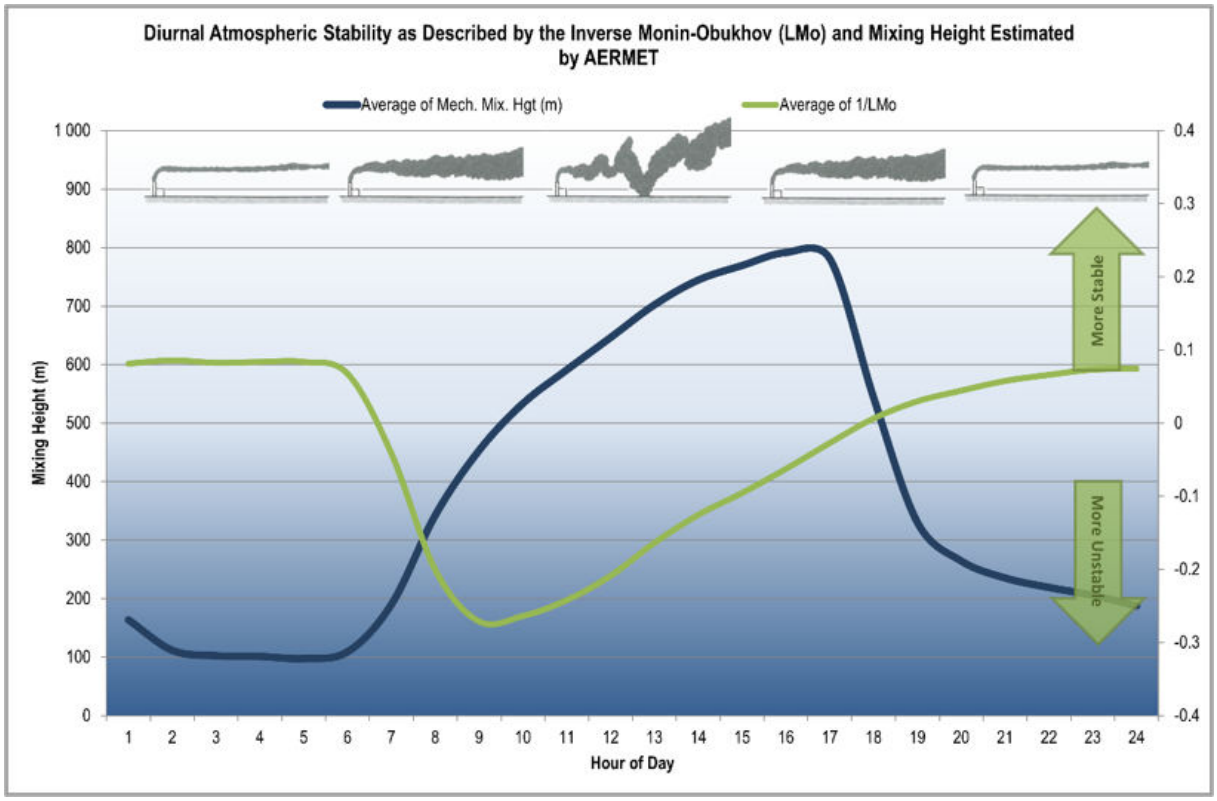


Figure 100: Diurnal atmospheric stability as described by the inverse of the measured Monin-Obukhov length (SAWS Welkom Data: 2023 to 2025) (Airshed Planning Professionals, 2026)

8.12.4 AMBIENT AIR QUALITY WITHIN THE REGION

8.12.4.1 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 exhaust emissions, household fuel combustion, biomass burning and windblown dust from exposed areas.

8.12.4.1.1 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), NO_x 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.

8.12.4.1.2 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.

8.12.4.1.3 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.

8.12.4.1.4 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.

8.12.4.1.5 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, farm 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.

8.12.4.1.6 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.

8.12.4.1.7 VEHICLE TAILPIPE EMISSIONS

Emissions resulting from motor vehicles can be grouped into primary and secondary pollutants. While primary pollutants are emitted directly into the atmosphere, secondary pollutants form in the atmosphere as a result of chemical reactions. Significant primary pollutants emitted 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.

8.12.4.2 AIR QUALITY SAMPLING RESULTS

In accordance with the NEMAQA, the responsibility for ambient air quality monitoring in South Africa is shared across national, provincial, and local spheres of government, supported by industrial and research entities.

The scope of work for the AQIA was to use existing measured ambient air quality data if available. Unfortunately, measured ambient air quality is not available for the area which was indicated as a limitation in section 1.6 of **Appendix F1**.

It should also be noted that the Dispersion Modelling Guidelines (section 2.3) constitute recommendations rather than mandatory standards, thereby permitting professional judgement flexibility. The ambient background concentrations are discussed under general modelling considerations in the Dispersion Modelling Guidelines. It stipulates that for isolated facilities, the background concentrations may only consist of regional background and might be negligible for many pollutants, except for PM_{10} levels. Assessment for compliance with NAAQS must follow procedures as follows: annual average concentrations must be less than the NAAQS, no exceedances allowed; short-term (99th percentile) concentrations must be less than the NAAQS. Given that the specific project activities are in areas with no other industrial operations in close proximity, it was considered isolated activities.

8.12.5 AIR QUALITY SENSITIVE RECEPTORS

Potential sensitive receptors within the project area, include individual households and residential areas (i.e., Virginia (suburbs of Meloding and Calabria) as well as surrounding mines' (Beatrix and Harmony Joel) residential areas. Relevant sensitive receptors within the area have been identified and are presented in the air dispersion model maps (refer to **Section 9.3.6**).

8.13 NOISE

Enviro-Acoustic Research undertook the Noise Impact Assessment (**Appendix F8**) for the proposed D3 Energy PR. This section provides details of the receiving acoustic environment as per the Noise Impact Assessment 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

8.13.1 POTENTIAL NOISE-SENSITIVE RECEPTORS (DEVELOPMENTS) AND NO-GO AREAS

Potentially sensitive receptors, also known as noise-sensitive developments ("NSR"), located within or near the mineral rights area was identified using Google Earth® during the scoping phase, highlighting that NSRs are scattered in a heterogenous manner in the area.

The online screening tool only identified two areas with a "very high" sensitivity to noise (see **Figure 101**), excluding most of the NSRs as identified in this assessment. NSR as identified during the are illustrated on **Figure 102** with illustrating NSR locations as verified during the site visit in November 2025. It should be noted that the NSR locations were verified during a drive by, and the use of the structures were not verified with discussions with the land owners. Structures that are maintained, or could be used for residential purposes was included in this assessment. There are however a number of NSR locations where structures appeared to be unused, including NSR locations 4, 5, 6, 14, 17, 22, 27, 34 and 35; this assessment will include these locations as potentially noise-sensitive as the structures may still be used for temporary or permanent residential purposes. NSR outside the PFA were not verified.

Generally, noises from mining and industrial activities:

- are limited to a distance of less than 500 m from active mining access roads, though this would normally be less than 200 m with low traffic volumes and speeds associated with such roads (night-time impacts). This can be increased to a distance of 1,000 m, normally associated with very busy roads (such as a busy national road where average speeds exceed 100 km/h). Noises from mining and processing activities are normally clearly audible and very significant within 200 m from such activities both night and day;
- can be significant at receptors staying within 500 m from active mining/industrial activities. Noises may be at a sufficient level to be considered disturbing. There are only one NSR location (NSR16[16]) located within 500m from a location where drilling may take place;
- are normally limited to a distance of approximately 1,000 m from the active mining/industrial activities. Ambient sound levels are increased due to noises from the activities, with the potential noise impact measurable. Noise levels from such activities are generally less than 45 dBA further than 1,000 m from these activities, and noises may be considered disturbing at night. There are 11 NSR locations located 500 – 1,000m from potential borehole locations;
- may be audible up to a distance of 2,000 m at night, though the noises may be audible up to 4,000 m during very quiet periods at night (during certain meteorological conditions). These noises are normally of a low concern at distances greater than 2,000 m from activities at night.

[16] Location not visited, due to road conditions during the site visit.

These distances may not be valid with very large mining or industrial operations, or in areas with very low ambient sound levels.

8.13.2 AMBIENT SOUND LEVEL MEASUREMENTS

Ambient (background) sound levels were measured over a period of four nights from 19 – 23 November 2025 at three locations considering the prescribed procedures of GNR320 of 2020, considering SANS 10103:2008 "***The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication***".

This data is sufficient, as it illustrates the rural nature of the area, with similar ambient sound levels expected at other locations away from roads, animal enclosures (including chicken coups, pigstys and cattle corral/kraal(s)). Additional measurement locations, as well as measurements over a longer period will not provide more information. The sound measurement locations are illustrated in **Figure 103** as blue squares. Measurements were mainly unattended semi-continuous long-term measurements over a two-night period, where the instrument will measure the sound level for a period of 10 minutes, save the data and immediately start with a new measurement.

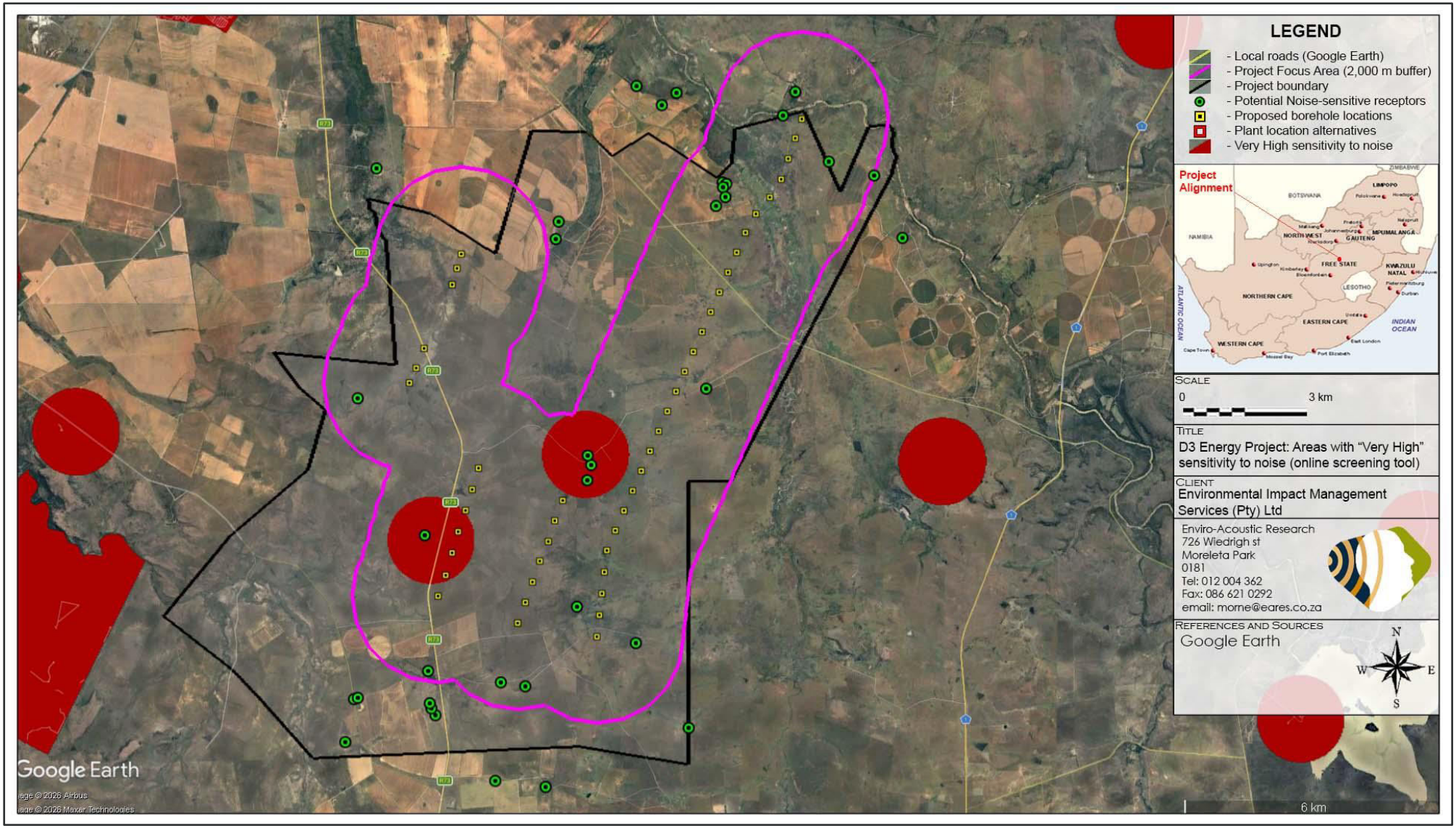


Figure 101: Areas identified by the online screening tool to have a "very high" sensitivity to noise (Enviro-Acoustic Research, 2026).

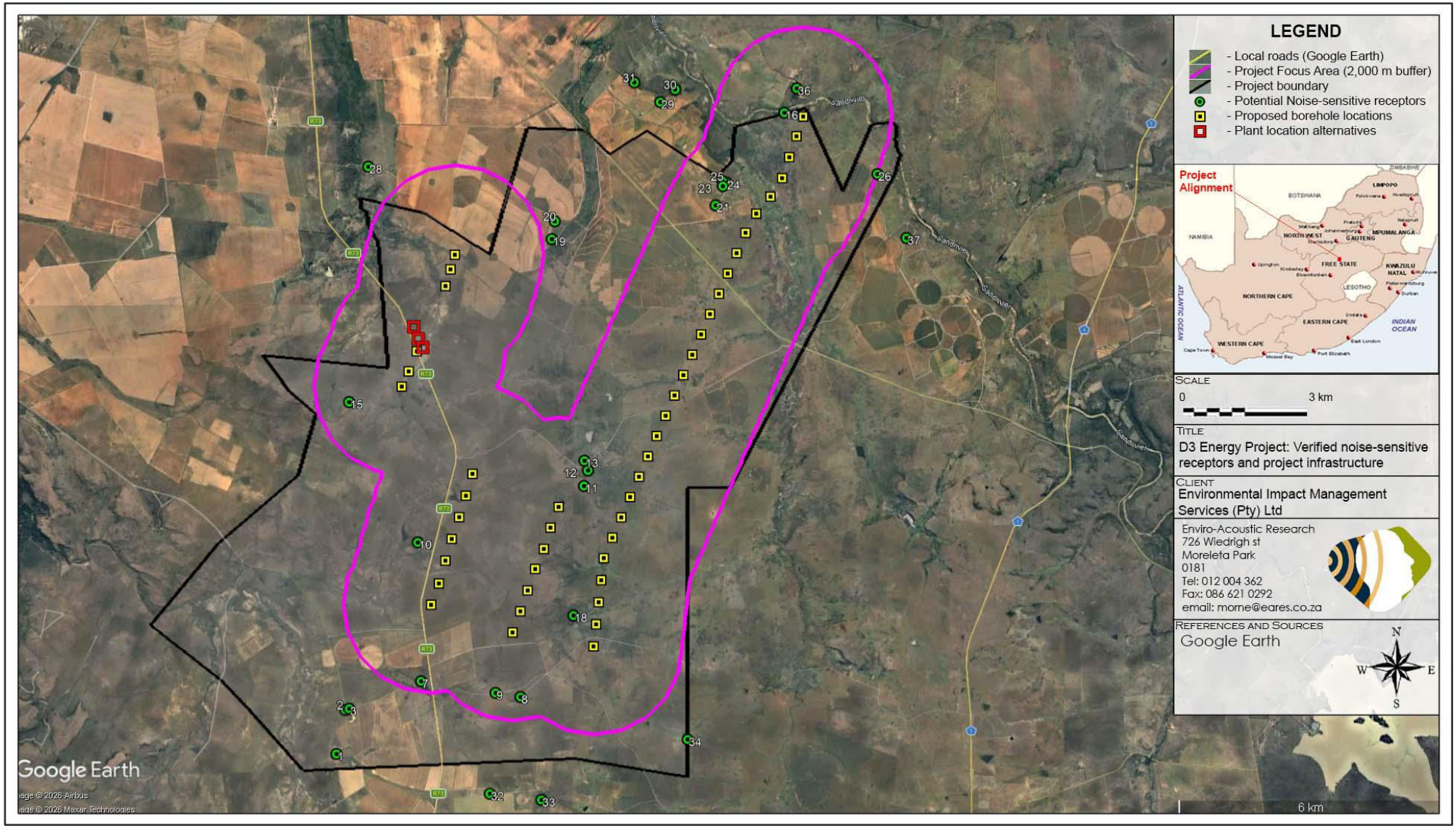


Figure 102: Aerial image indicating verified noise-sensitive receptors close to D3 Energy Project (Enviro-Acoustic Research, 2026).

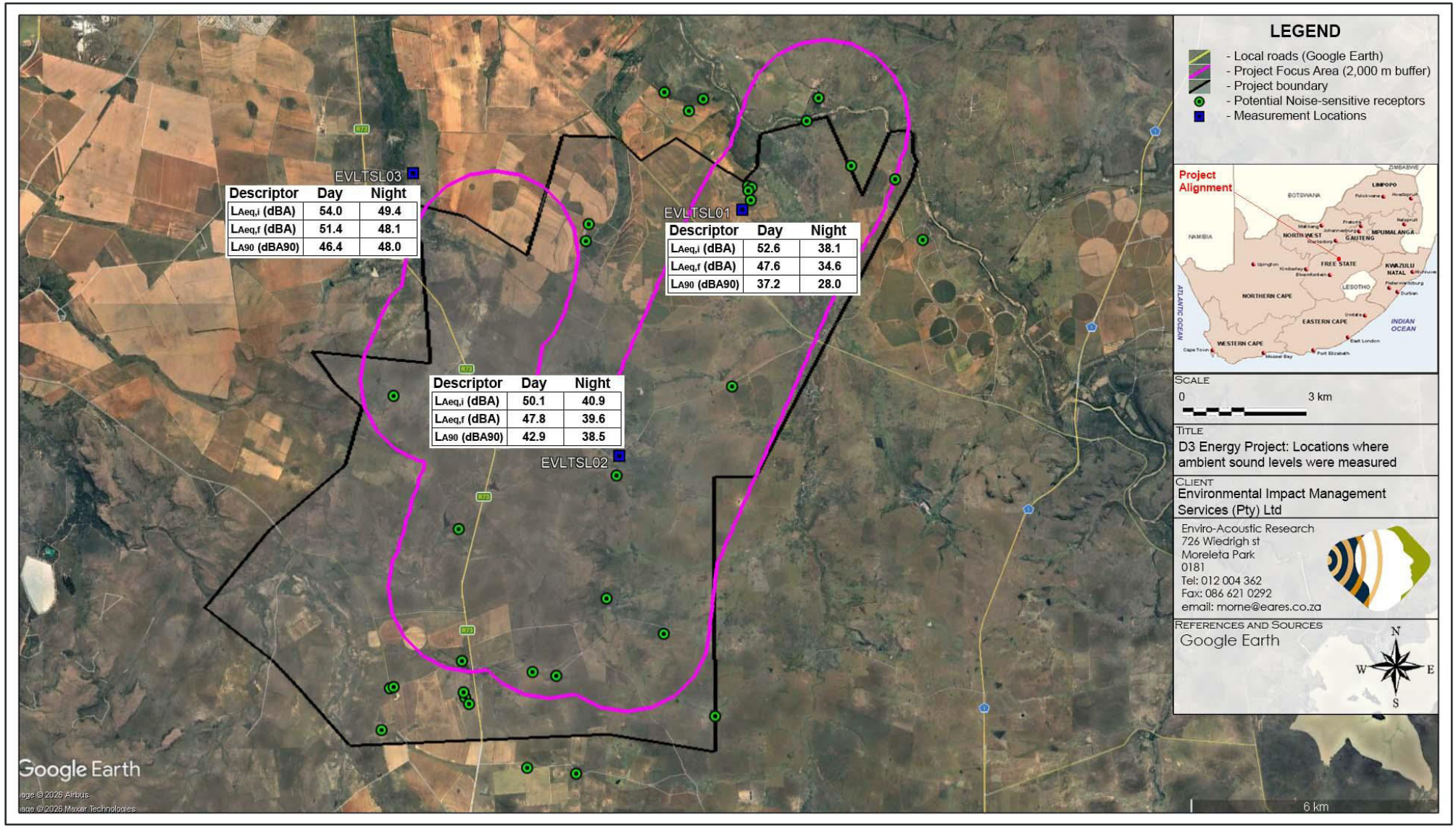


Figure 103: Localities where ambient sound levels were measured (Enviro-Acoustic Research, 2026).

8.13.2.1 AMBIENT SOUND LEVEL MEASUREMENT LOCATION – EVLTSL01

The instrument was deployed between the residential house and the property fence, with the microphone deployed under a number of trees. Sounds from birds and insects were generally constant and the dominant noise source in the area, with sounds from voices (in the house audible at times. The trees near the measurement location could increase ambient sound levels during periods with increased winds. Photos of the measurement location are presented in Appendix B.1 of The Noise Impact Assessment Report (**Appendix F8**). Spectral data confirmed that faunal noises were significant early mornings and most of the day.

Impulse time-weighted equivalent sound levels $L_{AIeq,10min}$ and fast time-weighted equivalent sound levels $L_{AFeq,10min}$ are summarised in **Table 52** below. The impulse time-weighted sound descriptor is mainly used in South Africa to define sound and noise levels with fast-weighted equivalent sound levels are included in this report as this is the sound descriptor used in most international countries to define the Ambient Sound Level.

The maximum (L_{Amax}), minimum (L_{Amin}) and 90th percentile (L_{A90}) statistical values are illustrated in **Table 52**. The L_{A90} level is presented in this report to define the "background ambient sound level", or the sound level that can be expected if there were little single events (loud transient noises) that impacts on average sound level. The L_{A90} level is typical as expected for a rural noise district.

Table 52: Sound levels considering various sound level descriptors at EVLTSL01 (Enviro-Acoustic Research, 2026).

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)
Day arithmetic average	-	52.6	47.6	37.2	-
Night arithmetic average	-	38.1	34.6	28.0	-
Day equivalent	-	61.2	56.5	-	-
Night equivalent	-	52.3	46.5	-	-
Day minimum	-	28.5	26.9	-	22.1
Day maximum	96.8	76.2	74.4	-	-
Night minimum	-	26.5	24.5	-	17.9
Night maximum	74.5	65.7	59.9	-	-

8.13.2.2 AMBIENT SOUND LEVEL MEASUREMENT LOCATION - EVLTSL02

The microphone was deployed near the common area (bar, relaxation, restaurant) of the Bloemskraal Guestfarm. As a result, this data may at time reflect voices of the guests of the guesthouse. During the times onsite, ambient sound levels were dominated by faunal noises, mainly birds and crickets, though voices were clearly audible at times. Photos of the measurement location are presented in Appendix B.3 of The Noise Impact Assessment Report (**Appendix F8**). Spectral data confirm that insect noises were significant at night, with various noises impacting on the soundscape during the day.

Impulse time-weighted equivalent sound levels $L_{AIeq,10min}$ and fast time-weighted equivalent sound levels $L_{AFeq,10min}$ are summarised in **Table 53** below. The L_{A90} levels were higher than expected from a rural noise district, with spectral data indicating that faunal noises were the main source of noise.

Table 53: Sound level descriptors as measured at EVLTSL02 (Enviro-Acoustic Research, 2026).

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)
Day arithmetic average	-	50.1	47.8	42.9	-
Night arithmetic average	-	40.9	39.6	38.5	-
Day equivalent	-	66.0	64.2	-	-
Night equivalent	-	45.3	43.1	-	-
Day minimum	-	33.9	33.3	-	28.2
Day maximum	97.5	90.2	88.5	-	-
Night minimum	-	30.0	29.9	-	24.1
Night maximum	78.0	58.0	54.2	-	-

8.13.2.3 AMBIENT SOUND LEVEL MEASUREMENT LOCATION - EVLTSL03

The microphone was deployed in a vegetable garden on the edge of the property. Bird and insect noises were generally dominant when the instrument was deployed and collected. Voices of farm workers were audible during deployment. Photos of the measurement location are presented in Appendix B.2 of The Noise Impact Assessment Report (**Appendix F8**). There was a noise that significantly impacted on the measurement, elevating the ambient sound levels and the data will not be used in this assessment.

Impulse time-weighted equivalent sound levels $L_{AIeq,10min}$ and fast time-weighted equivalent sound levels $L_{AFeq,10min}$ are summarised in **Table 54** below. The L_{A90} levels were must higher than expected from a rural noise district, with spectral data indicating significant faunal noises during the day (significant acoustic energy in the 500 – 800 Hz & 2,000 – 6,300 Hz range). A noise source with significant acoustic energy at 1,000 Hz also impacted on evening and night-time noises. The source(s) of this noise are undefined.

Table 54: Sound level descriptors as measured at EVLTSL03 (Enviro-Acoustic Research, 2026).

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)
Day arithmetic average	-	54.0	51.4	46.4	-
Night arithmetic average	-	49.4	48.1	48.0	-
Day equivalent	-	57.5	54.6	-	-
Night equivalent	-	51.9	52.2	-	-
Day minimum	-	40.8	36.3	-	29.7
Day maximum	94.1	72.4	68.7	-	-
Night minimum	-	34.0	33.6	-	28.2

	$L_{Amax,i}$ (dBA)	$L_{Aeq,i}$ (dBA)	$L_{Aeq,f}$ (dBA)	$L_{A90,f}$ (dBA90)	$L_{Amin,f}$ (dBA)
Night maximum	81.8	61.3	58.4	-	-

8.13.2.4 AMBIENT SOUND LEVELS – FINDINGS AND SUMMARY

The measurements done from 19 – 23 November 2025 resulted in more than 1,000 daytime, and 500 night-time measurements. When removing measurements collected at the third measurement location, there are still more than 700 day-, and 350 night-time measurements. Each measurement was collected over a 10-minute period and included a number of sound level descriptors, including; equivalent values, minimum and maximum levels, statistical sound levels as well as spectral information. Confidence levels in the resulting data are high and it is expected that the ambient sound level data would be applicable of other locations in the area (away from any roads).

Considering the average fast-weighted sound level data collected in the area, average:

- daytime fast-weighted sound levels ranged from 27 to more than 88 dBA, with average sound levels being 47.7 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 45 dBA for the daytime period; and
- night-time fast-weighted sound levels ranged from 24 to 60 dBA, with average sound levels being 37.1 dBA. This is typical of a rural to suburban noise district, setting a zone sound level of 35 dBA for the night-time period.

Considering the requirements of the PNCR (see **Section 4.3.4**), activities relating to the proposed project should not change the existing ambient sound levels with more than 5 dBA, nor exceed the WHO and IFC noise limits (see **Section 4.1.11**). Recommended upper noise limits therefore would be:

- 52 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for the daytime residential use; and
- 42 dBA (less than 5 dBA from the average ambient sound levels measured in the area) for night-time residential use.

If zoned as an industrial site, the project should also limit the noise level to less than 70 dBA during the daytime period and 60 dBA at night at the boundary (for the area zoned industrial).

9 ENVIRONMENTAL IMPACT ASSESSMENT

This section aims to identify and do a preliminary assessment on the potential environmental impacts associated with the proposed D3 Energy Production project. 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. The preliminary assessment will also serve to focus the subsequent EIA phase on the key issues and impacts.

9.1 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 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.

9.1.1 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:

$$\boldsymbol{C} = \frac{(\boldsymbol{E} + \boldsymbol{D} + \boldsymbol{M} + \boldsymbol{R}) * \boldsymbol{N}}{\boldsymbol{4}}$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in **Table 55** below.

Table 55: 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).

Aspect	Score	Definition
	5	Provincial / National / International (i.e. extends into numerous distinct geographical features or extends beyond 50 km from the site).
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 56**.

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 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 56: 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 57: Determination of Significance

Consequence	5- Very High[17]	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 58**.

Table 58: 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).

[17] 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.

S Score	Description
>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 measures (post-mitigation significance). This allows for a prediction in the degree to which the impact can be managed/mitigated.

9.1.2 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 59: 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 35**. 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 60**).

Table 60: Determination of Prioritisation Factor

Priority	Prioritisation Factor
2	1
3	1.125
4	1.25
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 61: 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

Significance Rating	Description
>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.

9.2 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.

Potential environmental impacts identified during the scoping process were identified by the EAP, the appointed specialists, as well as the public. **Table 62** provides the list of potential impacts identified.

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 62: Identified potential 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 / construction 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 construction 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 / construction 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 ○ Contamination of soils ○ Loss of fertility ○ Loss of flow paths ○ Emissions and dust	○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Nuisance and impacts on 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 Setting up site camps for drilling and seismic team and vehicles Setting up systems for managing drilling fluids, which may include containment sumps	○ Impacts on wetlands ○ Traffic impacts		○ Employment opportunities	
Production (Construction)	Drilling and seismic surveys Transportation of equipment and personnel to the drilling site Collecting, storing, and transporting drill core samples Collecting, storing, and disposing of drilling waste, including cuttings, fluids, and debris Surface and groundwater water management Trenching and Pipeline installation venting/ flaring of gas during well testing	○ Erosion due to storm water runoff ○ Impact due to topsoil stripping ○ Surface water contamination (contaminant transport) ○ Surface water, quantity (baseflow contributions) ○ Groundwater contamination ○ Contamination of soils ○ Loss of fertility ○ Loss of flow paths ○ Emissions and dust ○ Impacts on wetlands ○ Traffic impacts	○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Displacement of faunal species ○ Nuisance and impacts on 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 due to flaring and/or onsite workers, 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
Production (Operation)	Drilling and seismic surveys Collecting, storing, and transporting drill core samples Collecting, storing, and disposing of drilling waste, including cuttings, fluids, and debris Trenching and Pipeline installation Surface and groundwater water management Trucking operations Maintenance inspections Well testing including flaring / venting	○ Erosion due to storm water runoff ○ Impact due to topsoil stripping ○ Surface water contamination (contaminant transport) ○ Surface water, quantity (baseflow contributions) ○ Groundwater contamination ○ Contamination of soils	○ Loss/ destruction of natural habitat ○ Introduction/ Invasion by Alien Species ○ Displacement of faunal species ○ Nuisance and impacts on 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 due to flaring and/or onsite workers, 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

Main Activity / Action / Process	Ancillary Activity	Geo-physical (geology, topography, air, water)	Biological	Socio-economic	Heritage and cultural
	Plant operations including flaring	○ Loss of fertility ○ Loss of flow paths ○ Emissions and dust ○ Impacts on wetlands ○ Traffic impacts			
Post Construction Rehabilitation (Decommissioning of drilling and seismic surveys)	Revegetation Soil / slope stabilisation Backfilling (if necessary) Erosion control	○ 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	
Gas Analysis and Maintenance (Post construction)	Continuous analysis of gas quantity and quality Initiate maintenance and aftercare program Environmental aspect monitoring	○ 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	
Final Rehabilitation, Decommissioning and Closure	Plugging of boreholes Revegetation Soil / slope stabilisation Backfilling (if necessary) Erosion control	○ 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	
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	

9.3 DESCRIPTION AND ASSESSMENT OF IDENTIFIED 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.

The following potential impacts were identified during the scoping phase assessment and were assessed in terms of nature, significance, consequence, extent, duration and probability. The preliminary impact calculations during the scoping phase have been amendment based on the current EIA phase specialist assessment and the results of public consultation undertaken during the Scoping Phase. It must be noted that new potential impacts were also identified during this EIA phase.

9.3.1 INTERFERENCE WITH EXISTING LAND USES / ACTIVITIES

This section presents the identified potential impacts on existing land uses and activities associated with the proposed D3 Energy PR, taking into consideration the project description, alternatives assessment, environmental baseline, agricultural setting, potential existing underground mining and nearby gas activities, renewable energy developments, and surrounding land uses. The information presented in this section was sourced from the Site Sensitivity Verification (**Appendix E**) and various specialist studies (**Appendix F**).

9.3.1.1 DESCRIPTION OF IMPACT

The proposed D3 Energy PR is located within a predominantly agricultural landscape characterised by cultivated lands, grazing areas, game farms, farmsteads, water infrastructure, roads, existing mining operations, gas exploration infrastructure and planned / existing renewable energy developments. The northern, eastern and southern sections of the production right are largely associated with commercial agriculture, while parts of the western section are influenced by the existing Sibanye Stillwater FS 10005 MR, residential settlements and several renewable energy developments namely; Corona Solar Park (240 MW), Quagga Solar Park (240 MW), Virginia 1, 2, 3 and 4 Solar PVs. Refer to **Figure 1** to **Figure 7**.

Interference with existing land uses may arise during all phases of the project through temporary or localised occupation of land, restrictions on land access, disturbance of agricultural activities, interaction with existing infrastructure, and potential conflicts with concurrent land users.

9.3.1.1.1 ESTABLISHMENT / PLANNING PHASE

During the planning and site establishment phase, access negotiations, landowner engagement, surveying activities, specialist walkdowns, site pegging and route identification may result in temporary disruptions to normal farming practices and land management activities. Landowners may need to accommodate site inspections, environmental surveys and geophysical investigations which could temporarily affect cropping schedules, grazing rotations and farm operations.

The identification of drilling sites, access roads and seismic transects may also create concerns regarding future restrictions on land use, particularly on highly productive agricultural land, game farms and properties earmarked for future renewable energy developments. Temporary uncertainty regarding future land accessibility and operational constraints may affect ongoing land management decisions.

Potential conflicts may also occur where existing servitudes, pipeline corridors, powerline infrastructure, mineral rights, renewable energy agreements or other legally recognised land-use rights overlap with proposed activities.

9.3.1.1.2 CONSTRUCTION PHASE

The construction phase represents the period with the greatest potential for interference with existing land uses.

The establishment of drilling pads (approximately 50 m × 50 m per site), temporary laydown areas, waste storage areas, drilling equipment and vehicle movement will require the temporary occupation of primarily agricultural

and renewable energy development land. Although the overall footprint is relatively small, activities may result in:

- Temporary loss of cultivated land under active production.
- Localised reduction in grazing areas.
- Restricted movement of livestock and agricultural machinery.
- Disruption of irrigation, fencing and farm infrastructure.
- Temporary exclusion of farming activities around drilling areas for safety reasons.
- Interruption of game farming operations due to increased human presence.
- Reduced accessibility to portions of land during drilling activities.

Seismic surveys may interfere with farming operations, renewable energy activities or mining activities through the movement of vibroseis vehicles, AWD equipment, geophone deployment teams and support vehicles across agricultural land. Seismic transects may cross cultivated fields, grazing camps, canals, farm roads and watercourses. Although the activities are temporary, they may:

- Damage crops if not properly coordinated with landowners.
- Disturb livestock and game.
- Increase biosecurity risks through movement between farms.
- Interfere with harvesting, planting and irrigation schedules.
- Create access issues where gates are not properly managed.
- Result in temporary restrictions to normal agricultural operations.

Existing gas wells, mining infrastructure, underground workings, roads, powerlines, communications infrastructure and farm services could also be affected if not adequately identified and protected prior to construction activities.

9.3.1.1.3 PRODUCTION PHASE

As indicated in Section 3.1.5, the proposed development comprises a helium production and processing facility designed to receive, process, separate, store, and export helium and associated gas products from upstream gas production operations. Based on the updated site layout **(Figure 12)**, the facility will consist of gas treatment equipment, helium recovery systems, compression units, cryogenic processing infrastructure, produced water management facilities, loading facilities, utility systems, and a flare system for emergency gas disposal. The facility is planned within a fenced industrial site with an approximate footprint between 1.5 and 3.0 ha, including operational areas, access routes, storage facilities, and safety exclusion zones. The production activities will be operational for approximately 30-years which may result in localised long-term impacts on agriculture, driven by physical footprint constraints and safety protocols rather than widespread chemical contamination existing land-uses and/or infrastructure. The potential impact on renewable energy developments depends closely on proximity, given the distinct structural and atmospheric requirements of solar technologies. As indicated in **Figure 5** and **Figure 6**, there Gas Plants Options A, B and C do not directly intersect planned renewable energy developments, while the gas gathering pipelines do intersect several renewable energy developments. Therefore, the impact during the production phase on renewable energy developments would be associated with gas producing wells and pipelines which would be limited to maintenance activities rather than intensive / invasive impacts which with proper planning and coordination, it can be undertaken with little to minimal impacts / disruptions to the renewable energy activities.

9.3.1.1.3.1 PRODUCTION TESTING AND WELL MONITORING

Should production wells indicate commercial gas potential and require testing, monitoring or temporary retention for further investigation, there may be longer-term restrictions on surrounding land use. These

restrictions could affect crop cultivation, grazing management and future land development opportunities around retained wellheads. However, these impacts are expected to remain highly localised due to the limited footprint of the proposed wells.

9.3.1.1.4 DECOMMISSIONING AND REHABILITATION PHASE

Interference with land uses may continue during well plugging, removal of infrastructure and rehabilitation activities. Heavy vehicles and rehabilitation equipment may temporarily require access to affected areas. Disturbance associated with earthworks, topsoil replacement and revegetation activities may temporarily prevent immediate return to original land uses. However, once rehabilitation has been completed and rehabilitation success demonstrated, disturbed areas are expected to be returned to their pre-existing agricultural, grazing or game farming use. Consequently, long-term interference after rehabilitation is expected to be limited.

The impact ratings associated with the proposed activities related to interference with existing land uses are indicated in **Table 63** to **Table 67**.

9.3.1.2 IMPACT RATING

Table 63: Summary of impacts related to interference with agriculture and general farming activities.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to High	Medium to Low	**Medium to Low**
Seismic Surveys	Negative	Medium to High	Low	**Low**
Drilling Activities	Negative	High	Medium to Low	**Medium to Low**
Production (Wells, Pipelines and Gas Plant)	Negative	Medium to High	Medium to Low	**Medium to Low**
Decommissioning and Rehabilitation	Negative	Medium to Low	Low	**Low**

Table 64: Summary of impacts related to interference with existing and planned renewable energy land uses for Alternative L1 (co-existence with renewable energy developments).

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to High	Medium to Low	**Medium to Low**
Seismic Surveys	Negative	Medium to Low	Low	**Low**
Drilling Activities	Negative	Medium to High	Medium to Low	**Medium to Low**
Production (Wells, Pipelines and Gas Plant)	Negative	Medium to Low	Medium to Low	**Medium to Low**

Decommissioning and Rehabilitation	Negative	Medium to Low	Low	**Low**

Table 65: Summary of impacts related to interference with existing and planned renewable energy land uses for Alternative L2 (excluding directly affected renewable energy developments).

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to Low	Low	**Low**
Seismic Surveys	Negative	Medium to Low	Low	**Low**
Drilling Activities	Negative	Medium to Low	Low	**Low**
Production (Wells, Pipelines and Gas Plant)	Negative	Medium to Low	Low	**Low**
Decommissioning and Rehabilitation	Negative	Medium to Low	Low	**Low**

Table 66: Summary of impacts related to interference with existing and planned renewable energy land uses based on the pipeline route alternative assessment.

Project Phase	Nature and Description of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Pipeline Route Alternative 1 (Proposed Route) All Phases	Negative. Limited interaction with approved solar parks; lower fragmentation of renewable energy development areas.	Medium to Low	Low	**Low**
Pipeline Route Alternative 2 (Alternative Route) All Phases	Negative. Greater overlap with Virginia Solar developments and broader Solar PV application areas resulting in increased fragmentation and layout constraints.	Medium to High	Medium to Low	**Medium to Low**

Table 67: Summary of impacts related to interference with existing and planned mining activities.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to Low	Low	**Low**
Seismic Surveys	Negative	Medium to Low	Low	**Low**
Drilling Activities	Negative	Medium to Low	Low	**Low**

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Production (Wells, Pipelines and Gas Plant)	Negative	Medium to Low	Low	**Low**
Decommissioning and Rehabilitation	Negative	Medium to Low	Low	**Low**

9.3.1.3 POTENTIAL LOSS OF PV DEVELOPABLE LAND AND SAFETY BUFFER REQUIREMENTS

As indicated in the section above and **Section 3**, portions of the proposed D3 Energy PR overlap with existing, approved, and proposed renewable energy developments. In recognition of this constraint, additional well locations have deliberately been identified to provide flexibility should some proposed wells conflict with solar facilities. From a land-use perspective, the proposed gas production infrastructure has a comparatively small permanent footprint. Individual well pads occupy approximately 50 m × 50 m (2,500 m²) during drilling and construction, with the long-term operational footprint reduced substantially following rehabilitation and installation of simplified wellhead facilities. The gas gathering pipelines are buried and generally follow narrow servitude corridors approximately 10 m wide, while the helium recovery and gas processing plant occupies between 1.5 and 3.0 ha.

The Quantitative Risk Assessment (QRA) (**Appendix F10**) concludes that the production wells and low-pressure gathering pipelines represent a very low off-site risk and do not pose a fatality risk to neighbouring developments. Specifically:

- A catastrophic well failure would result in a jet-fire fatality distance of approximately **4 m**.
- A full-bore rupture of the 315 mm buried gathering pipeline would result in a maximum jet-fire distance of approximately **68 m**, a flash-fire distance of **4 m**, and a vapour cloud explosion (VCE) distance of approximately **9 m**.
- No residential areas fall within the well or pipeline consequence zones, and the risks remain confined to operational areas and servitudes.
- The gas gathering system is explicitly stated to **not constitute a Major Hazard Installation (MHI)** and is not classified as a major hazard pipeline establishment.

The QRA further concludes that well-related risks are spatially constrained and do not pose off-site fatality risks and that pipeline impacts remain confined to the servitude. Based on the QRA findings, there is **no indication that extensive exclusion zones are required around the production wells or buried gas gathering pipelines for land-use planning purposes**. The risk contours associated with these facilities are highly localised and do not extend beyond the immediate operational footprint. The greatest potential constraint to renewable energy development is therefore unlikely to be safety risk from the wells or gathering pipelines, but rather:

- Physical occupation of land by well pads and access routes.
- Restrictions associated with pipeline servitudes and maintenance access.
- Potential operational constraints around the central gas processing facility.
- Requirement to maintain access for drilling, maintenance and emergency response.

Based on the QRA and project design information, as well as existing arrangements for similar overlapping land-uses, a coexistence arrangement between the renewable energy developers and D3 Energy is considered feasible. From a South African perspective, the rise of overlapping land rights between underground mineral/gas extraction and surface-level wind or solar farms has made coexistence agreements essential for project development. The most prominent and recent co-existence agreement involving overlapping onshore gas activities and renewable energy developments is the Renergen & Springbok Solar Settlement (September 2025). This case serves as South Africa's premier template for how gas exploration/production and renewable

companies resolve overlapping land use rights. Subsequently, it is the EAP's opinion that D3 Energy and the affected renewable energy developers within PR16 can be able to co-exist.

9.3.1.4 CUMULATIVE IMPACT ASSESSMENT

The cumulative impact associated with interference with existing land uses must be considered within the broader regional context. The production area occurs within a landscape already influenced by:

- Existing agricultural cultivation and grazing activities.
- Existing underground and historical gold mining operations.
- Existing gas exploration and production infrastructure.
- Existing roads, powerlines and service infrastructure.
- Existing game farming activities.
- Existing and proposed renewable energy developments, particularly solar energy facilities.

Although the individual Production activities are temporary and of limited spatial extent, cumulative impacts may arise where production activities overlap spatially or temporally with agricultural production cycles, mining operations and renewable energy projects. Potential cumulative effects include:

- Progressive fragmentation of agricultural land.
- Multiple access agreements across the same properties.
- Increased vehicle movement affecting farm operations.
- Concurrent restrictions on land use from gas, mining and renewable energy rights.
- Increased difficulty for landowners in coordinating multiple infrastructure developments.
- Incremental loss of flexibility in future land-use planning.
- Increased pressure on farm access routes and service corridors.
- Potential cumulative disruption of grazing rotations and crop production where multiple projects overlap.

However, the following factors substantially reduce cumulative significance:

- The production footprint is relatively small.
- Certain activities are temporary and phased.
- Proposed drilling locations avoid direct overlap with most renewable energy developments.
- Existing agricultural activities will largely continue alongside production activities.
- Rehabilitation is proposed to restore land capability and existing land uses.
- Co-existence arrangements can be established with other infrastructure and servitude users.

Subsequently, the cumulative interference with existing land uses, mining activities, renewable energy developments and agricultural activities was assessed to be medium to low negative post mitigation.

9.3.1.5 PROPOSED MITIGATION MEASURES

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 same activities in the same region adopted for the proposed activities (**Appendix H**):

- Enter into formal written agreements with all affected landowners prior to commencement.

- Notify landowners prior to commencement of activities.
- Compile an asset and services baseline prior to site establishment.
- Establish and maintain a grievance management mechanism.
- Consult underground mining operators where applicable.
- Restrict activities to approved footprints.
- Utilise existing roads and disturbed areas where practicable.
- Limit vegetation clearance and land disturbance.
- Close all farm gates immediately after access.
- Repair any damage to infrastructure, fences, roads or services.
- Engage with landowners regarding compensation for temporary loss of productive land.
- Implement access control and security measures.
- Develop coexistence agreements where other rights or agreements exist.
- Coordinate activities with adjacent landowners and affected stakeholders.
- Adhere to AgriSA farm access protocols or equivalent standards.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Schedule seismic surveys and drilling activities outside critical planting and harvesting seasons where reasonably practicable.
- Schedule seismic surveys, drilling activities and gas gathering pipelines before construction of renewable facilities where possible.
- Avoid locating drilling pads within high-value cultivated areas unless no reasonable alternative exists.
- Prioritise degraded land, existing servitudes, fence lines and previously disturbed areas for infrastructure placement, where reasonably practicable.
- Maintain access for agricultural machinery and farming operations at all times unless otherwise agreed with the landowner. Temporary access restrictions may only be allowed if agreed upon with the landowner
- Reinstate drainage systems, irrigation channels and farm roads as soon as reasonably practicable following disturbance.
- Where topsoil stripping is required, ensure topsoil is stripped, stored separately and reinstated to maintain agricultural capability.
- Implement farm-specific biosecurity measures to prevent the spread of weeds, pests and livestock diseases.
- Post-rehabilitation monitoring should continue until agricultural productivity and grazing suitability are restored to baseline conditions or as agreed with the affected landowner.
- Establish formal engagement procedures with renewable energy developers where activities occur within 200m of approved renewable energy projects.
- Where activities overlap with renewable energy developments, obtain confirmation of planned infrastructure from affected renewable energy developers prior to finalising seismic, drilling and pipeline locations.
- Engage existing mining right holders to request and if possible, obtain confirmation of planned infrastructure from affected mining companies prior to finalising seismic, drilling and pipeline locations.

- Communicate execution plans, drilling locations, methods and depth with affected mining right holders. Take necessary measures to avoid impacting any mining activities.
- Prepare a conflict avoidance protocol where future gas, mining and renewable energy developments may overlap.
- Applicant must coordinate with affected mining right holders and prevent and/or manage any potential impacts on mining activities.

9.3.2 IMPACT ON EXISTING SERVICES / INFRASTRUCTURE

This section presents the identified potential impacts on existing services and infrastructure associated with the proposed D3 Energy PR activities, taking into consideration the project description, alternatives assessment, baseline environment, surrounding land uses, nearby existing gas infrastructure, potential mining infrastructure, agricultural services and renewable energy developments within and surrounding the production area. The information presented in this section was sourced from the Site Sensitivity Verification (**Appendix E**) and various specialist studies (**Appendix F**).

9.3.2.1 DESCRIPTION OF IMPACT

The D3 Energy PR area contains a range of existing infrastructure and services that support agricultural, residential, transportation, communication, water supply and energy-related activities. Existing infrastructure within and surrounding the production area includes:

- Farm roads and access tracks.
- Provincial roads (R73) and associated crossings.
- Agricultural fencing and gates.
- Irrigation systems, canals and agricultural water infrastructure.
- Existing groundwater boreholes and water supply infrastructure.
- Electrical distribution lines and substations.
- Telecommunications infrastructure.
- Existing gas wells and gas-related infrastructure.
- Potential underground mining infrastructure.
- Existing drainage, stormwater and water conveyance systems.
- Renewable energy infrastructure and associated services.

The proposed production activities may interfere with, damage, obstruct or temporarily disrupt existing services and infrastructure if not appropriately planned and managed.

9.3.2.1.1 ESTABLISHMENT / PLANNING PHASE

During the planning phase, final drilling locations, seismic transects, gas plant location, gathering pipeline routes and access routes are identified and surveyed. At this stage, the primary risk relates to the failure to adequately identify existing underground and aboveground services before activities commence.

Potential impacts include:

- Inadequate identification of buried services such as pipelines, communication cables or electrical cables.
- Conflicts with existing servitudes and infrastructure corridors.

- Selection of routes and/or locations that intersect critical agricultural infrastructure.
- Potential future conflicts with renewable energy infrastructure and planned developments.
- Risks associated with unrecorded underground mining infrastructure or shafts.

Where baseline surveys are not undertaken, production activities may inadvertently interfere with infrastructure relied upon by landowners, municipalities, mines or other service providers.

9.3.2.1.2 CONSTRUCTION PHASE (SITE ESTABLISHMENT, SEISMIC SURVEYS AND DRILLING)

The construction phase represents the highest risk period for impacts on existing services and infrastructure.

9.3.2.1.2.1 SEISMIC SURVEYS

Seismic vehicles, geophone deployment teams and support vehicles may traverse agricultural properties containing irrigation infrastructure, farm roads, gates, pipelines and powerline servitudes.

Potential impacts may include:

- Accidental damage to fences, gates and livestock control structures.
- Damage to irrigation pipelines, pivots and water reticulation systems.
- Damage to existing farm tracks and access roads.
- Increased wear on roads due to construction traffic.
- Temporary restrictions to infrastructure access by landowners.
- Interference with drainage canals and stormwater systems.
- Damage to boundary infrastructure through repeated vehicle movement

Seismic surveys may also cross areas containing existing mining-related infrastructure and utility services. Although the activities are generally non-invasive, accidental impacts remain possible where infrastructure is not properly identified.

9.3.2.1.2.2 DRILLING ACTIVITIES

The establishment of drilling pads, temporary access roads and associated support infrastructure may affect existing services through:

- Excavation near buried services.
- Physical damage to electrical infrastructure and utility poles.
- Accidental damage to buried telecommunication cables.
- Damage to agricultural water supply lines and irrigation systems.
- Damage to canals, water crossings and associated agricultural infrastructure.
- Interference with farm access roads.
- Damage to fences and livestock handling infrastructure.
- Potential interaction with existing gas wells and monitoring infrastructure.
- Potential interception of undocumented underground mine workings or shafts.

The movement of drilling rigs, service trucks, water trucks and support vehicles may also result in deterioration of farm roads and increased maintenance requirements.

9.3.2.1.1 PRODUCTION PHASE

The production activities will be operational for approximately 30-years which may result in minor localised long-term impacts on existing services and infrastructure. The most immediate and noticeable impact will occur on local road networks due to the heavy-vehicle loads during operations. There may also be a strain on local wastewater facilities if produced water volumes spike.

9.3.2.1.1.1 PRODUCTION TESTING AND MONITORING PHASE

Where wells remain for monitoring or temporary testing, minor long-term impacts may occur through:

- Ongoing access requirements to wellheads.
- Temporary limitations on future infrastructure placement by landowners.
- Continued need for access to monitoring equipment.
- Potential interaction with future agricultural and renewable energy infrastructure planning.

These impacts are expected to remain localised due to the small footprint of retained infrastructure.

9.3.2.1.2 DECOMMISSIONING AND REHABILITATION PHASE

During decommissioning, removal of infrastructure and rehabilitation activities may temporarily affect existing services and access routes.

Potential impacts include:

- Temporary road disruptions associated with well plugging and site rehabilitation.
- Damage to existing roads caused by heavy vehicles if not properly managed.
- Temporary interference with access to farming infrastructure during rehabilitation works.

Following successful rehabilitation and restoration, impacts on services and infrastructure are expected to be largely reversible. The impact ratings associated with the proposed activities related to existing services and infrastructure are indicated in **Table 68.**

9.3.2.2 IMPACT RATING

Table 68: Summary of impacts related to existing services and infrastructure.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to High	Medium to Low	**Medium to Low**
Construction (Seismic Surveys)	Negative	Medium to Low	Low	**Low**
Construction (Drilling Activities)	Negative	High	Medium to Low	**Medium to Low**
Production (Wells, Pipelines and Gas Plant)	Negative	Medium to Low	Low	**Low**
Decommissioning and Rehabilitation	Negative	Medium to Low	Low	**Low**

9.3.2.3 CUMULATIVE IMPACT ASSESSMENT

The cumulative impact on existing services and infrastructure must be considered within the broader regional context.

The D3 Energy PR area already contains numerous infrastructure networks and activities including:

- Existing roads and transportation routes.
- Existing utility services.
- Existing agricultural infrastructure.
- Existing gas exploration and production facilities.
- Existing communication and electrical infrastructure.
- Approved and proposed renewable energy developments requiring access roads, power evacuation infrastructure and service corridors.
- Potential underground mining infrastructure.

Cumulative impacts may arise where multiple developments utilise the same infrastructure networks or service corridors. Potential cumulative impacts include:

- Increased deterioration of rural access roads due to combined traffic from agricultural, mining, gas and renewable energy activities.
- Greater pressure on shared infrastructure corridors.
- Increased risk of conflicts between pipeline, powerline and communication infrastructure.
- Increased maintenance requirements for municipal and agricultural infrastructure.
- Reduced flexibility for future infrastructure development due to overlapping rights and servitudes.
- Greater complexity in managing multiple utility and infrastructure operators within the same area.

Subsequently, the cumulative impact on existing services and infrastructure resulting from the proposed activities combined with mining, gas, renewable energy and agricultural activities was assessed to be Medium to Low negative.

9.3.2.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on existing services and infrastructure due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the same activities in the same region adopted for the proposed activities (**Appendix H**):

- Prior to accessing any portion of land, enter into formal written agreements with affected landowners.
- Landowners must identify services and infrastructure located on their properties before activities commence.
- Compile an asset and services baseline prior to commencement.
- Engage underground mining companies where applicable.
- Develop a services impact and interruption management plan.
- Notify affected parties prior to any planned service interruption.

- Restrict vehicle movement to approved routes and access roads.
- Ensure any damaged infrastructure is repaired to its original condition.
- Use existing roads wherever possible.
- Maintain access control procedures.
- Establish a formal grievance mechanism.
- Maintain regular communication with landowners and service providers.
- Undertake ECO walkdowns and pre-construction surveys.
- Restrict activities to approved footprints and avoid unnecessary disturbance.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Clearly demarcate all identified services and infrastructure which may potentially be affected prior to activities.
- Maintain minimum separation distances from existing utility infrastructure in accordance with applicable standards.
- Verify the location of active and historical mine workings through consultation with mining companies and available records.
- Maintain a minimum of 50m setbacks from known gas wells, monitoring boreholes and related infrastructure.
- Confirm the location of existing and approved renewable energy infrastructure prior to final route selection.
- Establish coexistence agreements where the proposed activities occur within areas earmarked for renewable energy developments.
- Avoid planned electrical collector routes, substations and solar infrastructure wherever feasible.
- Establish formal engagement procedures with renewable energy developers where activities occur within properties of approved renewable energy projects.
- Coordinate with affected mining right holders and prevent and/or manage any potential impacts on mining activities.
- Maintain emergency contact details for all service providers and affected landowners.
- Any service interruption must be reported immediately to the affected party and repaired within agreed response times.

9.3.3 IMPACTS ON TEMPORARY DISPLACEMENT OF LANDOWNERS AND LIVESTOCK

This section presents the identified potential impacts associated with the temporary displacement of landowners, farm workers, livestock and game animals as a result of the proposed D3 Energy PR activities. The assessment considers the project area characteristics, proposed seismic surveys, production well development, gas gathering pipelines, helium recovery and gas processing plant, associated infrastructure, and the existing agricultural nature of the area. The project occurs within a predominantly agricultural landscape comprising cultivated lands, grazing camps, farmsteads, irrigation infrastructure and livestock farming activities, with existing gas infrastructure and planned renewable energy developments also occurring within parts of the broader region. The information presented in this section was sourced from the Site Sensitivity Verification (**Appendix E**) and various specialist studies (**Appendix F**).

9.3.3.1 DESCRIPTION OF IMPACT

The proposed D3 Energy PR is situated within a predominantly agricultural environment where livestock production, crop farming and associated agricultural activities represent the dominant land uses. A significant proportion of the properties within the project area contain grazing camps, livestock handling facilities, cultivated lands, farm roads, farmsteads, irrigation infrastructure and agricultural workers. The proposed project activities have the potential to temporarily displace landowners, farm workers, livestock and game from portions of farms during various project phases. Although permanent displacement is not anticipated due to the relatively small infrastructure footprints and rehabilitation commitments, temporary disruption and displacement may occur throughout the project lifecycle.

9.3.3.1.1 ESTABLISHMENT PHASE

During the planning and establishment phase, landowners may experience temporary disruption associated with site investigations, geotechnical investigations, land access negotiations, environmental walkdowns, route surveys, pegging of infrastructure and the establishment of temporary work areas. The presence of survey teams, environmental specialists and contractors may necessitate temporary exclusion of livestock from certain areas to ensure safety and prevent interference with surveys. Access restrictions may affect normal farm operations, livestock movement patterns and grazing schedules. In some instances, livestock may need to be temporarily relocated between camps while survey work is undertaken. The establishment of temporary work areas, laydown areas and construction access routes may also affect farmers' ability to utilise specific portions of land during the construction period. This may be more pronounced where surveys and site investigations coincide with planting, harvesting or livestock management activities.

9.3.3.1.2 CONSTRUCTION PHASE (SEISMIC SURVEYS AND PRODUCTION DRILLING)

9.3.3.1.2.1 SEISMIC SURVEYS

Temporary displacement impacts are most likely to arise during seismic and audio magnetotelluric survey activities. Seismic survey teams, vibroseis trucks, AWD equipment, geophone deployment, support vehicles and personnel may move through grazing areas, cultivated fields and farm camps. Livestock and game may temporarily avoid areas where equipment is operating due to noise, vibration, unfamiliar activity and increased human presence. Livestock may be moved by landowners away from active seismic transects to avoid stress, injury risks or interference with survey operations. Farm access restrictions during short-term surveying activities may also affect routine activities such as herd movement, veterinary treatment, supplementary feeding and livestock handling. While seismic activities are temporary and mobile in nature, localized displacement may occur for the duration of the survey campaign.

9.3.3.1.2.2 PRODUCTION DRILLING

Production drilling may result in temporary exclusion zones around drill pads to protect people, livestock and equipment. The establishment of drilling pads (approximately 50 m x 50 m), temporary storage areas, fencing, drilling equipment and support infrastructure may render portions of grazing land inaccessible for the duration of drilling operations. Livestock may require temporary relocation from affected camps during drilling, particularly where drilling activities generate elevated noise levels, increased traffic and continuous human activity. Farm workers may experience temporary changes to access routes or operational areas during drilling activities. Where multiple wells are drilled on a property or nearby properties, landowners may experience repeated periods of disruption, although these would remain temporary and localized.

9.3.3.1.3 PRODUCTION PHASE

The production phase has the greatest potential for longer-duration temporary displacement because it includes:

- Up to 43 production wells (plus 5 contingent wells).
- Gas gathering pipelines.

- Helium recovery and gas processing facilities.
- Associated roads and utility infrastructure.

Construction of production wells, pipeline trenches and the gas plant may require temporary occupation of grazing camps and agricultural land. Livestock may need to be moved while trenching activities and pipeline construction occur. Construction camps, increased workforce presence, heavy vehicle movement and temporary construction exclusion zones may alter normal grazing patterns and limit access to portions of farms.

The gas processing facility, although occupying a relatively small footprint, may require temporary displacement of grazing activities during construction. Farm workers and landowners may also experience temporary restrictions associated with construction traffic, infrastructure installation and safety requirements. Following construction, many areas surrounding production wells and pipelines may remain available for continued agricultural use. The underground nature of the gathering pipelines and small footprint of individual wellheads will significantly reduce long-term displacement impacts.

9.3.3.1.3.1 DECOMMISSIONING AND CLOSURE PHASE

Temporary displacement may also occur during decommissioning and rehabilitation activities. Livestock may need to be excluded from rehabilitation areas while earthworks are undertaken, infrastructure is removed and vegetation is re-established. Vehicle movements, plugging of wells, removal of pipelines (where applicable) and rehabilitation operations may temporarily affect access and grazing activities. However, these impacts are expected to be short-term and will reduce as rehabilitation progresses and agricultural land capability is restored. The impact ratings associated with the proposed activities related to temporary displacement of landowner and livestock are indicated in **Table 69**.

9.3.3.2 IMPACT RATING

Table 69: Summary of impacts related to temporary displacement of landowner and livestock.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to High	Low	**Medium to Low**
Construction (Seismic Surveys)	Negative	Medium to High	Medium to Low	**Medium to Low**
Construction (Drilling Activities)	Negative	Medium to High	Medium to Low	**Medium to Low**
Production (Wells, Pipelines and Gas Plant)	Negative	Medium to High	Low	**Low**
Decommissioning and Rehabilitation	Negative	Medium to Low	Low	**Low**

9.3.3.3 CUMULATIVE IMPACT ASSESSMENT

The project occurs within an area where agricultural activities represent the dominant land use, alongside existing gas production operations, historical mining activities and several renewable energy developments and proposed renewable energy projects. These activities collectively contribute to a gradual increase in land-use competition and temporary disruption of normal farming operations.

Cumulative displacement impacts may arise through:

- Simultaneous gas production activities on neighbouring properties.
- Existing and future gas infrastructure requiring overlapping access arrangements.
- Construction of renewable energy developments resulting in additional exclusion zones and construction traffic.
- Existing agricultural operations requiring movement of livestock between grazing camps.
- Multiple infrastructure projects reducing grazing flexibility on individual farms.
- Increased vehicle movement across rural farming areas.
- Increased temporary disruption of stock handling and farming activities due to overlapping development schedules.

Despite these cumulative factors, several characteristics reduce cumulative significance:

- Agricultural activities can largely continue around the majority of the infrastructure.
- Production wellheads occupy relatively small footprints.
- Gas gathering pipelines will be underground.
- Seismic surveys are temporary and mobile.
- Much of the disturbed land will be rehabilitated and returned to agricultural use.
- Existing renewable energy developments do not fully overlap with the proposed infrastructure footprint.
- The project area is extensive, and activities are dispersed over time

Subsequently, the cumulative temporary displacement of landowners, livestock and farming activities resulting from gas infrastructure, renewable energy developments and agricultural activities was assessed to be Medium to Low negative.

9.3.3.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on landowners and livestock due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the same activities in the same region adopted for the proposed activities (**Appendix H**):

- Prior to accessing any portion of land, formal written agreements must be concluded with affected landowners.
- Landowners must be notified in advance of proposed activities and schedules.
- Maintain regular and proactive communication with landowners throughout the project lifecycle.
- Landowner engagement must be undertaken regarding compensation for disturbance or temporary loss of grazing and agricultural land.
- Existing farm access roads must be utilised where possible.
- Disturbance footprints must be minimised and restricted to approved development areas.
- Areas outside approved footprints must not be disturbed.
- Vehicle movement must be restricted to approved routes.

- Farm gates must remain closed after entry and exit.
- Access control measures must be implemented.
- Activities should be coordinated with landowners.
- Co-existence agreements should be concluded where multiple rights or development interests exist.
- Rehabilitation must restore disturbed land to a condition supporting pre-existing land uses.
- Temporary access routes must be rehabilitated following completion of activities.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Temporary livestock relocation (where applicable) must be planned in consultation with affected landowners before activities commence.
- Any temporary livestock relocation costs incurred due to project activities must be compensated by the Holder where applicable.
- Livestock exclusion zones must be minimised to the smallest practical area and duration.
- Safe livestock crossings must be maintained during pipeline construction and trenching activities.
- Maintain safe livestock crossings during pipeline trenching.
- Open trenches must either be backfilled daily, fenced or fitted with escape ramps to prevent livestock entrapment.
- All temporary fencing must be installed in consultation with the affected landowner.
- Water points, supplementary feeding areas and handling facilities must remain accessible wherever possible.
- Production well locations should be positioned adjacent to existing fence lines, farm roads and disturbed areas wherever practical to minimise fragmentation of grazing land.
- Rehabilitation monitoring should include assessment of post-construction grazing suitability where grazing forms part of the agreed post-closure land use.

9.3.4 NUISANCE AND IMPACT ON SENSE OF PLACE

This section presents the identified potential nuisance impacts and impacts on the sense of place associated with the proposed D3 Energy PR project. The assessment considers the agricultural and rural character of the project area, existing farming activities, nearby gas infrastructure, mining influences, rural homesteads, and planned renewable energy developments. The assessment further considers all project components including seismic surveys, production wells, gas gathering pipelines, the helium recovery and gas processing plant, associated roads and supporting infrastructure. The information presented in this section was sourced from the Site Sensitivity Verification (**Appendix E**) and various specialist studies (**Appendix F**).

9.3.4.1 DESCRIPTION OF IMPACT

The concept of "sense of place" refers to the unique character, rural identity, visual character, tranquillity, agricultural setting and overall perception of the environment experienced by landowners, farm workers, residents, travellers and visitors. The project area is currently characterised predominantly by agricultural activities, open grassland landscapes, dispersed farmsteads, cultivated fields, grazing lands and relatively low levels of industrial activity, although portions of the broader area are influenced by existing mining activities, existing gas production operations and proposed renewable energy developments. Nuisance impacts may arise through noise, dust, traffic, lighting, visual intrusion, construction activity, increased human presence and other disturbances which alter the existing rural character and perceived quality of the environment.

9.3.4.1.1 ESTABLISHMENT PHASE

During planning and establishment, nuisance impacts may arise from increased site investigations, survey activities, stakeholder engagement, environmental walkdowns, geotechnical investigations and route selection processes.

Although relatively low intensity, landowners and nearby residents may experience:

- Increased vehicle movement on farm roads.
- Presence of survey teams and contractors.
- Temporary increases in noise associated with site investigations.
- Perceived uncertainty regarding future land use changes.
- Concerns regarding the future industrialisation of the rural landscape.

The establishment phase may also create apprehension among residents regarding future changes to the agricultural character of the area and possible visual intrusion associated with energy infrastructure developments.

9.3.4.1.2 CONSTRUCTION PHASE

9.3.4.1.2.1 SEISMIC SURVEYS

Seismic and audio magnetotelluric surveys have the potential to create short-term nuisance impacts due to:

- Movement of vibroseis trucks, AWD equipment and support vehicles.
- Temporary increases in traffic on rural roads.
- Noise generated by survey vehicles and vibration equipment.
- Increased dust generation along access roads.
- Presence of workers and equipment within otherwise quiet agricultural areas.

Although seismic operations are temporary and mobile, residents may perceive the activities as intrusive due to their novelty within the rural environment. Livestock owners may also perceive vibrations and increased activity as disruptive to normal farming operations. However, the impacts are generally short-term and move progressively through the landscape.

9.3.4.1.2.2 PRODUCTION DRILLING

Production drilling introduces a greater level of nuisance than seismic surveys. Potential impacts include:

- Continuous operation of drilling equipment.
- Construction-related noise.
- Increased lighting requirements during certain operational periods.
- Dust generation from vehicle movements.
- Temporary visual prominence of drilling rigs and support infrastructure.
- Increased workforce presence.
- Temporary exclusion zones and site fencing.
- Perceived industrialisation of rural areas.

Drilling rigs may become visually noticeable features within otherwise open agricultural landscapes. Noise generated by drilling equipment may affect nearby farmsteads and alter the perception of rural tranquillity. Increased vehicle movements associated with water supply, waste removal, staff transport and equipment deliveries may also contribute to nuisance impacts.

9.3.4.1.3 CONSTRUCTION PHASE

The construction phase presents the greatest potential for impacts on nuisance levels and sense of place because it involves longer-term infrastructure. Project components that may contribute include:

- Production wellheads.
- Gas gathering pipelines.
- Surface marker infrastructure.
- Maintenance access roads.
- Helium recovery and gas processing plant.
- Compression equipment.
- Product loading infrastructure.
- Flare systems during emergency or maintenance events.
- Increased operational traffic.

Unlike temporary exploration activities, production infrastructure may remain in place for approximately 30 years. The introduction of industrial infrastructure into a predominantly agricultural setting may alter the visual character of the landscape and affect perceptions of rural sense of place. The helium recovery and gas processing plant represents the most significant infrastructure component in terms of visual presence. During construction and operation, nuisance may arise from:

- Construction noise.
- Vehicle movement.
- Lighting during operational periods.
- Visual contrast with surrounding agricultural land.
- Intermittent flaring during commissioning, maintenance or emergency events.
- Perception of industrial encroachment into rural areas.

Although production wells are relatively small and pipelines are underground, the cumulative presence of multiple wellheads and supporting infrastructure may contribute to a gradual transformation of the rural landscape character.

9.3.4.1.4 DECOMMISSIONING AND CLOSURE PHASE

During decommissioning, nuisance impacts may arise from:

- Removal of infrastructure.
- Temporary construction equipment.
- Increased traffic associated with dismantling activities.
- Noise from demolition and rehabilitation equipment.

- Temporary disturbance associated with earthworks and rehabilitation.

These impacts are expected to be temporary and decline as rehabilitation progresses. Once infrastructure has been removed and land rehabilitated, the agricultural character and visual quality of the landscape are expected to recover substantially. The impact ratings associated with the proposed activities related to nuisance and impact on sense of place are indicated in **Table 70**.

9.3.4.2 IMPACT RATING

Table 70: Summary of impacts related to nuisance and impact on sense of place.

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to Low	Low	**Low**
Construction (Seismic Surveys)	Negative	Medium to High	Low	**Low**
Construction (Drilling Activities)	Negative	Medium to High	Medium to Low	**Medium to Low**
Production (Wells, Pipelines and Gas Plant)	Negative	High	Medium to Low	**Medium to Low**
Decommissioning and Rehabilitation	Negative	Medium to Low	Low	**Low**

9.3.4.3 CUMULATIVE IMPACT ASSESSMENT

The broader region already contains or may accommodate multiple infrastructure developments and land uses, including:

- Existing agricultural activities.
- Existing gas exploration and production infrastructure.
- Existing mining activities and infrastructure.
- Existing road and utility infrastructure.
- Approved and proposed renewable energy developments.
- Existing settlements and farmsteads.

The cumulative nuisance and sense of place impact could result from the combined effect of:

- Multiple energy-related developments within the landscape.
- Increased industrial infrastructure visibility.
- Combined traffic generated by gas, renewable energy and agricultural activities.
- Incremental increases in artificial lighting.
- Increased frequency of maintenance and operational activities.
- Visual fragmentation of previously uninterrupted agricultural landscapes.

- Progressive perception of industrialisation within a historically agricultural area.

The potential coexistence of gas production infrastructure and renewable energy developments may contribute to changing perceptions of the area's rural identity. Similarly, the presence of nearby gas infrastructure and existing mining activities may contribute incrementally to visual and experiential landscape transformation.

However, cumulative impacts are moderated by several factors:

- Production wells occupy small footprints.
- Gas gathering pipelines are buried underground.
- Existing agricultural activities will continue across most of the landscape.
- Infrastructure is dispersed across a large area.
- Existing gas operations already occur within parts of the region.
- Renewable energy developments are concentrated within specific areas and do not extensively overlap with all project infrastructure.
- Rehabilitation commitments are included for closure and decommissioning.

Subsequently, cumulative nuisance and impact on sense of place resulting from gas infrastructure, renewable energy developments and agricultural activities was assessed to be Medium to Low.

9.3.4.4 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on nuisance and sense of place due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the same activities in the same region adopted for the proposed activities (**Appendix H**):

- Restrict noisy activities as far as possible to daytime hours between 07:00 and 17:00.
- Provide at least 48 hours' notice to affected landowners prior to commencement of activities.
- Implement dust suppression measures where dust generation may occur.
- Maintain construction periods as short as possible.
- Restrict activities to demarcated project footprints.
- Limit vehicle access to approved routes.
- Implement speed limits of 20 km/h within project areas.
- Maintain regular communication with landowners and adjacent residents.
- Establish and maintain a grievance mechanism and complaints register.
- Investigate and address all nuisance-related complaints.
- Maintain all equipment in accordance with manufacturer specifications to minimise noise emissions.
- Implement viable noise reduction measures where complaints indicate nuisance conditions.
- Use existing roads and disturbed areas wherever possible.
- Position infrastructure within lower sensitivity areas where possible.
- Remove temporary infrastructure following completion of activities.

- Rehabilitate disturbed areas following activities.
- Utilise existing accommodation facilities rather than establishing large on-site camps.
- Feasible and available use of high-efficiency flare systems (≥ 98% to 99.5%) in line with regulatory and engineering standards to minimise visual impacts and noise i.e., ≤ 80–100 dBA at 60 meters (below threshold of pain).

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Minimise the height and visual prominence of aboveground infrastructure where technically and operationally feasible.
- Avoid unnecessary night-time illumination outside operational and safety requirements.
- Regularly maintain project access roads to minimise dust and road deterioration.
- Maintain an accessible grievance mechanism throughout all project phases
- Restrict flaring to commissioning, maintenance and emergency situations.

9.3.5 NOISE IMPACTS

This section presents the identified potential noise impacts associated with the proposed D3 Energy PR activities, taking into consideration the project description, alternatives assessment, environmental baseline, agricultural setting, existing gas infrastructure, planned renewable energy developments and surrounding land uses. The assessment specifically considers noise-generating activities associated with seismic surveys, production well development, gas gathering infrastructure, gas processing facilities and eventual decommissioning activities as per the Noise Impact Assessment Undertaken by Enviro-Acoustic Research (**Appendix F**8).

9.3.5.1 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked with the various activities associated with production, construction and operational phases. Noises emitted by the production, construction and operations can be associated with various noise sources, including mechanical sources due to operation of equipment, material impact noises (such as the noise made when materials are dropped at a height to ground level), electrical noise (reverse hooters from equipment, the “whine” of an electrical pump, etc.) and noises from vehicles moving around. It should be noted that there may not be a clear distinction between construction and operational activities in terms of noise.

As such this noise impact assessment considers conceptual scenarios to estimate the potential impact of noise on the surrounding NSR and the scenarios should not be seen as a reflection of a project schedule or the specific noise levels at receptors at any specific time. While actual activities and average traffic may be significantly less, this assessment considers potential worst-case scenarios as per the precautious principle.

This assessment focused on two potential scenarios, namely:

- Future construction phase, with various noise-generating activities conceptualized to illustrate a potential construction scenario. Both a day- and night-time scenario will be investigated, with equipment operating on ground level (no berms between activities and NSR), with various equipment operating simultaneously (worst-case scenario). This scenario also include borehole drilling as well as vibroseis activities, even though these activities may extent into the operational phase, with activities such as vibroseis starting before the construction activities start. This is a worst-case scenario, and may slightly overmodel noise levels with 1 - 5 dBA; and
- Future noise-generating activities associated with the potential operational phase of the project. Both a day- and night-time scenario will be investigated, considering a worst-case scenario (with power provided by an onsite generator). This is a worst-case scenario, and likely overmodel noise levels with 1 – 5 dBA.

9.3.5.1.1 POTENTIAL DRILLING AND CONSTRUCTION NOISE-GENERATING ACTIVITIES

The level and character of the drilling and construction noise will be highly variable as different activities with different equipment take place at different times, for different periods of time (operating cycles), in different combinations/sequences and on different parts of the construction site. The potential extent and impact of construction noises depend on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral character of the noise and the surrounding soundscape.

Potential maximum noise levels generated by construction equipment and/or activities, as well as the potential extent are presented in **Table 71**. The potential extent depends on a number of factors, including the prevailing ambient sound levels during the instance the maximum noise event occurred, as well as the spectral characteristics of the noise and the ambient soundscape in the surroundings.

Average or equivalent sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the receptor can experience. Typical sound power levels associated with various activities that may be found at a construction site is presented in **Table 72**.

A list of construction equipment and/or activities that was used for the modelling are defined in **Table 73**. Due to the various activities that may take place at different locations, this assessment will use the sound power level (PWL) of potential noise generating activities and equipment taking place at numerous locations to assess a potential worst-case scenario. A description of the various construction noise sources and activities are also discussed in the following subsections. It should be noted that while some of these activities may take place in isolation, there are typically a number of activities that would take place simultaneously, and noise is generally the cumulative effect from multiple activities taking place in the area.

Table 71: Potential maximum noise levels generated by construction equipment (Enviro-Acoustic Research, 2026).

Equipment Description[18]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential maximum noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Backhoe	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Bulldozer	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Gas flare (safety)	No	131.0	106.0	100.0	94.0	86.0	80.0	76.5	74.0	70.5	66.0	62.5	60.0	54.0
Generator	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Pile Driver - Impact	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Mounted Impact Hammer	Yes	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6
Soil Mix Drill Rig	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Tractor	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6

[18]Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Table 72: Potential equivalent noise levels generated by various equipment (Enviro-Acoustic Research, 2026).

Equipment Description	PWL (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	**10 m**	**20 m**	**50 m**	**100 m**	**150 m**	**200 m**	**300 m**	**500 m**	**750 m**	**1000 m**	**2000 m**
Compressor - Main gas	106.8	81.8	75.8	69.8	61.8	55.8	52.3	49.8	46.3	41.8	38.3	35.8	29.8
Drilling - Percussion	120.8	95.8	89.8	83.8	75.8	69.8	66.3	63.8	60.3	55.8	52.3	49.8	43.8
Fans - Air cooled condensers	100.5	75.5	69.5	63.5	55.5	49.5	46.0	43.5	40.0	35.5	32.0	29.5	23.5
General Noise	108.8	83.8	77.8	71.8	63.8	57.8	54.3	51.8	48.3	43.8	40.3	37.8	31.8
Generator - 3 MW G2P	95	70.0	64.0	58.0	50.0	44.0	40.5	38.0	34.5	30.0	26.5	24.0	18.0
Pumps and Valves – Gas	104	79.0	73.0	67.0	59.0	53.0	49.5	47.0	43.5	39.0	35.5	33.0	27.0
Trencher - Tracked	107.1	82.1	76.1	70.1	62.1	56.1	52.6	50.1	46.6	42.1	38.6	36.1	30.1
Vibroseis Truck	109.5	84.5	78.5	72.5	64.5	58.5	55.0	52.5	49.0	44.5	41.0	38.5	32.5

Table 73: Sound power emission levels used for modelling (Enviro-Acoustic Research, 2026).

Equipment	Sound power level, dB re1 pW, in octave band, Hz							PWL
Process	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**(dBA)**
Point noise sources (dBA re 1 pW)								
Compressor - Main gas	77.8	89.9	94.4	101.8	102	100.2	94	106.8
Drilling	95.4	107.2	109.7	112.1	114.2	115.1	112.3	120.8
Fans - Air cooled condensers	79.8	87.9	92.4	94.8	95	93.2	87	100.5
General Noise	68.8	83.9	94.4	101.8	105	101.2	101	108.8

Equipment	Sound power level, dB re1 pW, in octave band, Hz							PWL
Generator - 3 MW G2P	73.4	81.5	85	88.4	89.6	88.8	84.6	95
Pumps and Valves - Gas	67.8	79.9	89.4	97.8	100	98.2	92	104
Trencher - Tracked	81.8	92.9	96.4	100.8	102	101.2	96	107.1
Vibroseis Truck	91.8	98.9	101.4	102.8	104	102.2	97	109.5
Area noise sources (dBA/m^2 re 1 pW)								
General Noise (medium intensity)	95.0	100.0	103.0	105.0	105.0	100.0	100.0	65.0

9.3.5.1.1.1 CONSTRUCTION ACTIVITIES

Typical noise-generating activities associated with onshore development and construction for hydrocarbons and associated gas include vibroseis truck sweeping, well drilling, diesel power generation and heavy construction equipment. High noise-generating activities are:

- Road trucks: The transport of various equipment and material to the project area;
- Vibroseis (Thumper) Truck: A heavy, specialized truck with a large diesel engine that drop a large hydraulic pad onto the ground. The pad vibrates to push a low-frequency acoustic sweep into the earth for around 8 – 20 seconds, creating a loud, localized mechanical hum. This sweep normally repeats this sweep a number of times at the same location, before moving a few meters away to start again. Depending on the terrain and geology, a vibroseis truck can cover 500 – 1,500m per hour;
- Geophone Deployment Vehicles: Minor noises generated by light delivery vehicles (LDV) to lay out and retrieve ground microphones (geophones);
- Drilling activities: Consisting of a diesel engine to power the mechanical top drive that rotates the drill string, one or more mud circulation pumps and a large air compressor. Drilling can take a week or two at one location before moving to a next location.
- Power generation: A drilling site may also require a power generator to power lights and other ancillary equipment;
- Pipe Handling: The physical process of lifting, connecting, and lowering heavy steel casing pipes into the wellbore can cause loud impulsive noises due to metal-on-metal impacts; and
- Reverse alarms: Fitted to all mobile equipment, reverse alarms do not generate high noise levels. This noise are however frequently reported as a source of annoyance if audible at nearby receptors, especially when mobile equipment moves around at night.

9.3.5.1.1.2 CONSTRUCTION ACTIVITIES

Excluding seismic and drilling activities, the following are likely the main noise-generating activities during the construction phase:

- Road trucks: The transport of various equipment and material to the project area;
- Graders, bulldozers or tractor-loader-backhoes (TLB): Site preparation activities to clear any vegetation, stripping of soil (and stockpiling), levelling the surface for site infrastructure and developing access roads;
- TLB or excavators: Digging of foundations, trenches and drainage channels;
- Generators: One or more diesel generators to provide electrical power to various equipment and lights;
- Compressors: Required to drive air-powered equipment;
- TLBs, excavators and dump trucks: Excavation, loading and transport of excess material;
- General noises: Civils relating to the construction of the infrastructure and various material handling noises.

9.3.5.1.1.3 TRAFFIC NOISE

The potential significant source of noise during the construction phase are additional traffic to and from the site, as well as traffic on the site. Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary significantly during the construction period. Noise levels due to traffic were estimated using the methodology stipulated in RLS-90 (Calculating and predicting road traffic noise). For the

purpose of this assessment six (6) each heavy mobile vehicles (HMV) and LDVs per hour are assumed, with the vehicles travelling between the closest provincial road and project areas. All vehicles are travelling at an average speed of 40 km/h (daytime only). It is likely that actual traffic volumes would be less than the assumed traffic volumes or speeds.

9.3.5.1.2 POTENTIAL OPERATIONAL NOISE-GENERATING ACTIVITIES

9.3.5.1.2.1 PLANT ACTIVITIES

The typical noise-generating activities associated with an operational hydrocarbon and helium processing plant include gas to power generation, gas compression, cooling fan operation, and large centrifugal pumping. Unlike the temporary to short-term noises audible during the construction phase, a processing plant creates a permanent, 24/7 continuous industrial acoustic profile. A list of potential equipment (and activities) that were used for noise modelling are defined in **Table 69**, with this assessment considering a potential worst-case scenario (various noise generating activities taking place simultaneously, considering typical PWL of equipment, excluding the potential shielding effect from containerized activities/equipment). Main noise generating activities are:

- Generators: A generator to provide electrical power to various plant equipment, with noise generated by the reciprocating engine, exhaust noises, air intake and cooling system;
- Compressors (Reciprocating and/or Centrifugal): Machines that compress gas to ultra-high pressures that can generate a continuous, low-frequency noise. Compressors are fitted with industrial electric motors or gas-fired turbines that cumulative add to noise levels;
- Coolers – Fan fin or air-cooled condensers: Normally a bank of fans (and electric motors) containing numerous individual fans that generate mechanical hum and aerodynamic noises;
- Valves: When high-pressure gas passes through a constriction valve, it creates intense aerodynamic turbulence (a continuous rushing sound audible from piping);
- Pumps: Required to move liquid natural gas (LNG), condensed hydrocarbons, and cooling water;
- Plant Logistics: The regular movement of heavy fluid transport trucks, maintenance vehicles, and nitrogen/helium ISO-container trucks introduces localized reverse alarms and heavy diesel engine noise.

As with all noises, the audibility, as well as the potential of a noise impact on receptors, is determined by factors such as the sound character, spectral frequencies, number and magnitude of maximum noise events, the average noise levels etc. Potential maximum noise levels generated by a range of equipment and the potential extent of these sounds are presented in **Table 71**, with **Table 72** illustrating the equivalent (average) noise levels and potential extent.

9.3.5.1.2.2 TRAFFIC NOISE

A source of noise during the operational phase will be traffic to and from the plant, traffic around the infrastructure facilities and product transport. While trucks moving around on the site do have a clearly audible noise during passing, the average noise contribution during the day is relatively low compared to the other noise sources. For the purpose of this assessment 12 heavy mobile vehicles (HMV) and six LDVs per hour are assumed, with the vehicles travelling between the closest provincial road and plant areas. All vehicles are travelling at an average speed of 40 km/h (daytime only). It is likely that actual traffic volumes would be less than the assumed traffic volumes or speeds.

9.3.5.1.3 POTENTIAL NOISE SOURCES: FUTURE NOISE SCENARIO – DECOMMISSIONING

The Decommissioning Phase is considered as the phase which begins when insufficient gas are available to economically continue the processing plant. Activities that can take place include:

- Decommissioning and rehabilitation of the remaining infrastructure unless it is required for post-project impact management or for the final end land use. This includes the following:
    - Removal of all remaining redundant infrastructure;
    - Removal of any contaminated soil;
    - The rehabilitation of disturbed areas including the necessary ripping of compacted soils and the shaping of rehabilitated areas to ensure free drainage;
    - Placement of topsoil on rehabilitated surface areas followed by seeding (if necessary to re-establish vegetation);
    - Monitoring and maintenance of the rehabilitated areas.

However, while there are numerous activities that can take place during the decommissioning stage, the potential noise impact will only be discussed in general. This is because the noise impacts associated with the decommissioning phase is normally significantly less than both the construction and operational phases for the following reasons:

- Final decommissioning normally takes place only during the day, a time period when existing ambient sound levels are higher, generally masking most external noises for surrounding receptors; and
- There is a lower urgency of completing this phase and less equipment remains onsite (and are used simultaneously) to affect the noise levels during decommissioning.

9.3.5.2 PROJECTED NOISE RATINGS

9.3.5.2.1 CONCEPTUAL FUTURE SCENARIO – NOISE FROM CONSTRUCTION DRILLING AND SEISMIC ACTIVITIES

Noise will be generated during the production phase from:

- Site preparation activities (removing vegetation);
- Drilling;
- Seismic surveys;
- Transportation of equipment, people and drill core samples; and
- Trenching and pipeline installations.

Of the various construction activities, drilling and seismic were investigated in more detail, because these activities could generate significant noise and would take place at numerous locations as illustrated in **Figure 104**. Potential noise levels associated with seismic surveys (over the larger area) were estimated with the noise levels presented per NSR in **Table 74**. Potential noise levels associated with borehole drilling activities were estimated with the noise levels presented per NSR in **Table 75**.

Noise models were developed considering various construction activities as discussed in **Section 9.3.5.1.1** and conceptualised in **Figure 105**. As various activities should not be considered in isolation, certain activities are grouped to allow the calculation or estimation of the potential cumulative noise levels. The projected worst-case construction noise rating levels (various simultaneous activities) are illustrated in **Figure 106** and defined per NSR in ***Appendix C, Table 1*** for the daytime period, with the findings relevant for all alternatives.

9.3.5.2.2 CONCEPTUAL FUTURE SCENARIOS – NOISE FROM OPERATIONAL ACTIVITIES

Noise models were developed considering the conceptual operational activities as discussed in **Section 9.3.5.1.2** and conceptualised in **Figure 107**. This assessment only focusses on the potential plant activities for the operational phase. The scenario was selected to illustrate potential worst-case noise rating levels, at the same time assisting in defining (and illustrating) the effect of worst-case noise emissions from the project. The projected operational noise rating levels are illustrated in:

- **Figure 107** and defined per NSR for the daytime period *Appendix C, Table 2* of **Appendix F8**; and
- **Figure 108** and defined per NSR in *Appendix C, Table* 3 **of Appendix F8** for the night-time period.

9.3.5.2.3 POTENTIAL DECOMMISSIONING AND CLOSURE NOISE LEVELS

The potential for a noise impact to occur during the decommissioning and closure phase will be much lower than that of the construction and/or operational phases. This is because:

1. Decommissioning activities normally are limited to the daytime period, due to the lower urgency to complete this phase; and
2. Decommissioning activities normally use smaller and less equipment, generating less noise than the typical construction or operational phases.

If required, the noise levels for decommissioning can be compared with the daytime construction phase noise rating levels, and the noise impact are similar or less.

9.3.5.2.4 POTENTIAL POST-CLOSURE NOISE LEVELS

The potential for a noise impact to occur during the post-closure phase will be minimal and mainly relate to monitoring activities. The noise impact from this phase will not be investigated further.

9.3.5.2.5 EVALUATION OF ALTERNATIVES

Alternatives considered as part of the noise impact assessment were as follows (discussed in detail in **Section 6**):

- Activity alternatives;
- Location alternatives (including design and layout);
- Technology/Process alternatives;
- Design and Layout alternatives; and
- The No Action alternative (No-go Alternative).

Table 74: Potential noise levels at NSR locations due to vibroseis survey activities (Enviro-Acoustic Research, 2026).

Receptor	Distance between NSR and survey location (m)	Potential Noise Level (dBA)	Comments
NSR04	15	75.5	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR05	129	56.8	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR06	210	52.6	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR07	510	44.9	Far from drilling activities, though near proposed seismic line
NSR10	319	48.9	NSR within 350m from seismic line, and near borehole
NSR11	427	46.4	NSR within 500m from seismic line, and 745m from borehole
NSR12	562	44.0	NSR within 500m from seismic line, further than 1,000m from borehole
NSR13	402	46.9	NSR within 500m from seismic line, further than 1,000m from borehole
NSR16	82	60.7	Use not verified (access limitation). Near seismic line and proposed boreholes
NSR17	306	49.3	NSR within 500m from seismic line, and 922m from borehole. Structure appears unused.
NSR18	550	44.2	NSR within 500m from seismic line, and 550m from borehole
NSR21	312	49.1	NSR within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.
NSR22	40	67.0	Location not noise-sensitive. within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.
NSR23	144	55.8	NSR within 500m from seismic line, further than 900m from borehole
NSR24	240	51.4	NSR within 500m from seismic line, further than 900m from borehole
NSR25	233	51.7	NSR within 500m from seismic line, further than 1000m from borehole
NSR27	171	54.3	Location within 500m from seismic line, further than 1000m from borehole. Site not noise-sensitive
NSR35	121	57.4	Location near seismic line, though structure not used for noise-sensitive activities

Receptor	Distance between NSR and survey location (m)	Potential Noise Level (dBA)	Comments
NSR36	669	42.5	NSR further than 500m from seismic line and boreholes

Table 75: Potential noise levels at NSR locations due to nearby drilling activities (Enviro-Acoustic Research, 2026).

Receptor	Distance between NSR and survey location (m)	Potential Noise Level (dBA)	Comments
NSR01	3984	32.0	Far from project activities, noise levels will be low through all phases
NSR02	3061	34.3	Far from project activities, noise levels will be low through all phases
NSR03	2983	34.5	Far from project activities, noise levels will be low through all phases
NSR04	2739	35.3	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR05	2471	36.2	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR06	2585	35.8	Near potential seismic line, though site visit indicated no noise sensitive activities at area.
NSR07	1734	39.2	Far from drilling activities, though near proposed seismic line
NSR08	1462	40.7	Further than 1,000m from seismic line or proposed boreholes
NSR09	1412	41.0	Further than 1,000m from seismic line or proposed boreholes
NSR10	748	46.5	NSR within 350m from seismic line, and near borehole
NSR11	745	46.6	NSR within 500m from seismic line, and 745m from borehole
NSR12	1060	43.5	NSR within 500m from seismic line, further than 1,000m from borehole
NSR13	1197	42.4	NSR within 500m from seismic line, further than 1,000m from borehole
NSR14	465	50.7	Use of structures not noise-sensitive
NSR15	1240	42.1	NSR location not verified, far from project infrastructure

Receptor	Distance between NSR and survey location (m)	Potential Noise Level (dBA)	Comments
NSR16	435	51.2	Use not verified (access limitation). Near seismic line and proposed boreholes
NSR17	922	44.7	NSR within 500m from seismic line, and 922m from borehole. Structure appears unused.
NSR18	550	49.2	NSR within 500m from seismic line, and 550m from borehole
NSR19	2226	37.1	Further than 1,000m from seismic line or proposed boreholes
NSR20	2387	36.5	Further than 1,000m from seismic line or proposed boreholes
NSR21	917	44.8	NSR within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.
NSR22	803	45.9	Location not noise-sensitive. within 500m from seismic line, and 917m from borehole. Traffic may pass close to house.
NSR23	978	44.2	NSR within 500m from seismic line, further than 900m from borehole
NSR24	973	44.2	NSR within 500m from seismic line, further than 900m from borehole
NSR25	1058	43.5	NSR within 500m from seismic line, further than 1000m from borehole
NSR26	2024	37.9	Further than 1,000m from seismic line or proposed boreholes
NSR27	950	44.5	Location within 500m from seismic line, further than 1000m from borehole. Site not noise-sensitive
NSR28	2786	35.1	NSR further than 1,000m from seismic line or borehole
NSR29	3173	34.0	NSR further than 500m from seismic line and further than 1,000m from borehole
NSR30	2938	34.6	NSR further than 500m from seismic line and further than 1,000m from borehole
NSR31	3864	32.3	NSR further than 500m from seismic line and further than 1,000m from borehole
NSR32	3665	32.7	NSR further than 1,000m from seismic line or borehole
NSR33	3651	32.8	NSR further than 1,000m from seismic line or borehole
NSR34	2991	34.5	NSR further than 1,000m from seismic line or borehole

Receptor	Distance between NSR and survey location (m)	Potential Noise Level (dBA)	Comments
NSR35	637	47.9	Location near seismic line, though structure not used for noise-sensitive activities
NSR36	650	47.7	NSR further than 500m from seismic line and boreholes
NSR37	3122	34.1	NSR further than 1,000m from seismic line or borehole

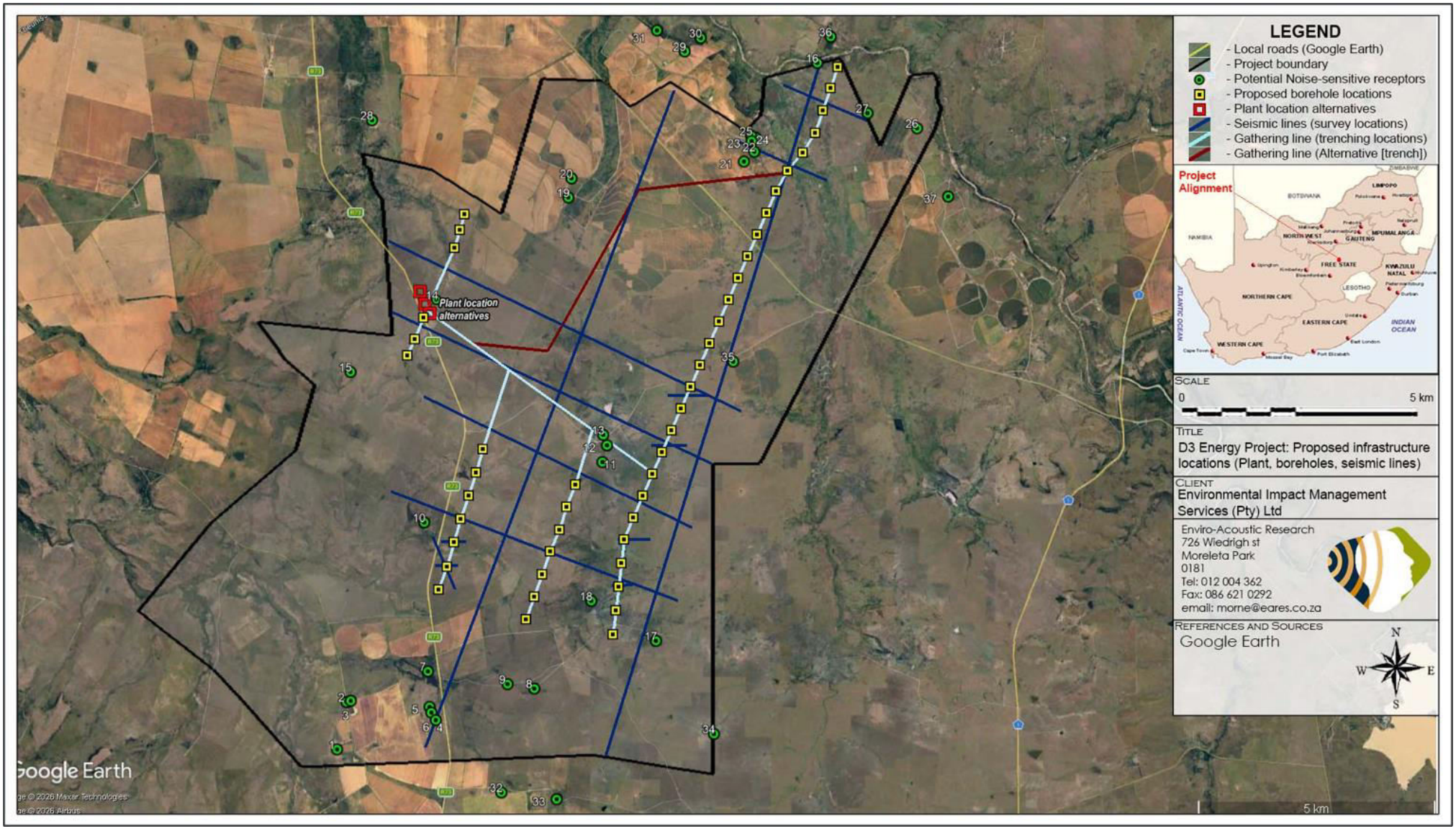


Figure 104: Infrastructure where noise generating activities could take place (Enviro-Acoustic Research, 2026).

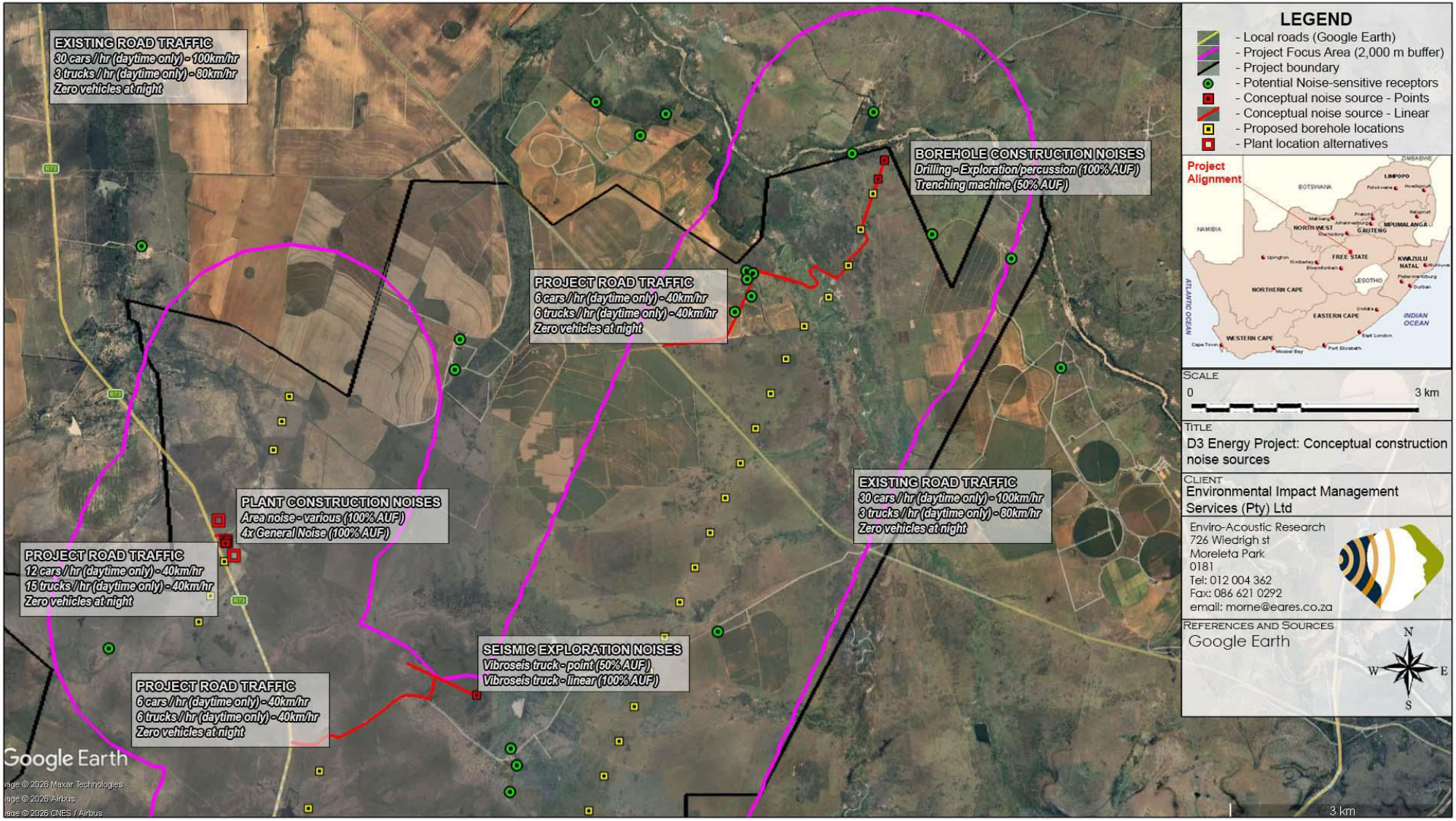


Figure 105: Conceptual noise-generating activities considered for construction activities (Enviro-Acoustic Research, 2026).

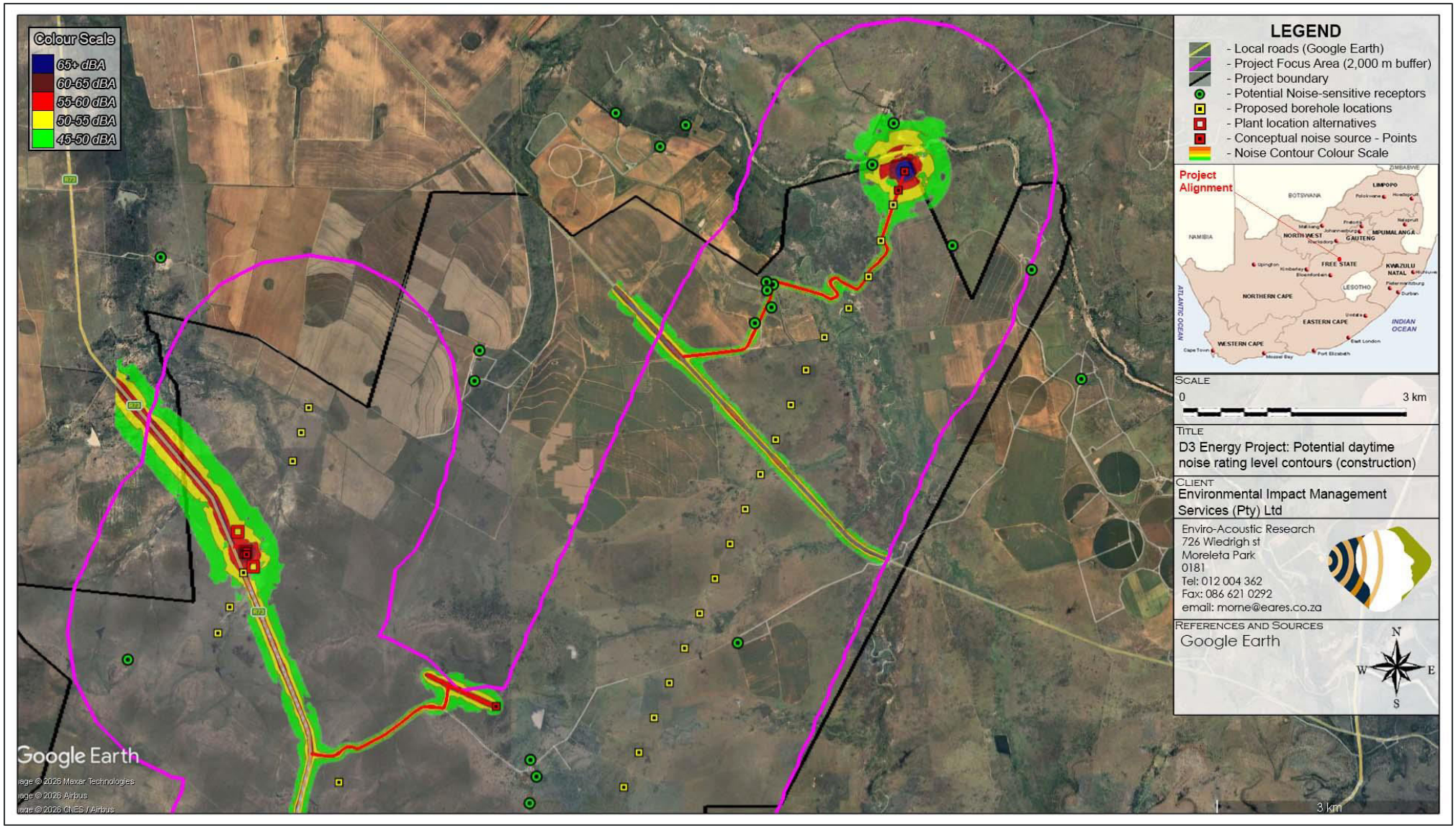


Figure 106: Projected daytime noise rating levels relating to the construction phase (Enviro-Acoustic Research, 2026).

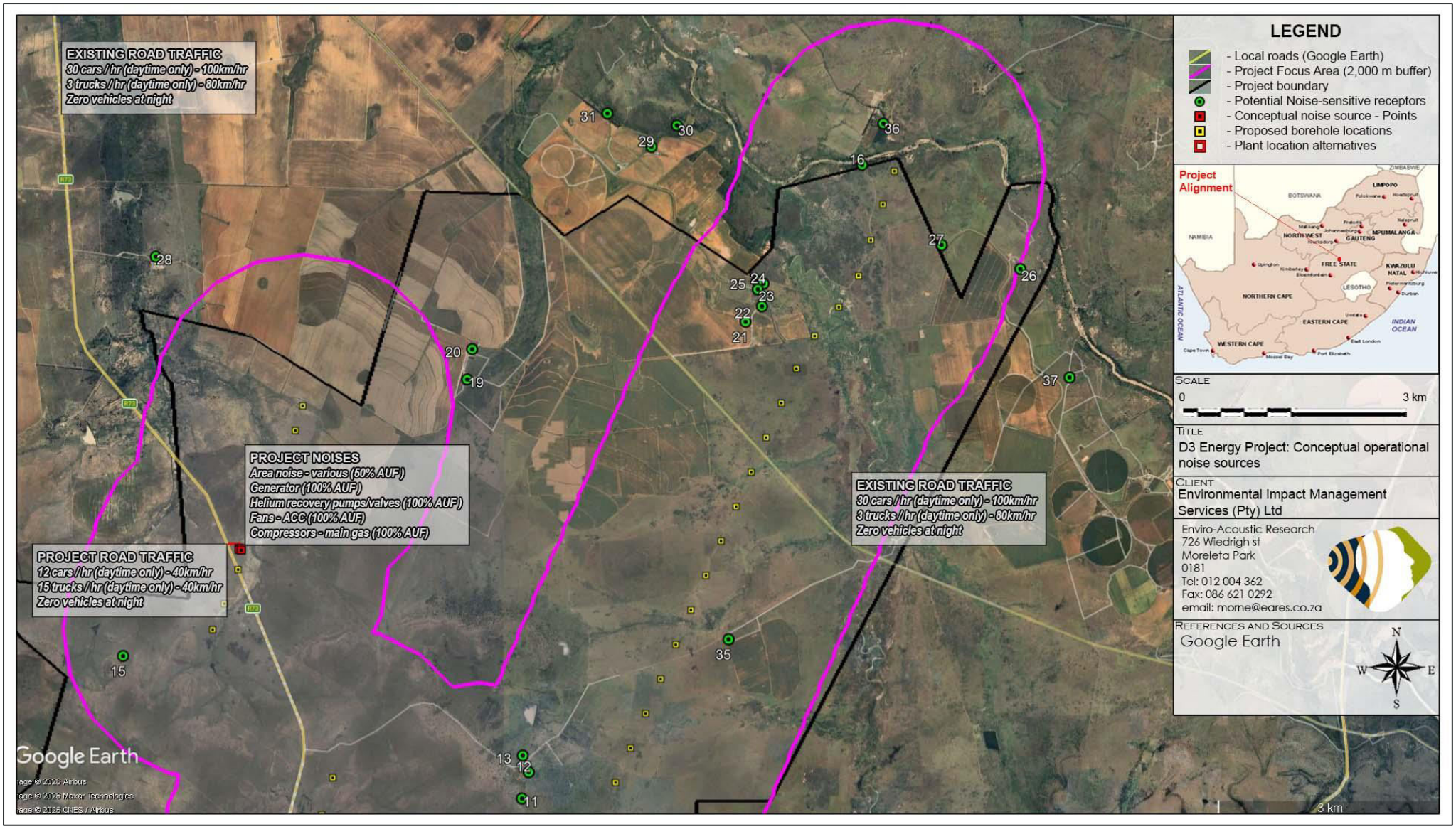


Figure 107: Conceptual noise-generating activities considered for the operational phase (Enviro-Acoustic Research, 2026).

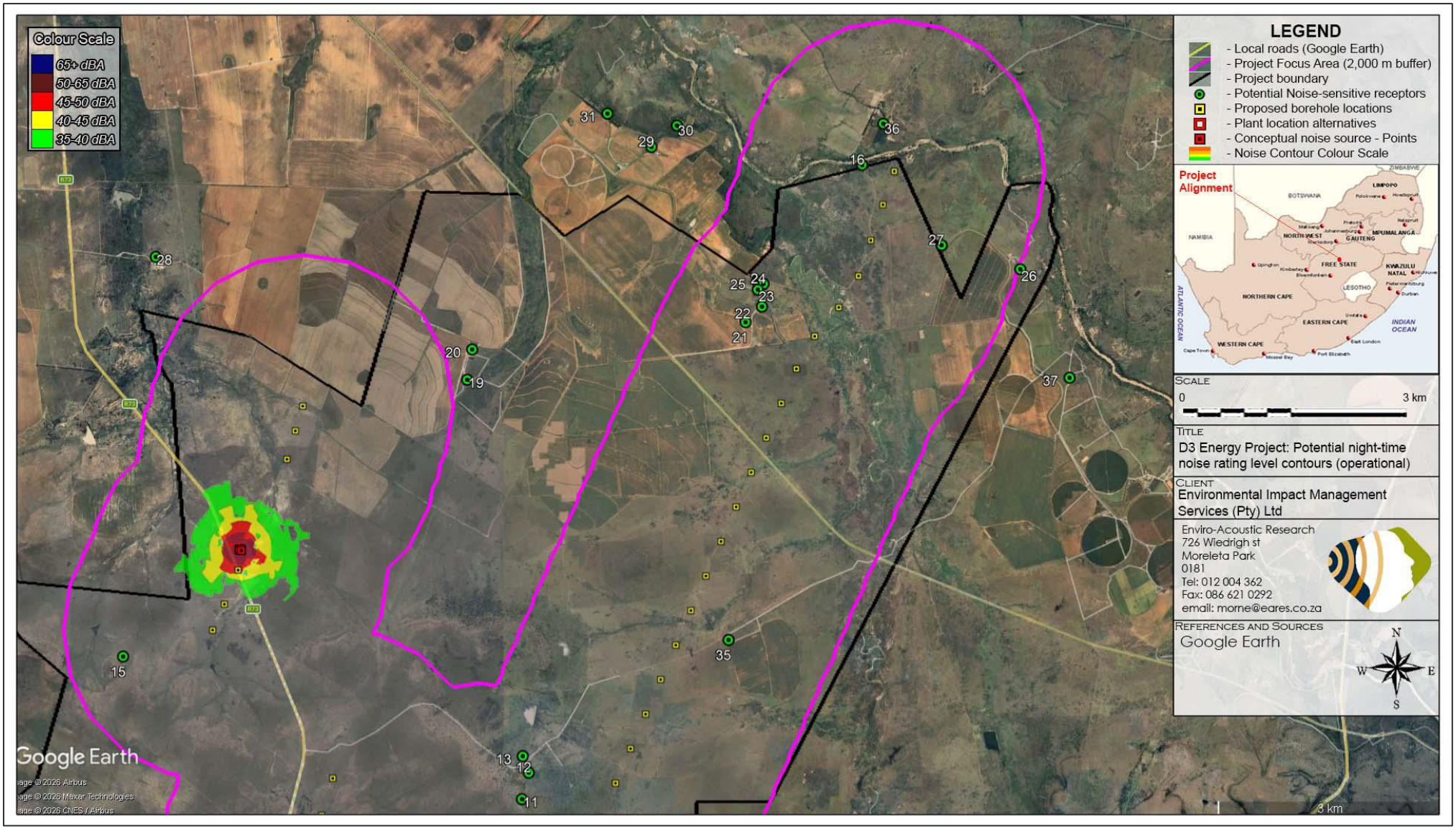


Figure 108: Projected night-time noise rating levels – conceptual operational activities (Enviro-Acoustic Research, 2026).

9.3.5.3 IMPACT RATING

The impact ratings associated with the proposed activities related to noise impacts are indicated in **Table 76.**

Table 76: Summary of impacts related to noise impact (Enviro-Acoustic Research, 2026).

Impact	Phase	Event	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance	Cumulative Impact
Daytime transport of people, equipment, material and drilling cores	Mobilisation	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Daytime transport of people, equipment, material and drilling cores	Construction	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Various daytime site preparation activities raising noise levels	Construction	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Seismic surveys raising noise levels during the day	Construction	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Trenching activities raising noise levels during the day	Construction	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Daytime drilling of boreholes (drilling, generator, compressor)	Construction	Normal operations or events	Medium to low -	Low -	Low -	Medium to Low -
Daytime drilling of boreholes (drilling, generator, compressor)	Operation	Normal operations or events	Medium to low -	Low -	Low -	Medium to Low -
Daytime transport of people, equipment, material and product	Operation	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Night-time transport of people, equipment, material and product	Operation	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Daytime plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	Low -	Low -	Low -	Medium to Low -

Impact	Phase	Event	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance	Cumulative Impact
Night-time plant operations (generator, compressors, fans, etc.)	Operation	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Emergency release or flaring of gas	Operation	Abnormal or unplanned events	Medium to low -	Medium to low -	Medium to low -	Medium to Low -
Dismantling of equipment and infrastructure (daytime)	Decommissioning	Normal operations or events	Low -	Low -	Low -	Medium to Low -
Rehabilitation activities (daytime)	Rehab and Closure	Normal operations or events	Low -	Low -	Low -	Medium to Low -

9.3.5.4 CUMULATIVE IMPACT ASSESSMENT

The cumulative impact associated with noise must be considered within the broader regional development context. The project area is already influenced by:

- Existing Tetra4 and other gas exploration and production activities.
- Existing agricultural cultivation and grazing operations.
- Farm machinery and agricultural vehicle movement.
- Existing mining-related activities within the broader area.
- Existing road traffic along regional and farm roads.
- Existing game farming and tourism activities.
- Existing and planned renewable energy developments, particularly solar PV facilities and supporting infrastructure.

Potential cumulative noise effects include:

- Simultaneous drilling activities occurring at multiple locations.
- Overlap between seismic surveys and agricultural activities.
- Combined traffic noise from gas, mining and renewable energy projects.
- Increased frequency of heavy vehicle movements on shared access roads.
- Concurrent construction activities associated with renewable energy projects.
- Multiple industrial noise sources contributing to changes in rural soundscapes.
- Increased disturbance at sensitive rural residences.

However, cumulative significance is moderated by:

- The dispersed nature of wells across the production right area.
- Temporary and phased implementation of development activities.
- Large separation distances between the gas processing plant and most receptors.
- Existing industrial and agricultural noise already present in parts of the receiving environment.
- The temporary nature of seismic activities and drilling programmes.
- Rehabilitation and restoration following project completion.
- The ability to coordinate construction schedules between developments.

While cumulative changes to the rural acoustic environment are expected, they are not anticipated to result in unacceptable long-term degradation of the regional noise environment provided appropriate mitigation and scheduling measures are implemented. Cumulative effects are expected to be insignificant, because noise does not contribute to other noises generated at other locations located further than 2,000m from a noise-generating activity. Therefore, the overall cumulative impact rating was assessed to be Medium to Low negative.

9.3.5.5 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 same 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 or Sunday which must be agreed upon between the affected parties and the Contractor.
- The contractor must attempt to restrict noisy activities as far as is possible to times and locations whereby the potential for noise nuisance is reduced. Noise producing activities must be limited to daytime after 07h00 and 17h00 on weekdays. A minimum of a 48-hour notice period is required to the landowner and directly adjacent landowners prior the activities.
- 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.
- All residents within 2 km of drilling activities and 1 km of seismic surveys should be informed regarding the 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.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Install temporary acoustic screens around drilling equipment where sensitive receptors occur within 1 km.
- Conduct periodic noise monitoring during drilling near occupied residences.

9.3.6 IMPACTS ON AIR QUALITY

This impact assessment evaluates the potential impacts on ambient air quality associated with the proposed D3 Energy PR project, including seismic surveys, production wells, gas gathering pipelines, helium recovery and gas processing facilities, gas-to-power generation infrastructure and associated support activities. The assessment is based on the findings of the D3 Energy Air Quality Impact Assessment undertaken by Airshed Planning Professionals (**Appendix F1**) together with the project description, alternatives assessment and baseline conditions. The project area is located within a predominantly agricultural landscape containing dispersed farmsteads, nearby residential receptors, existing gas operations, mining activities and planned renewable energy developments. Air quality-sensitive receptors include individual farmsteads, residential areas associated with Virginia, Meloding, Calabria, and surrounding mining residential areas.

9.3.6.1 SUMMARY OF EMMISSIONS

As per the AQIA (**Appendix F1**), Construction of the wells and the plant would result in PM emissions. Fugitive emissions are the dominant source of Volatile organic compounds (VOCs) emissions. VOC emissions during the construction phase (well drilling, testing and servicing operation) are estimated to be 10 tonnes per annum (tpa). Once the wells have been drilled, estimated VOC emissions during production, gathering and processing amount to 101 tpa, versus the 0.86 tpa from the combustion emissions. The majority of these emissions (100 tpa) are from venting, with 11 tpa from leaks and 0.1 tpa from flaring.

For the combustion emissions, the pollutant with the maximum emissions is NO_2, mostly from the combustion of natural gas in the power plant (84% of the total 15.7 tpa emissions). For the combustion emissions, the PM_{10} emissions are split between vehicles and drill rigs at the wells (0.11 tpa) and stationary combustion sources at the plant (0.08 tpa). Other gas exploration and production activities in the Free State Province include Tetra4 (production) as well as Rhino Oil and Gas (exploration) accounted in this assessment are indicated in **Table 77**.

Table 77: Cumulative emissions (Airshed Planning Professionals, 2026).

Company	Type of right	PM emissions (tpa)	VOC emissions (tpa)	NO_2 emissions (tpa)	Number of wells	Gas processed or produced/year (million m^3)
D3 Energy ER315 and PR16	Exploration and production	0.2	112	16	43	32
Tetra4	Exploration and production	11.5	264	49	300	204
D3 Energy ER386	Exploration	0.4	3.8	5.7	3	NA
Rhino Oil and Gas ER377	Exploration	unknown	unknown	unknown	20	NA
Rhino Oil and Gas ER378	Exploration	-	3.5	5.8	20	NA
Total	-	**12.1**	**383**	**76.5**	-	-

9.3.6.2 DISPERSION SIMULATION RESULTS AND COMPLIANCE ASSESSMENT

Pollutants with the potential to result in human health impacts which are assessed in this study include PM_{10}, NO_2 and VOC. Dispersion simulations were undertaken using the AERMOD dispersion model and results are presented as isopleth plots. The ground level concentrations are screened against the NAAQS and VOC comfort levels.

9.3.6.2.1 CONSTRUCTION ACTIVITIES

The construction site for the each well was assumed to be 50 m x 50 m for equipment movement and setup. The construction site for the plant was assumed to be 150 m x 150 m. Option C was selected as it is the closest option to the nearest AQSRs. Daily PM_{10} NAAQs are exceeded in the vicinity of the construction sites, but not at any of the nearest AQSRs (**Figure 109**).

9.3.6.2.2 WELL ACTIVITIES (FUGITIVE)

It was assumed that the well activities would occur at the wells (maximum 11 in a given year). The simulated annual NMVOC ground level concentrations due to wells are illustrated in **Figure 110**. The annual NMVOC concentrations are well below the comfort level of 200 µg/m³.

9.3.6.2.3 PRODUCTION ACTIVITIES (FUGITIVE AND COMBUSTION)

Stack parameters used in the dispersion model for the point sources are provided in **Table 78**.

Table 78: Point source stack parameters (Airshed Planning Professionals, 2026).

Point source	Stack height (m)	Stack diameter (m)	Temperature (°C)	Velocity (m/s)
Diesel generator	3	0.2	465	77
Gas 3MW power plant	5	0.6	425	12

9.3.6.2.3.1 NMVOC IMPACT

It was assumed that the gas production and gathering would be distributed over all the active wells (maximum 43 in a given year), and that the gas processing would happen at the plant. The plant would also be the location for the diesel generator and the gas power plant. The simulated annual NMVOC ground level concentrations due to production, gathering and processing activities as well as fuel combustion processes are illustrated in **Figure 111**. The annual NMVOC concentrations are well below the comfort level of 200 µg/m³.

Even conservatively assuming all the VOCs are benzene, the annual NAAQS for benzene of 5 µg/m³ would not be exceeded at the nearest sensitive receptor.

9.3.6.2.3.2 NO2 IMPACT

The simulated ground level concentrations due to the gas power plant are illustrated in **Figure 112**. Option C was selected as the site to be simulated as it is the closest option to the nearest AQSRs. The maximum hourly ground level concentration of 60 µg/m³ in the vicinity of the plant is well below the hourly NAAQS of 200 µg/m³.

9.3.6.2.3.3 PM10 IMPACT

It was assumed that the mobile combustion sources would be distributed over all the active well areas (maximum 43 in a given year). The simulated ground level concentrations due to the combustion sources (both mobile and stationary) and fugitive sources are illustrated in **Figure 113**. The maximum daily ground level concentrations are well below the daily NAAQS of 75 µg/m³. A summary of the impacts at the nearest AQSRs is given in **Table 79**. It was conservatively assumed that all VOCs are benzene. In reality benzene concentrations would be much lower.

Table 79: Simulated concentrations at the nearest AQSR (Airshed Planning Professionals, 2026).

Phase	PM_{10} 99th daily percentile (µg/m³)	NO_2 99th hourly percentile (µg/m³)	VOC annual average (µg/m³)	Benzene annual average (µg/m³)
Construction	10	-	-	-
Seismic	-	-	<1	<1
Operation (plant and wells)	0.005	4.5	2	2
NAAQS/Guideline	**75**	**200**	**200**	**5**

There are no official, specific ambient PM_{10} concentration thresholds set by South African legislation to protect crop yields or livestock. Field observations and global agricultural research show that crops begin experiencing physical and chemical stress when ambient PM_{10} levels consistently exceed standard human health guidelines. As the simulated PM_{10} impacts are compliant with NAAQS at the nearest receptors, no significant impact is anticipated for livestock or crops.

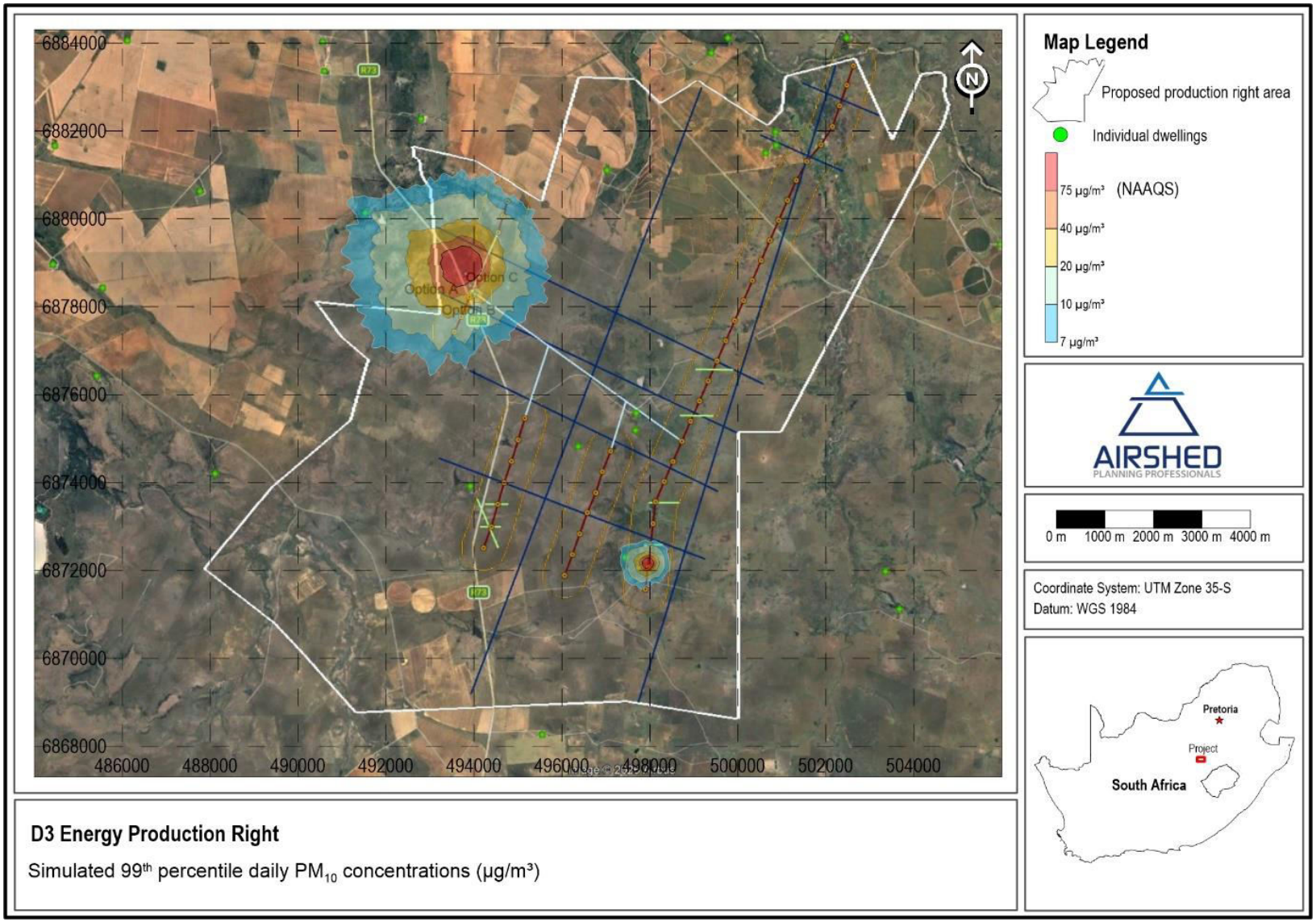


Figure 109: Simulated 99th percentile daily PM_{10} ground level concentrations due to construction activities (Airshed Planning Professionals,2026).

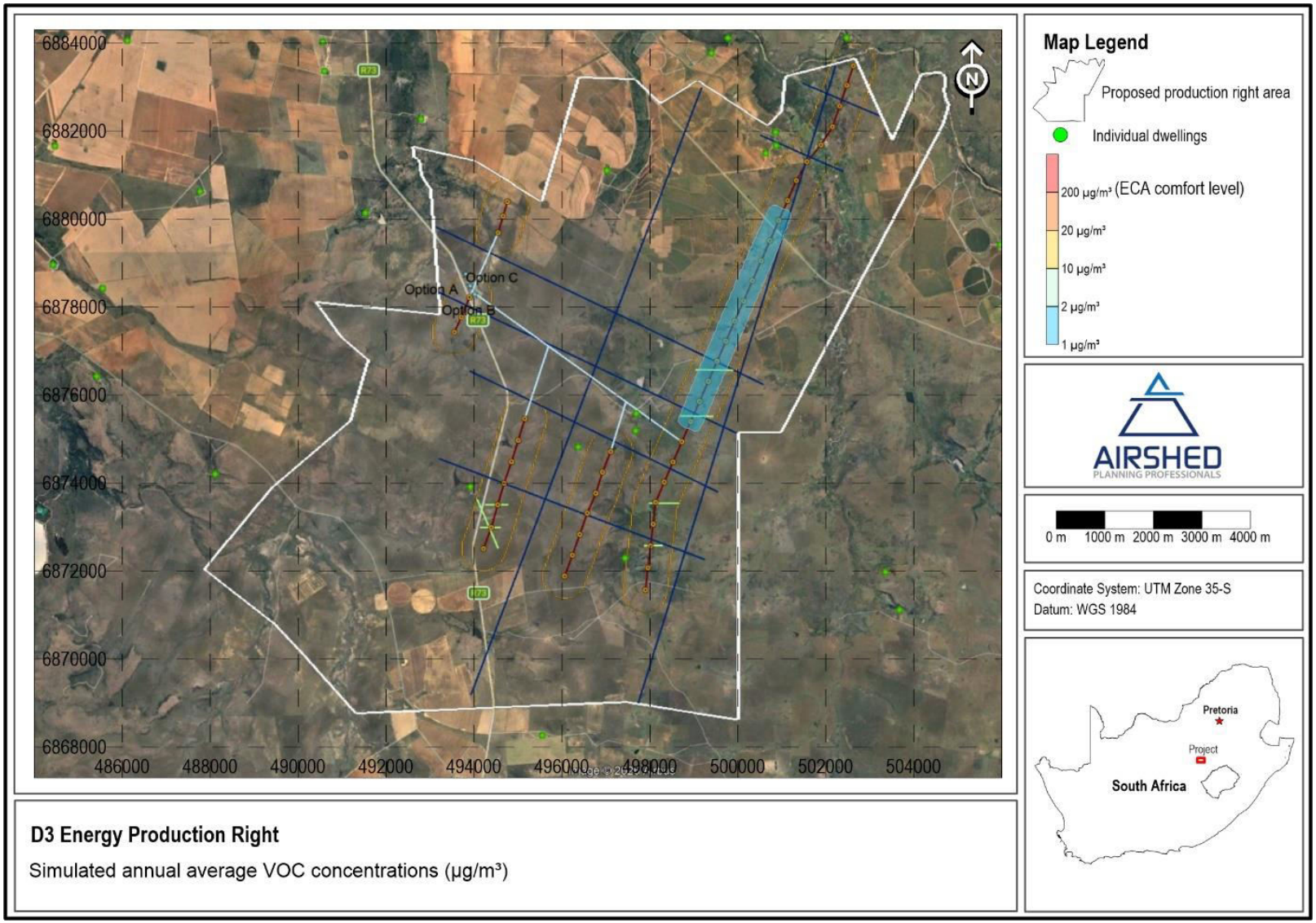


Figure 110: Simulated annual average VOC ground level concentrations due to well activities (Airshed Planning Professionals,2026).

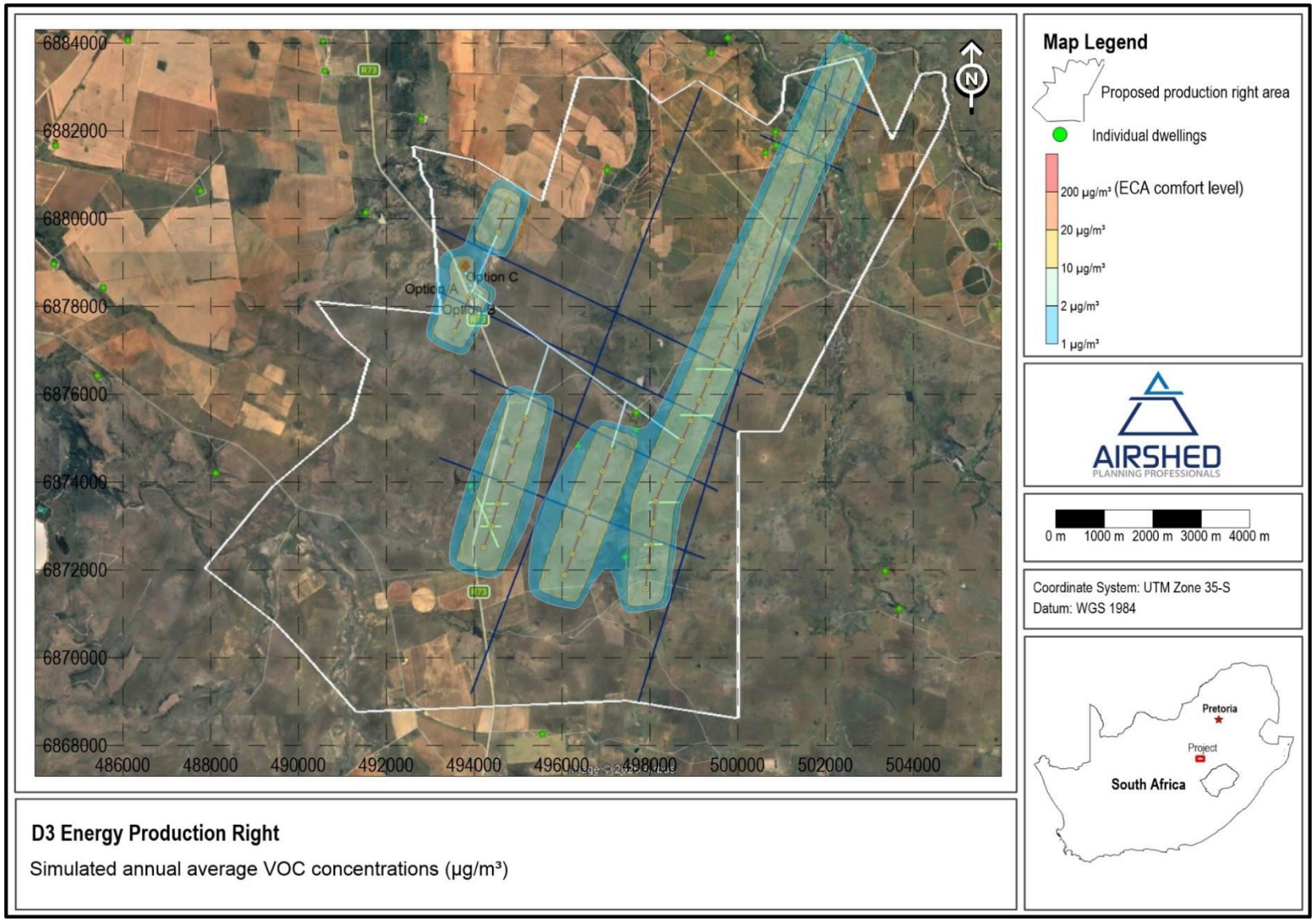


Figure 111: Simulated annual average VOC ground level concentrations due to fugitive and combustion activities (Airshed Planning Professionals,2026).

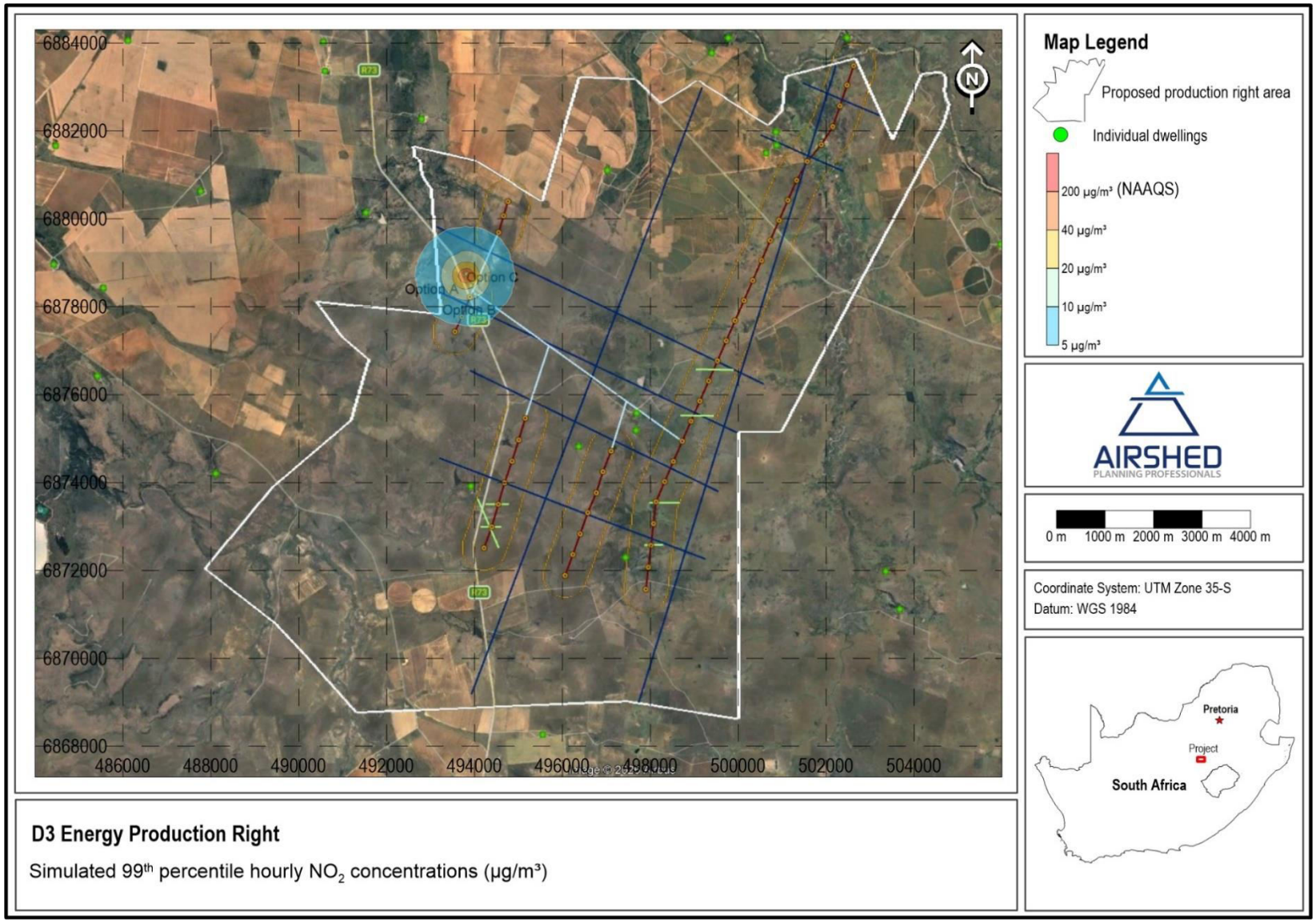


Figure 112: Simulated 99th percentile hourly NO_2 ground level concentrations due to combustion activities (Airshed Planning Professionals,2026).

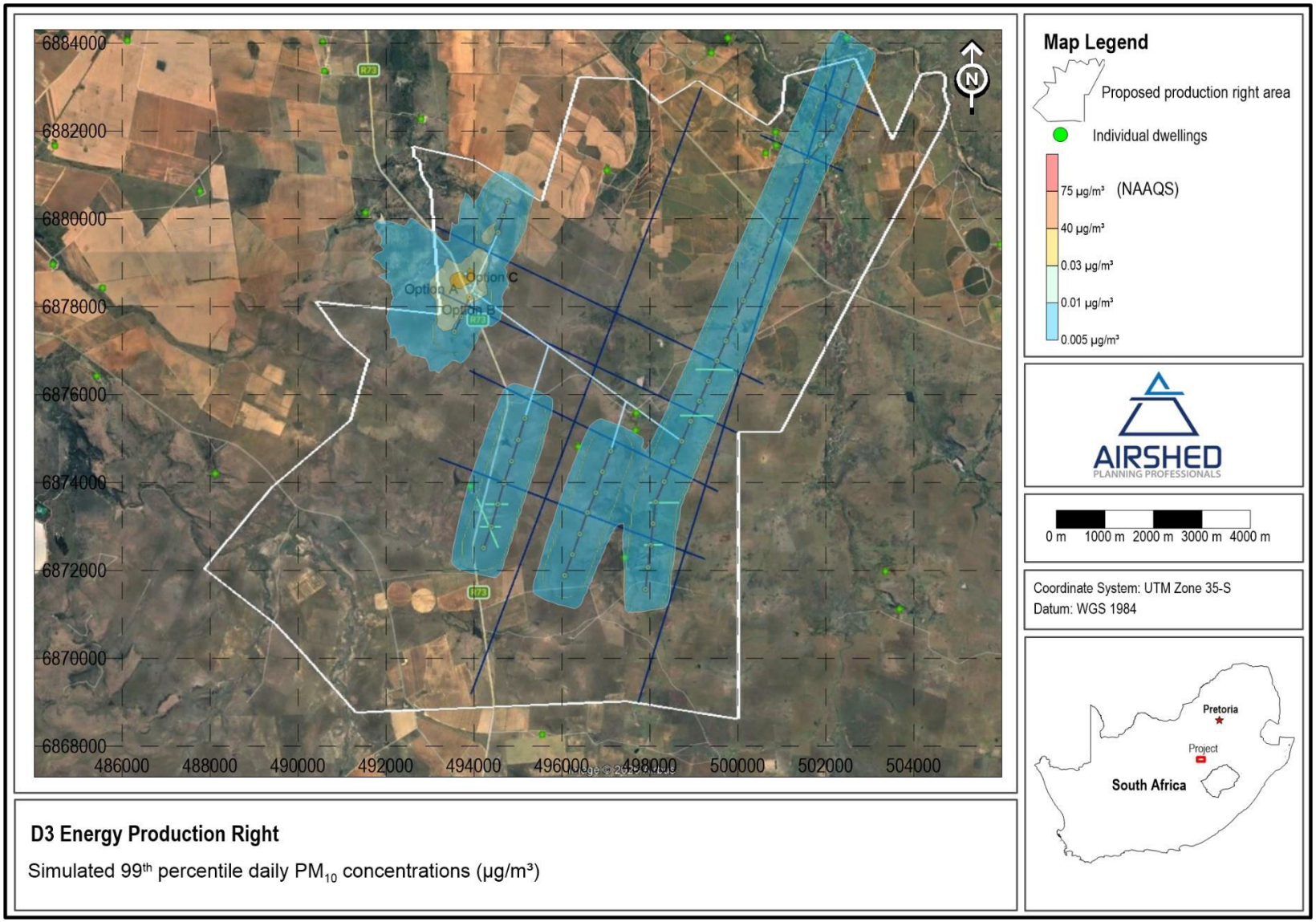


Figure 113: Simulated 99th percentile daily PM_{10} ground level concentrations due to combustion activities (Airshed Planning Professionals,2026).

9.3.6.3 DESCRIPTION OF IMPACT

Air quality impacts associated with the proposed project may occur through the generation of particulate matter (PM_{10} and $PM_{2.5}$), dust fallout, combustion-related pollutants (NOx, NO_2, CO and SO_2), volatile organic compounds (VOCs), fugitive gas emissions, odorous compounds and emissions associated with abnormal operating conditions. The severity and nature of impacts vary across the project lifecycle and depend on atmospheric conditions, prevailing wind direction, receptor proximity, operational activities and emission control measures. Meteorological analysis indicates that the project area is dominated by north-easterly winds with relatively stable atmospheric conditions during certain nighttime periods, which may influence pollutant dispersion.

For purposes of the assessment, air quality impacts are divided into:

- Impacts during Normal Operations.
- Impacts during Abnormal Events and Emergency Conditions.

9.3.6.3.1 ESTABLISHMENT PHASE

9.3.6.3.1.1 NORMAL OPERATIONS

During establishment and site preparation activities, air quality impacts are expected to arise mainly from vegetation clearing, site grading, movement of construction machinery and increased traffic on farm roads and access roads.

Potential emissions sources include:

- Land clearing and topsoil stripping.
- Earthworks and pad preparation.
- Construction traffic.
- Movement of heavy vehicles on unpaved roads.
- Material handling and storage.
- Temporary laydown areas.

The primary pollutant during this phase is particulate matter (PM_{10} and $PM_{2.5}$) generated through dust entrainment and exposed soil surfaces. The Air Quality Impact Assessment predicts that daily PM_{10} concentrations may temporarily exceed the PM_{10} National Ambient Air Quality Standard (NAAQS) within localized areas surrounding construction sites. Specifically, exceedances are predicted within an area of approximately 1 km × 1 km around the proposed plant footprint and up to 130 m from individual drill/well sites as a result of land-clearing activities. However, exceedances are not predicted at the nearest air quality sensitive receptors. Construction emissions may contribute to:

- Dust nuisance at nearby farmsteads.
- Reduced visibility along access roads.
- Temporary deterioration in local ambient air quality.
- Deposition of dust on crops, grazing areas and farm infrastructure.
- Short-term respiratory discomfort for nearby receptors during dry and windy conditions.

The impacts are expected to be localized, temporary and reversible.

9.3.6.3.1.2 ABNORMAL EVENTS

Potential abnormal events include:

- Excessive dust generation during strong wind conditions.
- Uncontrolled emissions from poorly maintained equipment.
- Accidental fires involving construction materials.

Such events may temporarily elevate local pollutant concentrations but are expected to remain short-term and manageable through implementation of standard environmental controls.

9.3.6.3.2 CONSTRUCTION PHASE

9.3.6.3.2.1 NORMAL OPERATIONS

9.3.6.3.2.1.1 SEISMIC SURVEYS

Seismic survey activities generate air emissions primarily from vehicle movements and support equipment. Potential emissions sources include:

- Vibroseis trucks and support vehicles.
- Workforce transport vehicles.
- Vehicle movement on unpaved roads.
- Temporary access route utilisation.

The AQIA found that combustion emissions associated with seismic activities are relatively minor, with pollutant releases significantly lower than those associated with drilling and production activities. PM_{10}, $PM_{2.5}$, NOx and CO emissions may occur from vehicle exhaust systems, while dust generation may occur along unpaved access routes. Although localized dust generation may occur, emissions are temporary and move progressively across the landscape as the survey advances.

9.3.6.3.2.1.2 DRILLING AND WELL TESTING

Development drilling introduces both particulate and gaseous air emissions. Key emission sources include:

- Drill rig diesel engines.
- Support generators.
- Vehicle traffic.
- Well testing.
- Temporary venting activities.
- Fugitive VOC emissions.

The AQIA estimates VOC emissions associated with drilling activities at approximately 10 tonnes per annum. These emissions originate primarily from venting during drilling, testing and servicing activities. Dispersion modelling indicates that annual VOC concentrations remain well below the adopted comfort criterion of 200 µg/m³ throughout the study area, with no exceedances of the VOC comfort threshold predicted at any distance from the drilling activities. Similarly, annual concentrations are below conservative benzene screening levels at all modelled receptors, including the nearest air quality sensitive receptors. As a result, VOC-related impacts are expected to be limited, localized and unlikely to pose a significant risk to surrounding receptors. Impacts during drilling may include:

- Localized dust generation.
- Elevated VOC concentrations near active drilling sites.

- Temporary odour impacts associated with gas releases.
- Combustion-related emissions from drilling equipment.
- Temporary deterioration in ambient air quality immediately surrounding well sites.

9.3.6.3.2.2 ABNORMAL EVENTS

Potential abnormal events during drilling include:

- Uncontrolled gas releases during well testing.
- Blowout events.
- Loss of well integrity.
- Equipment malfunction resulting in excessive emissions.
- Emergency flaring.
- Fuel storage or transfer incidents.

Such events may result in short-term elevated concentrations of VOCs, methane, combustion pollutants and odorous compounds. Although the probability of occurrence is low, the potential impact may be significant at a local scale if not properly controlled.

9.3.6.3.3 PRODUCTION PHASE

9.3.6.3.3.1 NORMAL OPERATIONS

The production phase represents the longest-duration air quality impact period and includes:

- Production wells.
- Gas gathering pipelines.
- Helium recovery and gas processing facilities.
- Gas compression facilities.
- Gas-to-power generation (approximately 3 MW).
- Routine maintenance operations.

9.3.6.3.3.1.1 FUGITIVE VOC EMISSIONS

The AQIA identified fugitive emissions as the dominant source of atmospheric emissions during production. VOC emissions from production, gathering and processing activities are estimated at approximately 101 tonnes per annum, most of which arise from venting and fugitive losses.

Potential emission sources include:

- Valves.
- Flanges.
- Connectors.
- Pressure relief devices.
- Compressors.
- Process equipment.

- Gathering pipelines.
- Loading and unloading operations.

Despite the magnitude of fugitive emissions, dispersion modelling indicates that annual VOC concentrations remain well below applicable screening criteria throughout the study area. The assessment did not predict any exceedances of the adopted VOC comfort criterion of 200 µg/m³, and therefore no threshold exceedance distance was identified. Furthermore, VOC concentrations, including conservative benzene-equivalent concentrations, remain below applicable screening levels at the nearest sensitive receptors, indicating a negligible risk of VOC-related air quality impacts beyond the immediate vicinity of the emission sources.

9.3.6.3.3.1.2 COMBUSTION EMISSIONS

Combustion emissions arise from:

- Gas-powered generators.
- Diesel generators.
- Maintenance vehicles.
- Operational vehicles.
- Emergency flaring events.

The AQIA found NOx/NO_2 emissions to be the dominant combustion pollutant, with approximately 84% of total NOx emissions originating from the gas-to-power facility. Dispersion modelling predicted maximum hourly NO_2 concentrations of approximately 60 µg/m³ in the immediate vicinity of the plant, which is substantially below the hourly NAAQS of 200 µg/m³. As a result, no exceedances of the NO_2 NAAQS were predicted at any distance from the plant, including at the nearest air quality sensitive receptors. Similarly, simulated operational PM_{10} concentrations remained well below the daily NAAQS of 75 µg/m³ across the study area, and no PM_{10} exceedance zone was identified during operations. The assessment further found that annual VOC concentrations remained below the adopted comfort criterion of 200 µg/m³ and conservative benzene screening levels throughout the modelled area. Although SO_2 and CO emissions were quantified in the emissions inventory, no ambient concentration exceedances or exceedance distances were reported for these pollutants. Overall, operational air quality impacts were predicted to comply with applicable assessment criteria at all sensitive receptors. Potential impacts include:

- Increased local NO_2 concentrations.
- Low-level PM_{10} and $PM_{2.5}$ generation.
- Minor increases in CO and SO_2 concentrations.
- Localized odour nuisances associated with hydrocarbons.
- Perceived air quality deterioration by nearby residents.

9.3.6.3.3.1.3 GAS PLANT OPERATIONS

The helium recovery and gas processing facility is expected to be the principal stationary air emission source, generating NOx/NO_2, CO, VOC, SO_2, PM_{10} and $PM_{2.5}$ emissions. Dispersion modelling indicates that operational emissions remain below applicable air quality thresholds throughout the study area. Maximum hourly NO_2 concentrations near the plant are approximately 60 µg/m³, compared to the NAAQS of 200 µg/m³, while PM_{10} and VOC concentrations also remain below their respective assessment criteria. No exceedances of the NAAQS or VOC screening criteria were predicted at any distance from the plant or at the nearest air quality sensitive

receptors. Accordingly, no exceedance distances were identified and no preferred plant location alternative exists from an air quality perspective.

9.3.6.3.3.2 ABNORMAL EVENTS

Abnormal events during production may include:

- Pressure spikes within processing equipment.
- Compressor failures.
- Valve failures.
- Pipeline leakage.
- Gathering system failures.
- Power outages.
- Process plant upset conditions.
- Emergency depressurisation.
- Emergency flaring.
- Loss of containment incidents.

These events may result in:

- Short-term elevated VOC concentrations.
- Methane releases.
- Temporary odour impacts.
- Elevated combustion emissions during emergency flaring.
- Localized reductions in ambient air quality.

Although such events are anticipated to be infrequent, they represent the highest-consequence air quality risks associated with the project and require robust operational management systems as stipulated in **Section 9.3.6.6**.

9.3.6.3.4 DECOMMISSIONING PHASE

9.3.6.3.4.1 NORMAL OPERATIONS

Decommissioning activities may generate impacts similar to those encountered during establishment:

- Removal of infrastructure.
- Road use by heavy vehicles.
- Demolition activities.
- Earthmoving and rehabilitation works.

Dust generation will represent the primary emission source during closure activities. The AQIA notes that PM_{10} impacts during rehabilitation are expected to be similar to those observed during construction activities. Provided rehabilitation is undertaken progressively, impacts are expected to be localized and temporary.

9.3.6.3.4.2 ABNORMAL EVENTS

Potential abnormal events include:

- Failure to properly seal wells.
- Leakage from abandoned infrastructure.
- Accidental releases during dismantling operations.

If wells are appropriately capped and plugged, no significant gaseous emissions are expected following closure. The impact ratings associated with the proposed activities related to air quality are indicated in **Table 80**.

9.3.6.4 IMPACT RATING

Table 80: Summary of impacts related to air quality (Airshed Planning Professionals, 2026).

Project Phase	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
Establishment / Planning	Negative	Medium to Low	Medium to Low	**Medium to Low**
Construction (Seismic Surveys)	Negative	Medium to Low	Medium to Low	**Medium to Low**
Construction (Drilling Activities)	Negative	Medium to Low	Medium to Low	**Medium to Low**
Production (Wells, Pipelines and Gas Plant)	Negative	Medium to Low	Medium to Low	**Medium to Low**
Abnormal Events (Uncontrolled Releases, Flaring, Equipment Failure)	Negative	Medium to High	Medium to Low	**Medium to Low**
Decommissioning and Rehabilitation	Negative	Medium to Low	Medium to Low	**Medium to Low**

9.3.6.5 CUMULATIVE IMPACT ASSESSMENT

The project is located within a region where air quality is influenced by a range of existing emission sources, including agricultural activities, mining operations, domestic fuel combustion, biomass burning, unpaved road traffic, and existing gas exploration and production activities. The Air Quality Impact Assessment identifies agriculture, mining, domestic fuel combustion, biomass burning and road dust as the principal contributors to baseline particulate matter concentrations in the area. However, no publicly accessible ambient air quality monitoring data were available for the study area and, consequently, the assessment could not determine whether existing ambient PM_{10}, $PM_{2.5}$, NO_2 or other pollutant concentrations already exceed the NAAQS. As such, a conservative assessment based on source emissions and dispersion modelling was undertaken.

The AQIA identified the following existing and planned activities as contributors to cumulative air quality impacts:

- Existing agricultural activities, including cultivation, grazing and windblown dust from disturbed soils.
- Existing Tetra4 gas production infrastructure and associated emissions.
- Exploration and production activities by D3 Energy, Rhino Oil and Gas and Tetra4.
- Mining operations and associated fugitive dust emissions.

- Rural road traffic on paved and unpaved roads.
- Seasonal biomass burning and veld fires.
- Domestic fuel combustion within surrounding settlements.
- Planned renewable energy developments, primarily during construction activities.

The AQIA estimated cumulative emissions from gas exploration and production developments in the Free State Province at approximately:

- 12.1 tpa particulate matter (PM).
- 383 tpa VOC emissions.
- 76.5 tpa NO_2 emissions.

Potential cumulative impacts may therefore include:

- Incremental increases in regional VOC concentrations from multiple gas production facilities.
- Combined NO_2 emissions from gas-powered generation and processing infrastructure.
- Elevated particulate concentrations due to concurrent construction, agricultural activities, mining operations and road traffic.
- Increased nuisance dust during dry and windy conditions.
- Localised increases in vehicle exhaust emissions associated with agricultural, mining and energy-sector activities.

It is noteworthy that the AQIA identified particulate matter as the pollutant most likely to contribute to cumulative impacts because the region is already characterised by numerous diffuse dust-generating activities, including agriculture, mining, road traffic and biomass burning. However, the absence of measured ambient air quality data means it could not be confirmed whether existing background PM_{10} levels already exceed applicable NAAQS. If ambient PM_{10} concentrations are already elevated due to regional sources, any additional particulate contribution from the proposed project would reduce the remaining air quality assimilative capacity and increase cumulative significance. Nevertheless, the project-specific modelling demonstrated that PM_{10} exceedances during construction are limited to approximately 1 km × 1 km around the plant site and approximately 130 m around individual well pads, with no exceedances predicted at the nearest air quality sensitive receptors. During the operational phase, PM_{10} concentrations remain well below the applicable NAAQS.

Similarly, cumulative impacts associated with NO_2 and VOC emissions are considered limited because dispersion modelling predicted maximum operational NO_2 concentrations of approximately 60 µg/m³, substantially below the hourly NAAQS of 200 µg/m³, while annual VOC concentrations remain well below the adopted comfort criterion of 200 µg/m³ throughout the study area. No exceedances of the applicable assessment criteria were predicted at sensitive receptors.

Several factors further reduce cumulative significance:

- Project emissions are predicted to comply with applicable air quality standards and screening criteria.
- Production wells are spatially dispersed, reducing the concentration of emissions in any single location.
- Gas gathering pipelines will be buried and will not constitute a significant source of routine atmospheric emissions.
- Renewable energy facilities typically generate negligible operational air emissions.

- Agricultural activities, biomass burning, road dust and mining remain the dominant regional particulate matter sources.
- Sensitive receptors are dispersed throughout the study area rather than concentrated within a single high-exposure zone.

Based on the available baseline information, the predicted project-specific impacts, and the cumulative emissions assessment, the cumulative air quality impacts associated with gas infrastructure, mining, agriculture, transportation activities and planned renewable energy developments are assessed as Medium-Low Negative post mitigation. This rating reflects the existing regional emission burden and the potential for cumulative particulate impacts while recognising that the proposed project's contribution is relatively small and is not predicted to result in exceedances of applicable air quality criteria at sensitive receptors.

9.3.6.6 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on air quality due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the same activities in the same region adopted for the proposed activities (**Appendix H**):

- Apply dust suppression on all disturbed surfaces. Water exposed areas during dry and windy conditions.
- Speed restriction of no more than 40 km/h must be implemented for all construction vehicles within the construction site.
- Maintain all vehicles, generators and drilling equipment according to manufacturer specifications.
- Notify residents within 600 m of drilling activities prior to commencement.
- Notify residents within 300 m of seismic activities prior to commencement.
- 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
    - Feasible and available use of Efficient Flare Systems (achieving a 98% or higher destruction efficiency) for flaring of excess gas during drilling activities
    - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
    - A 100-meter danger zone is immediately enforced around the wellhead
    - Active Spill Prevention, Control, and Countermeasure
    - Adequate emergency 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 and adequate and feasible methods which can include utilising calibrated rotameter combined with Tedlar bags with field-based or laboratory analysis for methane, infrared cameras (optical gas imaging), drones, satellites, and sensors, etc. to detect, locate, and quantify methane leaks from wells.

- Frequent (quarterly or even continuous) inspections.
- 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
- Reducing methane releases during well testing. Methane emissions must be monitored during well testing to assist with the greenhouse gas quantification.
- 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.
- Use of Feasible and available high-efficiency flare systems (≥ 98% to 99.5%) in line with regulatory and engineering standards to minimise visual impacts and noise i.e., ≤ 80–100 dBA at 60 meters (below threshold of pain).

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Restrict flaring to commissioning, maintenance and emergency situations other than the pilot flare required for operational and safety reasons.
- The selection of appropriate valves, flanges, fittings, seals, and packings should consider safety and suitability requirements as well as their capacity to reduce gas leaks and fugitive emissions.
- During well testing, flaring of produced hydrocarbons should be avoided wherever practical and possible, and especially near local communities or in environmentally sensitive areas
- Implementing Air Quality Monitoring as shown in **Table 81.** Methane emissions (for climate change) can be monitored during development and production to assist with the greenhouse gas quantification.

Table 81: Recommended air quality monitoring (Airshed Planning Professionals, 2026).

Project phase	Activity	Pollutant	Performance indicator	Frequency
Recommended air quality monitoring for the plant				
Construction	Construction of access roads and the plant	Dustfall	< 1200 mg/m²/day	Monthly dust fallout
Operation	Combustion and process emissions at the plant	VOCs NO_2	Benzene – 5 µg/m³ NO_2 – 40 µg/m³ VOC – 200 µg/m³	Quarterly or biannual passive sampling campaign for two weeks (VOC and NO_2) Stationary sensors can be supplemented with periodic mobile gas imaging to spot fugitive emission hot-spots (LDAR for VOCs)
Recommended air quality monitoring for the well sites				

Exploration	Well drilling and testing	VOCs	Benzene – 5 µg/m³ VOC – 200 µg/m³	Stationary sensors can be supplemented with periodic mobile gas imaging to spot fugitive emission hot spots (LDAR)
Operation	Fuel combustion emissions of drill rigs at the wells Fugitive emissions at the wells	VOCs NO_2	Benzene – 5 µg/m³ NO_2 – 40 µg/m³ VOC – 200 µg/m³	Quarterly or biannual passive sampling campaign for two weeks (at the relevant active wells) Stationary sensors can be supplemented with periodic mobile gas imaging to spot fugitive emission hot-spots (LDAR for VOCs)

9.3.7 IMPACTS ON CLIMATE CHANGE & GHG EMISSIONS

This impact assessment evaluates the potential impacts on ambient climate change and GHG emissions associated with the proposed D3 Energy PR project, including seismic surveys, exploration drilling, production wells, gas gathering pipelines, helium recovery and gas processing facilities, gas-to-power generation infrastructure and associated support activities. The assessment is based on the findings of the D3 Energy Climate Change Impact Assessment undertaken by Airshed Planning Professionals (**Appendix F4**) together with the project description, alternatives assessment and baseline conditions.

9.3.7.1 EMISSIONS

The GHG emissions estimated due to the project activities is provided in **Table 82**. There are no Scope 2 emissions as no electricity from the grid will be used during production activities. A duration of 30 years was assumed for the total GHG emissions. Total emissions for the 30-year period are based on variable gas produced, wells drilled and active wells per year.

Scope 1 and Scope 3 GHG emissions for the project are 809 057 tCO_2e and 1 930 635 tCO_2e respectively over the 30-year life of the project (29 221 tCO_2e and 191 915 tCO_2e per annum respectively). For comparison, international reporting considers a small facility as producing 10 000 tCO_2e per annum, medium at 25 000 tCO_2e per annum and large at 100 000 tCO_2e per annum (for Scope 1 and 2 emissions). This project would thus be considered a medium facility (29 221 tCO_2e per annum for Scope 1 and 2 emissions).

Table 82: GHG emissions estimated for the project (Airshed Planning Professionals, 2026).

Source	t CO_2e per year			
	Scope 1	**Scope 2**	**Scope 3**	**Total**
GHG released due to construction [(1)]	1 514			1 514
GHG released due to production [(2)]	7 101			7 101
GHG released due to gathering	2 345			2 345
GHG released due to processing [(3)]	1 207			1 207
GHG released due to abandoned wells	12			12
Natural gas (stationary combustion)	16 867			16 867
Diesel (stationary combustion)	13			13
Diesel (mobile combustion)	162			162

Purchased goods and services [(4)]			123 469	123 469
Fuel and energy related activities			40	40
Upstream transportation [(4)]			8 491	8 491
Waste			85	85
Business travel			46	46
Employee commuting			70	70
Downstream transportation			1 468	1 468
Use of sold natural gas			58 247	58 247
Total t CO_2e per year	**29 221**	**-**	**191 915**	**221 137**
Total t CO_2e for period (30 years)	**809 057**	**-**	**1 930 635**	**2 739 692**

(1) Construction emissions are split into leaks, venting and flaring as follows: 0, 1 448 and 67 tpa.

(2) Production emissions are split into leaks, venting and flaring as follows: 773, 6 257 and 71 tpa.

(3) Processing emissions are split into leaks, venting and flaring as follows: 60, 1 143 and 3 tpa.

(4) Purchasing of raw materials for well construction and transport of these materials was assumed to only take place initially and not for the life of the project

Emissions using the GWP values (20 and 100 years) from the IPCC Sixth Assessment report (given in more detail in Appendix C) amount to 32 772 t CO2e per year and 60 293 t CO2e per year. Even with the more conservative GWP factors, this project would still be considered a medium facility.

The project activities will also result in non-methane volatile organic compounds (NMVOCs) (**Table 83**) which are included in the assessment as they can produce increases in tropospheric ozone concentrations, increasing radiative forcing (warming of the atmosphere).

Table 83: NMVOC emissions estimated for the project (Airshed Planning Professionals, 2026).

Pollutant	Source	Value	Units
NMVOC	Emissions released from the well during construction	10	tpa
NMVOC	Emissions released from the well during production	73	tpa
NMVOC	Emissions released from the well during gathering	24	tpa
NMVOC	Emissions released from the well during processing	4	tpa
NMVOC	Total emissions released	**2 806**	tonnes for production period (30 years)

9.3.7.1.1 ABNORMAL EVENTS

Emissions provided above are generally considered routine operational and predictable upset emissions (like venting and flaring). Besides these emissions there is also a low probability of severe acute events such as well blowouts and pipeline explosions.

If a well blows out or a pipeline rupture without catching fire, massive volumes of raw natural gas are vented directly into the atmosphere. This gas is primarily CH_4. If the blowout or rupture ignites, the CH_4 is combusted. The main release would then be CO_2. The statistical probability of a well blowout during drilling operations typically ranges from roughly 1 in 3 200 to 1 in 10 000 wells. The overall statistical probability of a high-pressure natural gas transmission pipeline suffering a full-scale rupture is very low, typically ranging from about 0.2 to 0.4 incidents per 1,000 kilometres annually. It is important to note that the nature of the gas resources in this area are such that they do not typically occur at pressure. Therefore, the likelihood of intersecting a reservoir with significant pressures is very low.

Although the probability of a well blowout is very low, it represents the worst-case greenhouse gas emission event associated with the project. The production wells are expected to be completed within gas-bearing fractures at depths of approximately 500 to 650 m and are designed with steel casing, cement barriers and well-control measures to minimise the likelihood of uncontrolled releases. For the purposes of assessing a conservative climate change impact, a blowout from a single production well was assumed. Based on a gas flow rate of 85 m^3/hr, a gas density of 0.78 kg/m^3, and a methane content of 86.5%, the uncontrolled release rate would be approximately 66.3 kg/hr of raw gas, equivalent to approximately 57 kg/hr of methane (CH_4). Applying the IPCC AR6 20-year Global Warming Potential (GWP) of 82.5 for fossil methane results in a greenhouse gas emission rate of approximately 4 731 kg CO_2e/hr, assuming the gas does not ignite.

Given the remote nature of the production area and recognising the time potentially required to mobilise specialised well-control equipment, install a capping stack and restore well control, a conservative control period of 30 to 45 days is assumed. Under these conditions, the cumulative greenhouse gas release from a single uncontrolled and unignited well blowout could range between approximately 3 410 and 5 110 tonnes CO_2e, with 5 110 tonnes CO_2e regarded as the reasonable worst-case release. In the more likely event that the released gas ignites, approximately 98% of the methane would be combusted to carbon dioxide, substantially reducing the climate impact relative to direct methane venting. Under this scenario, emissions would decrease to approximately 249 kg CO_2e/hr, resulting in a maximum release of approximately 270 tonnes CO_2e over a 45-day control period.

The project incorporates multiple preventative measures, including steel-cased and cemented wells, pressure monitoring, blowout prevention procedures, emergency response planning, well-control systems and trained personnel, to minimise both the likelihood and duration of such an event. As a result, while the potential climate impact of an uncontrolled methane release is significant, the probability of occurrence is considered low.

9.3.7.1.2 CUMULATIVE EMISSIONS

Other gas exploration and production activities in the Free State Province include Tetra4 (production) as well as Rhino Oil and Gas (Exploration), refer to **Figure 114** and **Table 84**.

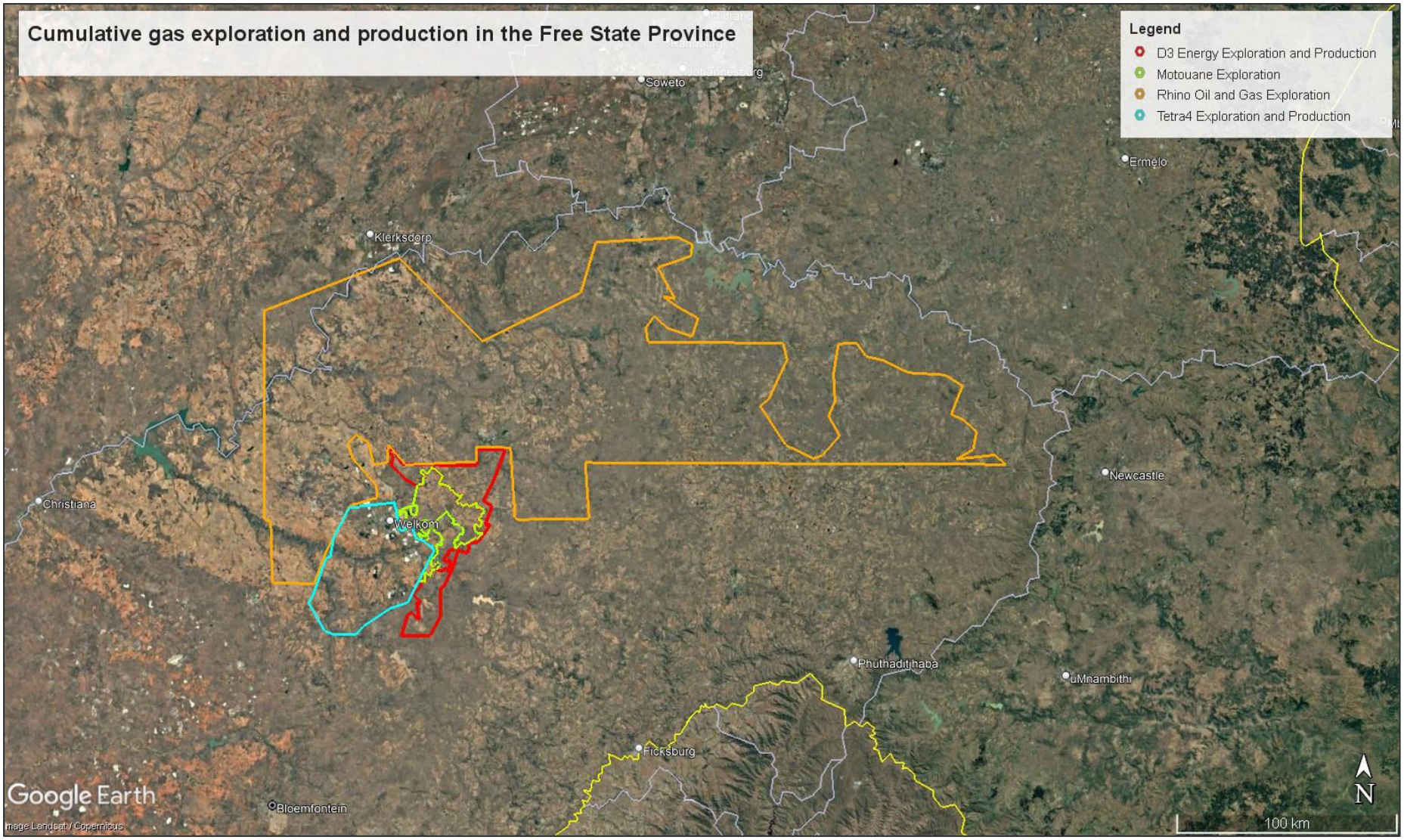


Figure 114: Cumulative gas exploration and production in the Free State Province (Airshed Planning Professionals, 2026).

Table 84: Emissions estimated for the cumulative projects in the area (Airshed Planning Professionals, 2026).

Company	Type of right	Scope 1 CO_2e emissions (tpa)	Number of wells	Gas processed or produced/year (million m^3)
D3 Energy ER315 and PR	Exploration and production	29 221	43	32
Tetra4	Exploration and production	163 748	300	204
D3 Energy ER386	Exploration	2 360	3	NA
Rhino Oil and Gas ER377	Exploration	unknown	20	NA
Rhino Oil and Gas ER378	Exploration	1 860	20	NA
Total		**197 189**		

9.3.7.2 THE PROJECT'S GHG IMPACT

9.3.7.2.1 IMPACT ON THE NATIONAL REMAINING CARBON BUDGET

According to the second NDC (**Section 4.2.1**), the South African remaining carbon budget is in the range of 320 – 380 Mt CO_2e by 2035. Using the lower end of the range for 2035, the project (Scope 1) would contribute approximately 0.009% of the remaining carbon budget per year and represent a contribution of 0.006% to the 2022 National GHG inventory total. Based on the more conservative AR6 for 20-year GWP, the project (Scope 1) would contribute approximately 0.019% of the remaining carbon budget per year and represent a contribution of 0.013% to the 2022 National GHG inventory total. While corporations use the Greenhouse Gas Protocol (GHG Protocol) to track Scopes 1, 2, and 3, NDCs operate strictly on a geographic, production-based accounting framework. Scope 3 emissions are excluded from National Targets to prevent massive global double-counting.

9.3.7.2.2 ALIGNMENT WITH NATIONAL POLICY

Most of the South African GHG policy is in early phases of implementation where GHG emissions have been reported to DFFE since 31 March 2018 and the Carbon Tax Act came into effect on the 23 May 2019. The project will be required to align to GHG reporting with national policy.

9.3.7.2.3 CUMULATIVE GHG IMPACT FOR THE AREA

Cumulative projects in the area would contribute approximately 0.06% of the remaining carbon budget per year and represent a contribution of 0.04% to the 2022 National GHG inventory total.

9.3.7.3 DESCRIPTION OF IMPACT

The proposed D3 Energy PR project will result in GHG emissions throughout all phases of the project lifecycle. Emissions will be generated directly through fuel combustion, venting, fugitive methane releases, gas processing activities and operational energy requirements, as well as indirectly through the manufacture and transportation of materials, waste generation and downstream use of produced gas. Climate change impacts resulting from these emissions are global in extent and contribute cumulatively to increasing atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other climate forcing pollutants. Methane emissions are of particular importance due to their elevated global warming potential relative to carbon dioxide. The Climate Change Assessment estimates Scope 1 emissions of approximately 29,221 tCO_2e/year and cumulative regional emissions of approximately 197,189 tCO_2e/year when considering other gas developments in the region. The impact is discussed below according to project phase and separated into normal operations and abnormal events.

9.3.7.3.1 ESTABLISHMENT PHASE

9.3.7.3.1.1 NORMAL OPERATIONS

During site establishment, emissions would arise from:

- Site clearing and preparation for seismic lines, drilling pads, access roads, pipeline servitudes and plant sites.
- Mobilisation of drilling rigs, seismic survey equipment, construction machinery and support vehicles.
- Diesel combustion from construction vehicles, generators, drilling support equipment and material transport.
- Manufacture, transportation and installation of steel casing, pipelines, concrete foundations, HDPE infrastructure and processing equipment.
- Vegetation clearing resulting in a minor reduction in local carbon sequestration capacity.
- Waste generation and transportation.

Although establishment emissions are temporary, they contribute to the project's overall carbon footprint and initiate long-term disturbance associated with gas development infrastructure. The impact remains negative due to the introduction of new anthropogenic GHG emissions and removal of limited carbon-absorbing vegetation.

9.3.7.3.1.2 ABNORMAL EVENTS

Potential abnormal events include:

- Fuel storage failures and project-related fires.
- Equipment malfunction resulting in excessive fuel consumption and combustion-related releases.
- Uncontrolled generator emissions.
- Accidents causing combustion-related releases.

These events would be localised and short-term but could increase GHG emissions beyond anticipated construction-related emissions.

9.3.7.3.2 CONSTRUCTION PHASE

9.3.7.3.2.1 NORMAL OPERATIONS

Construction activities include seismic surveys and drilling. Emissions may arise through:

- Seismic survey vehicles and support equipment operating across production corridors.
- Diesel-powered drilling rigs and auxiliary equipment.
- Drilling and well testing operations.
- Controlled venting and flaring associated with well testing.
- Fugitive methane emissions from wells, valves and connections.
- Transportation of materials, personnel and consumables.

The Climate Change Assessment identifies construction-related emissions as an important contributor to Scope 1 project emissions, particularly through venting and fugitive methane losses from wells. Methane emissions are important due to their higher climate forcing effect compared to CO_2.

9.3.7.3.2.2 ABNORMAL EVENTS

Potential abnormal events include:

- Loss of well control (blowouts).
- High-pressure gas releases during drilling.
- Equipment failure causing uncontrolled venting.
- Flaring system malfunction.
- Pipeline or temporary flowline failures during testing.

Although unlikely, these events may release significant quantities of methane over short periods. The Climate Change Assessment notes that a well blowout could release several thousand tonnes of CO_2e depending on duration and whether ignition occurs.

9.3.7.3.3 PRODUCTION PHASE

9.3.7.3.3.1 NORMAL OPERATIONS

The production phase represents the most significant contributor to climate change impacts due to its long duration (up to 30 years) and continuous operation. Emissions may arise from:

- **Production Wells**
  - Fugitive methane emissions from wellheads, valves, seals and pressure management systems.
  - Routine venting of gas during maintenance and operational activities.
  - Emissions from well workovers and periodic well interventions.
- **Gas Gathering Infrastructure**
  - Fugitive leaks from gas gathering pipelines.
  - Compressor station emissions.
  - Pressure regulation and gas handling losses.
- **Gas Processing Plant**
  - Gas processing and purification activities.
  - Helium extraction processes.
  - LNG and LHe liquefaction options.
  - Gas compression systems.
  - Gas-fired power generation (approximately 3 MW gas-to-power facility).
- **Transportation and Downstream Activities**
  - Product transport by road.
  - Employee commuting.
  - Use of sold natural gas and methane products by downstream customers.
  - Manufacture and replacement of equipment.

The Climate Change Assessment estimates direct Scope 1 emissions of approximately 29,221 tCO_2e annually and identifies gas combustion, venting and fugitive methane releases as the dominant sources. Scope 3 emissions are substantially larger and primarily relate to downstream use of sold natural gas. These emissions contribute to global warming and may indirectly exacerbate:

- Increasing temperatures.
- Increased frequency of hot days and heatwaves.
- Changes in rainfall patterns.
- Increased flooding and storm risks.
- Increased stress on water resources.
- Adverse impacts on agriculture and livestock production.

Climate projections for the project area indicate increasing temperatures, increasing heat extremes and changing rainfall patterns over the life of the project.

9.3.7.3.3.2 ABNORMAL EVENTS

Potential abnormal operational events include:

- Compressor failures.
- Pipeline ruptures.
- Pressure spikes.
- Emergency venting.
- Flare system failure.
- LNG/LHe plant process upsets.
- Major methane leaks.
- Gas plant fire or explosion.
- Wellhead failures.

Large, short-duration releases of methane can significantly increase the climate footprint despite their low probability. Pipeline ruptures and uncontrolled gas releases represent the most significant abnormal-event climate risks.

9.3.7.3.4 DECOMMISSIONING PHASE

9.3.7.3.4.1 NORMAL OPERATIONS

During decommissioning, emissions may arise from:

- Removal of equipment and infrastructure.
- Demolition of processing facilities.
- Rehabilitation activities.
- Transport of waste materials and salvageable components.
- Earthmoving and recontouring activities.

Proper rehabilitation and revegetation may partially offset some carbon losses through restoration of vegetation and associated carbon sequestration processes.

9.3.7.3.4.2 ABNORMAL EVENTS

Potential abnormal events include:

- Inadequate well plugging.
- Methane leakage from abandoned wells.
- Failure of well seals and cement plugs.
- Pipeline abandonment resulting in residual gas releases.

Long-term methane seepage from improperly abandoned wells could persist long after project closure and represents an important residual climate risk.

9.3.7.4 IMPACT RATING

The Draft National Guidelines for the Consideration of Climate Change Implications in Applications for Environmental Authorisations (in GN 6759 in GG 53574) provides a Climate Change Significance Rating Framework for assessments (summarised in Appendix D of the Climate Change Impact Assessment Report). This framework was used for the evaluation of significance for the project. 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: **moderate**;
- Impact of project on GHG emissions: **moderate**;
- Impact of cumulative projects on GHG emissions: **high.**

The climate change significance rating for catastrophic events such as a well blowout is difficult to assess because the likelihood of occurrence is very low and the duration of any uncontrolled release would depend on site-specific well-control requirements. Based on the conservative assumptions adopted in the D3 Energy Climate Change Assessment, an unignited blowout from a single well releasing methane at 57 kg/hr and remaining uncontrolled for up to 45 days could result in greenhouse gas emissions of approximately 5 110 tonnes CO_2e (using the IPCC AR6 20-year methane GWP of 82.5). The assessment categorises this as a low-significance impact due to the low probability of occurrence and the availability of well-control and emergency response measures. This falls in the LOW intensity range (< 10000 tpa CO_2e) and the overall impact significance is likely LOW (Airshed Planning Professionals, 2026). The impact ratings associated with the proposed activities related to climate change and greenhouse emissions are indicated in **Table 85** and **Table 86.**

Table 85: Summary of climate change significance rating for the project (Airshed Planning Professionals, 2026).

Climate Change Impacts or Risks	Impact of Climate Change Manifestations on the Project	Impact of the Project on Climate Change Adaptation or Resilience	Impact of Project on Greenhouse Gas Emissions
Impact or Risk	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.	The impact of the project on the resources is limited to some clearing of land for the construction and production areas.	The project would release GHG emissions into the atmosphere during the construction and production activities.
IMPACT CRITERIA			
1. Nature	Negative Direct	Negative Direct	Negative Indirect
2. Duration	Permanent	Permanent	Permanent
3. Extent	Localised	Localised	Global
4. Probability	Unlikely	Probable	Probable
5. Irreplaceability	Limited	Limited	VERY HIGH due to irreversibility of elevated GHG concentrations in the atmosphere.
6. Reversibility and mitigation potential	Easy	Moderate	Reversibility VERY DIFFICULT due to irreversibility of elevated GHG concentrations in the atmosphere.
7. Severity (intensity)	Slight	Moderate	MODERATE - more than 10 000 tCO_2e per year.
8. Significance	Low (-)	Moderate (-)	Moderate (-)
9. Residual risk	Low (-)	Moderate (-)	Moderate (-)

Table 86: Summary of Climate Change significance rating for the cumulative projects in the area (Airshed Planning Professionals, 2026).

Climate Change Impacts or Risks	Impact of Climate Change Manifestations on the Project	Impact of the Project on Climate Change Adaptation or Resilience	Impact of Project on Greenhouse Gas Emissions
Impact or Risk	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.	The impact of the project on the resources is limited to some clearing of land for the construction and production areas.	The projects would release GHG emissions into the atmosphere during the construction and production activities.
IMPACT CRITERIA			
1. Nature	Negative Direct	Negative Direct	Negative Indirect
2. Duration	Permanent	Permanent	Permanent
3. Extent	Localised	Localised	Global
4. Probability	Unlikely	Probable	Probable
5. Irreplaceability	Limited	Limited	VERY HIGH due to irreversibility of elevated GHG concentrations in the atmosphere.
6 Reversibility and mitigation potential	Easy	Moderate	Reversibility VERY DIFFICULT due to irreversibility of elevated GHG concentrations in the atmosphere.
7. Severity (intensity)	Slight	Moderate	HIGH - more than 100 000 tCO_2e per year.
8. Significance	Low (-)	Low to Moderate (-)	Medium to High (-)
9. Residual risk	Low (-)	Low to Moderate (-)	Medium to High (-)

9.3.7.5 CUMULATIVE IMPACT ASSESSMENT

The project will operate within a region where existing and future developments contribute to cumulative climate change pressures. Relevant cumulative contributors include:

- **Existing and Planned Gas Developments**
  - Existing Tetra4 gas production operations.
  - D3 Energy exploration activities.
  - Rhino Oil and Gas exploration rights.
  - Other future gas exploration and production developments in the Free State gas fields.
- **Renewable Energy Developments**
  - The region also hosts and is expected to host additional renewable energy projects, including utility-scale solar developments. These projects may partially offset national fossil fuel reliance and reduce net carbon intensity of regional energy supply.

- While renewable developments provide positive cumulative effects, they do not fully offset emissions generated by gas production and downstream combustion.

- **Agricultural Activities**
  - The surrounding area supports extensive:
    - Maize cultivation.
    - Livestock farming.
    - Dairy production.

The Climate Change Assessment estimates cumulative Scope 1 greenhouse gas emissions from regional gas developments, including D3 Energy, Tetra4, and other exploration and production projects, at approximately 197 189 tCO_2e per annum. These emissions contribute cumulatively to global atmospheric greenhouse gas concentrations and may indirectly exacerbate climate-related risks already anticipated for the region, including increasing temperatures, greater heat stress, changing rainfall patterns, and associated impacts on agricultural productivity and livestock health. Agricultural activities within the study area are particularly vulnerable to these climate stressors, given projections of increased temperatures and more frequent heat extremes over the operational life of the project.

The cumulative climate change impact was therefore assessed as High Negative, reflecting the substantial cumulative greenhouse gas contribution from regional gas developments, the additive and global nature of greenhouse gas emissions, and the limited reversibility of climate change impacts once greenhouse gases are released to the atmosphere.

Notwithstanding this rating, the specialist assessment concluded that the cumulative greenhouse gas impact does not represent a fatal flaw for the proposed development. The Climate Change Assessment found no climate-related reasons that would preclude the granting of Environmental Authorisation, noting that the cumulative emissions contribute only a small proportion of South Africa's remaining carbon budget and national greenhouse gas inventory, and that the project remains capable of implementing recognised mitigation measures, including minimisation of methane releases, leak detection and repair programmes, reduction of venting and flaring, and ongoing greenhouse gas reporting in accordance with national requirements. Consequently, while the cumulative climate impact is acknowledged as significant and requires active management and mitigation, it is not considered sufficient on its own to prevent the project from proceeding when weighed alongside the project's socio-economic benefits, regulatory compliance requirements, and the findings of the broader specialist studies undertaken for the Environmental Impact Assessment.

9.3.7.6 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.
- Ensure all onsite employees receive extreme heat (hot weather) training, maintain updated risk assessments, and monitor heat-related incidents.
- Reducing methane releases during well testing. Methane emissions must be monitored during well testing to assist with the greenhouse gas quantification. Options for gas 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
    - Feasible and available use of Efficient Flare Systems (achieving a 98% or higher destruction efficiency) for flaring of excess gas during drilling activities
    - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
    - A 100-meter danger zone is immediately enforced around the wellhead
    - Active Spill Prevention, Control, and Countermeasure
    - Adequate emergency 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 and adequate and feasible methods which can include utilising calibrated rotameter combined with Tedlar bags with field-based or laboratory analysis for methane, infrared cameras (optical gas imaging), drones, satellites, and sensors, etc. 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

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Implementing a health and safety plan for work practices to manage heat stress and temperature extremes for workers. This could consider the following measures:
    - Rotation of staff on hot days,
    - Wearing of protective safety or reflective clothing when exposed to the sun or being outdoors to reflect radiant heat from the ground or infrastructure,

- Heat-related incidences should also be reported as part of the facilities health and safety reporting, to have such records for future heat related stress,
- Provision of work-rest procedure – frequent breaks and short work periods

- Measures consistent with the Global Gas Flaring and Venting Reduction Voluntary Standard (part of the World Bank Group's Global Gas Flaring Reduction Public-Private Partnership (GGFR program) should be adopted when considering flaring and venting options for onshore activities.
- Before flaring is adopted, feasible alternatives for the use of the gas should be evaluated to the maximum extent possible and integrated into production design.
- An assessment of alternatives should be adequately documented and recorded. If none of the alternative options are currently feasible, then measures to minimize flare volumes should be evaluated and flaring should be considered as an interim solution, with the elimination of continuous production associated gas flaring as the preferred goal.

9.3.8 IMPACTS ON GEOHYDROLOGY (GROUNDWATER)

This section presents the identified potential impacts on groundwater associated with the proposed D3 Energy PR activities, taking into consideration the project area, proposed activities, alternatives assessment, hydrogeological baseline conditions, and findings of the Geohydrological Impact Assessment undertaken by Gradient Groundwater Consulting (**Appendix F7**). The assessment considers the full project lifecycle, including seismic surveys, production well development, gas gathering pipelines, gas processing facilities and decommissioning activities. The assessment has been informed by the hydrogeological baseline, groundwater modelling outcomes, source-pathway-receptor analysis and groundwater management recommendations.

9.3.8.1 SOURCE-PATHWAY-RECEPTOR EVALUATION

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 115**).

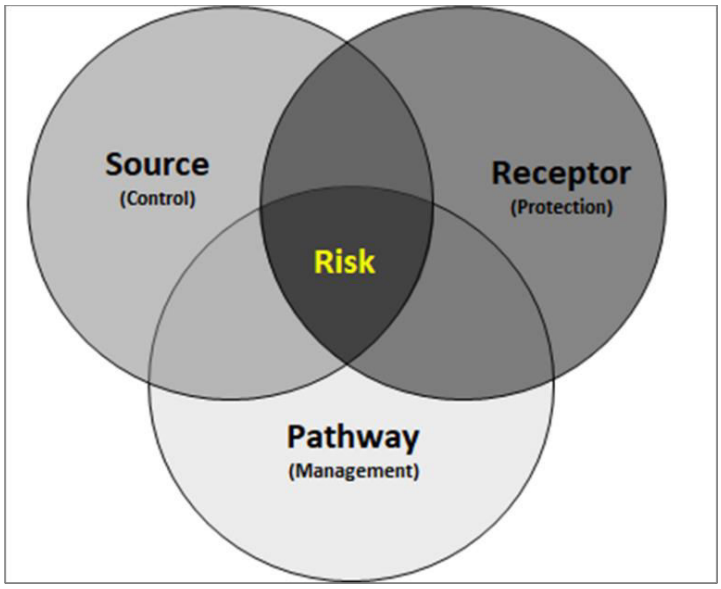


Figure 115: Source pathway receptor principle (Gradient Groundwater Consulting, 2026).

9.3.8.1.1 POTENTIAL SOURCES

The following potential sources have been identified:

i. Seepage of poor-quality water and leachate of waste products including drilling mud sump(s).

ii. Migration of saline groundwater from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.

iii. Migration of stray gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase.

iv. Migration of contaminants from the plant footprint as well as associated waste facilities and infrastructure into local water resources and host aquifers.

v. Mobilisation and maintenance of heavy vehicles and machinery on-site may cause hydrocarbon contamination of groundwater resources.

9.3.8.1.2 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 production wells will form preferential flow paths and serve as a direct connection between the deeper, fractured aquifer and shallow, potable aquifer unit(s).

9.3.8.1.3 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.

9.3.8.2 NUMERICAL MASS TRANSPORT MODEL

As detailed in Section **8.11.9**, Various management scenarios were modelled for the purposes of planning and decision making with stress periods listed in **Table 51**:

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 production phase.

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

iv. **Scenario 03:** Migration of stray methane (CH_4) gas emanating from the production zone to the overlying, potable aquifer(s) during the operations gas production 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 production zone to the overlying, potable aquifer(s) during the post-closure and decommissioning phase (50-year and 100-year scenarios).

vii. **Scenario 06:** Gas processing plant alternative evaluation and site selection.

9.3.8.2.1 SCENARIO 01: STEADY STATE BASELINE WATER BALANCE (∞)

Table 87 summarises the groundwater catchment water balance representing baseline steady state conditions. Recharge is assumed as the only source of inflow to the system and has been simulated at $2.738E^{+04}m^3/d$, while the largest loss to the groundwater system is via groundwater contribution to baseflow, $2.737E^{+04}m^3/d$. Water captured as storage equates to $1.328E^{+01}m^3/d$ while water released from storage is calculated as $4.400E^{-01}m^3/d$. The imbalance of the delineated aquifer unit, ignoring internal transfer, is calculated at $2.284E^{+01}m^3/d$.

Table 87: Catchment water balance: Scenario 01 – Steady state baseline water balance (Gradient Groundwater Consulting, 2026).

Scenario 01 – Steady State Catchment Groundwater Balance			
Parameter	**Inflow (m^3/d)**	**Outflow (m^3/d)**	**Balance (m^3/d)**
Recharge (m^3/d)	2.738E+04	0.000E+00	2.738E+04
Dirichlet/ Drain conductance (m^3/d)	0.000E+00	2.737E+04	-2.737E+04
Storage Capture(-)/Release(+)(m^3/d)	1.328E+01	4.400E-01	1.284E+01
Imbalance ignoring internal transfer (m^3/d)	0.000E+00	2.284E+01	-2.284E+01
Total (m^3/d)	**2.739E+04**	**2.739E+04**	**0.000E+00**

9.3.8.2.2 SCENARIO 02: MIGRATION OF SALINE GROUNDWATER FROM THE DEEP, FRACTURED AQUIFER TO THE OVERLYING, POTABLE AQUIFER(S) DURING THE OPERATIONAL GAS PRODUCTION PHASE

This scenario summarises the simulated point source TDS pollution plume migration of saline groundwater emanating from the deep, fractured aquifer should the integrity of the gas production boreholes be jeopardised i.e., leaking boreholes for the operational phase (30-year period). Accordingly, the unmitigated scenario entails simulation of a potential pollution plume migrating through open production boreholes i.e., uncased with no cement or grouting implemented. If casing and cementing will be performed according to the specifications provided, theoretically the migration of a pollution plume through the preferred groundwater flow pathway created by the borehole will be insignificant.

It should be noted that, due care will be taken to ensure that all production 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).

Due to the linear correlation of the groundwater elevation within the shallow, intergranular aquifer compared to relevant topographical elevation, the simulation indicates that the generated TDS pollution plume will generally mimic topography and will migrate from the gas production borehole(s) towards the lower laying drainage system. It is evident that regional geological lineaments act as preferred pathways for groundwater flow and contaminant transport mechanisms.

It can be observed that the simulated pollution plume migration is more sluggish within the denser Karoo formations, reaching a maximum distance of ~180.0m, whereas movement through the more unconsolidated alluvial deposits of the riparian zone suggest a larger flux reaching a maximum distance of ~350.0m during the operational 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 production right area. It should be noted that the pollution plumes originating from production boreholes situated within the riparian zone might potentially intersect local drainages i.e., Maselspruit, Merriespruit and Sandrivier including associated drainage systems and riparian zone aquifer.

The study found that the TDS mass load contribution ranges between ~980.0mg/l to approximately 1660.0mg/l, which is slightly above the SANS 241:2015 limits while the TDS mass load contribution ranges between < as the current background concentration of ~350.0mg/l to a maximum of approximately 800.0mg/l, which is below the SANS 241:2015 limits. It can be observed the mass load contribution is a function of the distance to the source or gas production borehole. It can be noted that conceptual receptors situated within the unconsolidated, riparian zone aquifer, reaches quasi-steady state much quicker than conceptual receptors within the denser Karoo formations. The latter can be attributed to more sluggish groundwater movement associated with the Beaufort group formations.

Figure 116 indicates the simulated particle tracking of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south with **Figure 117** showing the simulated particle tracking of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east. **Figure 118** indicates the TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south while **Figure 119** depicts the TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east for the operational phase.

9.3.8.2.3 SCENARIO 03: MIGRATION OF STRAY METHANE (CH4) GAS EMANATING FROM THE PRODUCTION ZONE TO THE OVERLYING, POTABLE AQUIFER(S) DURING THE OPERATIONS GAS PRODUCTION PHASE

This scenario summarises the simulated point source pollution plume migration of stray methane (CH_4) gas emanating from the deep, fractured aquifer should the integrity of the gas production boreholes be jeopardised i.e., leaking boreholes for the operational phase (30-year period).

It should be noted that, due care will be taken to ensure that all production 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).

The simulation indicates that the generated CH_4 pollution plume will also generally mimic topography and will migrate from the gas production borehole(s) towards the lower laying drainage system.

It can be observed that the simulated pollution plume migration is also more sluggish within the denser Karoo formations, reaching a maximum distance of ~150.0m, whereas movement through the more unconsolidated alluvial deposits of the riparian zone suggest a larger flux reaching a maximum distance of ~300.0m during the operational production phase.

The simulation indicates that the potential pollution plumes will also not intercept any privately owned, neighbouring boreholes during the duration of the simulation and do not extend beyond the production right area. It should be noted that the pollution plumes originating from production boreholes situated within the riparian zone might potentially intersect local drainages i.e., Maselspruit, Merriespruit and Sandrivier including associated drainage systems and riparian zone aquifer.

The study found that source term mass load contribution to is below the EPA safety threshold (2011) of 10.0mg/l ranging between 2.40-3.80mg/l, with the mass load contribution a function of the distance to the source or gas production borehole. While the CH_4 mass load contribution ranges between ~0.15mg/l (which is the current background concentration) to a maximum of approximately 0.49mg/l, which is below the EPA safety threshold (2011) of 10.0mg/l.

Figure 120 indicates the CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south while **Figure 121** depicts the CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east for the operational phase.

9.3.8.2.4 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 TDS pollution plume migration of saline groundwater emanating from the deep, fractured aquifer should the integrity of the decommissioned gas production 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 pollution plume migration distance reached is ~250.0m within the denser Karoo aquifer whereas the maximum pollution plume migration distance reached within the unconsolidated alluvial deposits of the riparian zone is ~450.0m. It should be noted that the pollution plumes originating from production boreholes situated within the riparian zone will continue migrating to the Maselspruit, Merriespruit and Sandrivier including associated drainage systems.

The study found that TDS mass load contribution to conceptually placed receptors situated in close proximity to simulated gas production boreholes (positioned 50m and 100m from the respective boreholes) for the post-closure phase, the TDS mass load contribution has reached an equilibrium above the SANS 241:2015 limits ranging between ~950.0mg/l to approximately > 1 600.0mg/l. The TDS mass load contribution of deeper, fractured and saline aquifer on existing boreholes in the vicinity of the proposed gas production boreholes targeting the potable shallow, intergranular aquifer for the post-closure phase ranges between ~380.0mg/l to a maximum of approximately 480.0mg/l, however remains below the SANS 241:2015 limits.

Figure 122 depicts the TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south while **Figure 123** depicts the TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east for the post-closure phases.

9.3.8.2.5 SCENARIO 05: MIGRATION OF STRAY METHANE (CH4) GAS EMANATING FROM THE PRODUCTION 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 deep, fractured aquifer should the integrity of the decommissioned gas production 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 pollution plume migration distance reached is ~180.0m within the denser Karoo aquifer whereas the maximum pollution plume migration distance reached within the unconsolidated alluvial deposits of the riparian zone is ~350.0m. It should be noted that the pollution plumes originating from production boreholes situated within the riparian zone will continue migrating to the Maselspruit, Merriespruit and Sandrivier including associated drainage systems.

The study found that the CH_4 mass load contribution to conceptually placed receptors targeting the shallow, intergranular as well as riparian zone aquifers for the post-closure phase has reached an equilibrium below the EPA safety threshold (2011) of 10.0mg/l ranging between 2.40-3.80mg/l, with the mass load contribution a function of the distance to the source or gas production borehole. The CH_4 mass load contribution to existing boreholes in the vicinity of the proposed gas production boreholes for the post-closure phase ranges between <0.15mg/l (current background concentration) to a maximum of approximately 0.65mg/l, however, remains below the EPA safety threshold (2011) of 10.0mg/l.

Figure 124 depicts the CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south while **Figure 125** depicts the CH_4 pollution plume migration of contaminants originating from the deeper,

fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east for the post-closure phases.

9.3.8.2.6 SCENARIO 06: GAS PROCESSING PLANT ALTERNATIVE EVALUATION AND SITE SELECTION

This scenario evaluates the three site alternatives for the proposed processing plant footprint (refer to **Figure 3** and **Section 6.2.1.2** for reference). The study found that the TDS mass load contribution of the potential waste infrastructure to a conceptually positioned receptor within the sensitive riparian zone aquifer for the duration of the operational phase ranges between <350.0mg/l (which is the current background value) for Plant locality C, to a maximum of approximately 1700.0mg/l for Plant locality B.

Figure 126 indicates the simulated particle tracking of contaminants originating from potential waste infrastructure associated with the proposed gas processing plant for alternative footprints (Operational phase). It can be observed that processing plant locality B suggest the most potential impact on the riparian zone aquifer with processing plant locality C indicating the least potential impact. It should however be noted that processing plant locality C it situated in close proximity to a geological lineament which can serve as a potential mechanism and preferred pathway for groundwater flow and contaminant transport.

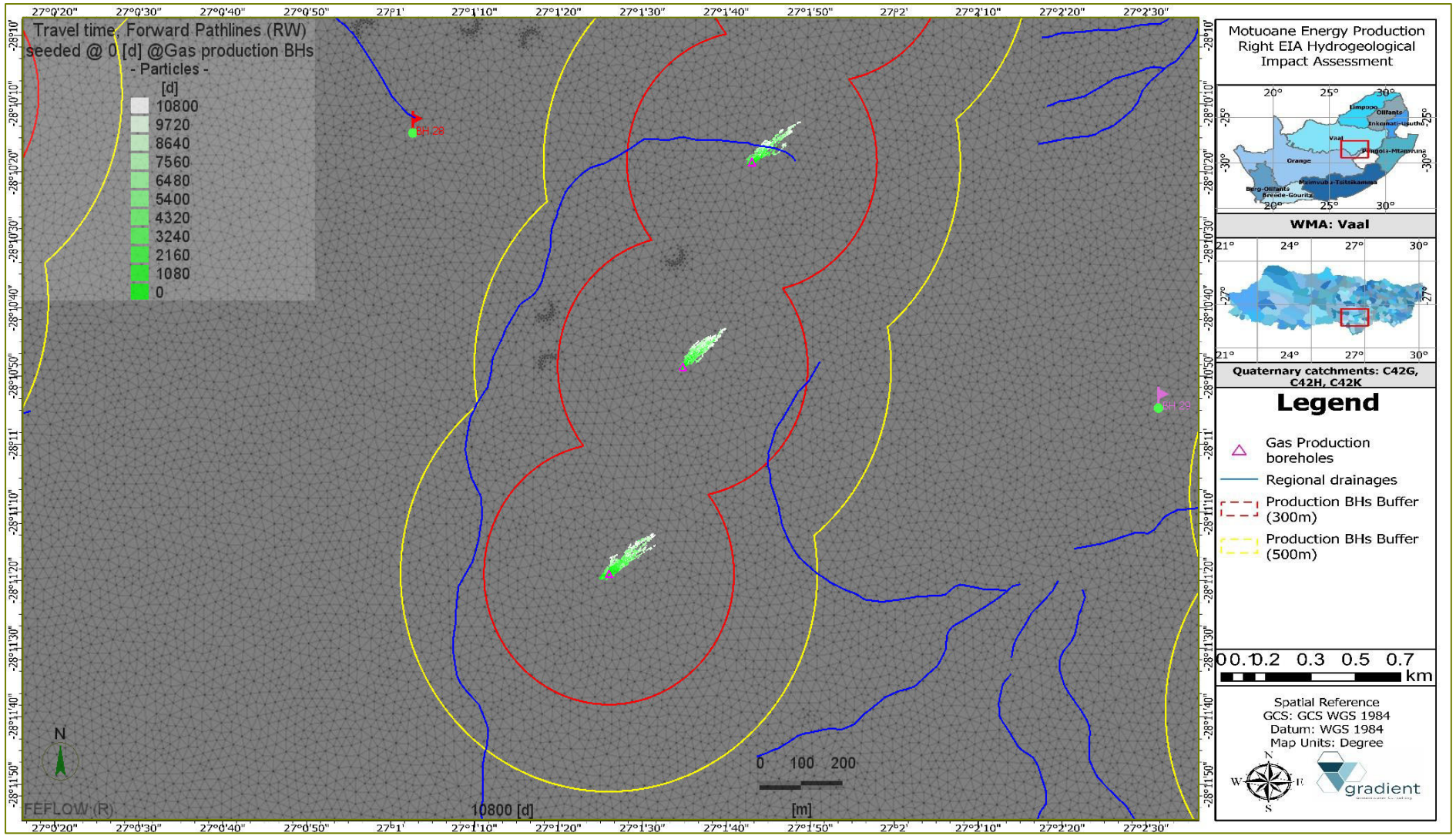


Figure 116: Scenario 02: Simulated particle tracking of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south (Operational phase) (Gradient Groundwater Consulting, 2026).

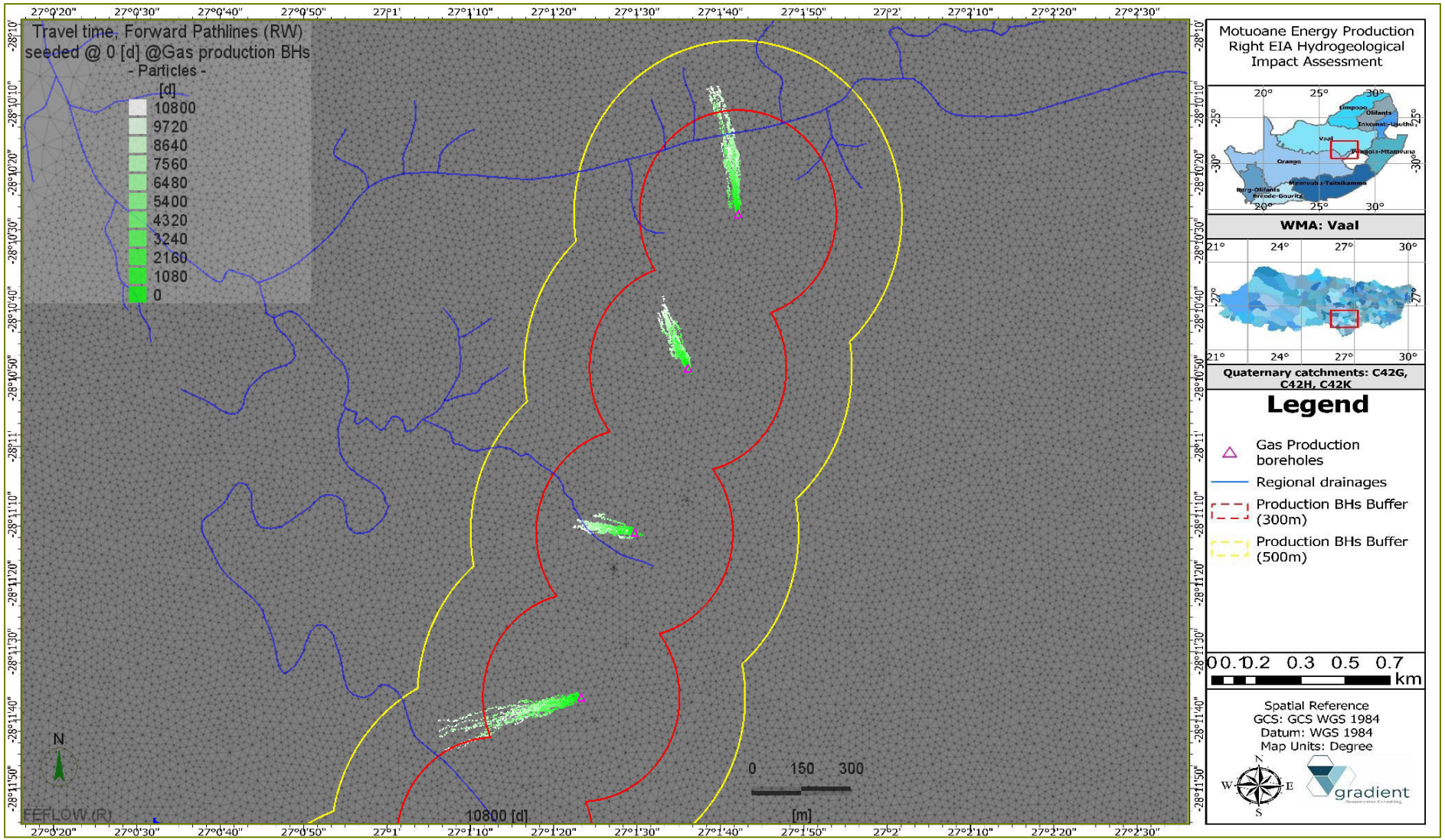


Figure 117: Scenario 02: Simulated particle tracking of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east (Operational phase) (Gradient Groundwater Consulting, 2026).

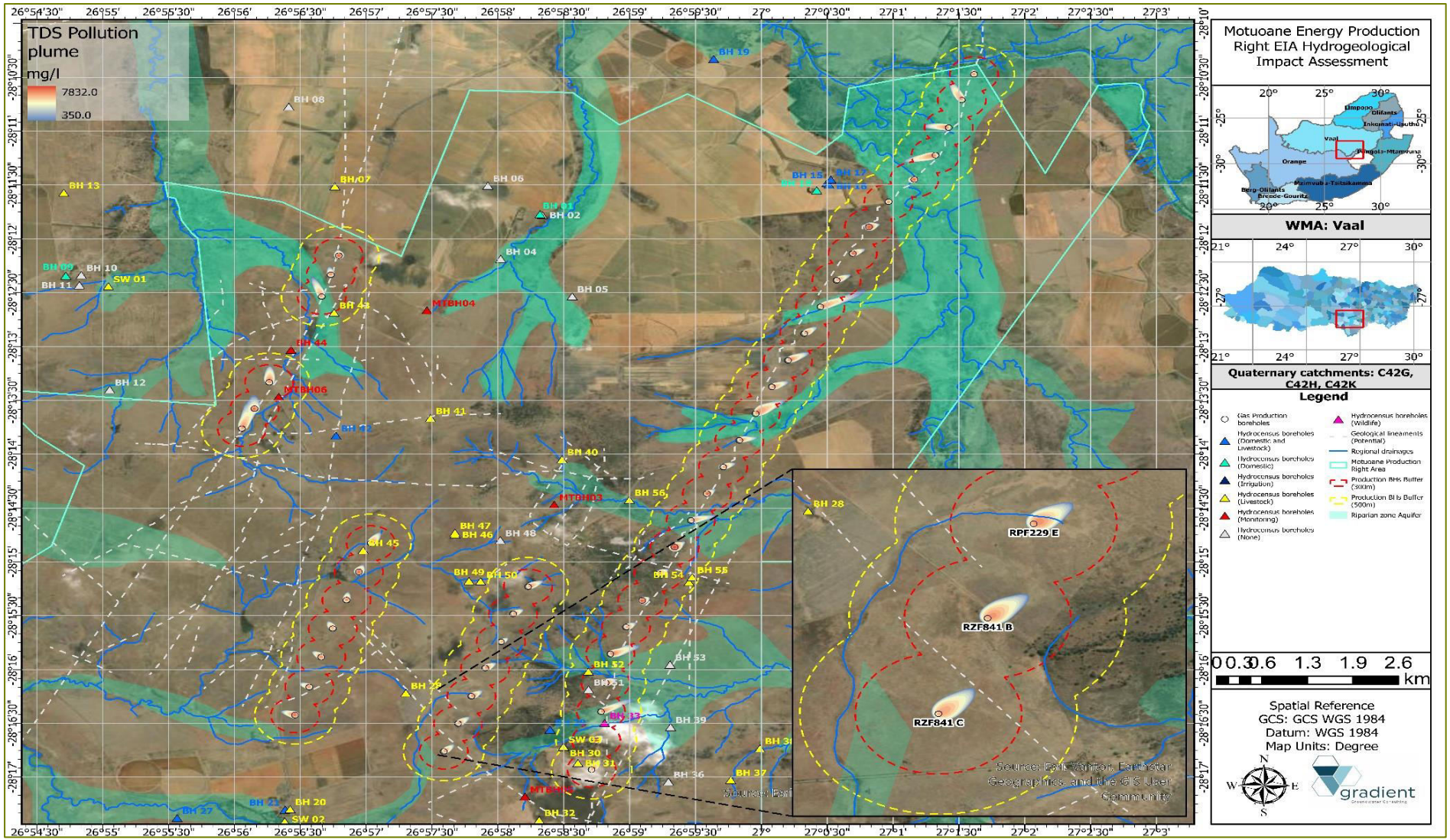


Figure 118: Scenario 02: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south (Operational phase) (Gradient Groundwater Consulting, 2026).

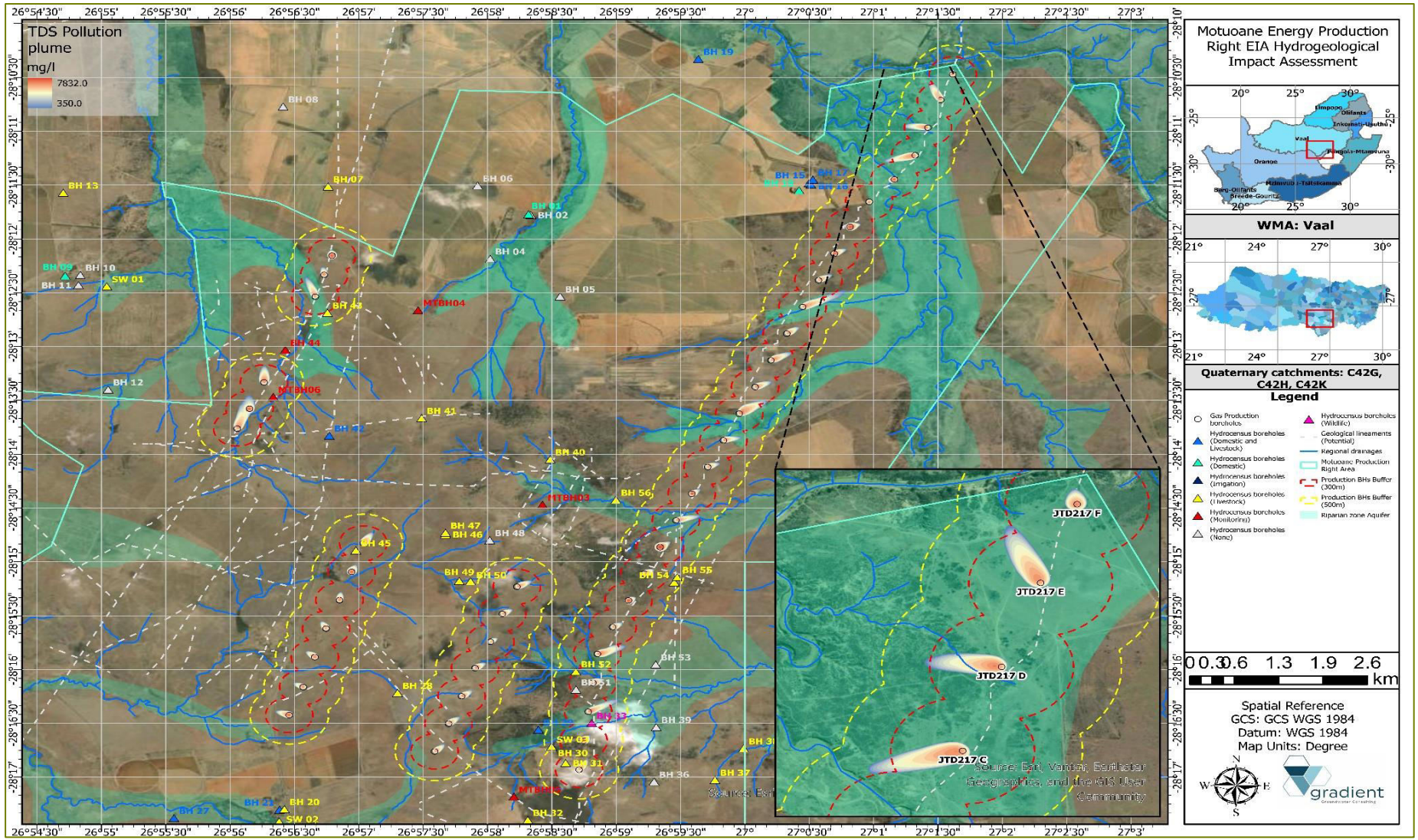


Figure 119: Scenario 02: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east (Operational phase) (Gradient Groundwater Consulting, 2026).

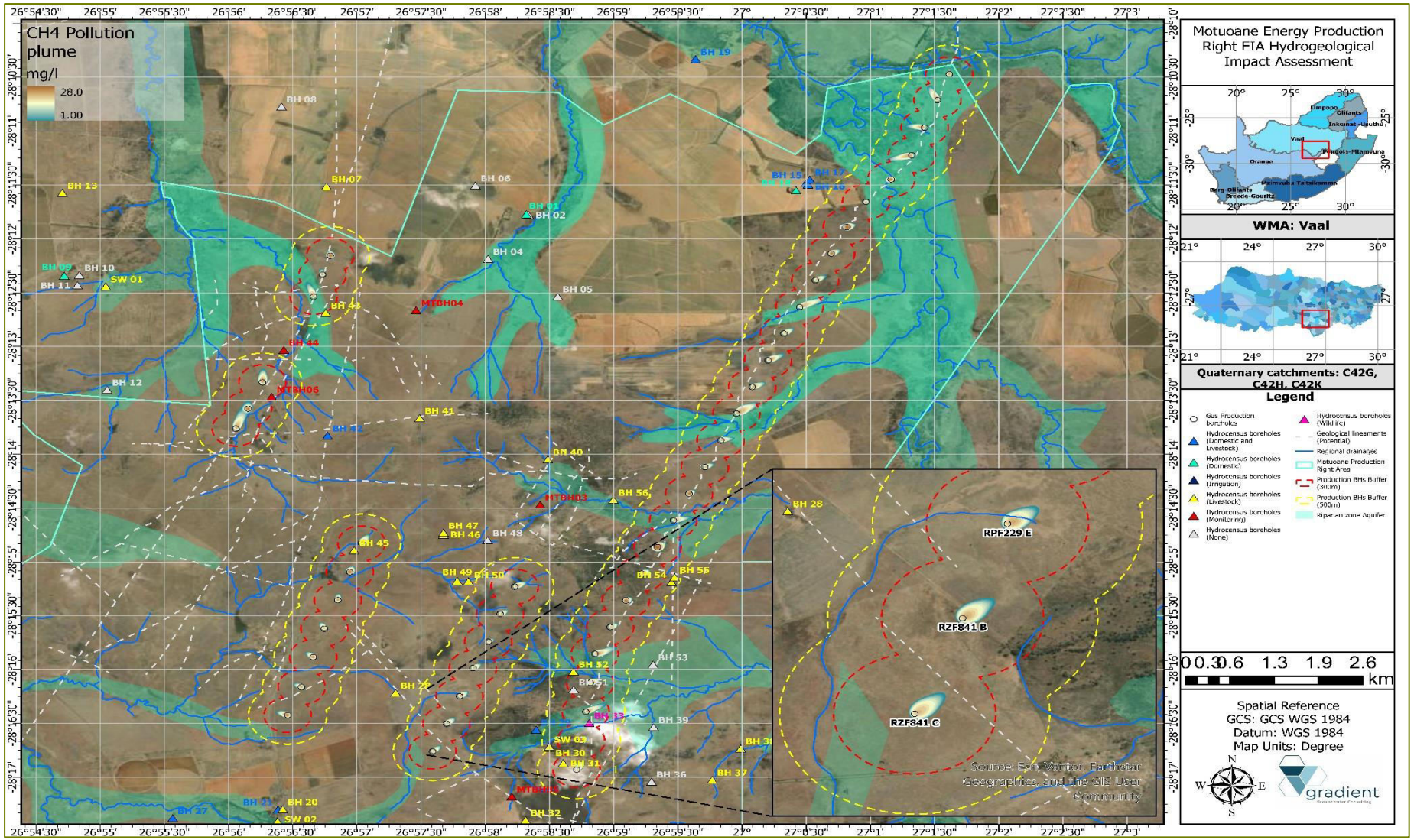


Figure 120: Scenario 03: CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south (Operational phase) (Gradient Groundwater Consulting, 2026).

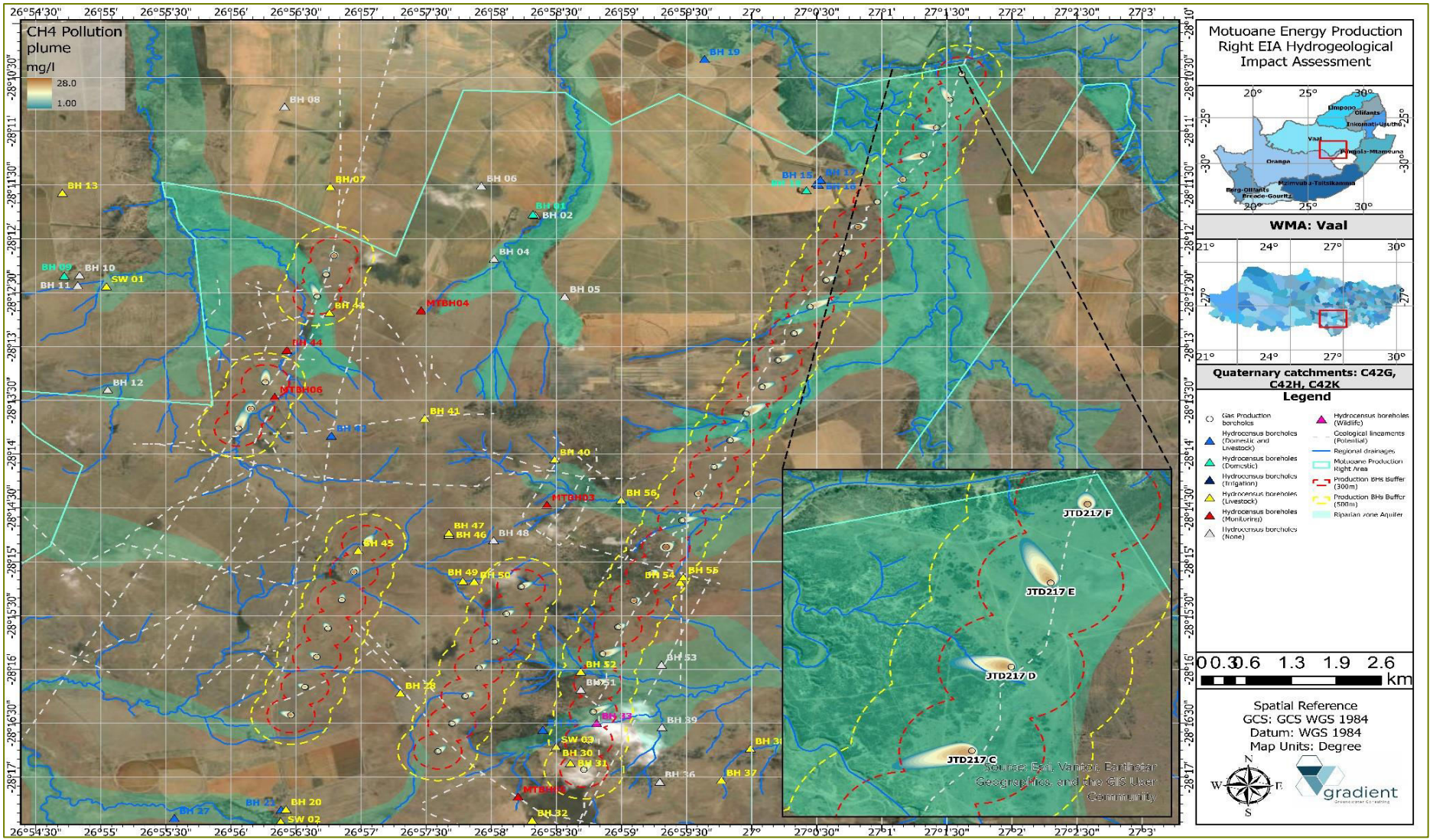


Figure 121: Scenario 03: CH_4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east (Operational phase) (Gradient Groundwater Consulting, 2026).

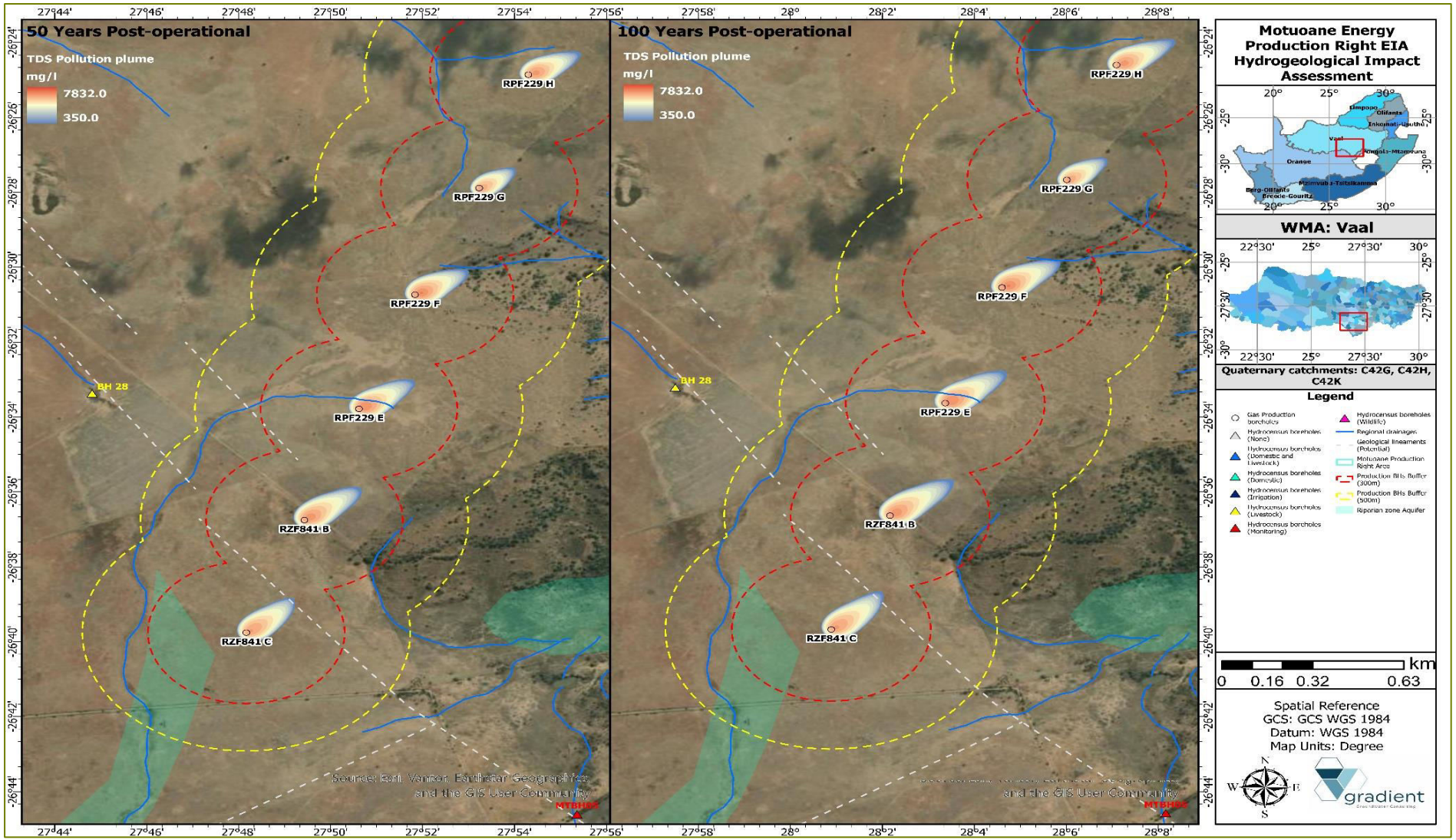


Figure 122: Scenario 04: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south (post-closure phase) (Gradient Groundwater Consulting, 2026).

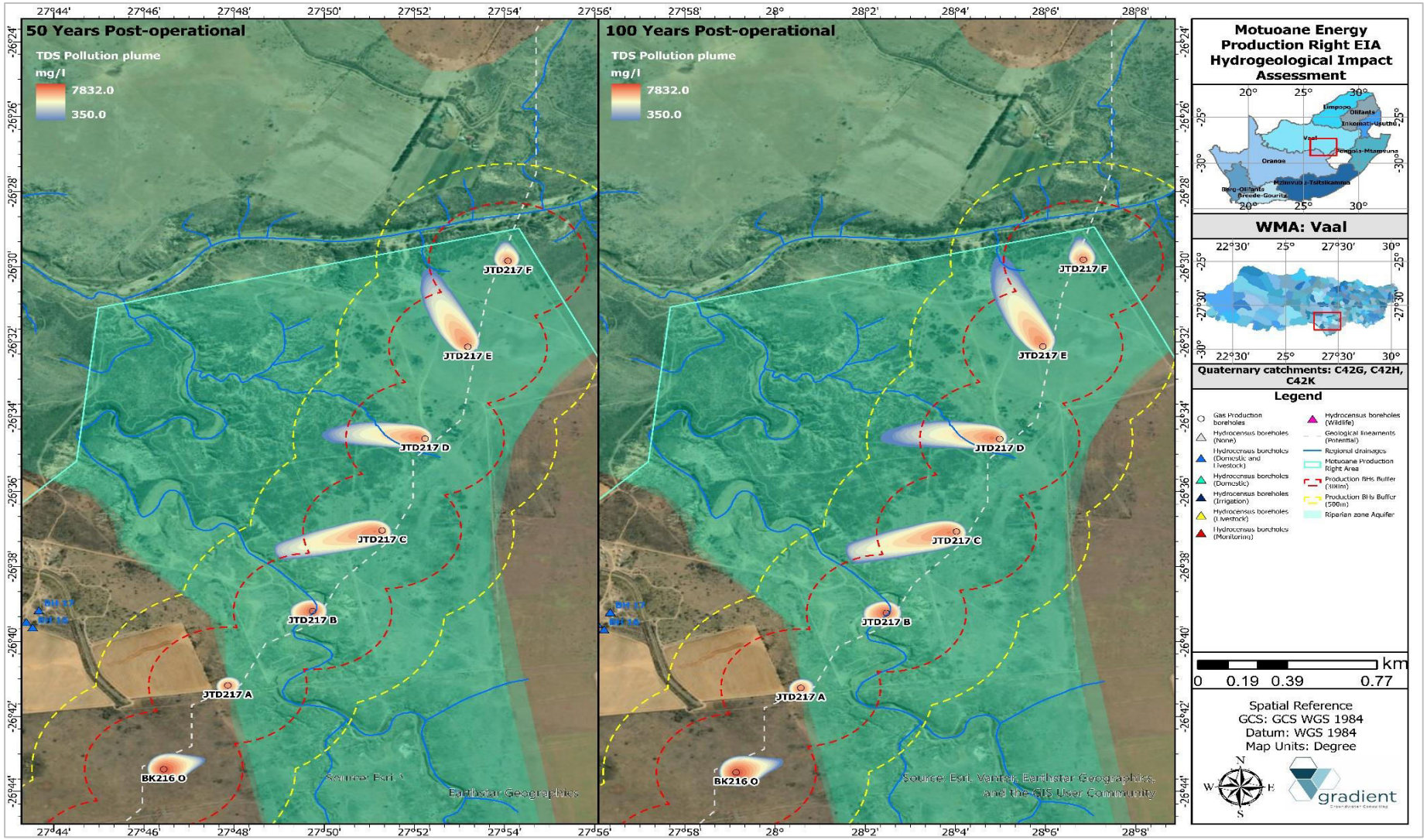


Figure 123: Scenario 04: TDS pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east (Post-closure phase) (Gradient Groundwater Consulting, 2026).

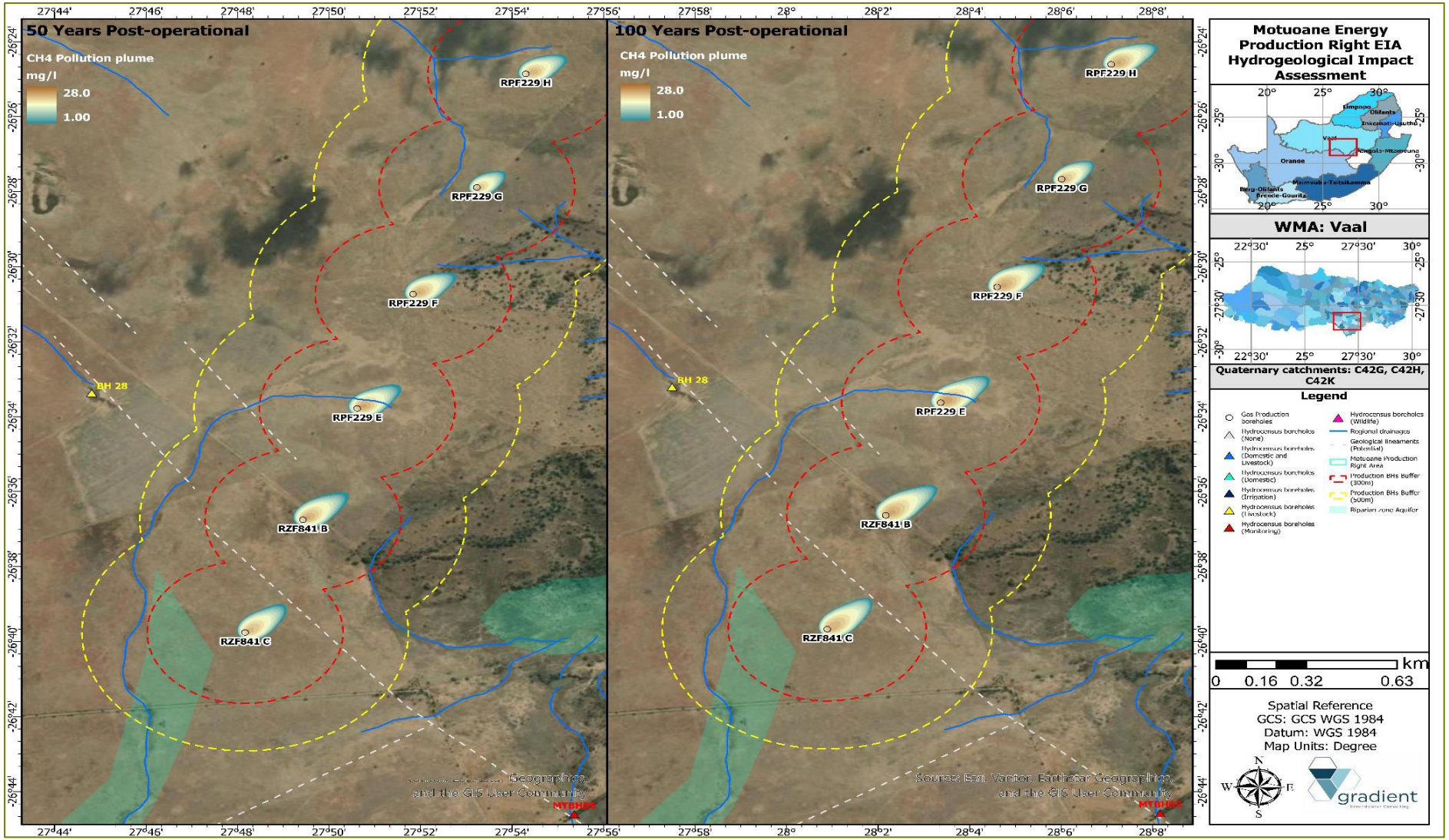


Figure 124: Scenario 05: CH4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the intergranular aquifer in the vicinity of production boreholes RZ841 towards the south (post-closure phase) (Gradient Groundwater Consulting, 2026).

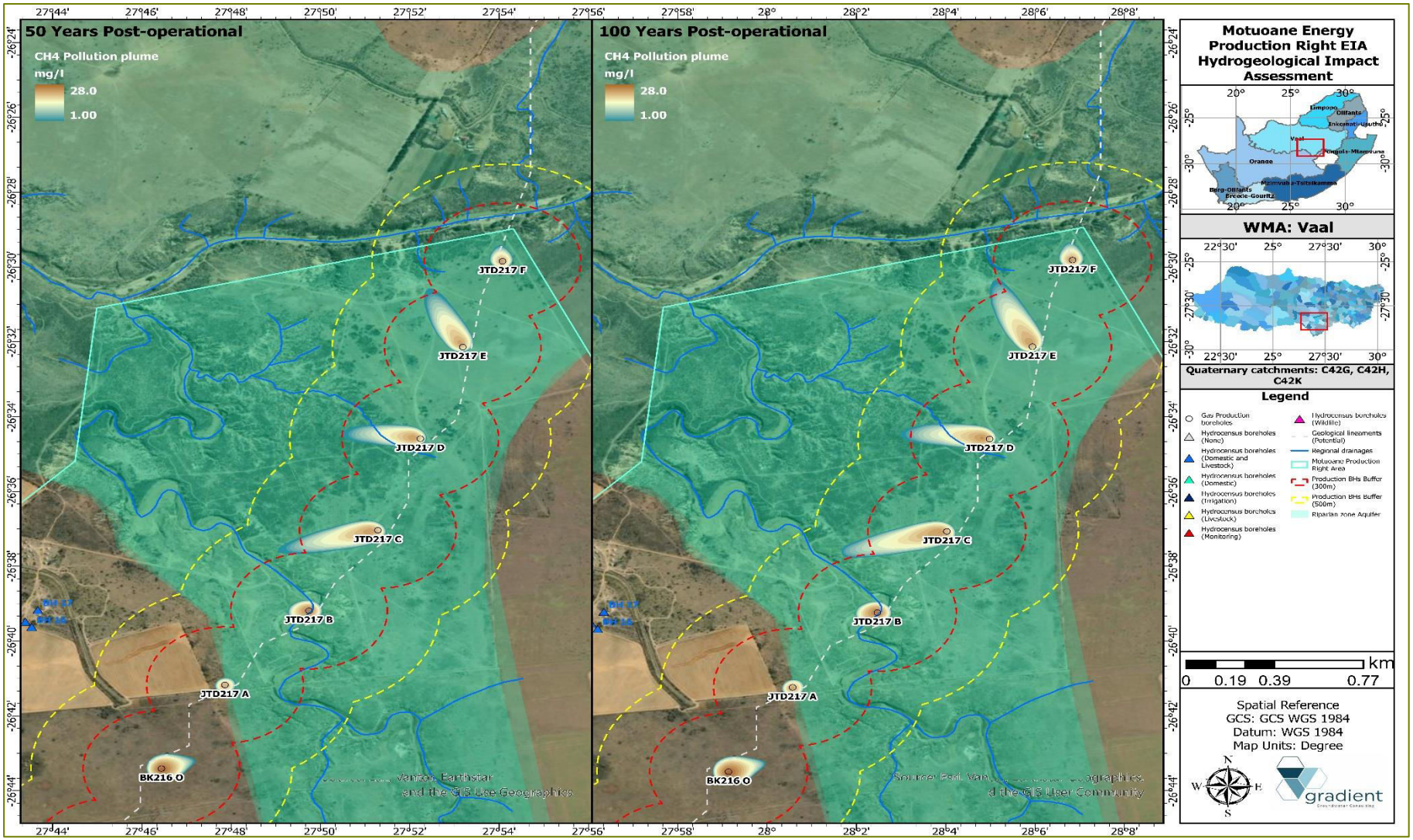


Figure 125: Scenario 05: CH4 pollution plume migration of contaminants originating from the deeper, fractured aquifer migrating to the riparian zone aquifer in the vicinity of production boreholes JTD217 towards the north-east (post-closure phase) (Gradient Groundwater Consulting, 2026).

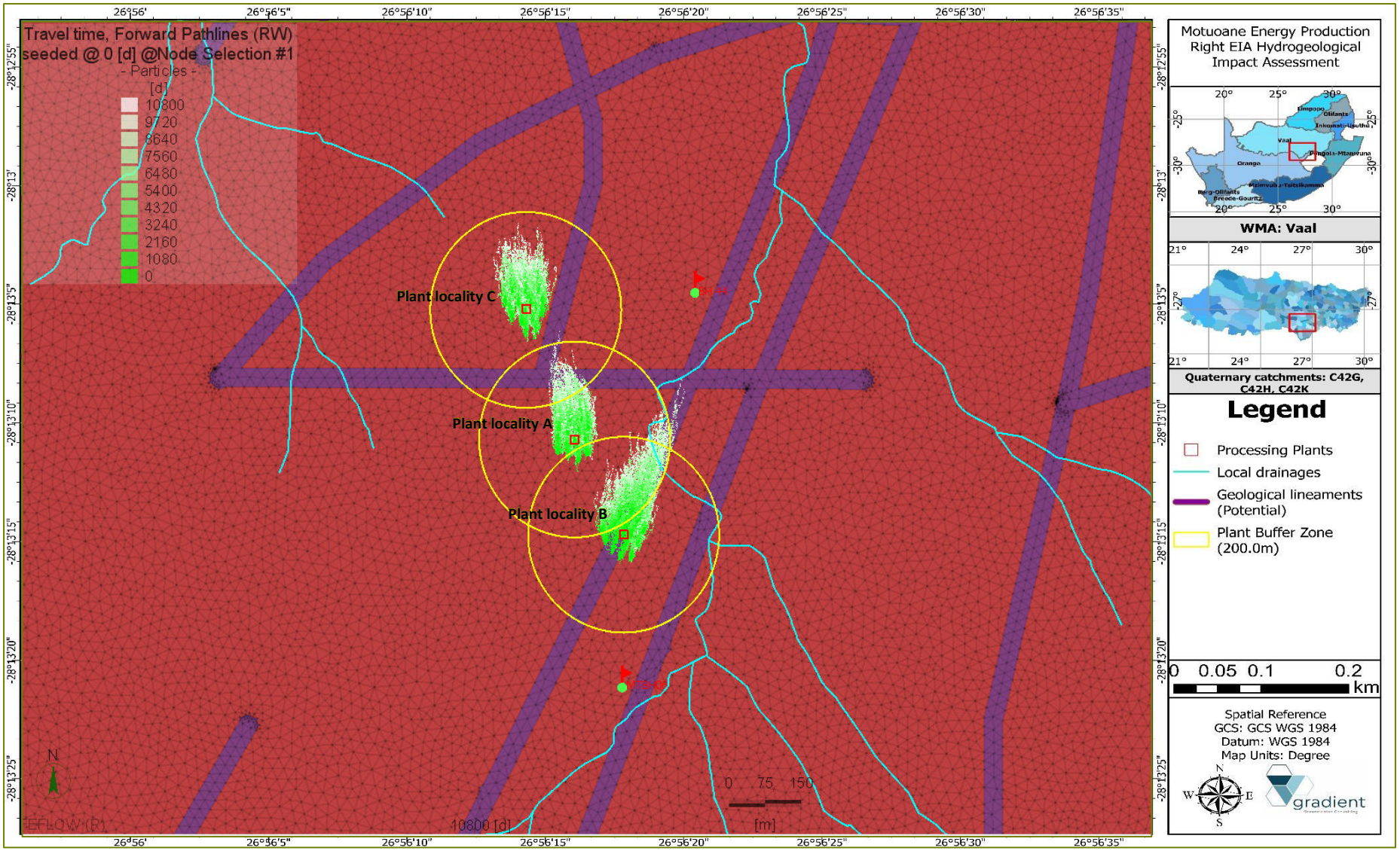


Figure 126: Scenario 06: Simulated particle tracking of contaminants originating from potential waste infrastructure associated with the proposed gas processing plant for alternatives footprints (Operational phase) (Gradient Groundwater Consulting, 2026).

9.3.8.3 CONSTRUCTION PHASE: ASSOCIATED ACTIVITIES AND IMPACTS

Refer to **Table 88** for a summary of the impact risk matrix and significance ratings for the construction phase. During the construction phase the environmental significance rating of potential groundwater impacts on down-gradient receptors are rated as **high** and **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. Site clearing and vegetation removal may cause increased turbidity and sediment loads in groundwater.

ii. Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area as well as drilling pads into recharge areas.

iii. Poor quality leachate including sewage and domestic wastewater emanating from the construction camp may have a negative impact on groundwater quality.

iv. Mobilisation and maintenance of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.

v. Borehole drilling can introduce various potential contaminants including drilling muds/additives and hydrocarbons into host-aquifers which may have a detrimental effect on the water quality.

vi. Drilling activities can disturb sediments and may result in silt formation in groundwater and can cause siltation within the potable water aquifer.

vii. Encountering of major water strikes and blow-out during the drilling process may reduce local groundwater levels.

viii. Groundwater pollution as a result of produced formation water or wastewater spills and seepage from drilling sumps.

ix. Handling of borehole drilling chips may pose a risk to groundwater contamination.

x. Borehole construction in terms of casing installation and concrete works might have a negative impact on groundwater quality.

xi. Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.

xii. Anthropogenic activities and movement related to the construction phase can cause potential groundwater pollution.

xiii. Groundwater pollution as a result of contact with drilling fluids, additives and lubricants.

xiv. Groundwater pollution as a result of unforeseen events such as saline water encountered during well blow-out.

xv. Unplanned releases of formation water.

xvi. Unplanned event such as well explosion can release saline formation water and gasses.

9.3.8.4 OPERATIONAL PHASE: ASSOCIATED ACTIVITIES AND IMPACTS

Refer to **Table 88** for a summary of the impact risk matrix and significance ratings for the operational phase. During the operational phase the environmental significance rating of potential groundwater impacts on down-gradient receptors are rated as **high** and **medium** to **high** without implementation of remedial measures and **medium** to **high** and **medium** to **low** with implementation of proposed mitigation measures. The main impacts associated with the operational phase activities include the following:

i. Inadequate casing or cementing can create a vertical flow pathway between different aquifers/ hydrostratigraphical units or between the production zone and potable aquifer.

ii. Migration of saline groundwater or groundwater with a different chemical composition originating from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase can cause mixing between aquifers.

iii. Upward migration of stray formation gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase can cause mixing between aquifers.

iv. Multiple gas wells can collectively affect groundwater levels, quality and hydraulic connectivity over a larger area.

v. Gas production can alter pressure differences and alter hydraulic gradients between different hydrostratigraphical units resulting in modification of local groundwater flow pathways.

vi. Poor quality leachate may emanate from the gas production zone which may have a negative impact on groundwater quality.

vii. Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution.

viii. Operation and maintenance of heavy vehicles as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.

ix. Leaking pipelines may cause contamination of groundwater resources

9.3.8.5 POST-OPERATIONAL AND DECOMMISSIONING PHASE: ASSOCIATED ACTIVITIES AND IMPACTS

Refer to **Table 88** for a summary of the impact risk matrix and significance ratings for the post-operational and decommissioning phase. During the decommissioning phase the environmental significance rating of potential groundwater impacts on down-gradient receptors are rated as **high** and **medium** to **high** without implementation of remedial measures and **medium** to **high** and **medium** to **low** with implementation of proposed mitigation measures. The main impacts associated with the operational phase activities include the following:

i. Poorly plugged and sealed decommissioned production boreholes can create preferred groundwater flow pathways causing migration of saline groundwater or groundwater with a different chemical composition originating from the deep, fractured aquifer to the overlying, potable aquifer(s) during the decommissioning phase can cause mixing between aquifers.

ii. Poorly plugged and sealed decommissioned production boreholes can create preferred groundwater flow pathways causing an upward migration of stray formation gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the decommissioning phase can cause mixing between aquifers.

iii. Multiple gas wells can collectively affect groundwater levels, quality and hydraulic connectivity over a larger area.

iv. Poor quality leachate may emanate from production zone footprint areas which may have a negative impact on groundwater quality.

v. De-mobilisation of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources.

vi. Site de-establishment and removal of infrastructure can potentially cause increased turbidity and sediment loads in groundwater.

vii. Legacy groundwater contamination i.e., historical spills and leakages can contribute to continued groundwater-quality deterioration during the post-closure phase.

9.3.8.6 IMPACT RATING

The impact ratings associated with the proposed development activities related to groundwater are indicated in **Table 88**.

Table 88: Summary of impacts related to groundwater (Gradient Consulting, 2026).

Project Phase	Impact Description	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	Site clearing and vegetation removal may cause increased turbidity and sediment loads in groundwater. Sediment loads may potentially be transported by drainages systems regionally, however will only last for the construction phase of the project. This impact will potentially be reversible only by incurring significant time and costs and has a low probability (pre-mitigation) and improbable probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to low -	Low -	Low -
	Groundwater deterioration and siltation due to contaminated stormwater run-off from the construction area as well as drilling pads into recharge areas. Contaminated stormwater may potentially be transported by drainages systems regionally, however will only last for the construction phase of the project. This impact will potentially be reversible only by incurring significant time and costs and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to low -	Low -	Medium to low -
	Poor quality leachate including sewage and domestic wastewater emanating from the construction camp may have a negative impact on groundwater quality. Contaminants originating from domestic wastewater and sewage may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be	Negative	Medium to low -	Low -	Low -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	reversible without incurring significant time and costs and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.				
	Mobilisation and maintenance of heavy vehicles, drilling rig as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources. Hydrocarbon pollutants originating from heavy vehicles and drilling rigs may potentially reach the regional, potable water aquifer, however will only last for the construction phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -
	Borehole drilling can introduce various potential contaminants including drilling muds/additives and hydrocarbons into host-aquifers which may have a detrimental effect on the water quality. These contaminants may reach the local potable water aquifer however will only last for the construction phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -
	Drilling activities can disturb sediments and may result in silt formation in groundwater and can cause siltation within the potable water aquifer. These sediments may reach the local potable water aquifer however will only last for the construction phase of the project. This impact will potentially be reversible only by incurring significant time and costs and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	Encountering of major water strikes and blow-out during the drilling process may reduce local groundwater levels. Removal of water from storage may negatively impact on the local potable water aquifer however will only last for the construction phase of the project. This impact will potentially be reversible only by incurring significant time and costs and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated low as there is a low probability that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to low -	Low -	Medium to low -
	Groundwater pollution as a result of produced formation water or wastewater spills and seepage from drilling sumps. Contaminants originating from wastewater spills and drilling sumps may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.		Medium to high -	Medium to low -	Medium to low -
	Handling of borehole drilling chips may pose a risk to groundwater contamination. Contaminants originating from the drilling chips may potentially reach the site, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a medium (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.		Medium to low -	Low -	Low -
	Borehole construction in terms of casing installation and concrete works might have a negative impact on groundwater quality. Contaminants originating from the concrete works may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.		Medium to high -	Medium to low -	Medium to low -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution. Contaminants originating from hazardous chemical substances may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.		Medium to low -	Low -	Medium to low -
	Anthropogenic activities and movement related to the construction phase can cause potential groundwater pollution. Contaminants originating from anthropogenic activities may potentially reach the regional, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.		Medium to high -	Medium to low -	Medium to low -
	Groundwater pollution as a result of contact with drilling fluids, additives and lubricants. Contaminants originating from drilling fluids and additives may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.		Medium to high -	Medium to low -	Medium to high -
	Groundwater pollution as a result of unforeseen events such as saline water encountered during well blow-out. Contaminants originating from saline water may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a high probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.		Medium to high -	Medium to low -	Medium to low -
	Unplanned releases of formation water. Contaminants originating from deeper, formation water may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a low probability (pre-and post-mitigation) of occurring. The cumulative	Negative	Medium to low -	Low -	Low -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	impact is rated low as it is improbable that formation water will be encountered simultaneously. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.				
	Unplanned event such as well explosion can release saline formation water and gasses. Contaminants originating from deeper, formation water may potentially reach the local, potable water aquifer, however will only last for the construction phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a low probability (pre-and post-mitigation) of occurring. The cumulative impact is rated low as it is improbable that formation water will be encountered simultaneously. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to low -	Low -	Low -
Operational Phase	Inadequate casing or cementing can create a vertical flow pathway between different aquifers/ hydrostratigraphical units or between the production zone and potable aquifer. Contaminants originating from the deeper, saline aquifer may potentially reach the local, potable water aquifer which can last for the duration of the operational phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated high as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	High -	Medium to low -	Medium to high -
	Migration of saline groundwater or groundwater with a different chemical composition originating from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase can cause mixing between aquifers. Contaminants originating from wastewater spills and drilling sumps may potentially reach the local, potable water aquifer, which can last for the duration of the operational phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability of occurring. The cumulative impact is rated high as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	High -	Medium to low -	Medium to low -
	Upward migration of stray formation gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the gas production phase can cause mixing between aquifers. Stray gas originating from the deep aquifer may potentially reach the local, potable water aquifer which can last for the duration of the operational phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial	Negative	High -	Medium to low -	Medium to high -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.				
	Multiple gas wells can collectively affect groundwater levels, quality and hydraulic connectivity over a larger area. This impact can last for the duration of the operational phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated high as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	High -	Medium to low -	Medium to high -
	Gas production can alter pressure differences and alter hydraulic gradients between different hydrostratigraphical units resulting in modification of local groundwater flow pathways. This impact can last for the duration of the operational phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated high as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	High -	Medium to low -	Medium to high -
	Poor quality leachate may emanate from the gas production zone which may have a negative impact on groundwater quality. Contaminants originating from the gas production zone may potentially reach the local, potable water aquifer which can last for the duration of the operational phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -
	Poor storage and management of hazardous chemical substances on-site may cause groundwater pollution. Contaminants originating from hazardous chemical substances may potentially reach the local, potable water aquifer which can last for the duration of the operational phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	Operation and maintenance of heavy vehicles as well as associated machinery on-site may cause hydrocarbon contamination of groundwater resources. Hydrocarbon pollutants originating from heavy vehicles and drilling rigs may potentially reach the regional, potable water aquifer which can last for the duration of the operational phase of the project. This impact will potentially be reversible without incurring significant time and costs and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -
	Leaking pipelines may cause contamination of groundwater resources. Pollutants originating from the pipeline infrastructure may potentially reach the regional, potable water aquifer however which will last for the duration of the operational phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -
Decommissioning / Rehabilitation	Poorly plugged and sealed decommissioned production boreholes can create preferred groundwater flow pathways causing migration of saline groundwater or groundwater with a different chemical composition originating from the deep, fractured aquifer to the overlying, potable aquifer(s) during the decommissioning phase can cause mixing between aquifers. Saline water may potentially reach the regional, potable water aquifer which may have a long-term impact and will continue through the decommissioning phase. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated high as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	High -	Medium to low -	Medium to high -
	Poorly plugged and sealed decommissioned production boreholes can create preferred groundwater flow pathways causing an upward migration of stray formation gas from the deep, fractured aquifer to the overlying, potable aquifer(s) during the decommissioning phase can cause mixing between aquifers. Formation gas may potentially reach the regional, potable water aquifer which may have a long-term impact and will continue through the decommissioning phase. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated high as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used	Negative	High -	Medium to low -	Medium to high -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.				
	Multiple gas wells can collectively affect groundwater levels, quality and hydraulic connectivity over a larger area. This impact may potentially have a negative effect on the regional, potable water aquifer which may have a long-term impact and will continue through the decommissioning phase. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated high as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	High -	Medium to low -	Medium to high -
	Poor quality leachate may emanate from production zone footprint areas which may have a negative impact on groundwater quality. Poor quality leachate may potentially reach the regional, potable water aquifer which may have a long-term impact and will continue through the decommissioning phase. The reversibility of this impact may potentially be prohibitively high time and cost and has a medium probability (pre-mitigation) and a low probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	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. Hydrocarbon pollutants originating from heavy vehicles and drilling rigs may potentially reach the regional, potable water aquifer however will only last for the de-mobilisation period of the decommissioning phase of the project. The reversibility of this impact may potentially be prohibitively high time and cost and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.	Negative	Medium to high -	Medium to low -	Medium to low -
	Site de-establishment and removal of infrastructure can potentially cause increased turbidity and sediment loads in groundwater. Sediment loads may potentially be transported by drainages systems regionally, however will only last for the de-establishment period of the decommissioning phase of the project. This impact will potentially be reversible only by incurring significant time and costs and has a high probability (pre-mitigation) and a medium probability (post-mitigation) of occurring. The cumulative impact is rated medium as it is probable that this impact may result in a spatial and temporal cumulative change. The value of the resource being impacted on is rated as high due to the shallow aquifer being used to supply 50% or more of	Negative	Medium to high -	Low -	Medium to low -

Project Phase	Impact Description	Nature of Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance Score
	domestic water for a given area, and for which there are no reasonable available alternative sources should the aquifer be impacted upon.				

9.3.8.7 CUMULATIVE IMPACT ASSESSMENT

A cumulative impact can be defined as a historical impact, current impact as well as reasonably foreseeable future activities and impacts which may become significant when combined with impacts from similar or different activities. The greater study area is characterised by existing agricultural activities, mining developments including associated infrastructure, existing gas development and production activities as well as renewable energy developments. As the gas production activities do not require significant groundwater abstraction, the main cumulative impact(s) will focus on groundwater quality. Agricultural activities can introduce several contaminant sources such as nitrate, phosphates, pesticides as well as hydrocarbons whereas mining activities can also introduce contaminants such as sulphates, metals, acidity, salinity as well as hydrocarbons. Hydrocarbons and sediments originating from renewable energy developments is also potential water quality risks while gas development and production operations may introduce contaminants such as drilling fluids, hydrocarbons, produced formation water as well as potential formation gasses. If the latter occur within the same aquifer unit, the cumulative effect can be substantial with progressive degradation of groundwater quality a major risk. It should be noted that the deep, saline aquifer is separated from the potable water aquifer by competent confining formations, and if gas wells are properly constructed and sealed, the incremental groundwater contribution of the gas development will be relatively low negative, even though the broader area has substantial cumulative development pressure taking into account all other sectors currently active.

9.3.8.8 PROPOSED MITIGATION MEASURES

The proposed mitigation measures to avoid adverse impacts on groundwater due to proposed activities are provided below.

Existing relevant management and mitigation measures tried and tested for the same 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 development 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 construction 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 construction 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.
- 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). The design shall comply with recognised petroleum industry standards and any requirements of PASA, the approved work programme, exploration or production right, and applicable legislation. Relevant well planning and drilling information shall be submitted to PASA in accordance with regulatory and reporting requirements prior to commencement of drilling.
- 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 development 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 must 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 where possible 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 must be reviewed periodically by a suitably qualified hydrogeologist and updated where monitoring results, additional site-characterisation data, drilling information, significant deviations from predicted groundwater behaviour, or material changes to the development indicate that refinement or recalibration of the model is required. The model shall remain an active groundwater management tool throughout the life of the project.

- 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.
- Due to the sensitivity of the riparian areas, seismic activities must be as minimal as far as possible within the riparian areas.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Prior to drilling of the proposed production borehole targets, an updated hydrocensus user survey should be conducted within a 500.0m buffer zone at target areas where limited boreholes were surveyed to identify any potential groundwater receptors or privately owned boreholes being utilised. It should be noted that a hydrocensus surveys was conducted as part of this investigation to cover the majority of buffer zone areas, however an updated survey is recommended in order to verify any newly established borehole positions and will be used to substitute the existing database.
- Any development and/or drilling which takes place within the primary porosity aquifer associated with alluvium material deposited in flood plains must be avoided where possible and restricted if it cannot be avoided. If there are no other alternatives available and drilling within the riparian zone aquifer is necessary, mitigation and management measures should be strictly adhered to.
- Additional monitoring boreholes should be established within the proposed target areas buffer zone as identified in Section 16 of the Geohydrological Impact Assessment Report, to evaluate the mass load contribution to sensitive environmental and groundwater receptors. 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.
- Pre-development monitoring can be considered in order to formulate a baseline to serve as benchmark going forward. Monitoring results should be evaluated and reviewed on a bi-annual basis by a registered hydrogeologist for interpretation and trend analysis and submitted to the Regional Head: Department of Water and Sanitation upon request.
- Develop and implement a stormwater management plan in accordance with GN704 to separate dirty/contact water from clean water circuits.
- If significant gas is encountered during drilling, respective boreholes should be sealed-off with a combination of casing and grouting to ensure isolation of the gas from the host-aquifer(s). Well design will be undertaken according to designs developed by a qualified well engineer.
- A surface casing vent flow test must be conducted to determine whether gas or liquid or a combination thereof is escaping from the casing. If gas is detected during this test, remedial work should be designed and implemented.
- Applicant must implement a NORM/TENORM monitoring and management programme, where applicable, during production operations. This programme should include the periodic inspection, monitoring and characterisation of produced water, scales, sludges, sediments, process residues, maintenance wastes and any other materials identified as having the potential to contain elevated concentrations of naturally occurring radionuclides. Monitoring requirements and sampling frequencies must be informed by operational experience, production characteristics, regulator requirements and recognised industry good practice.

9.3.9 SURFACE WATER (HYDROLOGICAL) IMPACTS

This section presents the identified potential impacts on hydrology and surface water resources associated with the proposed D3 Energy PR activities, taking into consideration the project description, alternatives assessment, hydrological baseline, aquatic biodiversity assessment, floodline assessment, existing gas infrastructure, agricultural activities and planned renewable energy developments. The assessment has been informed by the findings of the D3 Energy Hydrological Study undertaken by Smec South Africa (**Appendix F6**) and the D3 Energy Aquatics and Wetlands Impact Assessment undertaken by The Biodiversity Company (**Appendix F3**). The project area contains numerous wetlands, seeps, channelled and unchannelled valley-bottom wetlands, depressions, floodplain systems, the Sand River, Maselspruit, Doring River and Merriespruit, together with associated drainage features and flood-sensitive areas.

9.3.9.1 AQUATICS AND WETLANDS

As indicated in **Section 8.10.4**, the delineated wetlands were grouped into Hydrogeomorphic (HGM) units based on their topographic similarity, shared exposure to comparable threats, and the expectation that they provide similar ecological benefits. This approach ensures that wetlands with analogous landscape positions, hydrological regimes, and vulnerability to anthropogenic pressures are assessed collectively. Forty-two (42) HGM units were identified and delineated within the PR (**Figure 74**). These features were classified as channelled valley-bottoms, unchannelled valley-bottoms, seeps, depressions, and floodplain systems (refer to **Figure 70**). In addition, three riparian systems and several non-perennial drainage features and dams were identified. Furthermore, several artificial wet areas were delineated, which have resulted from stormwater management and land-use practices such as agricultural activities. The buffer requirements for the wetlands were calculated using the Site-Based Tool: Determination of buffer zone requirements for wetland ecosystems (Macfarlane *et al.,* 2014). The recommended post-mitigation buffers were calculated to be 15 m. A summary of the wetland area and percentage covers of wetland within the PR is provided in **Table 38**.

9.3.9.1.1 QUANTITATIVE RISK

The proposed project is anticipated to result in localised, predominantly temporary disturbance within the assessment footprint, primarily associated with vehicle movement along the planned seismic lines and drilling activities associated with the proposed areas for the drilling wells, and the excavation activities for the gathering pipelines situated between the drilling well localities. 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. The focus for mitigation was thus placed on minimising potential impacts.

It is anticipated that the project will pose “Low” and “Moderate” post-mitigation risks, this considers that the suggested mitigations are implemented and that wetlands will not be fully avoided. The impact of the proposed development can be mitigated to a large degree through the designing of the proposed facilities outside of the wetlands and their associated buffers. Although the proposed mitigation measures significantly reduce the severity of most anticipated impacts, several activities particularly those intersecting wetlands continue to exhibit moderate post-mitigation risks. These residual risks remain because certain impacts, such as hydrological alteration, habitat loss within wetland footprints, fragmentation, and long-term changes to flow pathways at crossings, cannot be fully eliminated. Conversely, risks relating to water quality impairment, alien and invasive plant encroachment, sedimentation, and vegetation clearance can be effectively mitigated to low provided the recommended buffer avoidance, stormwater management measures, rehabilitation provisions and operational controls are implemented.

9.3.9.1.2 IMPACT ASSESSMENT

The impacts associated with the proposed activities, was assessed in the impact matrix provided by EIMS and the results are given in **Table 89** to **Table 92** for the activities relating to the Seismic Transects, Drilling Wells, Gathering Lines and Gas Plant.

9.3.9.1.2.1 SEISMIC ACTIVITIES

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, soil compaction, vegetation disturbance and the development of localised erosion hotspots, with the potential for increased sediment and contaminant mobilisation towards 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 are the Construction Phase and Post-Development (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.

9.3.9.1.2.2 PRODUCTION WELLS

The proposed development drilling wells are expected to cause localised and largely temporary disturbance within the designated drilling sites and their 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 during the 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. In addition to construction-related impacts, the operational phase of the drilling wells has been assessed under two scenarios, namely normal operations and abnormal operations. Normal operations include routine well operation, site maintenance and associated vehicle access, which may result in ongoing disturbance, erosion, contaminated runoff and the spread of alien and invasive vegetation. Abnormal operations refer to unplanned but credible incidents, including blowouts during drilling or production, major hydrocarbon or chemical spills, releases of contaminated water, fires or explosions, and infrastructure or waste management failures, all of which may result in acute or chronic impacts on wetlands, drainage features and associated freshwater habitat.

9.3.9.1.2.3 GATHERING PIPELINES

The proposed gathering lines are expected to result in localised, linear disturbance along the pipeline servitudes, primarily associated with trench excavation, pipe installation, backfilling, and associated vehicle and machinery movement during the Construction Phase. The principal freshwater-related risks are linked to the excavation and reinstatement of trenches, particularly where gathering lines intersect or occur in close proximity to wetlands and drainage features. These activities may alter local surface and shallow subsurface flow patterns, disturb wetland soils and vegetation, and create erosion-prone disturbed surfaces, with the potential for increased sediment mobilisation to adjacent freshwater features. Additional risks include impaired water quality resulting from sediment-laden runoff, trench water, and accidental spills or leaks of fuels, oils, and other hazardous substances associated with construction machinery and materials handling. If not appropriately managed, soil stripping, spoil stockpiling, trench backfilling, and poor reinstatement of the trench corridor may result in temporary obstruction or diversion of natural overland flow, localised ponding, settlement, persistent erosion, and reduced wetland habitat quality. In addition, disturbance along the pipeline corridor may facilitate the establishment and spread of alien and invasive plant species in disturbed wetland and buffer areas.

Although the gathering lines are anticipated to be rehabilitated following installation, inadequate rehabilitation and poor re-establishment of pre-disturbance contours and vegetation cover may prolong impacts into the Rehab and Closure Phase. The phases assessed for the gathering lines therefore include the Construction Phase, the Operational Phase, and the Rehab and Closure Phase. For the Operational Phase, impacts are assessed for both **normal operations**, such as maintenance access and routine infrastructure management, and **abnormal operations**, including pipeline rupture, chronic leakage, accidental major spills, stormwater control failure and emergency incident response, which may result in contamination, soil disturbance and degradation of adjacent wetlands and drainage features.

9.3.9.1.2.4 GAS PLANT AND PRODUCTION ACTIVITIES

The proposed Gas Plant and associated production infrastructure are expected to result in localised but potentially persistent disturbance within the plant footprint and immediate surroundings. Freshwater-related risks are primarily associated with site establishment and earthworks during construction, the creation of hardened surfaces, stormwater generation, storage and handling of hydrocarbons, condensate and other hazardous substances, and the operation of process infrastructure. During the Operational Phase, the Gas Plant has similarly been assessed for both **normal operations** and **abnormal operations**. Normal operations may result in altered runoff patterns, increased stormwater volumes, contaminated runoff, habitat disturbance and ongoing risks associated with routine maintenance and vehicle activity. Abnormal operations may include major hydrocarbon or chemical releases, produced water or process water containment failure, fire or explosion, stormwater containment failure, and sewage or waste system failure, all of which could cause acute or chronic impacts on nearby wetlands, drainage features, wetland soils and vegetation if not effectively contained and managed. The Gas Plant assessment therefore considers impacts during the Construction Phase, the Operational Phase under both normal and abnormal scenarios, and the Rehab and Closure Phase where relevant.

The impact assessment indicates that the risks associated with the proposed activities are generally of Medium to Low significance prior to mitigation, with gathering lines presenting the highest pre-mitigation risk where interactions with wetlands and drainage features are unavoidable or difficult to manage. With the implementation of appropriate avoidance, management and mitigation measures, impacts are generally reduced to Medium to Low or Low significance, indicating that the identified risks can be effectively managed. The findings indicate that, provided that wetland avoidance is maintained where possible and that both routine operational controls and emergency response measures are effectively implemented, the long-term impacts on wetland and freshwater ecosystem health and functionality are expected to remain limited.

9.3.9.2 FLOODLINES

The peak flows estimated by the SDF method as presented in **Section 8.10.7.3** were used to simulate the floodlines of the rivers running through the D3 Energy PR. The floodlines are indicated in **Figure 127** below.

The sensitivities and constraints at the D3 Energy project site were assessed in accordance with the National Water Act Regulations (GN509, 2016) and the EIMS sensitivity assessment methodologies. Based on the National Water Act (GN509, 2016) described in **Section 4.1.9**, the area within the 1:100-year floodline is considered to be highly sensitive. A well site may not be located within the 1:100-year floodline. It is also recommended that the production plant (location A, B or C) is located outside the delineated 1:100-year floodline.

Figure 128 indicates a sensitivity map which was developed to assist in identifying sensitive features in relation to the 1:100-year flood within the project area with consideration for climate change impacts. According to **Figure 128** there is an estimated 8 gas wells located within or close to the very high sensitivity area (1:100-year floodline) of the project which would form part of the overall analysis and approval of placing final well infrastructure to be determined by the Client/Developer.

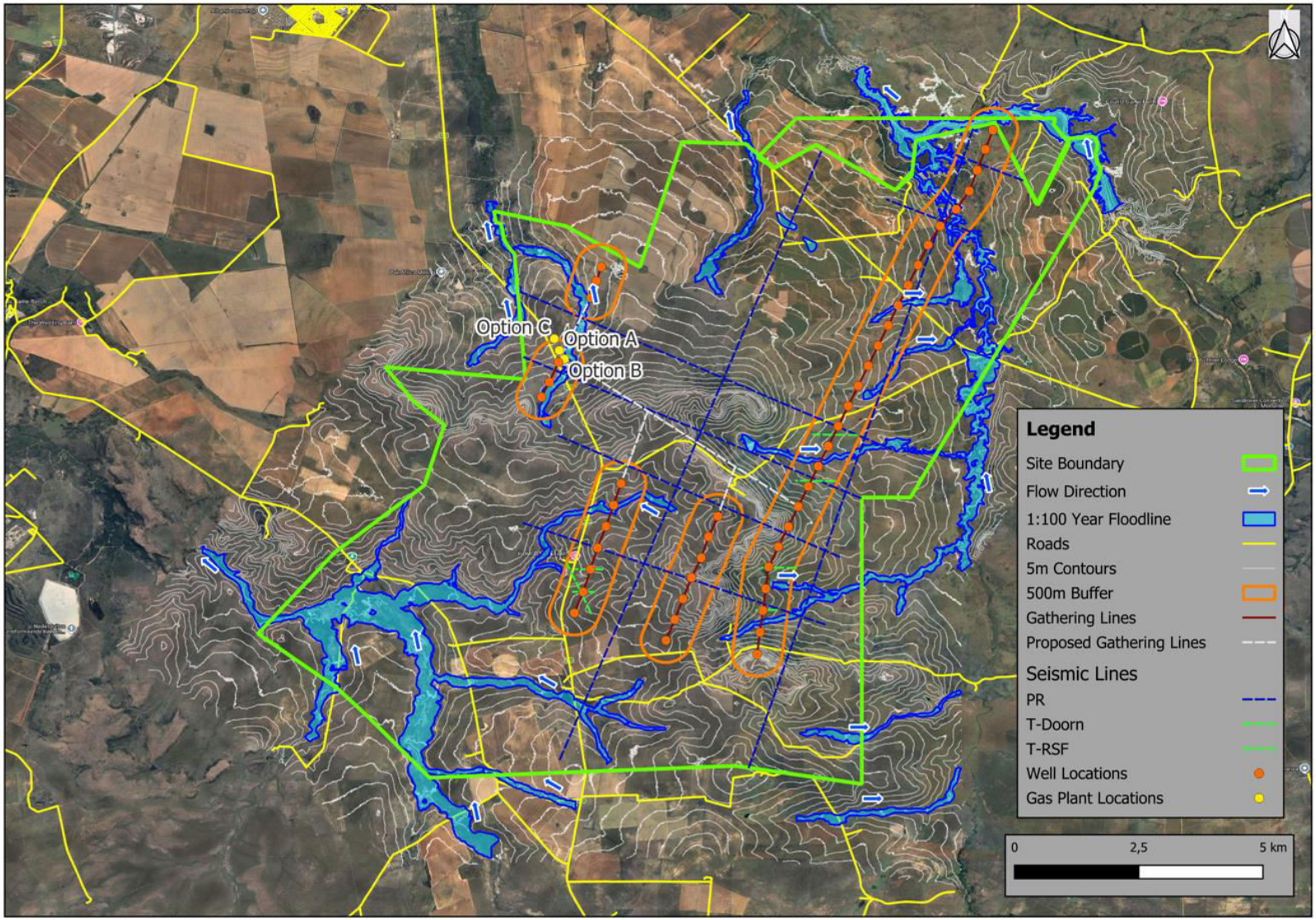


Figure 127: 100-Year Floodlines incorporating Climate Change (Smec South Africa, 2026).

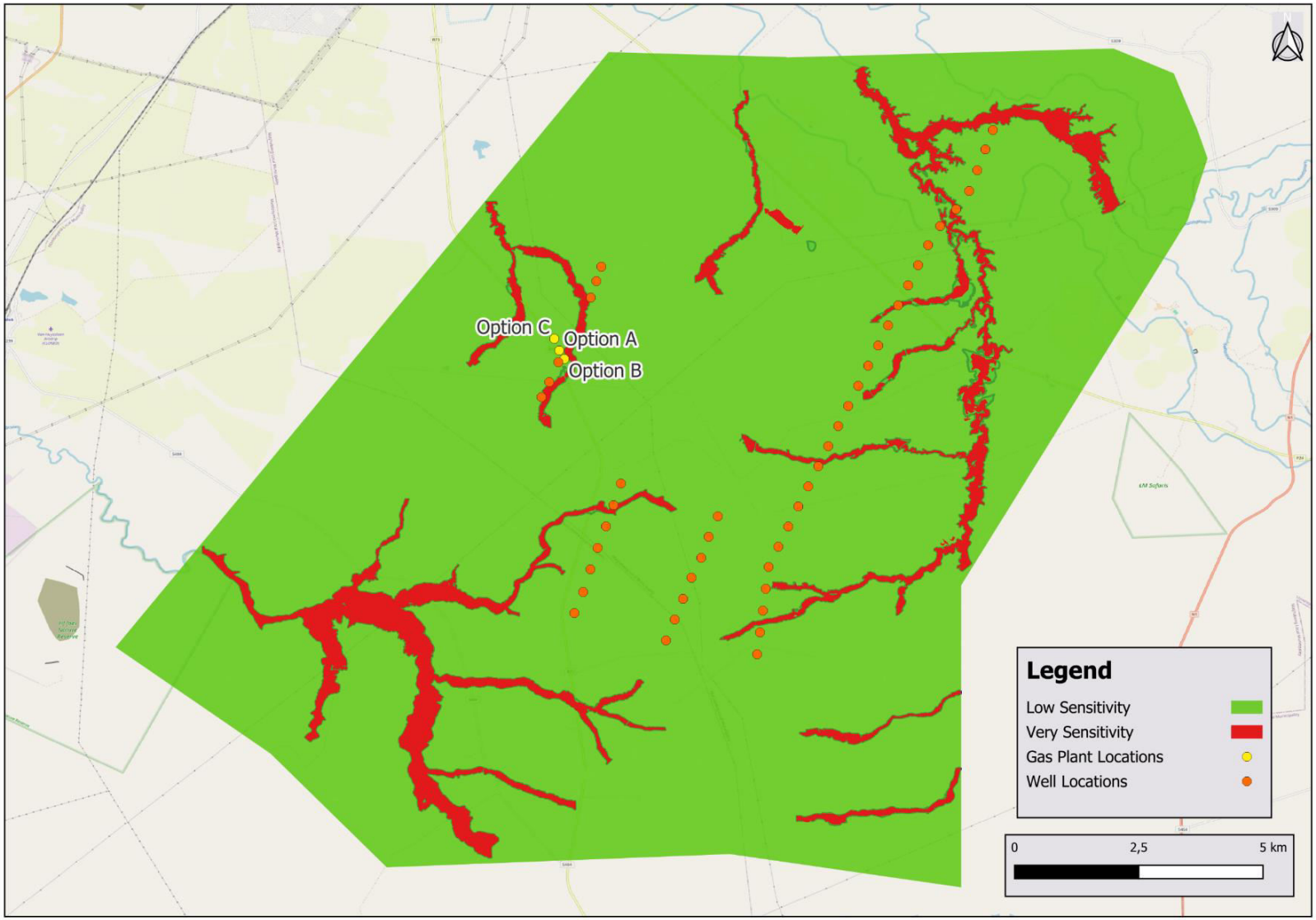


Figure 128: Floodline Sensitivity Map (Smec South Africa, 2026).

9.3.9.3 IMPACT RATING

Table 89: Summative results of the Impact Assessment conducted for the proposed activities in relation to the Seismic Transects (The Biodiversity Company, 2026).

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: WetA1	Construction	Medium to Low	Low	Low -
Impact: Altered surface flows from soil compaction and creation of preferential flow paths leading to erosion and sedimentation				
ID: WetA2	Construction	Medium to Low	Low	Low -
Impact: Soil compaction leading to increased risk of erosion and sedimentation				
ID: WetA3	Construction	Medium to Low	Low	Low -
Impact: Disturbance to wetland vegetation and soil leading to proliferation of alien invasive plants				
ID: WetA4	Construction	Medium to Low	Low	Low -
Impact: Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff				
ID: WetA5	Rehab and Closure	Medium to Low	Low	Low -
Impact: Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff from rehabilitation activities				
ID: WetA6	Rehab and Closure	Medium to Low	Low	Low -
Impact: Continued degradation of wetlands from improper post-development rehabilitation				
ID: WetA7		Low+		

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
Impact: Improvement in wetland functionality from successful rehabilitation	Rehab and Closure		Low to Medium +	Medium to low +

Table 90: Summative results of the Impact Assessment conducted for the proposed activities in relation to locations identified for drilling of wells (The Biodiversity Company, 2026).

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: WetB1 Impact: Altered surface flows from soil compaction and creation of preferential flow paths leading to erosion and sedimentation	Construction	Medium to Low	Low	Low -
ID: WetB2 Impact: Soil compaction leading to increased risk of erosion and sedimentation	Construction	Medium to Low	Low	Low -
ID: WetB3 Impact: Disturbance to wetland vegetation and soil leading to proliferation of alien invasive plants	Construction	Medium to Low	Low	Low -
ID: WetB4 Impact: Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff	Construction	Medium to Low	Low	Low -
ID: WetB5 Impact: Altered surface flows from soil compaction and creation of preferential flow paths leading to erosion and sedimentation	Construction (unplanned)	Medium to Low	Low	Low -
ID: WetB6 Impact: Soil compaction leading to increased risk of erosion and sedimentation	Construction (unplanned)	Medium to Low	Low	Low -

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: WetB7 Impact: Disturbance to wetland vegetation and soil leading to proliferation of alien invasive plants	Construction (unplanned)	Medium to Low	Low	Low -
ID: WetB8 Impact: Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff	Construction (unplanned)	Medium to Low	Low	Low -
ID: WetB9 Impact: Routine operation of the drilling wells may result in localised contaminated runoff, minor hydrocarbon leaks, and ongoing disturbance within the operational footprint, which may reduce water quality and habitat condition in nearby wetlands and drainage features if not appropriately managed	Operations	Medium to Low	Low	Low -
ID: WetB10 Impact: Routine maintenance access and associated vehicle movement may result in localised soil compaction, vegetation disturbance and erosion along access routes, with the potential to affect nearby wetland habitat and drainage patterns.	Operations	Medium to Low	Low	Low -
ID: WetB11 Impact: Continued disturbance within and around the well pad and associated access areas may facilitate the establishment and spread of alien and invasive plant species, resulting in reduced habitat quality in adjacent wetland and buffer areas..	Operations	Medium to Low	Low	Low -
ID: WetB12 Impact: An uncontrolled blowout during drilling or production could result in the release of hydrocarbons, drilling fluids and/or formation fluids into adjacent wetland areas, causing acute contamination of wetland soils and surface water, destruction of vegetation, and long-term degradation of wetland ecological integrity and functioning.	Operations (Abnormal or Unplanned)	Medium to High	Medium to Low	Medium to Low -
ID: WetB13		Medium to Low	Medium to Low	

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
Impact: An accidental major spill of fuel, hydrocarbons, lubricants, drilling additives or other hazardous substances during abnormal operations may result in contamination of wetland soils and water resources, loss of habitat quality, and impairment of wetland ecological processes.	Operations (Abnormal or Unplanned)			Medium to Low -
ID: WetB14 Impact: The accidental release of produced water, contaminated process water or drilling wastewater during abnormal operations could result in increased salinity and pollutant loading in wetland soils and surface water, adversely affecting vegetation, habitat quality and wetland functioning.	Operations (Abnormal or Unplanned)	Medium to High	Medium to Low	Medium to Low -
ID: WetB15 Impact: A fire or explosion associated with drilling or production infrastructure may result in direct damage to wetland vegetation and soils, while emergency response actions may cause secondary impacts through trampling, soil compaction, disturbance of wetland habitat and the release of firefighting agents.	Operations (Abnormal or Unplanned)	Medium to Low	Low	Medium to Low -
ID: WetB16 Impact: Failure of sewage, sanitation or waste management systems during drilling operations may result in the discharge of untreated effluent or waste materials into wetland areas, causing nutrient enrichment, contamination, odour impacts and a decline in habitat quality.	Operations (Abnormal or Unplanned)	Medium to High	Medium to Low	Medium to Low -
ID: WetB17 Impact: Failure of stormwater control or erosion management structures during extreme rainfall events may result in uncontrolled runoff, erosion, sediment deposition and transport of contaminants into wetlands, thereby altering hydrological functioning and reducing habitat quality.	Operations (Abnormal or Unplanned)	Medium to High	Medium to Low	Medium to Low -
ID: WetB18 Impact: Impaired water quality from hydrocarbon spills and leaks and associated contaminated runoff	Rehab and Closure	Medium to Low	Low	Low -
ID: WetB19 Continued degradation of wetlands from improper post-development rehabilitation	Rehab and Closure	Medium to Low	Low	Low -

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: WetB20 Improvement in wetland functionality from successful rehabilitation	Rehab and Closure	Low+	Low to Medium +	Medium to low +

Table 91 Summative results of the Impact Assessment conducted for the proposed activities in relation to excavations for gathering lines (The Biodiversity Company, 2026).

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: WetC1 Impact: Altered surface and shallow subsurface flow patterns from trench excavation, backfilling, and compaction, leading to erosion and sedimentation	Construction	Medium to High	Medium to Low	Medium to Low -
ID: WetC2 Impact: Soil disturbance and compaction along the trench corridor leading to increased erosion and sedimentation risk	Construction	Medium to High	Medium to Low	Medium to Low
ID: WetC3 Impact: Disturbance to wetland vegetation and soils within the pipeline corridor leading to habitat degradation and proliferation of alien invasive plants	Construction	Medium to High	Medium to Low	Medium to Low -
ID: WetC4 Impact: Impaired water quality from sediment-laden runoff, trench water, and contaminated runoff associated with construction activities	Construction	Medium to High	Medium to Low	Medium to Low -
ID: WetC5 Impact: Impaired water quality from accidental spills and leaks of fuels, oils, and other hazardous substances associated with machinery and construction activities	Construction	Medium to High	Medium to Low	Medium to Low -
ID: WetC6 Impact: Temporary obstruction or diversion of overland flow due to topsoil stripping, spoil stockpiling, and placement of construction materials	Construction	Medium to High	Medium to Low	Medium to Low -
ID: WetC7 Impact: Altered surface and shallow subsurface flow patterns from poorly managed trenching, collapse, or storm-related failure of trench sections leading to erosion and sedimentation	Construction (unplanned)	Medium to Low	Medium to Low	Medium to Low -
ID: WetC8	Construction	Medium to Low	Medium to Low	

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
Impact: Severe erosion and sedimentation resulting from intense rainfall on open trenches, exposed soils, and stockpiles	(unplanned)			Medium to Low -
ID: WetC9	Construction (unplanned)	Medium to Low	Medium to Low	Medium to Low -
Impact: Disturbance to wetland vegetation and soils leading to accelerated alien invasive plant establishment following failed rehabilitation or excessive disturbance				
ID: WetC10	Construction (unplanned)	Medium to Low	Medium to Low	Medium to Low -
Impact: Significant water quality deterioration from major hydrocarbon spills, chemical leaks, or contaminated runoff entering wetlands or drainage features				
ID: WetC11	Operation	Low	Low	Low -
Impact: Altered overland flow and localised erosion at poorly reinstated pipeline crossings and maintenance access points				
ID: WetC12	Operation	Low	Low	Low -
Impact: Disturbance to wetland-edge vegetation from routine maintenance access and associated proliferation of alien invasive plant species				
ID: WetC13	Operation (unplanned)	Low	Low	Low -
Impact: Impaired water quality from accidental pipeline leakage or maintenance-related hydrocarbon contamination				
ID: WetC14	Rehab and Closure	Medium to Low	Medium to Low	Medium to Low -
Impact: Persistent erosion, altered drainage, and water quality impairment resulting from inadequate rehabilitation of the trench corridor and disturbed wetland crossings				
ID: WetC15	Rehab and Closure	Medium to Low	Medium to Low	Medium to Low -
Impact: Continued proliferation of alien invasive plants and reduced wetland habitat quality due to failed revegetation of disturbed gathering line servitudes				
ID: WetC16	Rehab and Closure	Low+	Low to Medium +	Medium to low +
Improvement in wetland functionality from successful rehabilitation				

Table 92 Summative results of the Impact Assessment conducted for the proposed activities in relation to excavations for gathering lines (The Biodiversity Company, 2026).

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: WetD1 Impact: Site clearance, earthworks and establishment of the Gas Plant footprint may result in the loss of native vegetation, soil disturbance, erosion, sediment mobilisation and indirect impacts to nearby wetlands and drainage features.	Construction	Medium to High	Medium to Low	Medium to Low -
ID: WetD2 Impact: Storage and handling of fuels, oils, chemicals and construction materials may result in impaired water quality due to contaminated runoff, accidental spills or leaks reaching nearby wetlands and drainage features.	Construction	Medium to High	Low	Low -
ID: WetD3 Impact: Routine operation of the Gas Plant may result in altered runoff patterns, increased stormwater volumes, localised erosion, and contaminated runoff from hardened surfaces, reducing the quality of adjacent freshwater habitat.	Operation	Medium to Low	Low	Low -
ID: WetD4 Impact: Routine maintenance activities, vehicle movement and disturbance within and around the Gas Plant may result in vegetation disturbance, soil compaction and the establishment or spread of alien invasive plant species in adjacent disturbed areas.	Operation	Medium to Low	Low	Low -
ID: WetD5 Impact: A major release of hydrocarbons, condensate, chemicals or other hazardous substances at the Gas Plant or associated production infrastructure could result in contamination of nearby wetlands through runoff, infiltration or accidental discharge, thereby reducing water quality and habitat condition.	Operation (Unplanned)	Medium to High	Medium to Low	Medium to Low -
ID: WetD6 Impact: Failure of produced water or process water containment systems could result in discharge of contaminated water to surrounding wetland areas, causing salinisation, chemical contamination and impairment of wetland ecological functioning.	Operation (Unplanned)	Medium to High	Medium to Low	Medium to Low -
ID: WetD7 Impact: A fire or explosion at the Gas Plant may result in direct damage to adjacent habitat and secondary wetland impacts through contaminated runoff, firefighting activities and emergency access disturbance.	Operation (Unplanned)	Medium to High	Medium to Low	Medium to Low -
ID: WetD8 Impact: Failure of sewage, sanitation or waste handling infrastructure at the Gas Plant or associated support facilities may lead to the release of untreated effluent or waste into nearby wetland systems, causing contamination and habitat degradation.	Operation (Unplanned)	Medium	Low	Low -
ID: WetD9		Medium to High	Low	Low -

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
Impact: Failure of stormwater management infrastructure at the Gas Plant during abnormal rainfall or operational upset conditions may cause sediment-laden or contaminated runoff to enter wetlands, resulting in reduced water quality and altered wetland functioning.	Operation (Unplanned)			
ID: WetD10	Rehab and Closure	Medium to Low	Low	Low -
Impact: Inadequate rehabilitation and closure of the Gas Plant footprint may result in persistent erosion, altered runoff patterns, establishment of alien invasive species and reduced recovery of freshwater-sensitive habitat.				
ID: WetD11	Rehab and Closure	Low	Low	Low -
Impact: Successful rehabilitation of the Gas Plant footprint and associated disturbed areas may improve local habitat condition and support the recovery of freshwater ecosystem functioning over the longer term.				

9.3.9.4 CUMULATIVE IMPACT ASSESSMENT

The cumulative hydrological impact must be assessed within the broader regional landscape, which already contains:

- Existing D3 and nearby gas exploration infrastructure.
- Existing agricultural cultivation and grazing.
- Historical and active mining activities.
- Existing roads, pipelines and powerline corridors.
- Existing dams, drainage modifications and farm water infrastructure.
- Existing and planned renewable energy developments.
- Multiple wetlands and drainage systems connected through the regional catchment network.

Potential cumulative effects include:

- Progressive loss of wetland ecological functioning.
- Cumulative increases in sediment loading.
- Incremental reduction in flood attenuation capacity.
- Increased runoff due to expanding infrastructure footprints.
- Cumulative pressure on river crossing points.
- Increased fragmentation of aquatic habitat.
- Reduced catchment-scale hydrological connectivity.
- Increased risk of cumulative pollution events.
- Incremental alteration of surface water quality.

Factors reducing cumulative significance include:

- Small and dispersed project footprints.
- Avoidance of sensitive wetland features where feasible.
- Rehabilitation of temporary disturbances.
- Predominantly buried pipeline infrastructure.
- Application of stormwater attenuation measures.
- Adoption of wetland buffers and floodline setbacks.
- Long-term hydrological monitoring.

The cumulative Hydrology / Surface Water Impact was assessed to be Medium to Low negative. Although cumulative effects are expected, they are considered manageable provided hydrological and aquatic biodiversity mitigation measures are consistently.

9.3.9.5 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 construction 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 construction 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.
- 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
    - Feasible and available use of Efficient Flare Systems (achieving a 98% or higher destruction efficiency) for flaring of excess gas during drilling activities
    - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
    - A 100-meter danger zone is immediately enforced around the wellhead
    - Active Spill Prevention, Control, and Countermeasure

- Adequate emergency response team with sufficient containment materials and berms to be used to prevent leaked fluids from entering local waterways or soil

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- The Gas Plant footprint must be positioned outside wetlands and, where possible, outside recommended wetland buffers.
- Wetlands downstream of the facility must be inspected after major incidents or storm events.
- Surface runoff from operational areas must be managed to prevent discharge into wetlands.
- Stormwater infrastructure must be designed for extreme rainfall and upset conditions.
- Clean and dirty water systems must be separated and maintained.
- Stabilise exposed soils and stockpiles using mulch, brush packing, sheeting, or similar temporary measures where heavy rainfall risk exists.
- Install temporary sediment barriers downslope of exposed trenching areas and stockpiles where required based on erosion/runoff risk.
- Fire detection, suppression and emergency shutdown systems must be installed and maintained.
- Alien invasive plant monitoring and control must be implemented within and around the gas plant footprint.
- Inspect pipeline infrastructure and maintenance equipment regularly for signs of leaks or failure.
- Place topsoil, spoil, and construction material stockpiles outside wetlands, drainage lines, and natural flow paths.
- Keep stockpiles to the minimum required size and duration and stabilise them where erosion risk is evident.
- Do not place excavated material on the downslope side of wetlands or drainage features where it may obstruct or redirect flow.
- Inspect stockpile and trench areas regularly, especially after rainfall, and correct any flow diversion or erosion immediately.
- Prevent trench water from discharging directly into wetlands, drainage lines, or other watercourses.
- Pump or decant trench water to stable, vegetated upland areas only where sediment can settle and no runoff to wetlands will occur.

9.3.10 IMPACTS ON SOILS AND AGRICULTURAL POTENTIAL

The proposed D3 Energy PR area is located within an intensively utilised agricultural landscape comprising active dryland crop production (predominantly maize and soybean cultivation), livestock grazing areas, historical cultivated lands, protected agricultural areas associated with the Virginia Protected Agricultural Area (PAA), and soils ranging from high agricultural capability (Dundee, Griffin, Hutton, Clovelly and portions of Oakleaf soils) to lower capability and wetland-associated soils. The area is characterised by predominantly low to moderate slopes (0 to 5%), extensive agricultural production, and soils with varying erosion susceptibility. Sensitive agricultural areas include active cultivation fields, land capability Class I and II soils, and portions of the Virginia PAA. The assessment of potential impacts on soils and agriculture has been informed by the findings of the D3 Energy Soils and Agricultural Impact Assessment undertaken by The Biodiversity Company (**Appendix F12**).

9.3.10.1 LAND CAPABILITY

Fifteen land capabilities have been digitised by (DAFF, 2017) across South Africa, of which six potential land capability classes are located within the Project area and PAOI, including;

- Land Capability 3 to 5 (Very Low to Low Sensitivity);
- Land Capability 6 to 7 (Low-Moderate Sensitivity); and
- Land Capability 8 to 9 (Moderate to Moderate-High Sensitivity).

The land capability dataset (DAFF, 2017) indicates a range pf categories expected throughout the project focus areas. The proposed project area falls predominantly within "Low-Moderate" land capability sensitivity and with other areas having "Moderate to Moderate-High" and "Very Low to Low" land capability sensitivities (see **Figure 129).** Furthermore, the agricultural theme tool also indicated the presence of very highly and highly sensitive field crop boundaries (**Figure 130**). Moreover, portions of the project focus area, falls within Protected Agricultural Areas (PAAs), as stipulated by the DALRRD (2020; **Figure 131**).

The baseline soil findings, current land uses and the calculated land potential concur to an extent with the agricultural theme tool, in areas demarcated "Low-Moderate" and "Very Low to Low" land capability sensitivities and with highly sensitive field crop boundaries within the project focus areas. They further dispute to an extent the agricultural theme tool on all areas demarcated as highly sensitive for field crop boundaries and "Moderate to Moderate-High" land capability sensitivity. Commercial maize and soyabean production under rainfed conditions were confirmed within the D3 Energy PR.

Additionally, the proposed D3 Energy PR falls within an area that is classified as Virgina Protected Agricultural Area (PAA). The PAA are generally considered conducive for agricultural production, as these areas have made a significant contribution to the cultivation of various essential crops. Their protection is critical to ensure sustainable food production within South Africa. Evidently, not all demarcated (PAA) within Project Area are suitable for crop production, due to the presence of low potential soils and areas physically disturbed by solar PV construction. However, some areas overlap with active cropping under rainfed, and irrigation infrastructure and these areas should be conserved. The proposed activities associated with the project should ensure no/or minimal segregation of such areas.

Moreover, low and medium potential soils were identified within the project area. According to the Land Type Survey Staff (1972 – 2006), low and medium potential soils were confirmed within the entire D3 Energy PR. Moreover, highly and very highly sensitive field crop boundaries were identified within the D3 Energy PR by the help of the agricultural theme tool.

The D3 Energy PR activities will have acceptable expected changes to soil resources. As a result, based on the verified baseline findings, the proposed development will have a minimal impact on the soil resources.

9.3.10.2 SITE SENSITIVITY

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 7 (this land potential level is characterised by low potential. 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”, “VI” and “VIII” was assigned “Low” sensitivity. (**Figure 132**).

Considering the soil properties, agricultural potential as well as the current land use of the proposed target drilling areas, the area has a predominately “Low” agricultural sensitivity, with “Medium” and marginal “High” sensitive areas (see **Figure 132**). The allocated sensitivities for the theme are either disputed or validated in **Table 93** below.

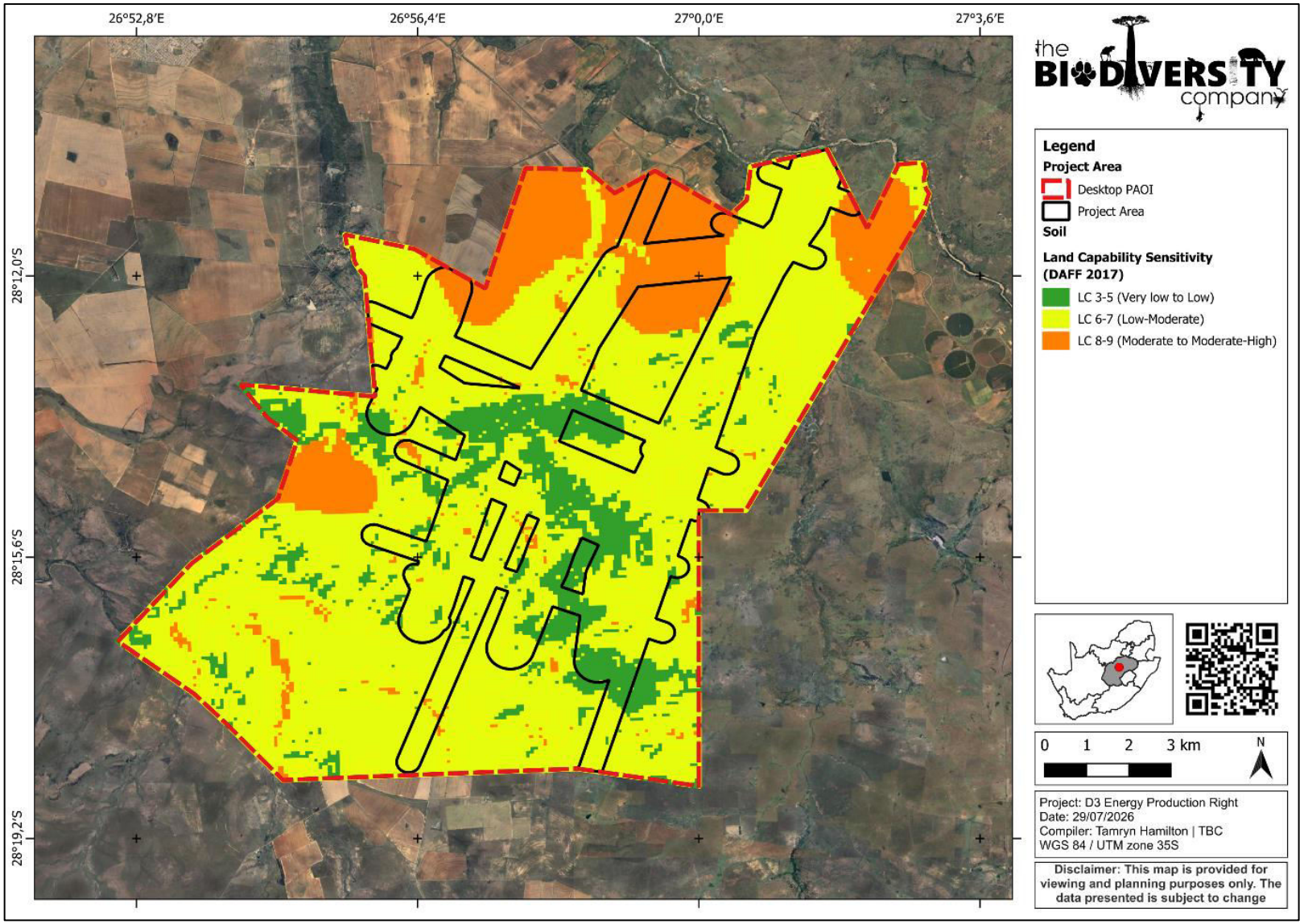


Figure 129: Land Capability Sensitivity (DAFF, 2017) (The Biodiversity Company, 2026).

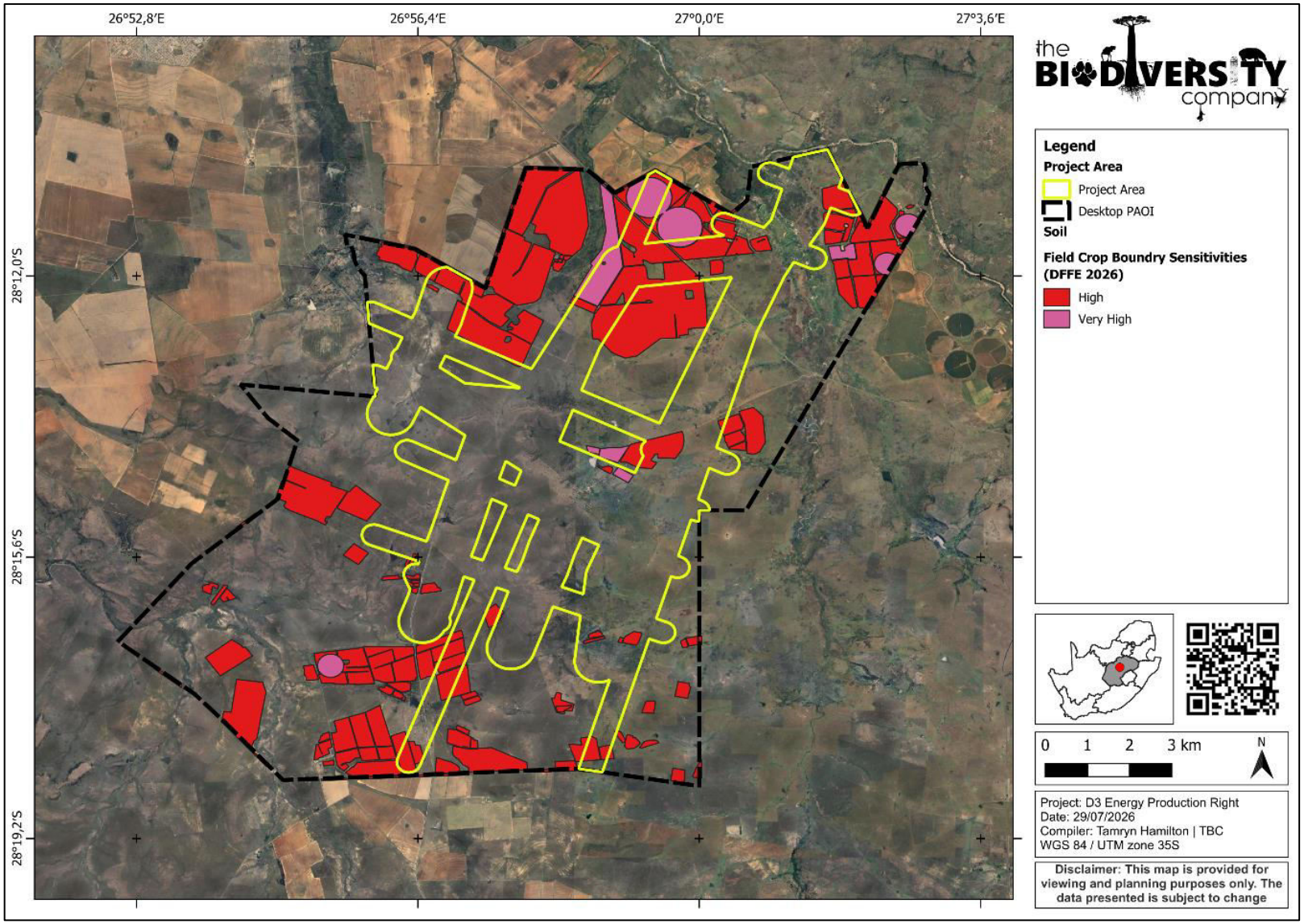


Figure 130: Field crop boundary sensitivity (DFFE 2026) (The Biodiversity Company, 2026).

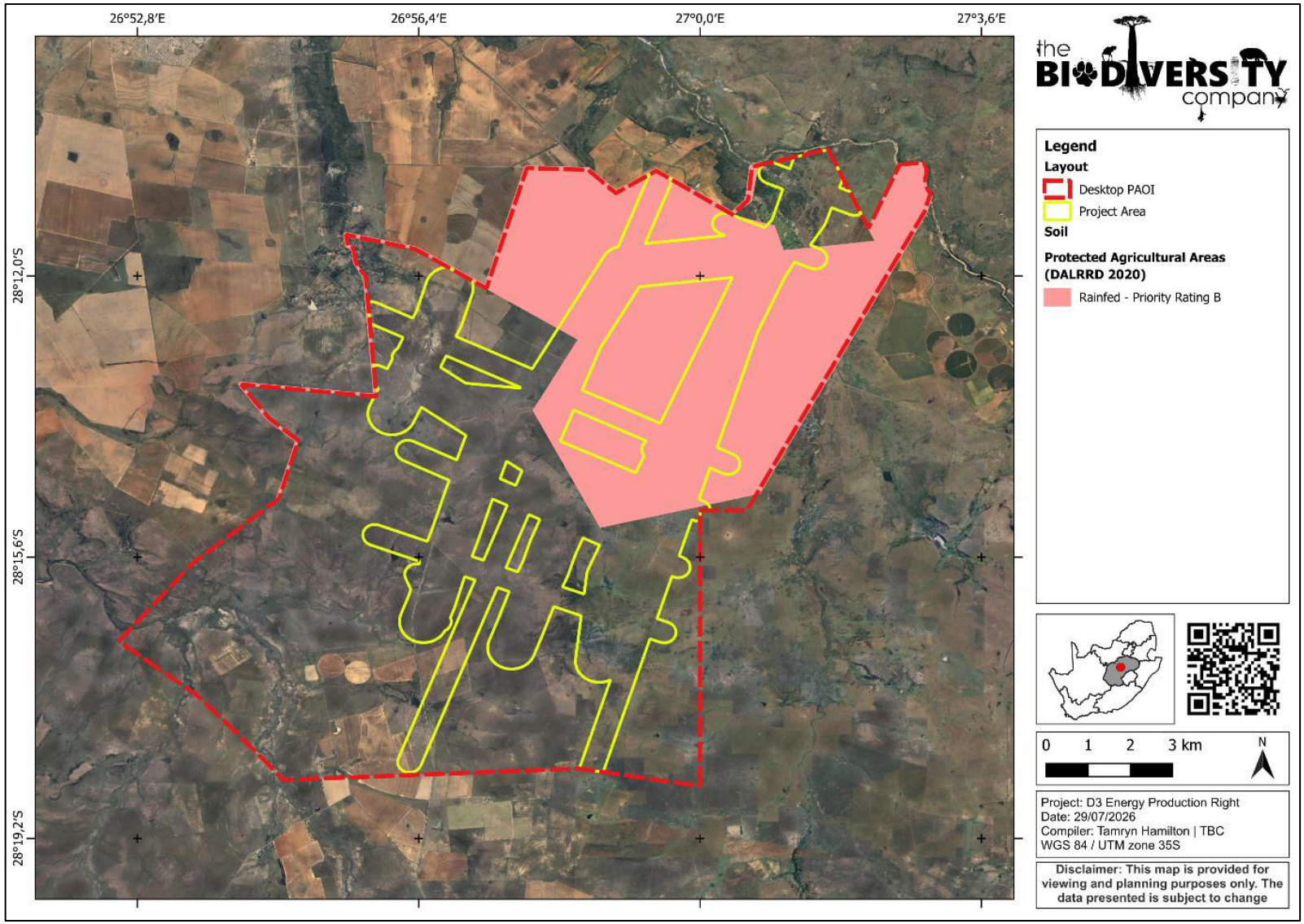


Figure 131: Protected Agricultural Areas (DALRRD, 2020) (The Biodiversity Company, 2026).

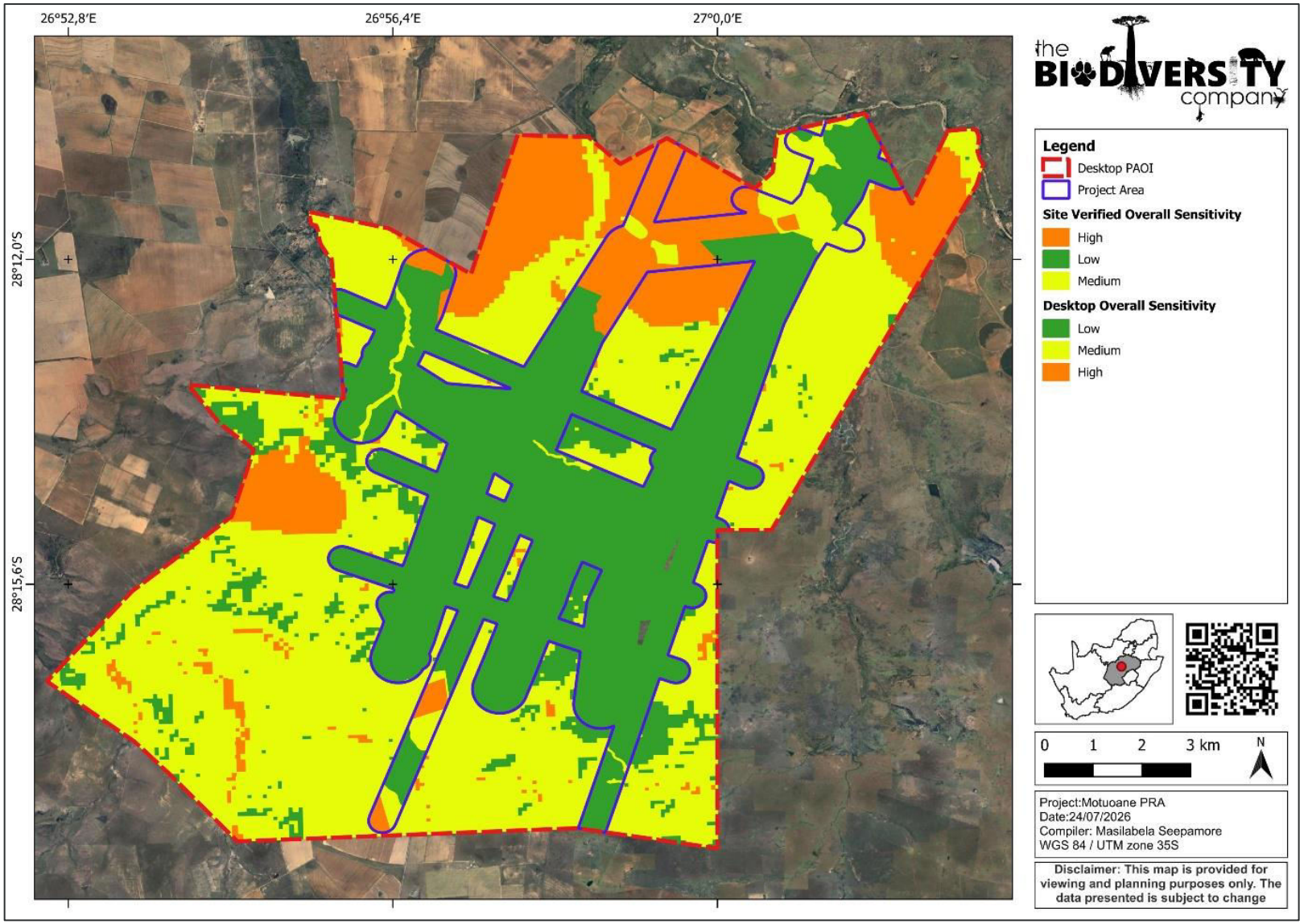


Figure 132: Overall sensitivity for the proposed D3 Energy PR (The Biodiversity Company, 2026).

Table 93: Summary of the screening tool vs specialist assigned sensitivities (The Biodiversity Company, 2026).

Screening Tool Theme	Feature	Screening Tool	Specialist	Tool Validated or Disputed by Specialist - Reasoning
Agricultural Theme	Virginia PAA	Very High	High	Disputed – Moderate to Moderate-High capability. The presence of maize and soya beans cultivation under rainfed conditions within the seismic transect buffer area.
	Virginia PAA	Very High	Medium	Disputed – Low-Moderate land capability. The absence of active cropping either rainfed or under irrigation infrastructure. Moreover, the presence of medium potential soils such as Dundee, Griffin, Hutton and Clovelly soil forms. Moreover, the presences of hydromorphic soils with signs of wetness such Rensburg and Cartref soil forms.
	Virginia PAA	Very High	Low	Disputed – Very Low to Low. The absence of active cropping either rainfed or under irrigation infrastructure. Moreover, the presence of low potential soils such as Swartland, Glen, Arcadia, Rustenburg, Mispah and Glenrosa soil forms which require irrigation to enhance their productivity. Additionally, the presence of anthropogenic soil materials such as Grabouw.
	Pivo Irrigation	Very High	Very High	Could not be verified – Lack of access
	Horticulture	Very High	Very High	Validated/Disputed – Lack of access, desktop verified
	Rainfed Annual Crop Cultivation / Planted Pastures	High	High	Validated – Moderate to Moderate-High capability. The presence of maize and soya beans cultivation under rainfed conditions in seismic transects buffer area.
	Rainfed Annual Crop Cultivation / Planted Pastures	High	Medium	Disputed - Low-Moderate land capability. The presence of historical crop fields on medium potential soils such as Dundee and Hutton soil forms.
	Rainfed Annual Crop Cultivation / Planted Pastures	High	Low	Disputed – Very Low to Low land capability. The presence of historical crop fields on low potential soils such as Swartland, Glen, Arcadia, Rustenburg, Glenrosa, Mispah and Grabouw soil forms.
	Old Fields	High	High	Could not be verified – Lack of access.
	Old Fields	High	High	Disputed - The presence of maize and soya beans cultivation under rainfed conditions within the seismic transects buffer area.
	Old Fields	High	Medium	Disputed - Low-Moderate land capability. The presence of historical crop fields on medium potential soils such as Dundee and Hutton soil forms.
	Old Fields	High	Low	Disputed - Very Low to Low land capability. The presence of historical crop fields on low potential soils such as Swartland, Glen, Arcadia, Rustenburg, Glenrosa, Mispah and Grabouw soil forms.
	Moderate to Moderate-High (LC 8-9)	High	Medium	Disputed – Low-Moderate land capability. The presence of medium potential such as Dundee, Griffin, Hutton and Clovelly soil forms. Moreover, the presences of hydromorphic soils with signs of wetness such Rensburg and Cartref soil forms.

Screening Tool Theme	Feature	Screening Tool	Specialist	Tool Validated or Disputed by Specialist - Reasoning
	Moderate to Moderate-High (LC 8-9)	High	Low	Disputed – Very Low to Low land capability. The presence of low potential soils such as Swartland, Glen, Arcadia, Rustenburg, Mispah and Glenrosa soil forms which require irrigation to enhance their productivity. Additionally, the presence of anthropogenic soil materials such as Grabouw.
	Low-Moderate (LC 6-7)	Medium	Medium	Validated - Low-Moderate land capability. The presence of medium potential such as Dundee, Griffin, Hutton and Clovelly soil forms. Moreover, the presences of hydromorphic soils with signs of wetness such Rensburg and Cartref soil forms.
	Low-Moderate (LC 6-7)	Medium	Low	Disputed – Very Low to Low land capability. The presence of low potential soils such Swartland, Glen, Arcadia, Rustenburg, Glenrosa, Mispah and Grabouw soil forms.
	Very Low to Low (LC 3-5)	Low	Medium	Disputed – Low-Moderate land capability. The presence of medium potential such as Dundee, Griffin, Hutton and Clovelly soil forms. Moreover, the presences of hydromorphic soils with signs of wetness such Rensburg and Cartref soil forms.
	Very Low to Low (LC 3-5)	Low	Low	Validated - Very Low to Low land capability. The presence of low potential soils such as Swartland, Glen, Arcadia, Rustenburg, Mispah and Glenrosa soil forms which require irrigation to enhance their productivity. Additionally, the presence of anthropogenic soil materials such as Grabouw.

9.3.10.3 DESCRIPTION OF IMPACT

The impact relates to the direct and indirect loss, degradation, contamination, compaction, erosion and reduced productivity of soils and agricultural land arising from seismic surveys, production well development, gas gathering pipelines, gas processing infrastructure, associated roads and traffic, and decommissioning activities. The impact also includes temporary or permanent sterilisation of agricultural land, disruption of farming operations and potential reduction in soil productivity.

For assessment purposes, impacts are divided into:

- Normal Operations
- Abnormal Events (pressure spikes, equipment failures, well integrity failures, pipeline leaks, uncontrolled releases, major spills, blowouts and emergency incidents).

9.3.10.3.1 ESTABLISHMENT PHASE

9.3.10.3.1.1 NORMAL OPERATIONS

During planning and site establishment, impacts may arise through the final selection of drilling locations, seismic alignments, gathering line routes, access roads and gas plant infrastructure. Poor siting of infrastructure within active cultivated fields, high land capability soils, hydromorphic soils or protected agricultural areas may result in unnecessary land sterilisation and fragmentation. Surveys, geotechnical investigations and access establishment may cause limited disturbance, particularly where vehicles traverse agricultural lands.

The final location of well pads, gathering pipelines and the gas processing facility has the potential to remove productive agricultural land from cultivation for the operational life of the project. Although the overall footprint remains relatively small compared to the 14 440-ha production right area, impacts within individual farms may be significant where infrastructure overlaps cultivated fields or high capability soils.

9.3.10.3.1.2 ABNORMAL EVENTS

Abnormal impacts during planning may result from inappropriate infrastructure placement due to inadequate soil investigations, poor route selection, failure to identify sensitive agricultural areas, or failure to implement specialist recommendations. Such failures may unnecessarily increase the extent of agricultural land sterilisation and long-term soil degradation.

9.3.10.3.2 CONSTRUCTION PHASE (SEISMIC SURVEYS AND DRILLING)

9.3.10.3.2.1 NORMAL OPERATIONS

9.3.10.3.2.1.1 SEISMIC SURVEYS

Seismic surveys are expected to have the lowest soil impact of all project components. Vibroseis vehicles, AWD systems and survey vehicles will move along predefined alignments. Impacts will be largely temporary and localised and may include:

- Surface compaction of topsoil;
- Localised disturbance of crop rows;
- Reduced soil infiltration;
- Minor rutting and surface disturbance;
- Increased susceptibility to erosion following disturbance;
- Temporary disruption of farming operations; and

- Disturbance of soil structure within cultivated lands.

The impact is expected to be temporary and largely reversible where agricultural management practices and rehabilitation are effectively implemented.

9.3.10.3.2.1.2 DEVELOPMENT DRILLING

Development drilling results in significantly greater soil impacts than seismic surveys because each well requires a drill pad, stockpile areas, equipment laydown areas and vehicle access. Potential impacts include:

- Removal of topsoil and vegetation;
- Disturbance and mixing of soil horizons;
- Soil compaction from heavy drilling equipment;
- Loss of arable agricultural land;
- Temporary fragmentation of cultivated fields;
- Increased runoff and erosion risk;
- Soil profile disturbance;
- Loss of productive topsoil;
- Reduced infiltration and permeability;
- Interference with agricultural operations and crop production.

The Agricultural Assessment identified Dundee, Griffin, Hutton and Clovelly soils as among the most agriculturally valuable soils within the study area. Disturbance of these soils may lead to temporary or permanent reductions in agricultural capability if rehabilitation is not properly undertaken.

9.3.10.3.3 ABNORMAL EVENTS

Potential abnormal events include:

- Drilling fluid losses;
- Hydrocarbon spills;
- Fuel and lubricant leaks;
- Well blowouts;
- Loss of well integrity;
- Overflow of drilling sumps;
- Failure of containment systems;
- Contamination of stockpiled topsoil;
- Uncontrolled runoff from drill pads.

Such events may result in:

- Localised soil contamination;
- Reduced soil fertility;
- Salinisation;

- Loss of agricultural productivity;
- Long-term contamination requiring excavation and remediation.

Although the probability is low, the consequences may be severe where contamination occurs within high capability agricultural soils.

9.3.10.3.4 PRODUCTION PHASE (PRODUCTION WELLS, GAS GATHERING PIPELINES AND GAS PLANT)

9.3.10.3.4.1 NORMAL OPERATIONS

9.3.10.3.4.1.1 PRODUCTION WELLS

Long-term impacts may arise through:

- Permanent occupation of agricultural land;
- Continued exclusion of farming activities from well pads;
- Long-term compaction around well infrastructure;
- Restriction of cultivation practices;
- Potential interference with irrigation and mechanised farming.

9.3.10.3.4.1.2 GAS GATHERING PIPELINES

Approximately 28 km of underground HDPE gathering pipelines are proposed. Pipeline installation will require trenching through agricultural land and may result in:

- Removal and stockpiling of topsoil;
- Mixing of soil horizons;
- Temporary loss of cultivation areas;
- Soil compaction along servitudes;
- Altered drainage characteristics;
- Increased erosion risk before rehabilitation.

Although pipelines will be buried between 750 mm and 1 000 mm below ground level, poorly executed reinstatement may reduce agricultural productivity above pipeline servitudes.

9.3.10.3.4.1.3 GAS PROCESSING PLANT

The gas processing facility represents the largest concentrated footprint and may result in:

- Permanent loss of agricultural land;
- Complete transformation of soil resources within the plant footprint;
- Long-term sterilisation of productive soils;
- Increased runoff from hardened surfaces;
- Localised erosion at disturbed areas.

9.3.10.3.4.2 ABNORMAL EVENTS

Potential abnormal operational events include:

- Gas pipeline rupture;

- Condensate or hydrocarbon leaks;
- Well integrity failures;
- Produced water spills;
- Storage tank leaks;
- Failure of evaporation pond liners;
- Fire suppression runoff contamination;
- Blowouts and uncontrolled releases.

These events may cause:

- Soil contamination;
- Long-term degradation of agricultural productivity;
- Reduced crop viability;
- Need for extensive remediation;
- Potential removal of contaminated soils.

9.3.10.3.5 DECOMMISSIONING AND CLOSURE PHASE

9.3.10.3.6 NORMAL OPERATIONS

Decommissioning will involve:

- Removal of infrastructure;
- Plugging and abandonment of wells;
- Excavation of buried infrastructure where required;
- Rehabilitation and decompaction;
- Reinstatement of soil profiles;
- Replacement of topsoil.

Short-term disturbance may occur, but the objective is restoration of agricultural capability and soil function.

9.3.10.3.7 ABNORMAL EVENTS

Potential abnormal impacts include:

- Cement spills;
- Hydrocarbon contamination during dismantling;
- Failure of rehabilitation measures;
- Inadequate decompaction;
- Incomplete restoration of soil horizons.

Poor rehabilitation may lead to persistent reductions in agricultural productivity beyond closure.

9.3.10.4 IMPACT RATING

Table 94: Summative results of the Impacts Assessment conducted for the proposed activities in relation to the Seismic Activities (The Biodiversity Company, 2026).

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: SoilA1 Impact: Soil Compaction	Operation	Medium to Low	Low	Low -
ID: SoilA2 Impact: Soil Erosion	Operation	Medium to Low	Low	Low -
ID: SoilA3 Impact: Soil Contamination for planned events	Operation	Medium to Low	Low	Low -
ID: SoilA4 Impact: Soil Contamination for unplanned events	Operation	Medium to High	Low	Low -
ID: SoilA5 Impact: Soil Contamination during unplanned events	Rehab and closure	Medium to Low	Low	Low -

Table 95: Summative results of the Impacts Assessment conducted for the proposed activities in relation to the Drilling Activities (The Biodiversity Company, 2026).

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: SoilA1 Impact: Loss of Cultivated Lands	Construction	High	Medium to Low	Medium to High -
ID: SoilA2 Impact: Soil Compaction	Construction	Medium to Low	Low	Low -
ID: SoilA3 Impact: Soil Erosion	Construction	Medium to Low	Low	Low -
ID: SoilA9 Impact: Soil Contamination for unplanned events	Operation	Medium to Low	Low	Low -
ID: SoilA10 Impact: Soil Contamination during unplanned events	Construction	Medium to Low	Low	Low -
ID: A Impact: Soil Contamination during unplanned events	Construction	Medium to Low	Low	Low -

Table 96: Summative results of the Impacts Assessment conducted for the proposed activities in relation to the Gathering Lines (The Biodiversity Company, 2026).

Impact	Phase	Pre-Mitigation Significance	Post-Mitigation Significance	Final Significance
ID: SoilA6 Impact: Soil Compaction	Operation	Medium to Low	Low	Low -
ID: SoilA7 Impact: Soil Erosion	Operation	Medium to Low	Low	Low -
ID: A8 Impact: Soil Contamination for planned events	Operation	Medium to Low	Low	Low -
ID: SoilA9 Impact: Soil Contamination for unplanned events	Operation	Medium to Low	Low	Low -
ID: SoilA10 Impact: Soil Contamination during unplanned events	Construction	Medium to Low	Low	Low -
ID: A Impact: Soil Contamination during unplanned events	Construction	Medium to Low	Low	Low -

9.3.10.5 CUMULATIVE IMPACT ASSESSMENT

The project occurs within a landscape already influenced by:

- Existing Tetra4 gas production infrastructure;
- Existing exploration wells and seismic infrastructure;
- Approved and proposed renewable energy developments;
- Existing agricultural cultivation and grazing activities;
- Existing mining activities within the broader region.

Cumulative impacts may arise through:

- Progressive loss of cultivated land;
- Incremental fragmentation of farming units;
- Expansion of access roads and servitudes;
- Additional soil disturbance from multiple infrastructure projects;
- Increased erosion susceptibility;
- Combined effects of renewable energy developments and gas infrastructure on the Virginia Protected Agricultural Area;
- Increased pressure on high capability soils.

While the individual footprint of each well is relatively small, cumulative impacts become more significant when considering production wells, gathering pipelines, gas processing facilities, renewable energy facilities and existing agricultural fragmentation together. The cumulative impact is considered Medium to High negative without coordinated land-use planning and rehabilitation but can be reduced to Medium to Low negative through implementation of integrated rehabilitation, avoidance of high capability soils, co-location of infrastructure and effective pipeline reinstatement.

9.3.10.6 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 H**):

- 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 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.
- 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
    - Feasible and available use of Efficient Flare Systems (achieving a 98% or higher destruction efficiency) for flaring of excess gas during drilling activities
    - Specific, site-tailored intervention strategies to be deployed to circulate out reservoir influxes and re-establish hydrostatic pressure
    - A 100-meter danger zone is immediately enforced around the wellhead
    - Active Spill Prevention, Control, and Countermeasure
    - Adequate emergency response team with sufficient containment materials and berms to be used to prevent leaked fluids from entering local waterways or soil

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Designate refuelling and maintenance areas at least 50 m from any wetland or watercourse.

9.3.11 IMPACTS ON VEGETATION AND FLORA ASSESSMENT

This section assesses the potential impacts of the proposed D3 Energy PR on vegetation communities, flora resources, protected plant species and ecological habitats associated with the seismic surveys, production wells, gas gathering pipelines, gas processing plant and associated infrastructure. The assessment is based on the Terrestrial Biodiversity Impact Assessment for The Proposed D3 Energy PR Application undertaken by The Biodiversity Company (**Appendix F13**).

The project area has experienced changes both currently and historically. Nine (9) major habitats have been identified of which one (1) is considered non – terrestrial. Habitats identified include Alluvial Vegetation (Medium SEI), Central Free State Grassland including Central Free State Grassland (Medium SEI), Degraded Grassland (Low SEI), Winberg Grassy Shrubland (Medium SEI), Modified (Very Low SEI), Secondary Central Free

State (Low SEI), Rocky Grassland (High SEI), Disturbed Central Free State Grassland (Medium SEI) and non – terrestrial Water Resources (Low to High SEI).

Nine (9) provincially protected species [*Ammocharis coranica* (Berg Lily), *Anacampseros papyracea* (Karoo Gansmis), *Anacampseros subnuda subnuda, Boophone disticha* (Bushman Poison Bulb), *Eucomis autumnalis* (Pineapple Lily), *Euphorbia clavarioides* (Lion's Spoor), *Gladiolus permeabilis edulis, Helichrysum nudifolium* (Hairy Everlasting) *and Helichrysum zeyheri* (Vaalbergkaroo)*]*. These species were recorded within all habitats apart from the Modified habitat type. Therefore, a site walkdown to record provincially protected species for all target areas must be conducted prior to Seismic survey. No fauna SCC were observed; however suitable habitat is found within the project area.

The D3 Energy PR was identified by the DFFE National Environmental Screening Tool as possessing a 'Very High' sensitivity within a Terrestrial Biodiversity theme. However, the D3 Energy PR was assessed to have varying sensitivities, as detailed in section 3.4.2. Specifically, the Sand River, Rocky Grassland, Seep, UVB, and CVB areas are classified as High sensitivity. Alluvial Vegetation Central Free State Grassland, Central Free State Grassland (No Access), Windberg Grassy Shrubland, Disturbed Central Free State, and Depression areas are classified as Medium sensitivity. Degraded Grassland, Secondary Central Free State, and Artificial Drainage Channel areas are classified as Low sensitivity. The Plant sensitivity is classified as Low according to the DFFE National Environmental Screening Tool and was validated during the assessment. The Animal sensitivity is classified as Medium according to the DFFE National Environmental Screening Tool and was validated for seven (7) habitat units and disputed as being Low for four (4) habitat units.

According to the Free State Biodiversity Plan (2015), the D3 Energy PR overlaps with areas classified as Critical Biodiversity Areas (CBA 1: Irreplaceable and CBA 2: Optimal) as well as Ecological Support Areas (ESA 1: Functional and ESA 2: Degraded) (see **Figure 133**). Consultation with regulating authorities is strongly recommended for any seismic activities within the Project Area, especially where these intersect with sensitive biodiversity areas. In particular, such consultation is essential for any activities within Critical Biodiversity Areas and threatened ecosystems to ensure compliance with biodiversity conservation requirements. The impacts of the proposed seismic activities within High SEI areas are anticipated to be short-term, with good rehabilitation potential, and it is assumed that these areas can be restored to their pre-seismic condition with appropriate mitigation measures.

The ecological integrity, importance and functioning of these habitats play a crucial role and an important habitat for various fauna and flora. The preservation of these systems is the most important aspect to consider for the proposed project. These habitats need to be protected and improved due to the role they play in a fragmented landscape. **Table 97** illustrates the habitats, condition, SE.

Table 97: Summary of Habitat Units, Condition, Sensitivity, Biodiversity Spatial Planning Categories, and Development Potential for the D3 Energy Production Right Project Area (The Biodiversity Company, 2026).

Habitat	Condition	SEI	Free State Biodiversity Spatial Plan	Developability
Modified	Irreversibly and Severely Modified	Very Low	CBA 2, ESA 2, ONA, Degraded Areas	Mitigated development permitted, with concurrent rehabilitation
Alluvial Vegetation	Disturbed	Medium	ESA 1, ESA 2	Mitigated development permitted, with concurrent rehabilitation
Central Free State Grassland and Central Free	Semi-natural and Disturbed	Medium	ESA 1, ESA 2	Mitigated development permitted, with concurrent rehabilitation

Habitat	Condition	SEI	Free State Biodiversity Spatial Plan	Developability
State Grassland (No Access)				
Degraded Grassland	Degraded	Low	CBA 1, CBA 2, ESA 1, ESA 2, Degrade Areas	Mitigated development permitted, with concurrent rehabilitation
Winberg Grassy Shrubland	Semi-natural	Medium	CBA 2, ESA 1, ESA 2, ONA	Mitigated development permitted, with concurrent rehabilitation
Secondary Central Free State Grassland	Disturbed	Low	ESA 1, ESA 2	Mitigated development permitted, with concurrent rehabilitation
Rocky Grassland	Intact	High	CBA 2, ESA 1, ONA	Low-impact development permitted, with concurrent rehabilitation.
Water Resources	Artificial, Disturbed and Natural	Low to High		See wetland assessment (TBC, 2026)

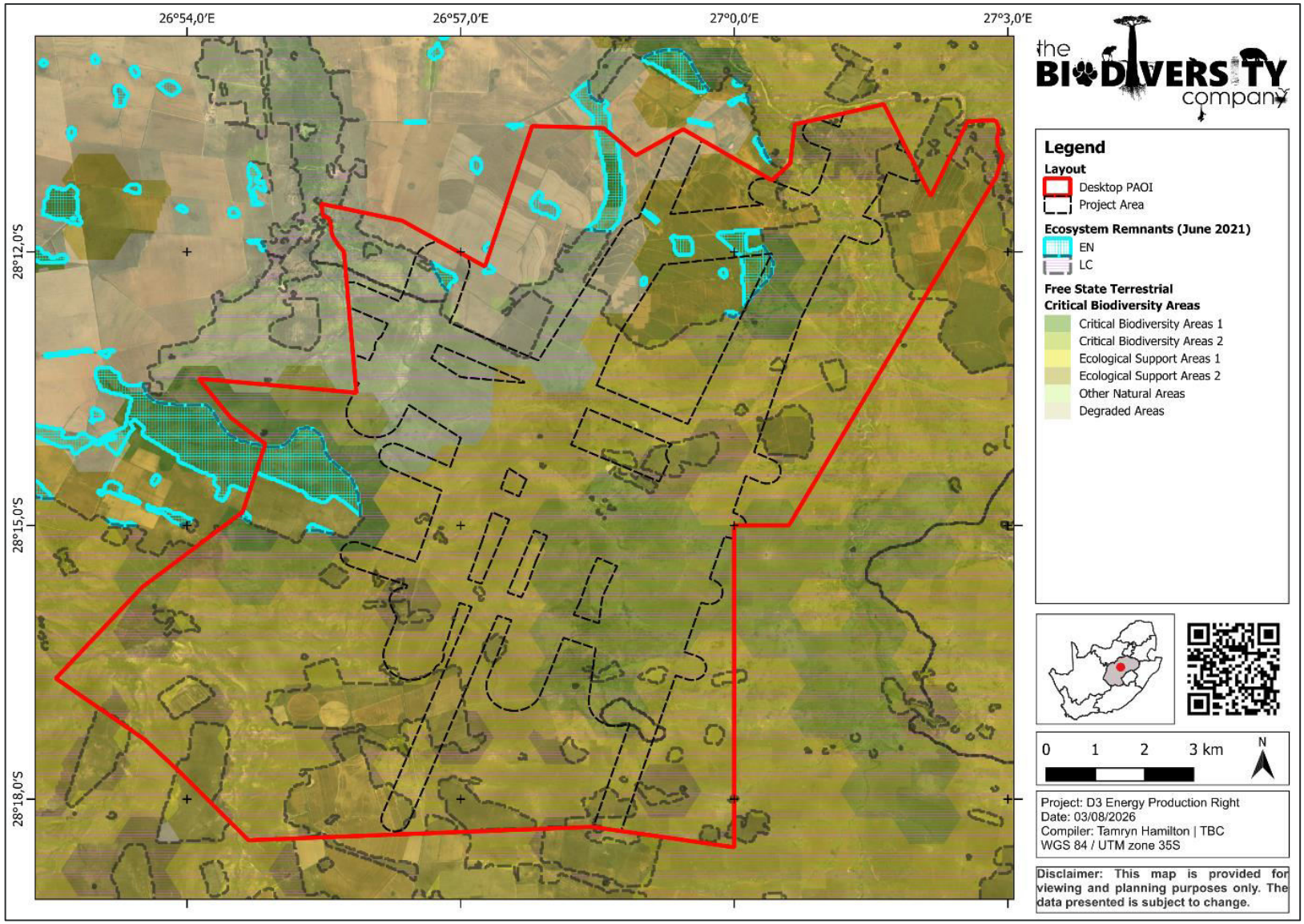


Figure 133: Map illustrating the D3 Energy PR in relation to the Free State Biodiversity Spatial Plan and Remnants dataset (The Biodiversity Company, 2026).

9.3.11.1 DESCRIPTION OF IMPACT

As indicated in **Section 8.9**, the project is located within a landscape comprising Vaal-Vet Sandy Grassland (Endangered), Central Free State Grassland (Least Concern), Highveld Alluvial Vegetation (Least Concern) and Bloemfontein Karroid Shrubland (Least Concern), with portions of the project area overlapping CBA 1, CBA 2, ESA 1, ESA 2 and NPAES priority areas. Nine provincially protected plant species were recorded within the project area.

9.3.11.1.1 ESTABLISHMENT PHASE

During planning and establishment, vegetation and flora impacts may arise from:

- Final positioning of seismic transects, production wells, gathering pipelines and gas plant infrastructure.
- Ecological walkdowns and site demarcation activities.
- Surveying and access establishment.
- Selection of areas for temporary laydown areas, storage areas, contractors' facilities and access routes.

Inappropriate siting may result in avoidable encroachment into:

- High SEI Rocky Grassland habitats.
- Water resource habitats.
- Endangered Vaal-Vet Sandy Grassland remnants.
- CBA and ESA areas.
- Areas supporting protected plant species.

Although direct vegetation loss is limited during this phase, decisions taken at this stage can determine the magnitude of impacts throughout the project life cycle.

9.3.11.1.2 CONSTRUCTION PHASE

9.3.11.1.2.1 SEISMIC SURVEYS

Seismic surveys represent the lowest vegetation impact component of the project. Vibroseis, AWD and magnetotelluric surveys are temporary in nature and mainly involve movement of survey teams and vehicles along predefined transects.

Potential impacts include:

- Localised trampling of vegetation.
- Damage to sensitive plant species.
- Disturbance within grassland habitats.
- Creation of wheel tracks and temporary access routes.
- Fragmentation of vegetation where off-road access occurs.
- Damage to protected species encountered along transects.
- Dust-related impacts on adjacent vegetation.

Without controls, repeated vehicle movements may result in habitat degradation and facilitate invasion by alien species.

9.3.11.1.2.2 DEVELOPMENT DRILLING

Development drilling presents the greatest vegetation impact during the development phase.

Activities include:

- Drill pad establishment (approximately 50 m × 50 m per site).
- Clearing of indigenous vegetation.
- Temporary storage areas.
- Heavy equipment movement.
- Access road establishment.
- Topsoil stripping and stockpiling.

Potential impacts include:

- Permanent and temporary loss of indigenous vegetation.
- Destruction and fragmentation of natural habitats.
- Loss of ecological corridors.
- Removal of protected plant species.
- Disturbance of CBA and ESA habitats.
- Increased vulnerability to erosion.
- Establishment and spread of alien invasive species.
- Reduction in biodiversity function within disturbed areas.

Protected plant species such as *Ammocharis coranica* (Karoo lily)*, Boophone disticha* (poison bulb), *Eucomis autumnalis* (autumn pineapple lily) and other Schedule 6 species may be affected where development footprints overlap suitable habitat.

9.3.11.1.3 PRODUCTION PHASE

9.3.11.1.3.1 PRODUCTION WELLS

Production wells introduce long-term vegetation impacts through the permanent presence of operational infrastructure. Potential impacts include:

- Long-term habitat fragmentation.
- Permanent vegetation loss around wellheads.
- Restricted natural revegetation.
- Ongoing maintenance disturbances.
- Removal of woody vegetation within safety zones.
- Creation of disturbed ecological edges.

Although the individual footprint of wells is relatively small, impacts become more significant through cumulative habitat fragmentation.

9.3.11.1.3.2 GAS GATHERING PIPELINES

Construction of gas gathering pipelines requires trench excavation across multiple vegetation communities. Potential impacts include:

- Clearing of vegetation along servitudes.
- Disturbance of grassland habitats.
- Fragmentation of ecological corridors.
- Soil disturbance facilitating AIP establishment.
- Damage to protected flora.
- Reduction in ecological connectivity.

Although pipelines will be underground and the servitudes rehabilitated, vegetation recovery may be slow in sensitive habitats, particularly rocky grassland and alluvial vegetation areas.

9.3.11.1.3.3 GAS PLANT

The gas processing plant will result in the greatest permanent vegetation loss. Potential impacts include:

- Permanent removal of vegetation.
- Transformation of habitat within the plant footprint.
- Loss of ecological functionality.
- Long-term habitat fragmentation.
- Increased edge effects.
- Potential indirect dust deposition impacts.

The gas plant footprint may permanently transform approximately 1 ha of vegetated habitat, depending on the final site selected.

9.3.11.1.4 DECOMMISSIONING AND CLOSURE PHASE

Closure activities generally have positive long-term vegetation outcomes through rehabilitation and restoration. Potential impacts include:

- Temporary disturbance associated with infrastructure removal.
- Soil disturbance during rehabilitation works.
- Introduction or spread of alien species if rehabilitation is poorly managed.
- Incomplete recovery of vegetation communities.
- Failure to restore ecological functionality.

Proper rehabilitation should promote:

- Re-establishment of indigenous vegetation.
- Recovery of habitat connectivity.
- Restoration of ecological processes and ecosystem services.

9.3.11.2 IMPACT RATING

The impact ratings associated with the proposed activities related to vegetation and flora are indicated in **Table 98**.

Table 98: Summary of impacts related to vegetation and flora (The Biodiversity Company, 2026).

Project Phase	Activity	Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Planning	Site selection and layout design	Encroachment into sensitive habitats and protected flora areas	Medium to High	Medium to Low	Medium to Low -
Construction	Seismic surveys	Vegetation disturbance and habitat fragmentation	Medium to High	Low	Low -
Construction	Drilling	Destruction, further loss and fragmentation of vegetation communities	High	Medium to Low	Medium to Low -
Construction	Drilling	Loss of protected flora species	High	Medium to Low	Medium to Low -
Construction	Seismic and drilling activities	Introduction and spread of alien invasive species	Medium to High	Low	Low -
Production	Production wells	Long-term vegetation loss and ecological fragmentation	High	Medium to Low	Medium to Low -
Production	Gas gathering pipelines	Vegetation clearing and habitat disturbance along servitudes	Medium to High	Medium to Low	Medium to Low -
Production	Gas plant infrastructure	Permanent habitat transformation and vegetation loss	High	Medium to Low	Medium to Low -
Production	Operations and maintenance	Ongoing habitat disturbance and alien vegetation establishment	Medium to High	Low	Low -
Closure	Rehabilitation period	Delayed recovery and invasive species establishment	Medium to Low	Low	Low -

9.3.11.3 CUMULATIVE IMPACT ASSESSMENT

The cumulative impact must be considered alongside:

- Existing D3 Energy exploration infrastructure.
- Existing Tetra4 gas production infrastructure.
- Existing agricultural transformation.
- Existing linear infrastructure.
- Existing mining impacts.
- Approved and proposed renewable energy developments.
- Existing habitat fragmentation across the region.

Potential Cumulative Effects include:

- Incremental loss of Endangered Vaal-Vet Sandy Grassland.
- Progressive reduction in habitat connectivity.
- Increased vegetation fragmentation.
- Increased spread of alien invasive species.
- Increased edge effects and ecological degradation.
- Cumulative loss of CBA and ESA functionality.
- Combined impacts on protected flora populations.

The specialist assessment concluded that although cumulative vegetation and floral loss will occur, the overall cumulative impact can be limited through avoidance of high sensitivity areas and implementation of rehabilitation measures. The assessed overall cumulative impact assessment is Medium-Low negative.

9.3.11.4 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 H):

- 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 construction.
- 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 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 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 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 phase has been concluded.
- An Alien Invasive Plant Management Plan must be compiled and implemented during the construction 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 construction 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 Production 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.
- 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.

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 gas plant location sites and along final gas gathering pipeline routes 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 at the final gas plant location site and along final gas gathering pipeline routes 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 fire action plan needs to be complied and implemented to restrict the impact unplanned fires might have on the surrounding areas.

9.3.12 IMPACTS ON NATURAL HABITAT

This section presents the identified potential impacts on natural habitats associated with the proposed D3 Energy PR, taking into consideration the project description, alternatives, terrestrial biodiversity baseline, existing gas infrastructure, agricultural activities, renewable energy developments and the findings of the Terrestrial Biodiversity Assessment for the proposed D3 Energy PR Application undertaken by The Biodiversity Company (**Appendix F13**).

9.3.12.1 DESCRIPTION OF IMPACT

The D3 Energy PR occurs within a landscape comprising a mosaic of natural, semi-natural and transformed habitats (refer to **Section 8.9.5.5**), including:

- Central Free State Grassland.
- Disturbed Central Free State Grassland.
- Rocky Grassland.
- Winberg Grassy Shrubland.
- Alluvial Vegetation.
- Water Resource habitats (rivers, wetlands, seeps and drainage systems).
- Secondary and Degraded Grassland.
- Modified agricultural and mining-disturbed areas.

The biodiversity assessment identified habitats with Site Ecological Importance (SEI) ratings ranging from Very Low to High, with Rocky Grassland, Sand River habitats, wetland systems and certain CBA-associated habitats representing the most sensitive natural receptors. The project area also overlaps Critical Biodiversity Areas (CBA 1 and CBA 2), Ecological Support Areas (ESA 1 and ESA 2), NPAES priority areas and portions of the Endangered Vaal-Vet Sandy Grassland ecosystem. The primary natural habitat impacts relate to habitat loss, habitat degradation, fragmentation, alien invasive species establishment, reduction in ecological connectivity and disturbance of ecological processes.

9.3.12.1.1 ESTABLISHMENT PHASE

During planning and site establishment, natural habitat impacts may arise from:

- Selection of production well locations.
- Routing of gas gathering pipelines.

- Identification of gas plant sites.
- Access road planning.
- Site establishment and demarcation activities.

Poor infrastructure placement may result in:

- Encroachment into CBA and ESA habitats.
- Encroachment into High SEI habitats.
- Avoidable habitat fragmentation.
- Loss of ecological corridors.
- Increased future disturbance of wetland and riverine systems.

Although physical disturbance is limited during this phase, planning decisions determine the magnitude of habitat impacts throughout the life of the project.

9.3.12.1.2 CONSTRUCTION PHASE

9.3.12.1.2.1 SEISMIC SURVEYS

Seismic and audio-magnetotelluric surveys represent the least intrusive development activity. Impacts may include:

- Temporary disturbance of natural habitats.
- Vegetation trampling.
- Minor habitat fragmentation.
- Disturbance of ecological corridors.
- Introduction of invasive species through vehicle movement.
- Localised disturbance of wetland and grassland habitats.

The biodiversity assessment notes that seismic activities generally have short-term impacts with good rehabilitation potential where avoidance measures are implemented.

9.3.12.1.2.2 DEVELOPMENT DRILLING

Development drilling represents the most significant habitat impact during the construction phase. Activities include:

- Vegetation clearing.
- Drill pad establishment.
- Temporary laydown areas.
- Topsoil disturbance.
- Access roads.
- Machinery movement.

Potential impacts include:

- Direct habitat loss.

- Habitat fragmentation.
- Destruction of indigenous habitat.
- Loss of ecosystem services.
- Disturbance of ecological corridors.
- Increased erosion.
- Increased invasion by alien invasive species.
- Reduction in ecological integrity.

The biodiversity assessment identifies "destruction, further loss and fragmentation of the vegetation community" as one of the primary biodiversity impacts associated with drilling activities.

9.3.12.1.3 PRODUCTION PHASE

9.3.12.1.3.1 PRODUCTION WELLS

Production wells result in long-term habitat modification and fragmentation through:

- Permanent infrastructure.
- Exclusion zones.
- Ongoing maintenance requirements.
- Vehicle access.

Potential impacts include:

- Permanent habitat transformation.
- Long-term habitat fragmentation.
- Reduction in ecological functioning.
- Degradation of ecological connectivity.

9.3.12.1.3.2 GAS GATHERING PIPELINES

Pipeline construction creates linear disturbances across multiple habitat types. Potential impacts include:

- Habitat clearing.
- Trenching through grassland habitats.
- Disturbance of alluvial habitats.
- Temporary fragmentation of ecological corridors.
- Increased invasion by alien plants.
- Habitat degradation through poor rehabilitation.

Although pipelines are underground, ecological recovery may take considerable time within sensitive habitats.

9.3.12.1.3.3 GAS PROCESSING PLANT

The gas plant will result in the most intensive habitat transformation within the project. Potential impacts include:

- Permanent habitat loss.
- Loss of ecosystem services.
- Long-term habitat fragmentation.
- Transformation of natural habitat into industrial land use.
- Reduction in habitat connectivity.

9.3.12.1.3.4 OPERATIONAL ACTIVITIES

Operational impacts may arise through:

- Maintenance activities.
- Vehicle movement.
- Dust generation.
- Ongoing habitat disturbance.

These impacts are generally localised but persistent throughout the operational life of the facility

9.3.12.1.4 DECOMMISSIONING AND REHABILITATION PHASE

Closure activities involve:

- Infrastructure removal.
- Rehabilitation.
- Topsoil replacement.
- Revegetation.

Potential impacts include:

- Temporary habitat disturbance.
- Continued habitat fragmentation if rehabilitation fails.
- Invasive species establishment.
- Reduced ecological recovery.

Conversely, rehabilitation provides an opportunity for habitat restoration, improved ecological function and re-establishment of connectivity where successful.

9.3.12.2 IMPACT RATING

The impact ratings associated with the proposed activities related to natural habitat are indicated in **Table 99**.

Table 99: Summary of impacts related to natural habitat (The Biodiversity Company, 2026).

Project Phase	Activity	Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Planning / Establishment	Infrastructure siting and route planning	Encroachment into sensitive habitats and ecological corridors	Medium to High	Medium to Low	Medium to Low -
Construction	Seismic surveys	Temporary habitat disturbance and fragmentation	Medium to High	Low	Low -
Construction	Seismic surveys	Introduction and spread of alien invasive species	Medium to High	Low	Low -
Construction	Drilling	Destruction, loss and fragmentation of natural habitats	High	Medium to Low	Medium to Low -
Construction	Drilling	Habitat degradation and reduction of ecosystem services	High	Medium to Low	Medium to Low -
Construction	Drilling	Disturbance of ecological corridors and connectivity	High	Medium to Low	Medium to Low -
Production	Production wells	Long-term habitat fragmentation and habitat loss	High	Medium to Low	Medium to Low -
Production	Gas gathering pipelines	Habitat clearing and ecological corridor disruption	Medium to High	Medium to Low	Medium to Low -
Production	Gas gathering pipelines	Alien invasive species establishment and habitat degradation	Medium to High	Low	Low -
Production	Gas processing plant	Permanent habitat transformation and loss of ecological function	High	Medium to Low	Medium to Low -

Project Phase	Activity	Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Production	Operational maintenance activities	Ongoing habitat disturbance	Medium to High	Low	Low -
Decommissioning	Infrastructure removal	Temporary habitat disturbance	Medium to Low	Low	Low -
Decommissioning	Rehabilitation and closure	Delayed habitat recovery or unsuccessful restoration	Medium to Low	Low	Low -
Post-Closure	Residual habitat impacts	Continued habitat fragmentation or ecological degradation	Medium to Low	Low	Low -

9.3.12.3 CUMULATIVE IMPACT ASSESSMENT

The cumulative habitat impact must be assessed together with:

- Existing gas exploration and production activities.
- Existing agricultural transformation.
- Existing mining infrastructure.
- Existing roads and transmission infrastructure.
- Existing habitat fragmentation.
- Approved and proposed renewable energy developments.

Potential cumulative impacts include:

- Incremental habitat loss.
- Progressive habitat fragmentation.
- Increased edge effects.
- Increased ecological isolation.
- Reduced habitat connectivity.
- Continued pressure on CBA and ESA habitats.
- Increased risk of invasive species spread.
- Reduction in ecosystem functionality.

The biodiversity specialist concluded that cumulative habitat impacts are moderated by:

- Relatively small project footprints.
- Phased implementation.
- Rehabilitation commitments.
- Avoidance of sensitive habitats where feasible.
- Existing degraded and transformed portions of the landscape

The specialist assessment concluded that although cumulative habitat loss will occur, the overall cumulative impact can be limited through avoidance of high sensitivity areas and implementation of rehabilitation measures. The assessed overall cumulative impact assessment is Medium-Low negative.

9.3.12.4 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 H**):

- 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 construction.

- 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 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 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 phase has been concluded.
- The construction 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 Production Right, then depending on the final location of the seismic survey / drill site with respect to the locations sensitivity as defined by the maximum 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.
- 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.

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 gas plant location sites and along final gas gathering pipeline routes 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 at the final gas plant location site and along final gas gathering pipeline routes 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 fire action plan needs to be complied and implemented to restrict the impact unplanned fires might have on the surrounding areas.
- Where possible, work should be restricted to one area at a time and be systematic. This is to reduce the number and extent of on-site activities, allowing fauna to move off as the Project progresses. This will give the smaller birds, mammals and reptiles a chance to weather the disturbance in an undisturbed zone close to their natural territories.
- Prior to commencing work each day, at least one individual should traverse the working area in order to scare away any fauna within the seismic or drilling area, promoting temporary fauna migration from direct line of impact.
- Any holes/deep excavations must be done in a progressive manner on a need only basis. Minimal holes/excavations may be left open overnight. In the event holes/excavations are required to remain open overnight, these areas must be subsequently inspected prior to backfilling.

9.3.13 IMPACTS ON FAUNA SPECIES

The assessment of potential impacts on fauna is based on the Terrestrial Biodiversity Impact Assessment for The Proposed D3 Energy PR Application undertaken by The Biodiversity Company (**Appendix F13**). Refer to Section 9.3.11 above for the site conditions and sensitivities in relation to terrestrial biodiversity.

9.3.13.1 DESCRIPTION OF IMPACT

The proposed D3 Energy PR Area is situated within an agricultural and semi-natural landscape approximately 12 km southeast of Virginia, Free State Province. The area comprises a mosaic of Central Free State Grassland, Vaal-Vet Sandy Grassland, Highveld Alluvial Vegetation, Bloemfontein Karroid Shrubland, wetlands, drainage features, cultivated lands and modified habitats. These habitats support a variety of mammals, reptiles, amphibians and avifauna, including Species of Conservation Concern (SCC) such as Secretarybird (*Sagittarius serpentarius*), Blue Korhaan (*Eupodotis caerulescens*), Marsh Owl (*Asio capensis*), Cape Clawless Otter (*Aonyx capensis*) and Spotted-necked Otter (*Hydrictis maculicollis*).

The proposed activities include seismic surveys, production well development, underground gas gathering pipelines, a helium recovery and gas processing facility and associated infrastructure. These activities may result in habitat loss, disturbance, displacement, direct mortality, fragmentation of movement corridors and disruption of ecological processes affecting fauna populations.

9.3.13.1.1 ESTABLISHMENT PHASE

During planning and site establishment, impacts on fauna are generally indirect and associated primarily with project siting and preparation activities. Potential impacts include:

- Planning infrastructure within sensitive habitats supporting SCC.

- Disturbance arising from ecological surveys, pegging and access investigations.
- Increased human presence within otherwise undisturbed areas.
- Disturbance of breeding, nesting or refuge areas.
- Temporary displacement of fauna from survey corridors.
- Increased vehicle traffic and associated noise.

Although impacts are generally temporary during this phase, poor infrastructure placement could lock-in future impacts on important fauna habitats, ecological corridors and wetland systems. Areas of particular concern include High SEI Rocky Grassland habitats, the Sand River corridor, wetland systems and alluvial vegetation associated with faunal movement corridors.

9.3.13.1.2 PRODUCTION PHASE

9.3.13.1.2.1 SEISMIC SURVEYS

Seismic surveys using Vibroseis, Accelerated Weight Drop (AWD) and Magnetotelluric (MT) techniques are temporary activities; however, they present a significant source of disturbance to fauna. Potential impacts include:

- Temporary displacement of mammals, reptiles, amphibians and birds.
- Disturbance from vehicle movement, vibration and noise.
- Disturbance of breeding, nesting and foraging activities.
- Increased road mortalities.
- Mortality of slow-moving species such as reptiles and amphibians.
- Disturbance of avifauna SCC utilising wetlands and grasslands.
- Loss of refuge areas through repeated vehicle movement.
- Restriction of fauna movement through temporary activity zones.

The specialist assessment identified fauna SCC likely to utilise grassland and wetland habitats, particularly Marsh Owl, Secretarybird, Blue Korhaan and otter species associated with water resources.

9.3.13.1.2.2 CONSTRUCTION DRILLING

9.3.13.1.2.2.1 NORMAL OPERATIONS

Construction drilling presents a greater risk to fauna than seismic activities due to the establishment of drill pads, continuous operations and vehicle activity. Potential impacts include:

- Direct habitat loss and degradation.
- Displacement of fauna due to prolonged human activity.
- Destruction of burrows, shelter sites and microhabitats.
- Increased roadkill risk.
- Entrapment of fauna within excavations.
- Disturbance associated with lighting and noise.
- Habitat fragmentation.

- Attraction of predators and scavengers through waste generation.
- Increased risk of poaching or intentional killing.
- Disturbance of wetland-associated fauna.

Direct mortality may occur through vegetation clearing, earthmoving activities and accidental trapping within excavations. Certain species, such as tortoises, amphibians and small mammals, are particularly vulnerable.

9.3.13.1.2.2.2 ABNORMAL EVENTS DURING CONSTRUCTION

Abnormal events could include:

- Hydrocarbon spills.
- Drilling fluid releases.
- Fires.
- Major equipment failures.
- Uncontrolled releases.

Such events may result in:

- Mortality of terrestrial and aquatic fauna.
- Contamination of drinking and foraging resources.
- Disruption of ecological processes.
- Long-term habitat degradation.

9.3.13.1.2.3 PRODUCTION PHASE

9.3.13.1.2.3.1 PRODUCTION WELLS

Operational production wells will generate long-term but localised disturbance through maintenance activities, vehicle access and infrastructure presence. Potential impacts include:

- Ongoing disturbance of fauna.
- Localised habitat fragmentation.
- Restriction of movement corridors.
- Reduced habitat availability around wellheads.
- Continued avoidance of infrastructure by SCC.

9.3.13.1.2.3.2 GAS GATHERING PIPELINES

Although pipelines are underground, construction and maintenance may affect fauna through:

- Clearing of habitats during trenching.
- Disturbance of movement corridors.
- Temporary exclusion of fauna.
- Increased edge effects.
- Habitat fragmentation during construction.

Following rehabilitation, impacts are expected to decrease substantially.

9.3.13.1.2.3.3 GAS PROCESSING PLANT

The gas plant represents the most significant permanent fauna impact because it introduces a long-term industrial footprint into the landscape. Potential impacts include:

- Permanent habitat loss.
- Long-term noise generation.
- Increased vehicle activity.
- Lighting impacts on nocturnal fauna.
- Barrier effects.
- Reduced use of surrounding habitat by sensitive species.

9.3.13.1.2.3.4 ABNORMAL EVENTS DURING PRODUCTION

Potential abnormal events include:

- Gas leaks.
- Hydrocarbon releases.
- Fires.
- Produced water spills.
- Evaporation pond failures.

Potential consequences include:

- Direct fauna mortality.
- Loss of foraging resources.
- Water contamination affecting amphibians, mammals and birds.
- Disturbance of sensitive wetland ecosystems.

9.3.13.1.2.4 DECOMMISSIONING AND REHABILITATION PHASE

Decommissioning impacts are generally temporary and associated with infrastructure removal, well plugging and rehabilitation.

Potential impacts include:

- Short-term disturbance to fauna.
- Temporary habitat disruption.
- Vehicle-related disturbance.
- Mortality associated with excavations.
- Delayed habitat recovery if rehabilitation is unsuccessful.

Conversely, the rehabilitation phase provides positive outcomes through habitat restoration and recovery of ecological connectivity.

9.3.13.2 IMPACT RATING

The impact ratings associated with the proposed activities related to fauna are indicated in **Table 100**.

Table 100: Summary of impacts related to fauna (The Biodiversity Company, 2026).

Project Phase	Activity	Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Planning / Establishment	Site selection, surveys and demarcation	Disturbance and displacement of fauna from sensitive habitats, movement corridors, wetlands and breeding areas	Medium to High	Medium to Low	Medium to Low -
Construction	Seismic Surveys (Vibroseis, AWD and MT)	Disturbance and temporary displacement of mammals, reptiles, amphibians and avifauna due to vehicle movement, noise and vibration	Medium to High	Low	Medium to Low -
Construction	Seismic Surveys	Direct mortality of fauna resulting from vehicle collisions and disturbance of nesting, breeding and refuge sites	Medium to High	Low	Medium to Low -
Construction	Drilling, Drill Pad Establishment and Access Roads	Direct habitat loss, habitat degradation and displacement of faunal communities due to drilling infrastructure and vegetation clearing	High	Medium to Low	Medium to Low -
Construction	Drilling	Direct mortality of fauna through vegetation clearing, earthworks, trenching, excavations and vehicle movement	High	Medium to Low	Medium to Low -
Construction	Drilling	Loss and fragmentation of fauna habitat, ecological corridors and SCC habitat areas	High	Medium to Low	Medium to Low -
Construction	Drilling and Seismic Activities	Introduction of alien invasive species resulting in habitat degradation and alteration of fauna assemblages	Medium to High	Low	Low
Construction	Drilling and Seismic Activities	Disturbance of ecological life cycles (breeding, feeding, migration and nesting) due to noise, vibration, lighting and dust	High	Medium to Low	Medium to Low -
Construction	Drilling and Seismic Activities	Loss of SCC and protected fauna species through disturbance, poaching, trapping, road mortalities and habitat modification	High	Medium to Low	Medium to Low -
Construction	Abnormal Events (hydrocarbon spills, fires, drilling fluid releases)	Mortality of fauna and degradation of habitat resulting from contamination and pollution incidents	High	Medium to Low	Medium to Low -
Production	Production Wells	Long-term disturbance and displacement of fauna resulting from operational well infrastructure and maintenance activities	Medium to High	Medium to Low	Medium to Low -

Project Phase	Activity	Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Production	Production Wells	Long-term habitat fragmentation and reduced use of habitat by sensitive fauna species	Medium to High	Medium to Low	Medium to Low -
Production	Gas Gathering Pipelines (Construction)	Disturbance of fauna movement corridors and habitat connectivity during trenching and construction	Medium to High	Medium to Low	Medium to Low -
Production	Gas Gathering Pipelines (Operation and Maintenance)	Localized disturbance and mortality risk during maintenance activities	Medium to Low	Low	Low -
Production	Gas Processing Plant	Permanent habitat loss, displacement of fauna and reduction in habitat availability within and surrounding the plant footprint	High	Medium to Low	Medium to Low -
Production	Gas Processing Plant Operations	Long-term disturbance associated with lighting, noise, vehicle movements and human activity	Medium to High	Low	Low
Production	Abnormal Events (pipeline failure, gas releases, produced water spills, fires)	Mortality of fauna and habitat contamination resulting from uncontrolled releases and emergency incidents	High	Medium to Low	Medium to Low -
Decommissioning	Infrastructure Removal and Well Plugging	Temporary disturbance and displacement of fauna associated with decommissioning activities	Medium to Low	Low	Low -
Decommissioning	Closure and Rehabilitation	Delayed recovery of fauna habitat and ecological functionality	Medium to Low	Low	Low -
Rehabilitation / Post-Closure	Rehabilitation Success	Continued displacement and fragmentation of fauna communities if rehabilitation is unsuccessful	Medium to Low	Low	Low -
Rehabilitation / Post-Closure	Alien Species Encroachment	Continued habitat degradation from alien invasive species reducing habitat quality for fauna	Medium to Low	Low	Low -

9.3.13.3 CUMULATIVE IMPACT ASSESSMENT

The cumulative fauna impact must be viewed in the context of:

- Existing D3 Energy exploration activities.
- Existing Tetra4 gas production infrastructure.
- Existing agricultural activities and habitat fragmentation.
- Existing roads and powerline infrastructure.
- Existing mining activities.
- Planned and approved solar developments within the Production Right Area.

Potential Cumulative Effects

- Increased fragmentation of grassland habitats.
- Additional disturbance to SCC.
- Expanded road mortality risks.
- Progressive reduction in available habitat.
- Increased disturbance around wetlands and rivers.
- Combined pressure from multiple developments on movement corridors.
- Incremental reduction in ecological connectivity.

The Biodiversity Impact Assessment concludes that fauna populations remain supported by extensive surrounding habitat and that impacts are largely localised and mitigable. The specialist therefore assessed cumulative impacts as manageable provided habitat avoidance, rehabilitation and fauna-specific management measures are implemented. The cumulative impact assessment was assessed to be Medium-Low negative.

9.3.13.4 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 H**):

- The duration of the construction 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 / development 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 construction 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 Production Right, then depending on the final location of the seismic survey / drill site with respect to the locations sensitivity as defined by the maximum 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.
- 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

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 gas plant location sites and along final gas gathering pipeline routes 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 at the final gas plant location site and along final gas gathering pipeline routes 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.

- Where possible, work should be restricted to one area at a time and be systematic. This is to reduce the number and extent of on-site activities, allowing fauna to move off as the Project progresses. This will give the smaller birds, mammals and reptiles a chance to weather the disturbance in an undisturbed zone close to their natural territories.
- Prior to commencing work each day, one individuals should traverse the working area in order to scare away any fauna within the seismic or drilling area, promoting temporary fauna migration from direct line of impact.
- Any holes/deep excavations must be done in a progressive manner on a need only basis. Minimal holes/excavations may be left open overnight. In the event holes/excavations are required to remain open overnight, these areas must be subsequently inspected prior to backfilling.
- A fire action plan needs to be complied and implemented to restrict the impact unplanned fires might have on the surrounding areas.

9.3.14 IMPACTS ON CULTURAL HERITAGE FEATURES

This section presents the identified potential impacts on archaeological, historical and cultural heritage resources associated with the proposed D3 Energy PR Application based on the Archaeological and Cultural Heritage Impact Assessment undertaken by Dr Lucien James of EIMS (**Appendix F2**). The assessment considers the proposed seismic surveys, production wells, gas gathering pipelines, gas processing plant and associated infrastructure within the Production Right Area. Refer to **Section 8.6** for the site heritage conditions and locations.

9.3.14.1 DESCRIPTION OF IMPACT

The Heritage Impact Assessment identified a total of 13 heritage resources that may potentially be affected by the proposed development. These comprise:

- Later Stone Age (LSA) archaeological remains (MPR019).
- Historical farmstead remains and foundations (MPR001, MPR005, MPR008, MPR009, MPR010, MPR017 and MPR018).
- Historical burial grounds and graves (MPR003, MPR004, MPR006, MPR012, MPR014 and MPR021).
- Historical middens and associated cultural material

Of particular concern are; MPR018, a historical foundation which intersects or lies in close proximity to a proposed gathering pipeline, MPR021, a grave site containing approximately 10 to 15 graves situated near a proposed gathering pipeline, and MPR019, a Later Stone Age lithic site situated near a gathering line corridor.

The primary heritage impact is therefore the disturbance, damage, destruction or loss of archaeological and cultural heritage resources through ground disturbance and infrastructure development.

9.3.14.1.1 ESTABLISHMENT PHASE

During project planning and establishment, impacts may arise through:

- Final selection of well pad locations.
- Siting of gathering pipelines.
- Siting of gas plant infrastructure.
- Establishment of access roads and servitudes.

- Seismic line alignment.
- Surveying, pegging and site demarcation activities.

Inappropriate infrastructure placement may result in direct overlap with known heritage resources, graves, historical farm complexes or archaeological sites. Although physical disturbance is limited during this phase, poor planning may result in future unavoidable impacts during construction and operation.

9.3.14.1.2 CONSTRUCTION PHASE

9.3.14.1.2.1 SEISMIC SURVEYS

The seismic programme includes approximately eight seismic transects and seven telluric lines. Heritage impacts may occur through:

- Vehicle movement across previously undisturbed areas.
- Pegging and marking of seismic routes.
- Temporary vegetation clearance.
- Disturbance of surface archaeological material.
- Damage to isolated heritage features located along survey corridors.

Although seismic impacts are generally temporary and linear in nature, they may disturb unrecorded archaeological material or previously undocumented graves.

9.3.14.1.2.2 DEVELOPMENT DRILLING

Development drilling presents a greater risk due to intensive ground disturbance associated with:

- Drill pad establishment.
- Excavation activities.
- Access road construction.
- Laydown areas.
- Temporary camps and support infrastructure.

Potential impacts include:

- Direct destruction of archaeological material.
- Damage to historical structures or foundations.
- Disturbance of burial grounds.
- Destruction of subsurface heritage resources.
- Loss of archaeological context.

The Heritage Impact Assessment specifically identifies the risk of encountering unidentified below-ground archaeological resources during excavation activities.

9.3.14.1.3 PRODUCTION PHASE

9.3.14.1.3.1 PRODUCTION WELLS

The Production Right proposes up to 43 production wells (plus 5 contingent wells) operated over an estimated 30-year period. Impacts may include:

- Permanent alteration of heritage landscapes.
- Continued restriction of access to heritage sites.
- Disturbance associated with maintenance activities.
- Secondary impacts through expansion of infrastructure.

Where wells are located near heritage resources, long-term impacts may occur through repeated site access and maintenance activities.

9.3.14.1.3.2 GAS GATHERING PIPELINES

Gas gathering pipelines represent the most significant heritage risk because trenching activities have the potential to directly intersect archaeological and heritage resources. Potential impacts include:

- Disturbance of graves and burial grounds.
- Destruction of archaeological deposits.
- Damage to historical farmstead remains.
- Loss of archaeological context.
- Exposure of previously unknown heritage resources.

The Heritage Assessment specifically highlights MPR018 and MPR021 as resources located close to proposed gathering pipelines which require avoidance

9.3.14.1.3.3 GAS PLANT AND ASSOCIATED INFRASTRUCTURE

Construction of the helium recovery and gas processing facility may result in:

- Permanent transformation of portions of the cultural landscape.
- Disturbance of previously unidentified heritage resources.
- Destruction of buried archaeological material during earthworks.

The risk is largely associated with excavation and site preparation activities.

9.3.14.1.4 DECOMMISSIONING AND REHABILITATION PHASE

Decommissioning may generate impacts similar to the construction phase through:

- Demolition of infrastructure.
- Removal of pipelines.
- Ground disturbance associated with rehabilitation.
- Earth-moving and regrading activities.

If heritage controls are not maintained during closure activities, heritage resources may be damaged in the same manner as during construction. Following rehabilitation, no long-term heritage impacts are anticipated provided identified resources remain protected and avoided.

9.3.14.2 IMPACT RATING

The impact ratings associated with the proposed activities related to archaeological and cultural heritage are indicated in **Table 101**.

Table 101: Summary of impacts related to archaeological and cultural heritage (EIMS, 2026).

Project Phase	Activity	Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Planning / Establishment	Infrastructure siting and route selection	Encroachment into known heritage sites, graves and archaeological resources	Medium to High	Medium to Low	Medium to Low -
Development	Seismic surveys	Disturbance of surface heritage material and unidentified archaeological resources	Medium to Low	Low	Low -
Development	Drilling and supportive infrastructure	Disturbance or destruction of historical structures, cultural material and archaeological resources	Medium to Low	Low	Low -
Development	Drilling and excavation	Disturbance of unidentified below-ground archaeological resources	Medium to High	Medium to Low	Medium to Low -
Development	Drilling and excavation	Disturbance of graves and burial sites	Medium to Low	Low	Low -
Production	Production well establishment	Damage to unidentified heritage resources through new infrastructure footprints	Medium to High	Medium to Low	Medium to Low -
Production	Gas gathering pipelines	Damage to historical foundations, archaeological resources and heritage sites	Medium to High	Medium to Low	Medium to Low -
Production	Gas gathering pipelines	Disturbance of graves and burial grounds	Medium to High	Low	Low -
Production	Gas plant construction	Disturbance of unidentified archaeological resources and modification of cultural landscape	Medium to High	Medium to Low	Medium to Low -
Production	Operations and maintenance	Disturbance of buffered heritage sites through access and maintenance activities	Medium to Low	Low	Low -
Decommissioning	Infrastructure removal and rehabilitation	Disturbance of known or unknown heritage resources during earthworks and rehabilitation	Medium to Low	Low	Low -
Decommissioning / Closure	Rehabilitation and closure	Residual impacts on heritage landscape	Low	Low	Low -

9.3.14.3 CUMULATIVE IMPACT ASSESSMENT

The cumulative impact must be assessed within the broader regional landscape which already contains:

- Existing gas exploration and production infrastructure.
- Existing agricultural activities and land transformation.
- Existing roads and service corridors.
- Existing mining-related activities.
- Approved and proposed renewable energy developments.

Potential cumulative impacts include:

- Progressive alteration of the historical agricultural landscape.
- Incremental loss of cultural context surrounding historical farmsteads.
- Increased pressure on heritage resources where multiple developments overlap.
- Increased probability of disturbance to previously unknown archaeological resources.
- Incremental reduction in heritage landscape integrity.

However, the specialist concluded that:

- Most identified heritage features can be avoided.
- No National or Provincial Heritage Sites occur within the development footprint.
- Implementation of buffers around graves and structures will substantially reduce impacts.
- Chance Find Procedures provide protection for unidentified resources

The potential cumulative heritage impacts associated with the proposed project relate primarily to the incremental disturbance of an already modified rural heritage landscape. Existing gas wells and associated activities, together with surrounding land uses such as renewable energy developments, existing infrastructure and agricultural activities, have already contributed to varying degrees of landscape alteration and surface disturbance. The proposed production-related activities may therefore add to these existing disturbances, particularly where new ground disturbance, vehicle movement, trenching, drilling, vegetation clearance or maintenance activities occur in proximity to identified or previously recorded heritage features. The most sensitive receptors in this regard are the identified grave sites and burial grounds, as well as any as-yet unidentified archaeological material that may be encountered as chance finds during construction or operational activities. While the proposed project is not expected to fundamentally alter the regional heritage character on its own, it may contribute incrementally to the continued reduction, fragmentation or loss of local heritage context if avoidance, buffering and chance find procedures are not implemented. With strict adherence to the recommended mitigation measures, including avoidance of known graves and heritage features, implementation of appropriate buffers, and application of a Chance Find Procedure, the cumulative heritage impact is expected to remain manageable and assessed to be Medium-Low negative.

9.3.14.4 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 H**):

- Should additional seismic surveys and/or drilling wells fall outside of the assessed footprint areas, but within the Production 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 location.

- The planning of all additional construction 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 construction 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.
- 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.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- A 30m buffer around all identified heritage structures (particularly MPR018) and the LSA site (MPR019) must be implemented, within which no proposed activities are to take place.
- A 50m buffer around all identified graves (particularly MPR021) must be implemented within which no proposed activities are to take place.
- Should finds of an alarming significance, for example, a grave or high density of small finds be discovered during construction, the ECO must be informed of the discovery. SAHRA (or the relevant provincial heritage authority) must likewise be contacted, and a qualified Archaeologist must be consulted to provide advice on how to proceed.

9.3.15 IMPACTS ON PALAEONTOLOGICAL HERITAGE

This section presents the identified potential impacts on palaeontological heritage associated with the proposed D3 Energy PR, including seismic surveys, production wells, gas gathering pipelines, gas compression infrastructure, helium recovery and gas processing facilities, access roads and associated infrastructure as per the Palaeontological Impact Assessment undertaken by Banzai Environmental (**Appendix F9**).

9.3.15.1 DESCRIPTION OF IMPACT

The palaeontological sensitivity of the project area is principally associated with the Adelaide Subgroup (Beaufort Group, Karoo Supergroup), which has been classified as having **Very High palaeontological sensitivity** by both the SAHRIS PalaeoMap and the DFFE National Environmental Screening Tool. The Adelaide Subgroup hosts the fossil-rich Daptocephalus Assemblage Zone and has the potential to preserve significant Permian-Triassic vertebrate fossils of national and international scientific importance. Although no fossiliferous outcrops

or in situ fossils were identified during the field verification survey, the specialist notes that fossil occurrence within the Adelaide Subgroup is inherently sporadic and unpredictable, and fossils may be encountered during excavation, drilling and trenching activities.

9.3.15.1.1 ESTABLISHMENT PHASE

No direct impacts on palaeontological heritage are expected during the planning and detailed design phase because there is no excavation or disturbance of geological substrates. However, project design and infrastructure placement have the potential to influence future impacts through:

- Selection of well locations.
- Alignment of gathering pipelines.
- Positioning of gas processing infrastructure.
- Access road design.
- Identification of excavation footprints.

Inappropriate siting may increase the likelihood of future disturbance of fossil-bearing geological units during construction activities.

9.3.15.1.2 CONSTRUCTION PHASE

9.3.15.1.2.1 SEISMIC SURVEYS

Seismic and audio-magnetotelluric surveys are regarded as the least intrusive of the proposed activities. Potential impacts include:

- Minor surface disturbance.
- Limited localised disturbance of shallow sediments.
- Temporary access route establishment.
- Accidental exposure of fossil-bearing deposits along disturbed corridors.

The palaeontological specialist concluded that seismic surveys are generally temporary, localised and largely reversible and consequently represent a low palaeontological risk.

9.3.15.1.2.2 DEVELOPMENT DRILLING

Development drilling presents the greatest palaeontological risk during the development phase.

Possible impacts include:

- Excavation of drill pads.
- Creation of sumps and foundations.
- Removal of soil and weathered rock.
- Penetration of fossil-bearing strata.
- Permanent destruction of previously unknown fossil material.
- Loss of scientific information associated with fossil occurrence and geological context.

Because fossils cannot be replaced once removed or destroyed, the loss of fossil heritage is regarded as potentially irreversible where significant material is encountered.

9.3.15.1.3 PRODUCTION PHASE

9.3.15.1.3.1 PRODUCTION WELLS

The establishment of up to 43 production wells (plus 5 contingent wells) will involve repeated excavation and infrastructure placement within fossil-sensitive geological formations. Potential impacts include:

- Permanent destruction of buried fossil resources.
- Disturbance of fossil-bearing strata.
- Loss of scientific information.
- Reduction of future palaeontological research opportunities.

Although individual well footprints are relatively small, impacts become cumulative through the number of wells proposed

9.3.15.1.3.2 GAS GATHERING PIPELINES

Pipeline trenching creates one of the most significant mechanisms for palaeontological impacts because it involves continuous linear excavation across long distances. Potential impacts include:

- Exposure and destruction of fossil-bearing geological strata.
- Disturbance of fossils within trench excavations.
- Irretrievable loss of scientific information.
- Permanent modification of geological context.

The specialist considers pipeline construction to present impacts equivalent to those associated with drilling activities.

9.3.15.1.3.3 GAS PLANT CONSTRUCTION

Construction of the helium recovery and gas processing facility involves:

- Bulk earthworks and excavations.
- Site levelling.
- Infrastructure installation.

Potential impacts include:

- Permanent destruction of fossil-bearing deposits.
- Loss of geological context.
- Irretrievable loss of fossil material if uncovered and not appropriately managed.

Gas plant construction is therefore assessed as having a similar palaeontological impact profile to drilling activities.

9.3.15.1.4 DECOMMISSIONING AND REHABILITATION PHASE

The palaeontological specialist concluded that no significant impacts on palaeontological heritage are expected during decommissioning or closure activities because fossil-bearing geological materials would already have been disturbed during the construction phase. Consequently, no material additional disturbance of palaeontological resources is anticipated, and no significant residual palaeontological impacts are expected from rehabilitation activities.

9.3.15.2 IMPACT RATING

The impact ratings associated with the proposed activities related to palaeontological heritage are indicated in **Table 102**.

Table 102: Summary of impacts related to palaeontological heritage (Banzai Environmental, 2026).

Project Phase	Activity	Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Planning / Establishment	Infrastructure siting and detailed design	Future disturbance of fossil-bearing geological units through poor infrastructure placement	Medium to Low	Low	Low -
Construction	Seismic surveys and magnetotelluric surveys	Minor disturbance and accidental exposure of fossil-bearing sediments	Low	Low	Low -
Construction	Development drilling and drill pad construction	Loss of fossil heritage through excavation of fossil-bearing strata	High	Medium to High	Medium to High -
Construction	Development drilling and ancillary earthworks	Destruction of buried fossil material and loss of scientific information	High	Medium to High	Medium to High -
Production	Production well establishment	Permanent disturbance of fossil-bearing geological units	High	Medium to High	Medium to High -
Production	Gas gathering pipelines	Fossil loss through trenching and infrastructure construction	High	Medium to High	Medium to High -
Production	Gas plant construction	Destruction of fossil-bearing strata through earthworks and foundations	High	Medium to High	Medium to High -
Production	Gas plant operation and maintenance	No additional disturbance to fossil heritage anticipated	Low	Low	Low -
Decommissioning	Closure and rehabilitation activities	No significant impact on fossil heritage anticipated	Low	Low	Low -
Post-Closure	Residual palaeontological impacts	No further palaeontological disturbance anticipated	Low	Low	Low -

9.3.15.3 CUMULATIVE IMPACT ASSESSMENT

The cumulative palaeontological impact must be assessed together with:

- Existing gas exploration infrastructure.
- Existing production activities.
- Existing agricultural activities.
- Existing roads and service infrastructure.
- Proposed renewable energy developments.
- Other future earth-disturbing developments within the region.

The specialist concluded that cumulative palaeontological impacts are constrained by the following:

- Fossils occur sporadically rather than continuously.
- Existing developments have generally limited palaeontological footprints.
- The proposed development footprint remains localised within a wider palaeontologically sensitive region.
- Implementation of the Chance Find Protocol significantly reduces cumulative impacts.

The palaeontological specialist therefore assigned the cumulative impact a **Low negative significance rating** following implementation of mitigation measures.

9.3.15.4 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 H**):

- The planning of all additional construction footprints must take cognizance of the heritage sensitivities depicted on the heritage sensitivity maps.
- 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.

9.3.16 RISK, HEALTH AND SAFETY IMPACTS

This section presents the identified potential risk, health and safety impacts associated with the proposed D3 Energy PR Activities, including seismic surveys, production wells, gas gathering pipelines, helium recovery facilities, gas processing facilities (CNG and/or LNG), flare systems and associated infrastructure. The assessment is based on the findings of the Quantitative Risk Assessment for the proposed D3 Energy PR activities undertaken by Riscom (**Appendix F10**).

9.3.16.1 RISK ANALYSIS

9.3.16.1.1 BACKGROUND

It is important to understand the difference between a hazard and a risk.

A hazard is anything that has the potential to cause damage to life, property and the environment. Furthermore, it has constant parameters (like those of petrol, chlorine, ammonia, etc.) that pose the same hazard wherever present. On the other hand, a risk is the probability that a hazard will actually cause damage and goes along with how severe that damage will be (consequence). A risk is therefore the probability that a hazard will manifest itself. For instance, the risks of a chemical accident or spill depend upon the amount present, the process the chemical is used in, the design and safety features of its container, the exposure, the prevailing environmental and weather conditions and so on.

Risk analysis consists of a judgement of probability based on local atmospheric conditions, generic failure rates and severity of consequences, based on the best available technological information. Risks form an inherent part of modern life. Some risks are readily accepted on a day-to-day basis, while certain hazards attract headlines even when the risk is much smaller, particularly in the field of environmental protection and health. For instance, the risk of one-in-ten-thousand chance of death per year associated with driving a car is acceptable to most people, whereas the much lower risks associated with nuclear facilities (one-in-ten-million chance of death per year) are deemed unacceptable.

A report by the British Parliamentary Office of Science and Technology (POST), entitled 'Safety in Numbers? Risk Assessment and Environmental Protection', explains how public perception of risk is influenced by a number of factors in addition to the actual size of the risk. These factors were summarised as follows in **Table 103**.

Table 103: Influence of public perception of risk on acceptance of that risk, based on the POST report (Riscom, 2026).

Control	People are more willing to accept risks they impose upon themselves or they consider to be 'natural' than to have risks imposed upon them.
Dread and Scale of Impact	Fear is greatest where the consequences of a risk are likely to be catastrophic rather than spread over time.
Familiarity	People appear more willing to accept risks that are familiar rather than new risks.
Timing	Risks seem to be more acceptable if the consequences are immediate or short term, rather than if they are delayed (especially if they might affect future generations).
Social Amplification and Attenuation	Concern can be increased because of media coverage, graphic depiction of events or reduced by economic hardship.
Trust	A key factor is how far the public trusts regulators, policy makers or industry; if these bodies are open and accountable (being honest as well as admitting mistakes and limitations and taking account of differing views without disregarding them as emotive or irrational), then the public is more likely consider them credible.

A risk assessment should be seen as an important component of ongoing preventative action, aimed at minimising or hopefully avoiding accidents. Reassessments of risks should therefore follow at regular intervals

and after any changes that could alter the nature of the hazard, so contributing to an overall prevention programme and emergency response plan of the facility. Risks should be ranked with decreasing severity and the top risks reduced to acceptable levels. Procedures for predictive hazard evaluation have been developed for the analysis of processes when evaluating very low probability accidents with very high consequences (for which there is little or no experience), as well as more likely releases with fewer consequences (for which there may be more information available). These addresses both the probability of an accident, as well as the magnitude and nature of undesirable consequences of that accident. A risk is usually defined as some simple function of both the probability and consequence.

9.3.16.1.2 PREDICTED RISK

Physical and consequence modelling addresses the impact of a release of a hazardous component without taking into account the probability of occurrence. This merely illustrates the significance and the extent of the impact in the event of a release. Modelling should also analyse cascading or knock-on effects due to incidents in the facility and the surrounding industries and suburbs.

During a risk analysis, the likelihood of various incidents is assessed, the consequences calculated and finally the risk for the facility is determined.

9.3.16.1.2.1 GENERIC EQUIPMENT FAILURE SCENARIOS

Given the broad scope of this study and the limited availability of detailed information, the analysis included only major equipment failures. Pump / compressor and transport scenarios, such as road tanker failures were not included due to their effects likely being surpassed by those of the larger vessels on-site. Unless otherwise stated, analysis was completed by using published failure rate data (RIVM 2009). Equipment failures can occur in tanks, pipelines and other items handling hazardous chemical components. These failures may result in the:

- Release of combustible, flammable and explosive components with fires or explosions upon ignition; or the,
- Release of toxic or asphyxiant components.

9.3.16.1.2.2 STORAGE VESSELS

Scenarios involving storage vessels can include catastrophic failures that would lead to leakage into the bund with a possible bund fire. The fracture of a nozzle or transfer pipeline could also result in leakage into the bund. Typical failure frequencies for atmospheric and pressure vessels are listed, respectively, in **Table 104** and in **Table 105**.

Table 104: Failure frequencies for atmospheric vessels (Riscom, 2026).

Event	Leak Frequency (per item per year)
Small leaks	$1x10^{-4}$
Severe leaks	$3x10^{-5}$
Catastrophic failure	$5x10^{-6}$

Table 105: Failure frequencies for pressure vessels (Riscom, 2026).

Event	Failure Frequency (per item per year)
Small leaks	$1x10^{-5}$
Severe leaks	$5x10^{-7}$
Catastrophic failure	$5x10^{-7}$

9.3.16.1.2.3 PROCESS PIPING

Piping may fail as a result of corrosion, erosion, mechanical impact damage, pressure surge (water hammer) or operation outside the design limitations for pressure and temperature. Failures caused by corrosion and erosion usually result in small leaks, which are easily detected and corrected quickly. For significant failures, the leak duration may be from 10 to 30 minutes before detection. Generic data for leak frequency for process piping is generally expressed in terms of the cumulative total failure rate per year for a 10 m section of pipe for each pipe diameter. Furthermore, failure frequency normally decreases when increasing the pipe diameter. Scenarios and failure frequencies for a pipeline apply to pipelines with connections, such as flanges, welds and valves.

The failure data given in **Table 106** represents the total failure rate, incorporating all failures of whatever size and due to all probable causes. These frequencies are based on an assumed environment where no excessive vibration, corrosion, erosion or thermal cyclic stresses are expected. For incidents causing significant leaks (such as corrosion), the failure rate will be increased by a factor of 10.

Table 106: Failure frequencies for process pipes (Riscom, 2026).

Description	Frequencies of Loss of Containment for Process Pipes (per meter per year)	
	Full Bore Rupture	**Leak**
Nominal diameter < 75 mm	$1x10^{-6}$	$5x10^{-6}$
75 mm < nominal diameter < 150 mm	$3x10^{-7}$	$2x10^{-6}$
Nominal diameter > 150 mm	$1x10^{-7}$	$5x10^{-7}$

9.3.16.1.2.4 IGNITION PROBABILITY OF FLAMMABLE GASES AND LIQUIDS

The estimation of the probability of an ignition is a key step in assessment of risk for installations where flammable liquids or gases are stored. There is a reasonable amount of data available relating to the characteristics of ignition sources and the effects of the release type and the location. The probability of ignition for stationary installations is given in **Table 107** (along with classification of flammable substances in **Table 108**). These can be replaced with ignition probabilities related to surrounding activities. For example, the probability of a fire from a flammable release at an open flame would increase to a value of 1.

Table 107: Probability of direct ignition for stationary installations (RIVM 2009) (Riscom, 2026).

Substance Category	Source-Term Continuous	Source-Term Instantaneous	Probability of Direct Ignition
Category 0	< 10 kg/s	< 1000 kg	0.2
Average to high reactivity	10 – 100 kg/s	1000 – 10 000 kg	0.5
	> 100 kg/s	> 10 000 kg	0.7
Category 0	< 10 kg/s	< 1000 kg	0.02
Low reactivity	10 – 100 kg/s	1000 – 10 000 kg	0.04
	> 100 kg/s	> 10 000 kg	0.09
Category 1	All flow rates	All quantities	0.065

Substance Category	Source-Term Continuous	Source-Term Instantaneous	Probability of Direct Ignition
Category 2	All flow rates	All quantities	0.0043[19]
Category 3 **Category 4**	All flow rates	All quantities	0

Table 108: Classification of flammable substances (Riscom, 2026).

Substance Category	Description	Limits
Category 0	Extremely flammable	Liquids, substances and preparations that have a flashpoint lower than 0°C and a boiling point (or the start of the boiling range) less than or equal to 35°C Gaseous substances and preparations that may ignite at normal temperature and pressure when exposed to air
Category 1	Highly flammable	Liquids, substances and preparations that have a flashpoint of below 21°C
Category 2	Flammable	Liquids, substances and preparations that have a flashpoint equal to 21°C and less than 55°C
Category 3		Liquids, substances and preparations that have a flashpoint greater than 55°C and less than or equal to 100°C
Category 4		Liquids, substances and preparations that have a flashpoint greater than 100°C

Note:

Methane is classified as an unreactive gas. As such, the pipeline probability was equal to the typical overall probabilities for Natural Gas, used by HSE (IGEM/TD/2 (2012)), as follows:

- Immediate ignition resulting in a fireball followed by jet fire: 0.25;
- Delayed ignition resulting in a jet fire: 0.1875; or,
- No ignition: 0.5625.

9.3.16.1.2.5 RISK CALCULATIONS

9.3.16.1.2.5.1 MAXIMUM INDIVIDUAL RISK PARAMETER

Standard individual risk parameters include: average individual risk; weighted individual risk; maximum individual risk; and, the fatal accident rate. The lattermost parameter is more applicable to occupational exposures. Only the maximum individual risk (MIR) parameter will be used in this assessment. For this parameter, the frequency of fatality is calculated for an individual who is presumed to be present at a specified location. This parameter (defined as the consequence of an event multiplied by the likelihood of the event) is not dependent on knowledge of populations at risk. So, it is an easier parameter to use in the predictive mode than the average individual risk or weighted individual risk. The unit of measure is the risk of fatality per person per year.

[19] This value is taken from the CPR 18E (Purple Book; 1999). RIVM (2009) gives the value of a delayed ignition as zero. RISCOM (PTY) LTD believes that the CPR 18E is more appropriate for warmer climates and is a conservative value.

9.3.16.1.2.5.2 ACCEPTABLE RISKS

The next step, after having characterised a risk and obtained a risk level, is to recommend whether the outcome is acceptable. In contrast to the employees at a facility, who may be assumed to be healthy, the adopted exposure assessment applies to an average population group that also includes sensitive subpopulations. Sensitive subpopulation groups are those people that for reasons of age or medical condition have a greater than normal response to contaminants. Health guidelines and standards used to establish risk normally incorporate safety factors that addresses this group.

Among the most difficult tasks of risk characterisation is the definition of acceptable risk. In an attempt to account for risks in a manner similar to those used in everyday life, the UK Health and Safety Executive (HSE) developed the risk ALARP triangle (**Figure 134**). Applying the triangle involves deciding:

- Whether a risk is so high that something must be done about it;
- Whether the risk is or has been made so small that no further pre-cautions are necessary; or,
- If a risk falls between these two states so that it has been reduced to levels as low as reasonably practicable (ALARP).

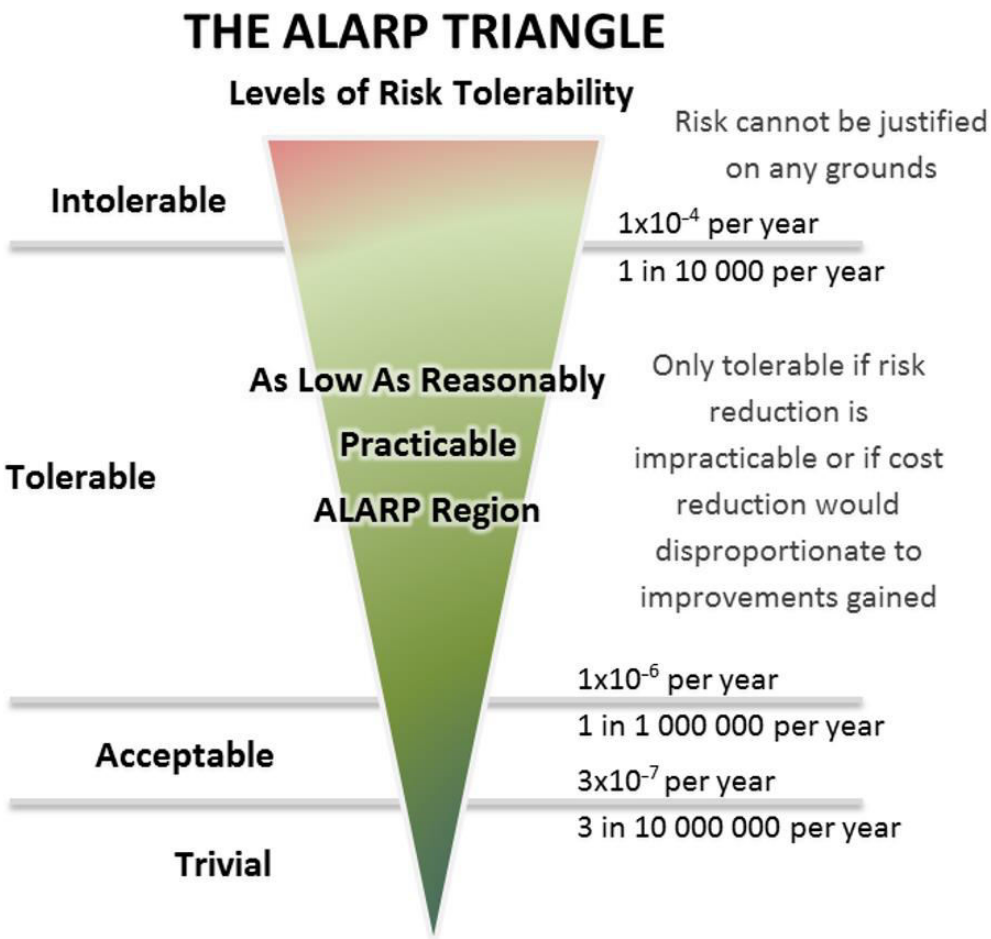


Figure 134: UK HSE decision-making framework (Riscom, 2026).

9.3.16.1.2.5.3 LAND PLANNING

There are no legislative land-planning guidelines in South Africa and in many parts of the world. Further to this, land-planning guidelines vary from one country to another, and thus it is not easy to benchmark the results of this study to international criteria. In this instance, RISCOM would only advise on applicable land planning and would require governmental authorities to make the final decisions. Land zoning applied in this study follows

the HSE (UK) approach of defining the area affected into three zones, consistent to the ALARP approach (HSE 2011). The three zones are defined as follows:

- The inner zone is enclosed by the risk of 1x10-5 fatalities per person per year isopleth;
- The middle zone is enclosed by the risk of 1x10-5 fatalities per person per year and the risk of 1x10-6 fatalities per person per year isopleths; and,
- The outer zone is enclosed by the risk 1x10-6 fatalities per person per year and the risk of 3x10-7 fatalities per person per year isopleths.

The risks decrease from the inner zone to the outer zone, as shown in **Figure 135** and **Figure 136**.

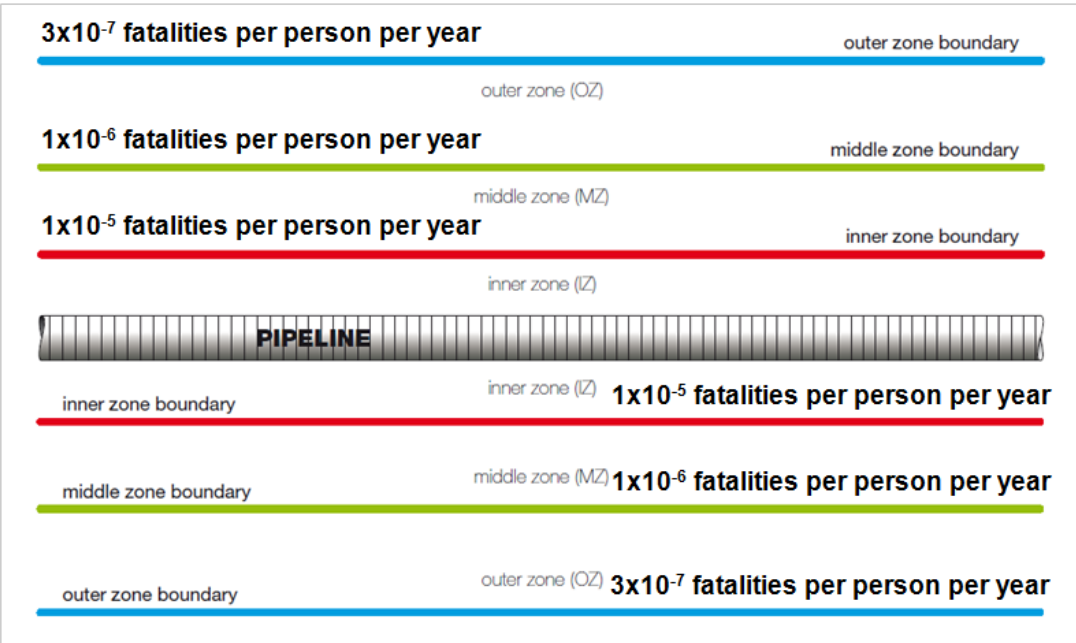


Figure 135: Town-planning zones for pipelines (Riscom, 2026).

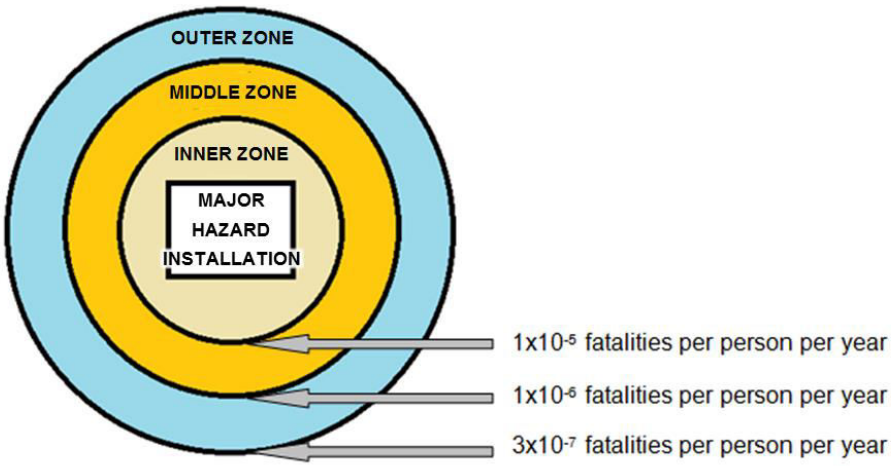


Figure 136: Town-planning zones (Riscom, 2026).

Once the zones are calculated, the HSE (UK) methodology then determines whether a development in a zone should be categorised as 'advised against' (AA) or as 'don't advise against' (DAA), depending on the sensitivity of the development, as indicated in **Table 109**. There are no land-planning restrictions beyond the outer zone.

Table 109: Land-use decision matrix (Riscom, 2026).

Level of Sensitivity	Development in Inner Zone	Development in Middle Zone	Development in Outer Zone
1	DAA	DAA	DAA
2	AA	DAA	DAA
3	AA	AA	DAA
4	AA	AA	AA

The sensitivity levels are based on a clear rationale, in order to allow progressively more severe restrictions to be imposed as the sensitivity of the proposed development increases. There are four sensitivity levels, with the sensitivity for housing defined below:

- Level 1: workers who have been advised of the hazards and trained accordingly;
- Level 2: based on the general public at home and involved in normal activities;
- Level 3: based on the vulnerable members of the public (e.g., children, those with mobility difficulties or those unable to recognise physical danger); and,
- Level 4: large examples of Level 3 and large examples of Level 2.

9.3.16.2 QUANTITATIVE RISK ASSESSMENT (QRA) SCENARIOS

Risk assessment done in accordance with the MHI regulations are required to be conducted according to SANS 1461 (2018). This standard is specific to the MHI risk assessment that is required to be done prior to construction and includes elements that is not usually available at the preparation, such as emergency plans and mitigation suggested during the EIA process. The QRA process is summarised with the following steps:

1. Identification of components that are flammable, toxic, reactive or corrosive and that have the potential to result in a major incident from fires, explosions or toxic releases;
2. Development of accidental loss of containment (LOC) scenarios for equipment containing hazardous components (including release rate, location and the orientation of the release);
3. For each incident developed in Step 2, determination of consequences (such as thermal radiation, domino effects, toxic-cloud formation and so forth); and,
4. For scenarios with off-site consequences (greater than 1% fatality off-site), calculation of maximum individual risk (MIR), taking into account all generic failure rates, initiating events (such as ignition), meteorological conditions and lethality.

Scenarios included in this QRA have impacts externally to the establishment. The 1% fatality from acute affects (thermal radiation, blast overpressure and toxic exposure) is determined as the endpoint (RIVM 2009). Thus, a scenario producing a fatality of less than 1% at the establishment boundary under worst-case meteorological conditions would be excluded from the QRA.

Guidelines for the selection of scenarios is given in RIVM (2009) and CPR 18E (Purple Book; 1999). A particular scenario may produce more than one major consequence. In such cases, consequences are evaluated separately and assigned failure frequencies in the risk analysis. Some of these phenomena are described in the subsections that follow.

9.3.16.2.1 SCENARIOS FOR RELEASE OF A PRESSURISED LIQUEFIED GAS

The nature of the release of a liquefied gas from a pressurised vessel is dependent on the position of the hole. A hole above the liquid level will result in a vapour release only, and the release rate would be related to the

size of the hole and internal pressure of the tank. Over a period of time, bulk temperature reduces, with an associated decrease in the vapour release rate. A hole below the liquid level will result in a release of a liquid stream. In the reduced pressure of the atmosphere, a portion of the liquid will vaporise at the normal boiling point. This phenomenon is called flashing and is shown in **Figure 137**. The pool, formed after flashing, then evaporates at a rate proportional to the pool area, surrounding temperature and wind velocity.

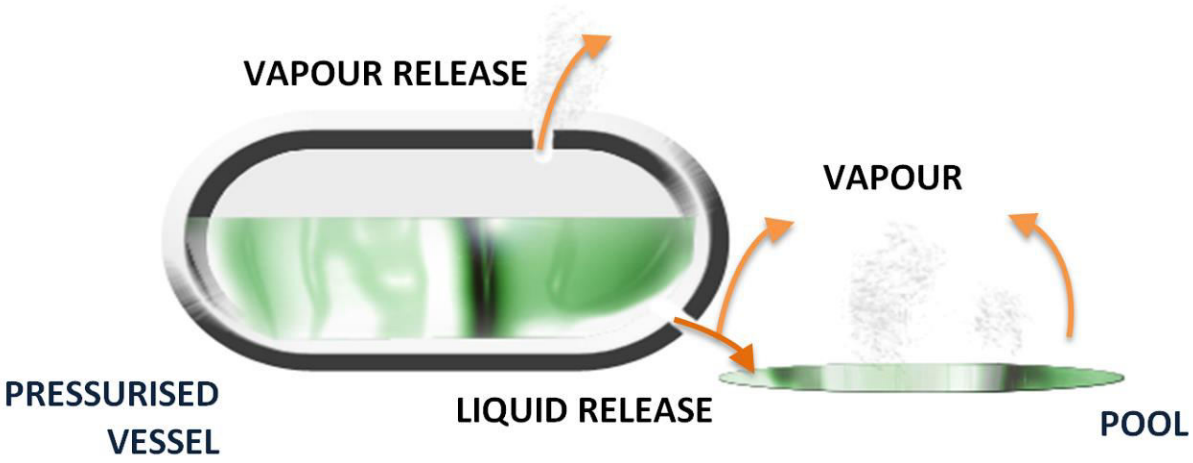


Figure 137: Airborne vapours from a loss of containment of liquefied gas stored in a pressurised vessel (Riscom, 2026).

9.3.16.2.2 INSTANTANEOUS RELEASE OF A PRESSURED LIQUEFIED FLAMMABLE GAS

An instantaneous loss of containment of a liquefied flammable gas could result in the consequences, given in the event tree of **Figure 138**. Probability of the events occurring is dependent on a number of factors and is determined accordingly.

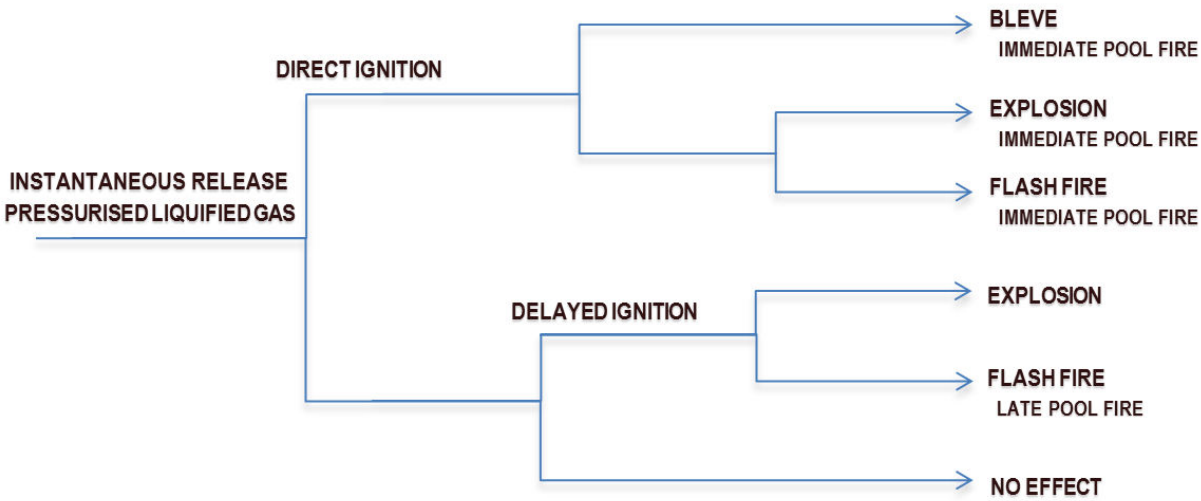


Figure 138: Event tree for an instantaneous release of a liquefied flammable gas (Riscom, 2026).

9.3.16.2.3 CONTINUOUS RELEASE OF A PRESSURISED LIQUEFIED FLAMMABLE GAS

The continuous loss of containment of a liquefied flammable gas could result in the consequences, given in the event tree of **Figure 139**. Probability of the events occurring is dependent on a number of factors and is determined accordingly.

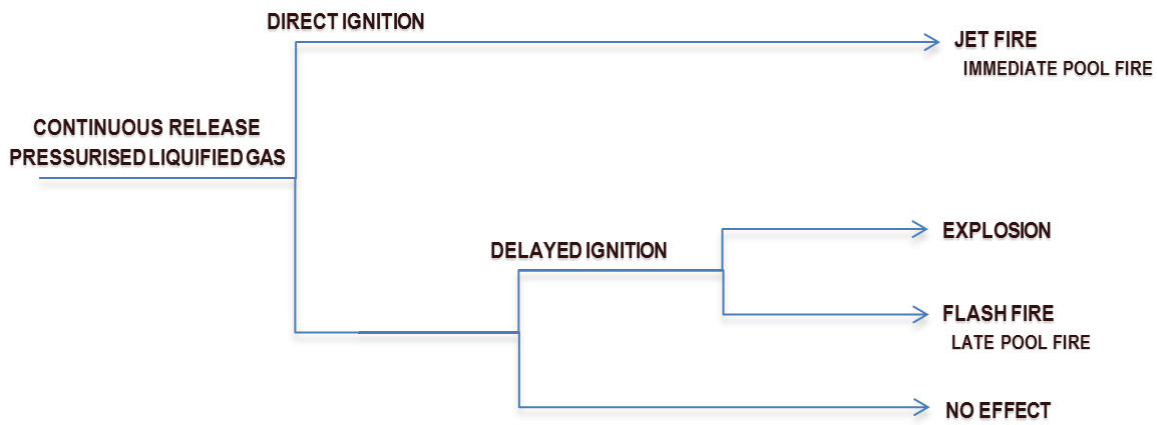


Figure 139: Event tree for a continuous release of a liquefied flammable gas (Riscom, 2026).

9.3.16.2.4 CONTINUOUS RELEASE OF A FLAMMABLE GAS

The continuous loss of containment of a flammable gas could result in the consequences, given in the event tree of **Figure 140**. Probability of the events occurring is dependent on a number of factors and is determined accordingly.

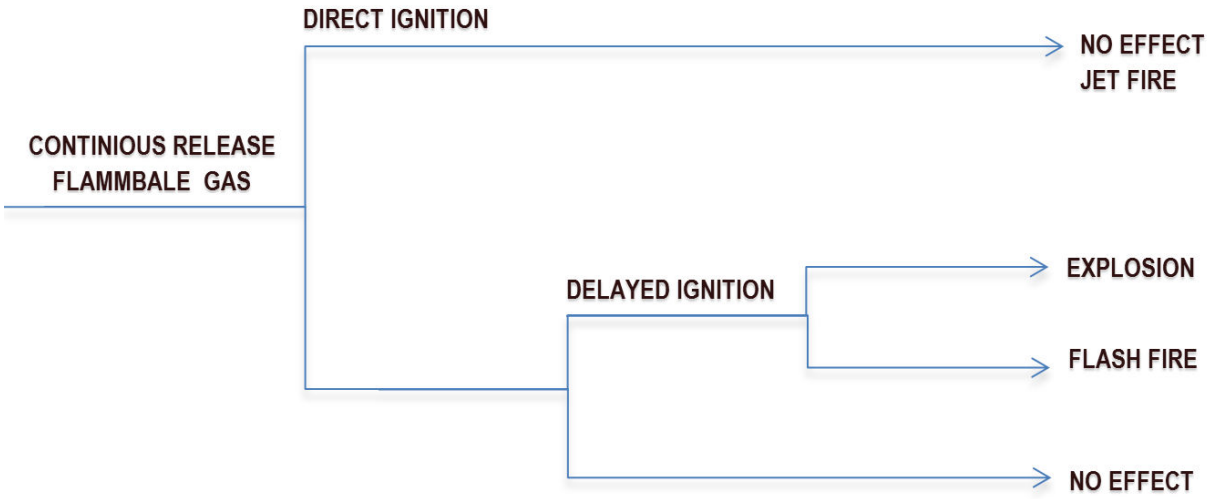


Figure 140: Event tree for a continuous release of a flammable gas (Riscom, 2026).

9.3.16.2.5 CONTINUOUS RELEASE OF A FLAMMABLE LIQUID

The continuous loss of containment of a flammable liquid could result in the consequences, given in the event tree of **Figure 141**. Probability of the events occurring is dependent on a number of factors and is determined accordingly.

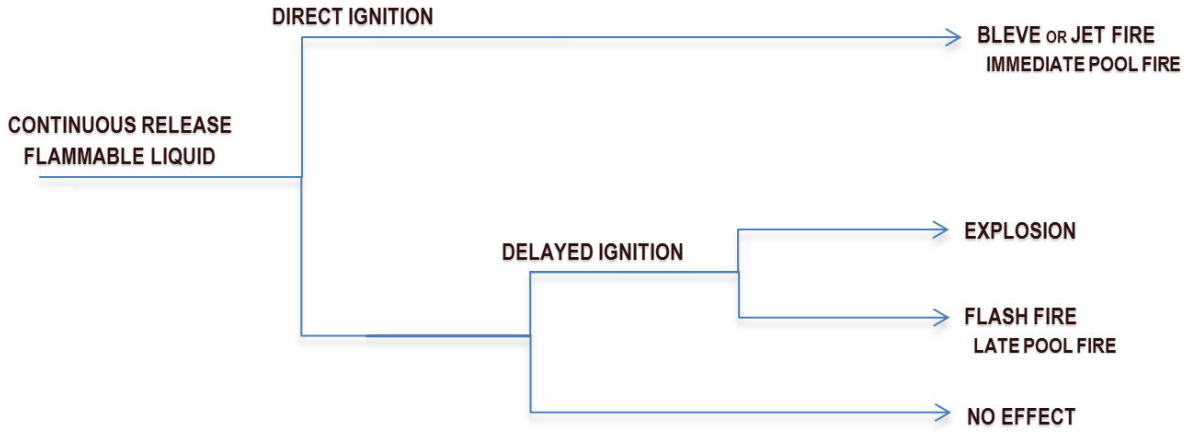


Figure 141: Event tree for a continuous release of a flammable liquid (Riscom, 2026).

9.3.16.3 RISK ASSESSMENT

A risk assessment was done for each processing unit by firstly selecting a scenario and then completing consequence and outflow modelling. Consequences with possible impacts beyond the site boundary were retained for risk analysis of the unit. Finally, the risk of the entire facility is determined as a combination of the risk calculated for each unit.

9.3.16.3.1 GAS WELLS AND GAS GATHERING PIPELINE

9.3.16.3.1.1 WELLS AND PIPELINE

In total, there are 43 well development locations (plus 5 contingent wells) that are located along known faults and close to either existing blowers or exploration wells drilled by D3 Energy. The initial development will focus on the wells located on the Virginia fault where there are 13 new well locations and 3 existing wells that will be utilised in the development. Each well is expected to have a maximum pressure of 50 psig (3.5 bar) and a maximum flow rate 250 MMSCFD (295 m^3/hr).

9.3.16.3.1.2 WELL FAILURE

A well failure would result in a vertical release of natural gas. In the event of a release without ignition, the flammable cloud is shown in **Figure 142**. The release will be a turbulent free jet, with a limited diameter at the reference level of 1 m above grade. To this end, the flammable region extends around the release jet, which has a small diameter and poses no significant potential for a vapour cloud explosion.

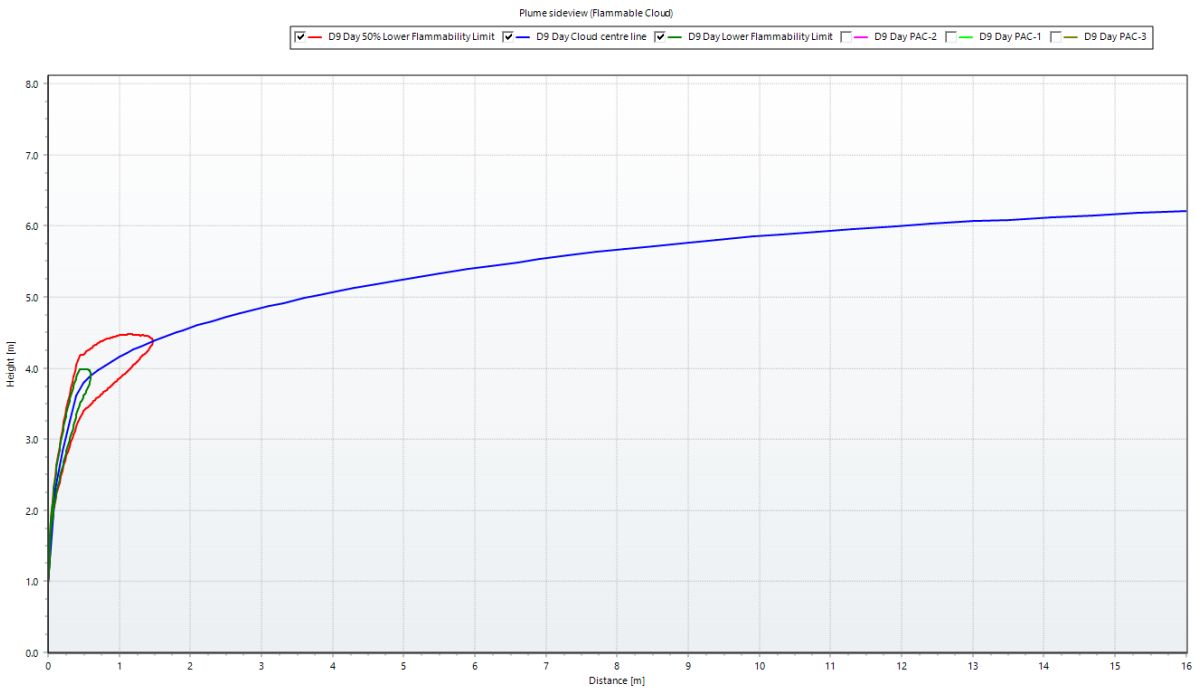


Figure 142: Maximum extent of the flammable cloud from a failure of an individual well (side-view) (Riscom, 2026).

In the event of an ignition, a jet fire could form in the vertical plane. A strong wind could tilt the flame producing thermal radiations, as shown in **Figure 143**. The 4 kW/m^2 is capable of breaking glass and is the lower limit in emergency planning for escape routes. The 10 kW/m^2 is the value for the 1% fatality for unprotected people, with an exposure duration at 20 seconds. The 37.5 kW/m^2 represents the critical thermal radiation flux for damage to metal equipment. The 1% fatality could extend 4m downwind from the release.

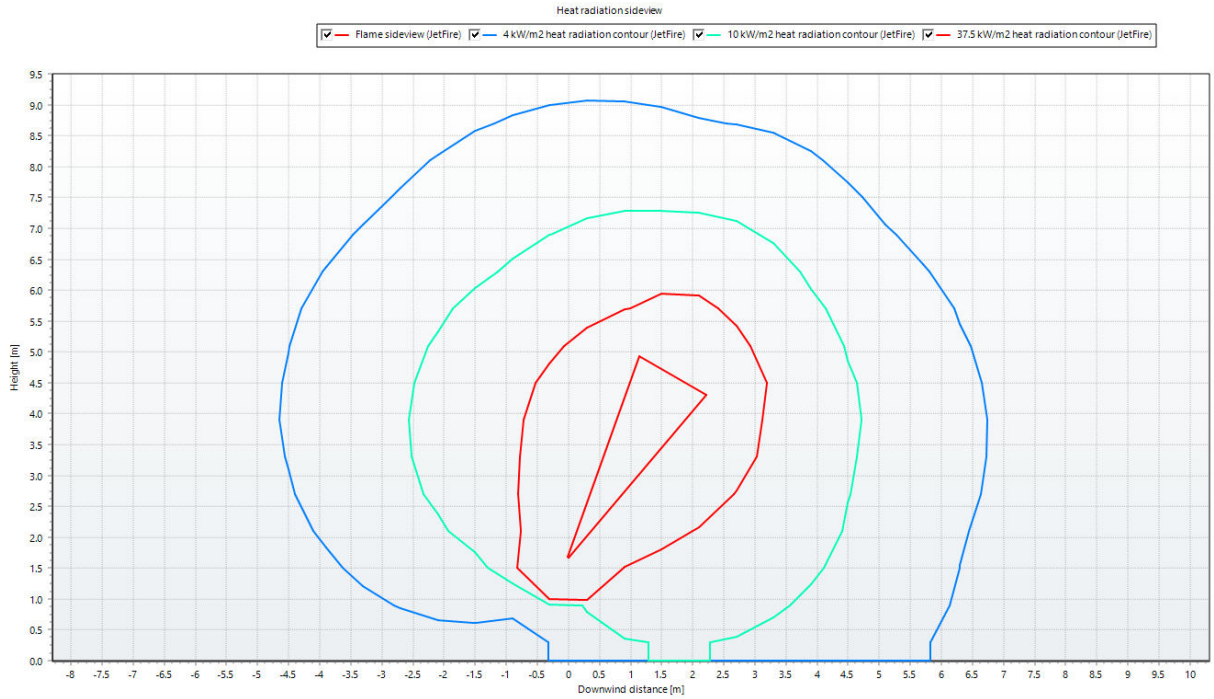


Figure 143: Side-view of the jet fire from a large release from a single well (Riscom, 2026).

9.3.16.3.1.3 COLLECTION PIPELINE

The maximum distance to the 1% fatality from a release of the natural gas pipeline, is shown in **Figure 144**. The maximum distance would occur with a high wind speed and could cause severe damage at the point of release, but it is not expected to impact residential areas.

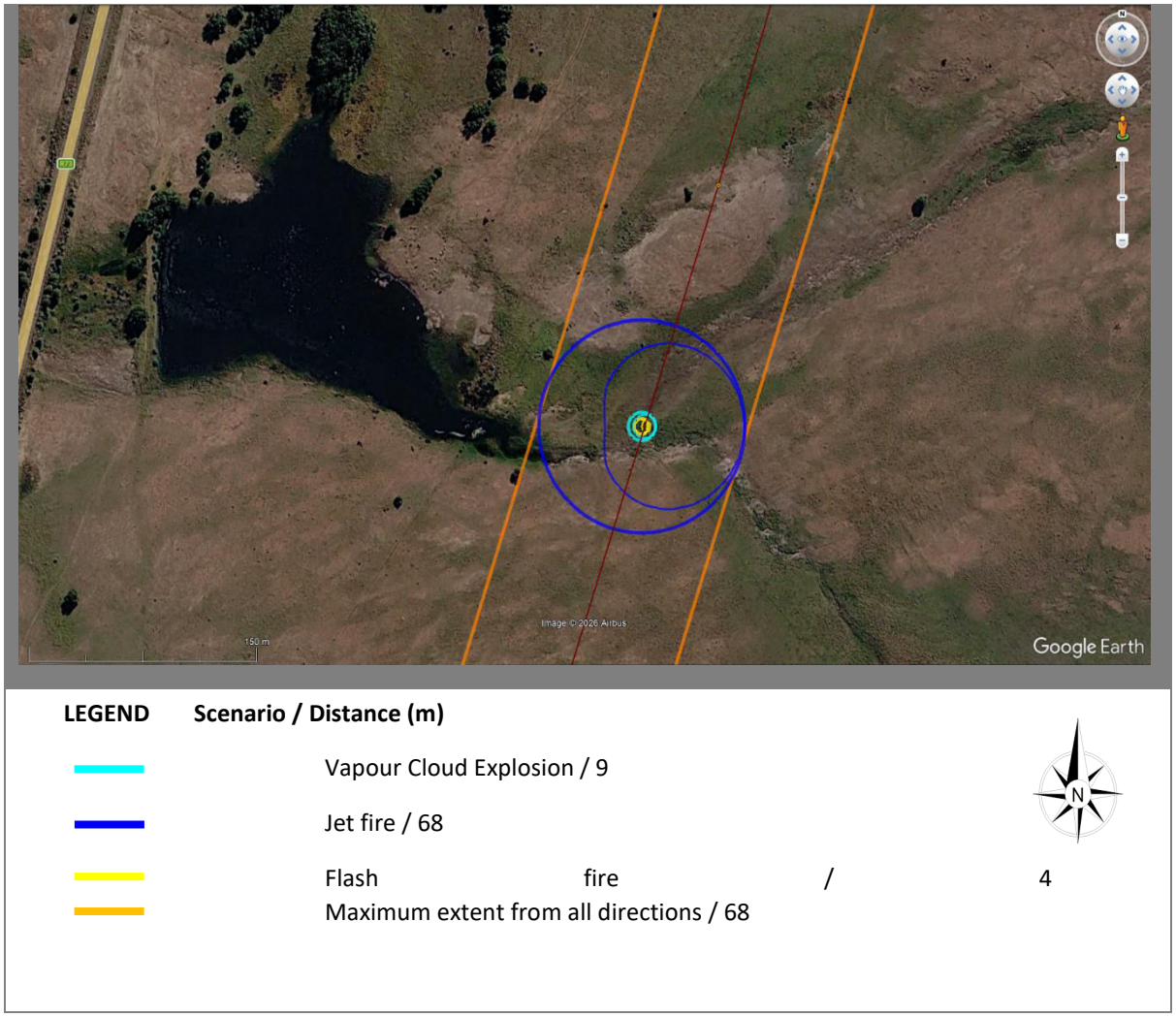


Figure 144: The maximum extent to the 1% fatality from the natural gas pipeline failure (Riscom, 2026).

9.3.16.3.2 GAS PROCESSING PLANT

The gas processing plant will receive gas from the well, extract the helium as a marketable product, and purify the remaining stream into saleable compressed natural gas (CNG) and liquefied natural gas (LNG).

9.3.16.3.2.1 CONSEQUENCE MODELLING

The scenarios modelled for the gas-to-power facility, are listed in **Table 110**. Some of these scenarios are discussed further in the sections below.

Table 110: Scenarios modelled for the gas-to-power facility (Riscom, 2026).

Equipment	Scenarios Modelled	Potential Consequences	Comments / Assumptions
Helium storage	• Catastrophic failure • 10 Minute release • 10 mm Hole	Toxic release (Asphyxiant)	• Volume: 110 m^3 • Storage temperature: -269^oC • Storage pressure: 0.32 bar(g)

Equipment	Scenarios Modelled	Potential Consequences	Comments / Assumptions
Helium tanker	• Tanker failure • Hose failure • Hose leak	Toxic release (Asphyxiant)	• ISO Tank container: 41 m^3 • 1 x ISO Tank container / week
LNG tanker	• Tanker failure • Hose failure • Hose leak	• Pool fires • Flash fires • VCE	• Road tankers: 45 m^3 - 5 Road tankers per week • Pressure: 300 kpa(g) • Temperature: -162°C
CNG storage	• Catastrophic failure • 10 Minute release • 10 mm Hole	• Jet fires • Flash fires • VCE	• Capacity: 25 m^3 • Pressure: 260 bar(g) • Temperature: 35°C
CNG tanker	• Tanker failure • Hose failure • Hose leak	• Jet fires • Flash fires • VCE	• Road tankers: 8 Road tankers per day • Pressure: 260 bar(g) • Temperature: 35°C
CNG compressor	• Failure	• Jet fires • Flash fires • VCE	• Flow: 165 m^3/day • Pressure: 260 bar(g) • Temperature: 35°C

9.3.16.3.2.2 HELIUM

Helium is not a toxic gas, but may displace oxygen resulting in asphyxiation and is analysed in a similar manner to toxic gas. The 1% fatality represents the endpoint for risk assessment calculations, with various scenarios shown in **Figure 145**. Fatalities from a large release of helium will be limited to the site.

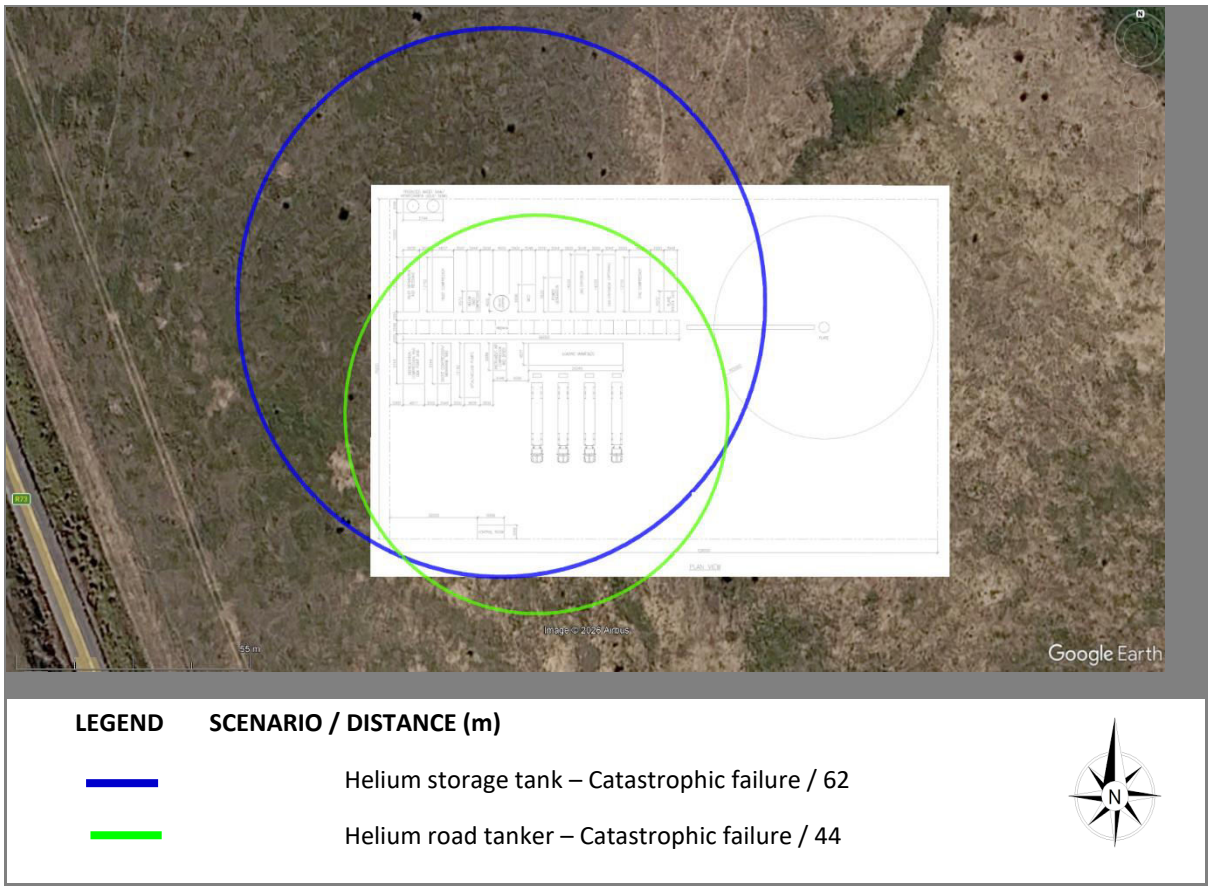


Figure 145: The extent of an expected 1% fatality in the open following large releases of helium (Riscom, 2026).

9.3.16.3.2.3 AMMONIA

Ammonia used in the refrigeration system is listed by the EPA as being extremely toxic. It is stored in vessels within the refrigeration plant and is used as a refrigerant. PAC-3 is the maximum air concentration below, which it is believed that nearly all individuals could be exposed without experiencing or developing life-threatening health effects. The PAC-2 concentration is the maximum air concentration below, which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or serious health effects or symptoms that could impair an individual's ability to take protective action. The PAC 2 value is used for emergency planning to indicate the furthest downwind distance for evacuation of nearby populations in the event of a release.

Figure 146 illustrates the PAC-2 and PAC-3 endpoint distances and the 1% fatality endpoint distance for the worst-case release scenario in worst-case meteorological conditions. This was found to be the fixed duration release of the -10°C surge tank at a low wind speed. The thicker lines indicate a westerly wind, while the thinner lines indicate all wind directions.

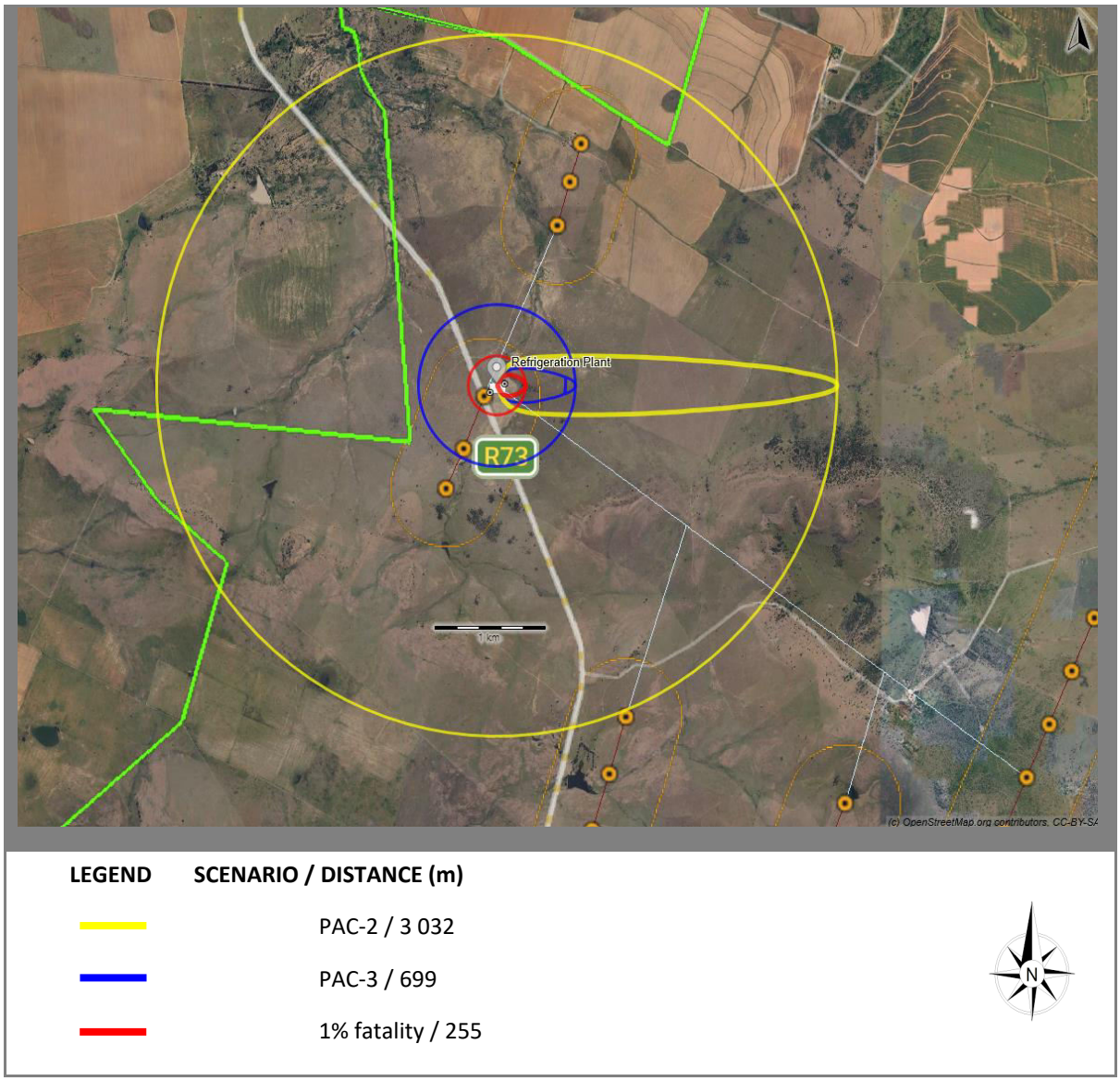


Figure 146: The maximum extent of the impact of air concentrations of ammonia following a large release of ammonia, using the PAC-2 and PAC-3 value and the 1% fatality at the reference level of 1 m above the ground (Riscom, 2026).

The impacts from a large ammonia release could extend up to 3 km downwind to the PAC-2 endpoint, representing the evacuation endpoint. No fatalities would be expected in nearby residential areas. The PAC-2 distance is substantial and is retained for emergency-planning purposes; the identified residential receptors are beyond this modelled endpoint. PAC-2 denotes the distance at which serious or irreversible health effects may occur, rather than a fatality contour.

9.3.16.3.2.4 LNG LOADING GANTRY

The LNG will be loaded into road tankers at a frequency of 5 tankers per week. The maximum extent to the 1% fatality will occur from a catastrophic failure of a 60 m^3 road tanker at low wind speeds, as shown in **Figure 147.** The thin lines show the maximum extent of the potential effects from a westerly wind direction, while the thicker coloured lines indicate the maximum distance from all directions. In this case, the flash fire dominates the impacts and determines the maximum extent to the 1% fatality. The 1% fatality for the VCE would result in damage to equipment within the gas processing plant but would not extend beyond the site boundary and would not impact residential areas. The impacts from a vapour cloud explosion could result in damage to the LNG storage vessels and piping, that could result in a knock-on effect. However, good engineering of the LNG storage vessels can minimise such events.

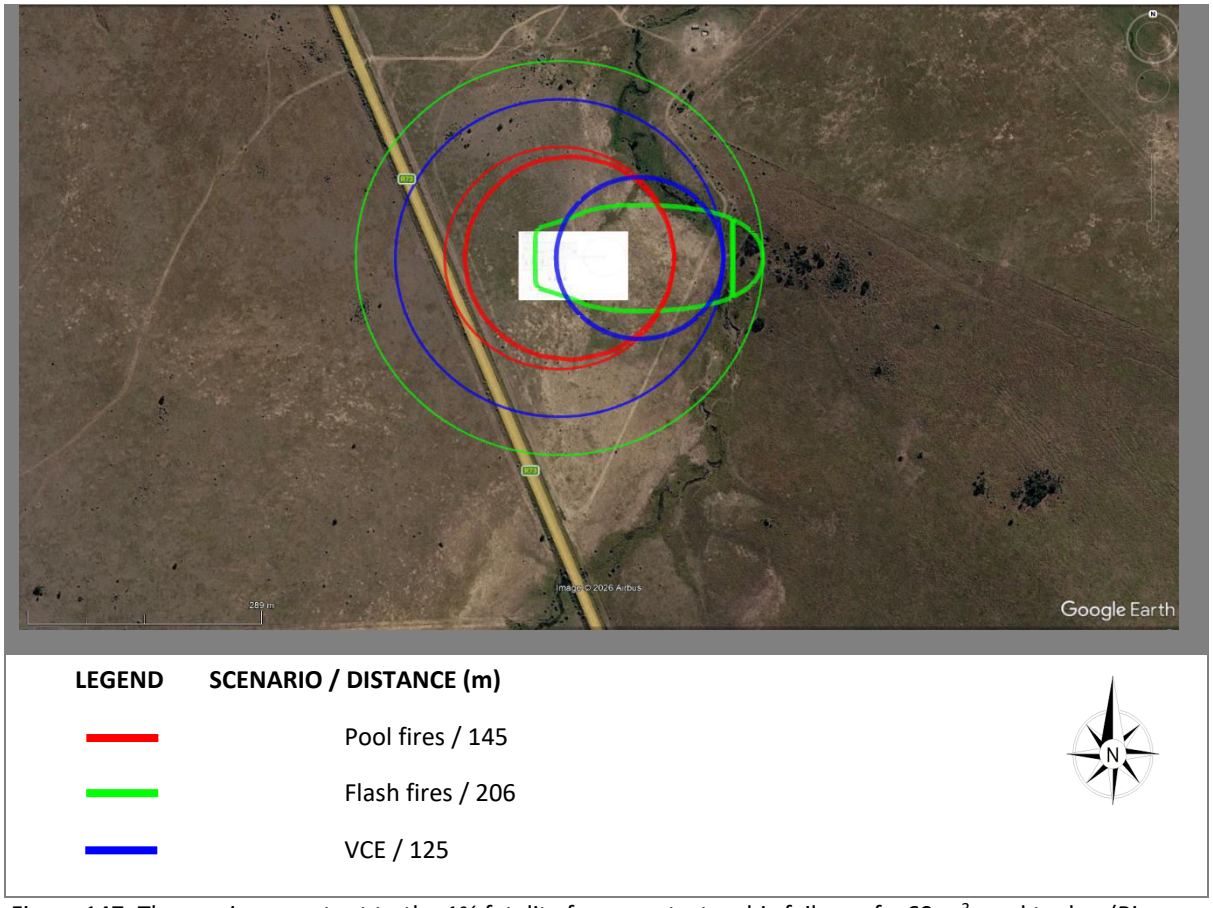


Figure 147: The maximum extent to the 1% fatality from a catastrophic failure of a 60 m^3 road tanker (Riscom, 2026).

9.3.16.3.2.5 CNG STORAGE

The CNG will be stored in a 25 m^3 storage tank at 260 bar(g). The maximum extent to the 1% fatality will occur from a release of the instantaneously failure of the 25 m^3 CNG storage tank, as shown in **Figure 148**. The thick lines show the maximum extent of the potential effects from a westerly wind direction, while the thin lines indicate the maximum extent from all wind directions. In this case, the flash fire dominates the impacts and determines the maximum extent to the 1% fatality. The 1% fatality for the VCE would result in damage to the gas processing plant and may extend beyond the R73 road.

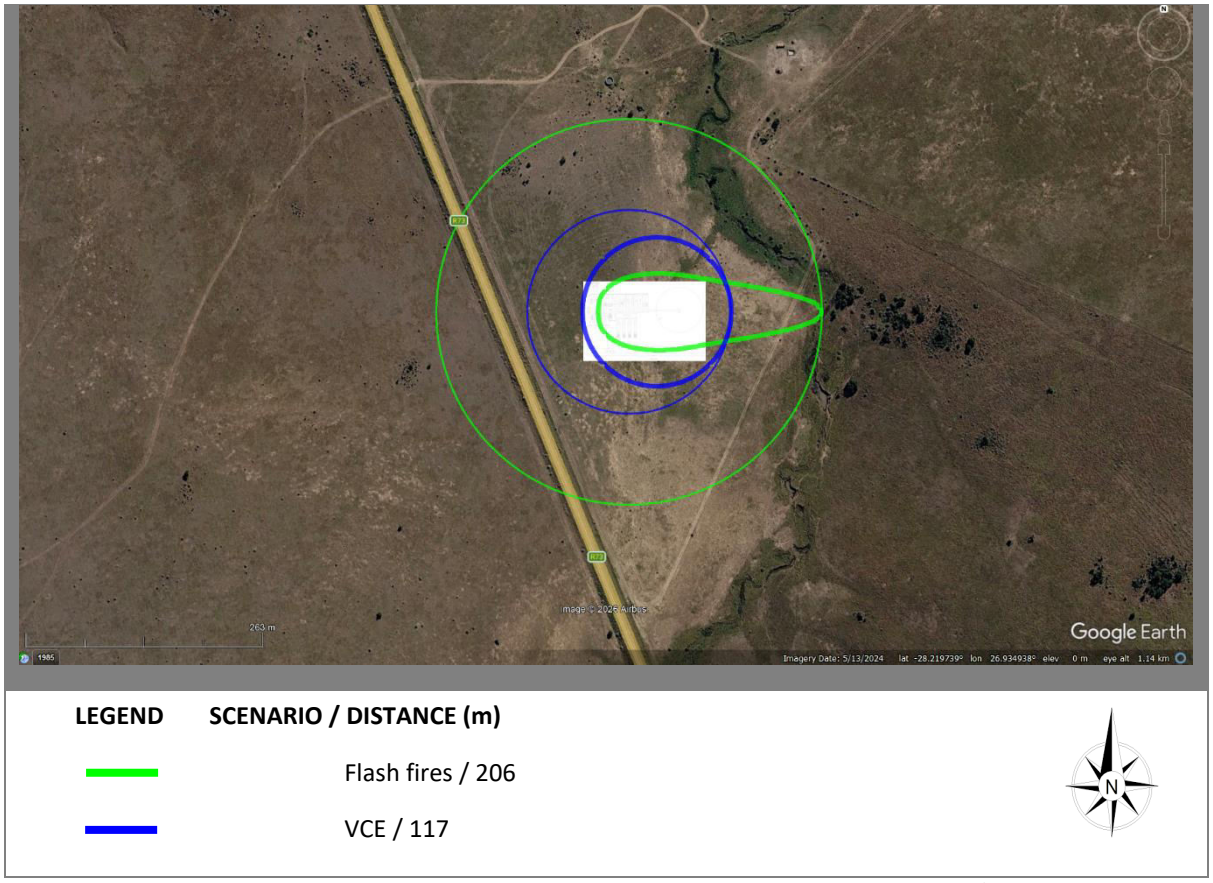


Figure 148: The maximum extent to the 1% fatality from a catastrophic failure of a 25 m^3 CNG storage tank (Riscom, 2026).

9.3.16.3.2.6 CNG LOADING GANTRY

CNG will be loaded into trucks with a capacity of 22 m^3 and a pressure at 260 bar(g). The maximum extent to the 1% fatality will occur from a release of the instantaneously failure of the 22 m^3 CNG road tanker, as shown in Figure 5-8. The thick lines show the maximum extent of the potential effects from a westerly wind direction, while the thin lines indicate the maximum extent from all wind directions. In this case, the flash fire dominates the impacts and determines the maximum extent to the 1% fatality. The 1% fatality for the VCE would result in damage to the gas processing plant and may extend beyond the R73 road.

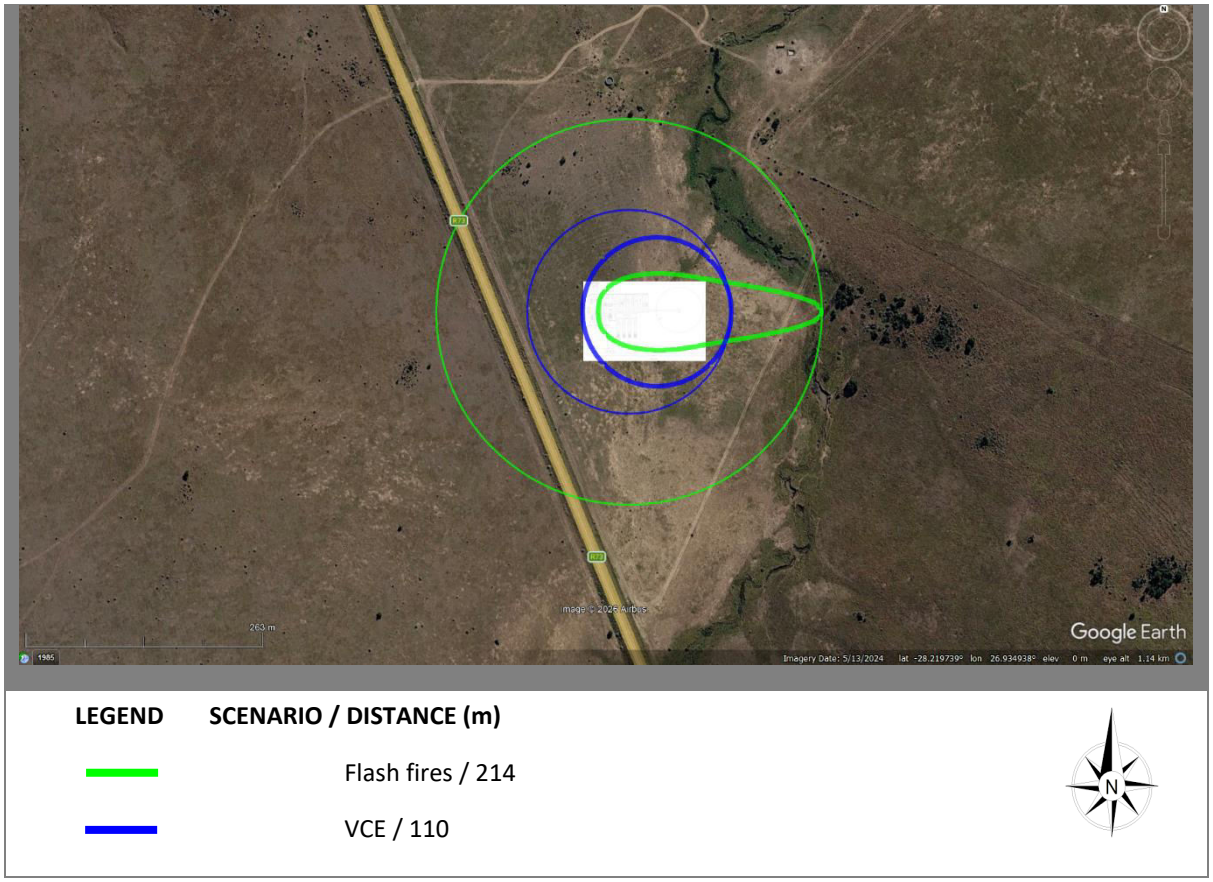


Figure 149: The maximum extent to the 1% fatality from a catastrophic failure of a 22 m^3 CNG road tanker (Riscom, 2026).

9.3.16.3.2.7 FLARE

The purpose of the flare is to safely remove the dangers of flammable materials by combusting the materials at an elevated height. In this assessment, the flammable material removed by the flare was modelled as methane.

Guideline levels for thermal radiation from continuous and emergency flaring, are given in the API 521 (2007) standard and are listed below in **Table 111**. The maximum thermal radiation should be evaluated against these guidelines. It should be noted that the maximum radiation would depend on the wind speed, flare design and exiting velocity.

Table 111: Recommended design thermal radiation for personnel (API 521-2007) (Riscom, 2026).

Permissible Design Level (kW/m^2; $Btu/h{\cdot}ft^2$)	Conditions
9.46; 3000	Maximum radiant heat intensity at any location where urgent emergency action by personnel is required. When personnel enter or work in an area with the potential for radiant heat intensity greater than 6.31 kW/m^2 (2000 $Btu/h{\cdot}ft^2$), then radiation shielding or special protective apparel (e.g. a fire approach suit) should be considered. **SAFETY PRECAUTION:**

Permissible Design Level (kW/m²; Btu/h·ft²)	Conditions
	It is important to recognise that personnel with appropriate clothing[20] cannot tolerate thermal radiation at 6.31 kW/m² (2000 Btu/h·ft²) for more than a few seconds.
6.31; 2000	Maximum radiant heat intensity in areas where emergency actions lasting up to 30 sec can be required by personnel without shielding, but with appropriate clothing[1].
4.73; 1500	Maximum radiant heat intensity in areas where emergency actions lasting 2 min to 3 min can be required by personnel without shielding, but with appropriate clothing[1].
1.58; 500	Maximum radiant heat intensity at any location where personnel with appropriate clothing[1] can be continuously exposed.

In pilot-flame mode, the flare remains small, consuming minimal fuel to sustain the flame. The thermal radiation of 1.58 kW/m² (the radiation that permits continual exposure with appropriate clothing) that occurs during the flare operation, is shown in **Figure 150**. This level is not expected to reach ground level.

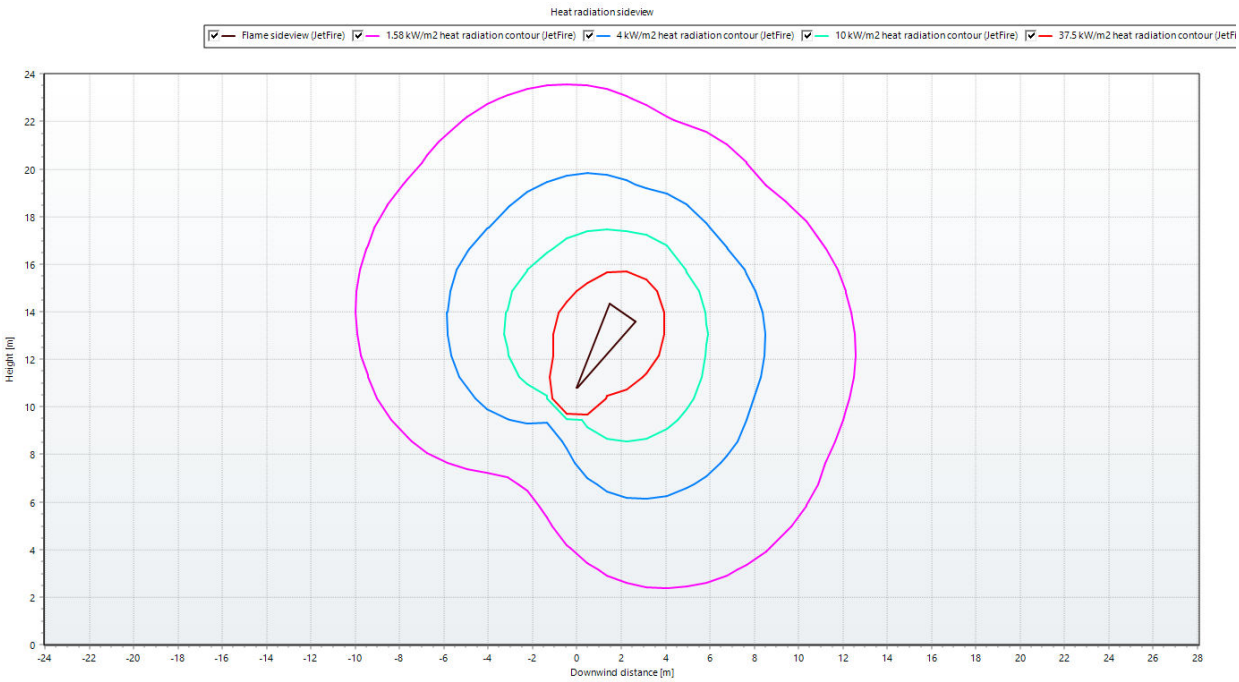


Figure 150: Thermal radiation that occurs during the flare operation (Riscom, 2026).

In the event of a flame-out, a potential flammable cloud could form with potential flash fires, as shown in Figure 5-11. Under the worst meteorological conditions of a strong wind, the flammable cloud would not reach the representative height of the receiver at 1 m above the ground.

20 Appropriate clothing consists of a hard hat, long-sleeved shirts with cuffs buttoned, work gloves, long-legged pants and work shoes. Appropriate clothing minimises direct skin exposure to thermal radiation.

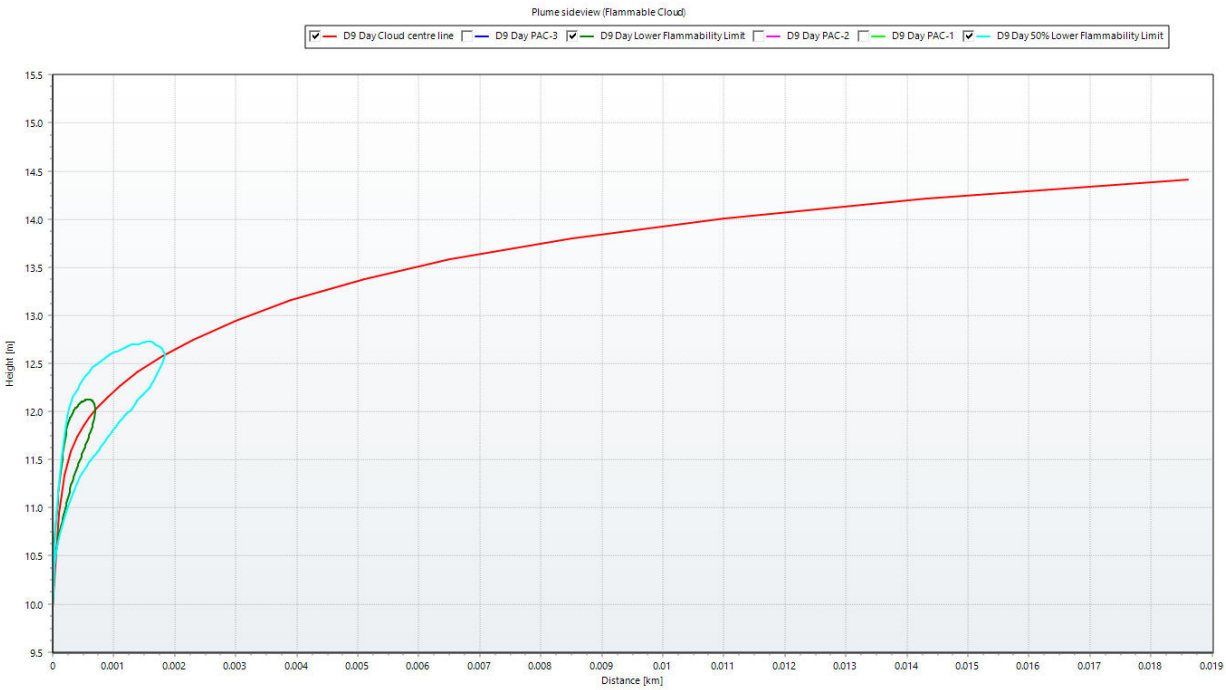
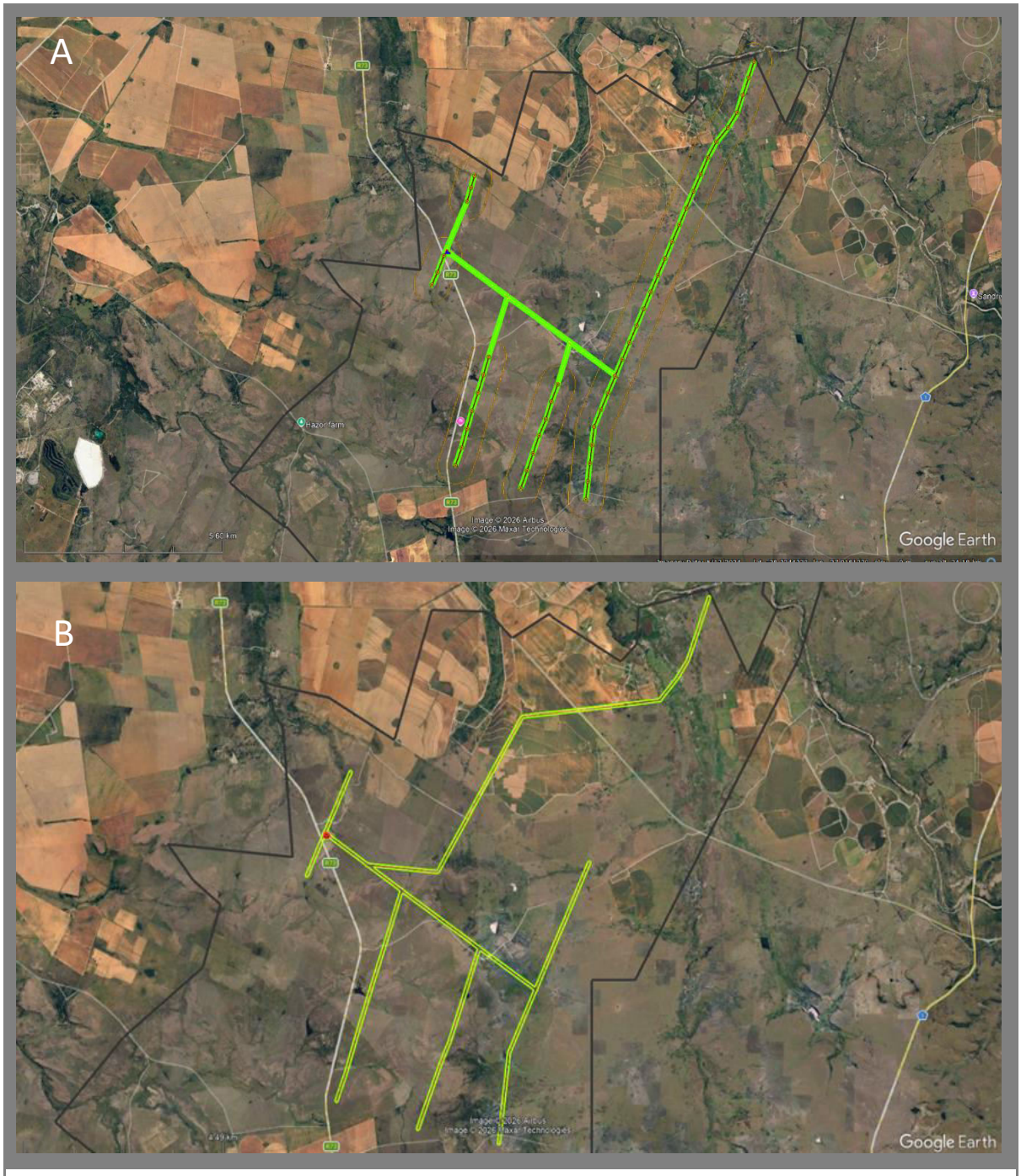


Figure 151: Maximum extent of a flammable cloud that occurs during a flame-out flare operation (Riscom, 2026).

9.3.16.3.2.8 COMBINED SITE INDIVIDUAL RISK

Considering the extent of the consequences of the releases contemplated in the preceding subsections, as well as the frequency of occurrence of each release, the combined site risk is the summation of all the individual risks and is shown in **Figure 152A**, with the enlarged map shown in **Figure 153**. Individual risk describes the chance of fatality of an individual situated at a particular location, due to operations onsite. The maximum individual risk assumes that an individual is situated at a particular location 24 hours per day for 365 days per year. This tends to be an overstatement of risk, but one generally accepted as sufficiently conservative.

The alternative pipeline routing is shown in **Figure 152B**. Road crossings along the gas gathering pipeline routes require special attention during detailed design, construction and operation, and additional mitigation may be required at these locations. Each crossing should be subject to a site-specific assessment that considers traffic loading, burial depth, pipe protection, third-party interference and emergency access. Appropriate measures may include increased cover or protective sleeves, clearly marked crossing points, controlled excavation procedures, suitable isolation and leak-detection arrangements, and coordination with the relevant road authority. Crossings of higher-traffic roads should be prioritised for enhanced inspection and integrity monitoring because a loss of containment at these locations could expose road users and complicate emergency response.



LEGEND	RISK (fatalities per person per year)
	$1x10^{-3}$
	$1x10^{-4}$
	$1x10^{-5}$
	$1x10^{-6}$
	$3x10^{-7}$

Figure 152: Individual risk contours – Combined risk (A – Proposed layout; B – Alternative Layout) (Riscom, 2026).

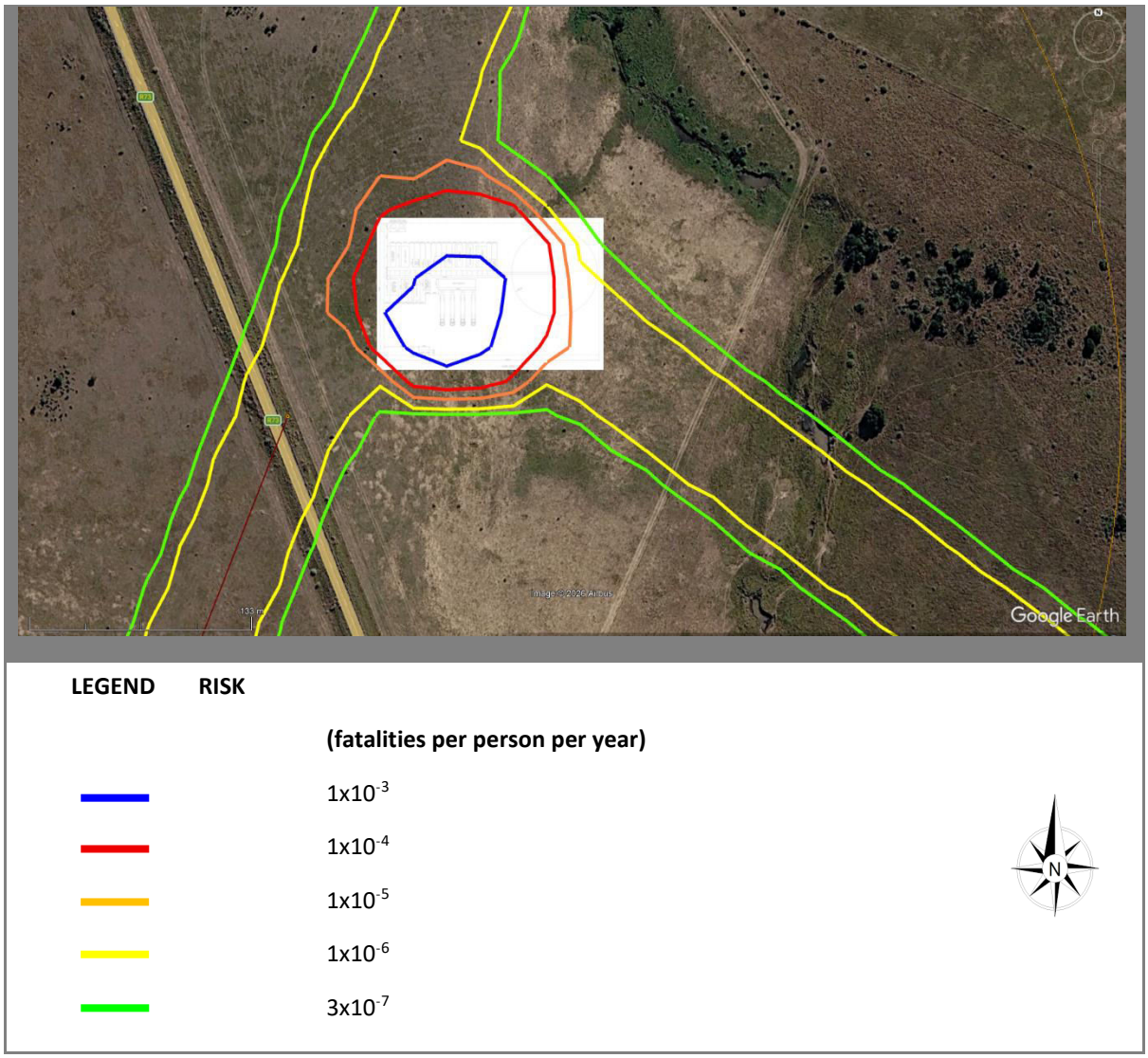


Figure 153: Individual risk contours – Combined risk enlarged (Riscom, 2026).

The individual risk contours illustrated in **Figure 153** extend as follows:

- The $3x10^{-7}$ fatalities per person per year contour does not extend into residential areas. This contour represents the threshold for 'trivial' risk and represent acceptability to vulnerable people outside of the isopleth. Risks below this threshold is considered trivial.
- The risks between the $3x10^{-7}$ and $1x10^{-6}$ fatalities per person per year is considered 'broadly acceptable' to the general public, but 'tolerable if proven to be ALARP' for vulnerable populations such as hospitals, retirement homes, nursery schools, prisons, large gatherings in the open, and so forth.
- The $1x10^{-4}$ fatalities per person per year is considered excessive to the general public and does not extend into residential areas.
- The $1x10^{-3}$ fatalities per person per year contour, is considered excessive to workers and is located within the processing plant and would have to be mitigated prior to construction. This is related to the assumed LNG storage and particularly the overfilling protection.

Acceptability criteria for an individual risk are detailed in *Section 8.7* of **Appendix F10**. No new land planning should be approved without the consultation of the Planning Advice for Developments near Hazardous Installations land-planning tables described in Appendix C of **Appendix F10**.

9.3.16.4 DESCRIPTION OF IMPACTS

The principal hazards identified include:

- Thermal radiation from fires.
- Overpressure effects from explosions.
- Toxic vapour exposure (primarily ammonia).
- Asphyxiation hazards from helium releases.
- Gas releases from wells and gathering pipelines.
- High-pressure equipment failures.
- Loading and transport incidents involving CNG and LNG.
- Occupational health and safety incidents associated with construction and maintenance activities.

For this EIA purposes, impacts are assessed under **Normal Operations** and **Abnormal Events**

9.3.16.4.1 ESTABLISHMENT PHASE

During planning and establishment, health and safety impacts may arise from:

- Site surveying.
- Geophysical investigations.
- Access route establishment.
- Site demarcation.
- Interaction between project personnel and farming activities.
- Vehicle movements on public and farm roads.

Risks are generally associated with workplace safety incidents, traffic interactions and public access to active work areas.

9.3.16.4.2 CONSTRUCTION PHASE

9.3.16.4.2.1 SEISMIC SURVEYS

Potential impacts include:

- Vehicle and equipment-related injuries.
- Interaction with livestock and farm operations.
- Noise exposure.
- Dust generation.
- Occupational safety risks associated with seismic equipment deployment.

The Quantitative Risk Assessment indicates that seismic activities are generally low-risk activities with limited off-site consequences.

9.3.16.4.2.2 DEVELOPMENT DRILLING

9.3.16.4.2.2.1 NORMAL OPERATIONS

Potential impacts include:

- Occupational injuries.
- Working at height.
- Rotating drilling equipment.
- Heavy vehicle movement.
- Exposure to fuels, lubricants and chemicals.
- Noise and vibration exposure.
- Well-site occupational accidents.

9.3.16.4.2.2.2 ABNORMAL EVENTS

Potential impacts include:

- Well blowouts.
- Gas releases.
- Equipment failures.
- Fires.
- Hydrocarbon releases.
- Uncontrolled pressure events.

The risk assessment indicates that catastrophic well failure could result in a vertical jet fire with a 1% fatality distance of approximately 4 m, remaining localised to the well site.

9.3.16.4.3 PRODUCTION PHASE

9.3.16.4.3.1 PRODUCTION WELLS

9.3.16.4.3.1.1 NORMAL OPERATIONS

Potential impacts include:

- Exposure to pressurised gas systems.
- Routine maintenance hazards.
- Vehicle movement.
- Occupational safety risks at wellheads.
- Exposure to process equipment.

9.3.16.4.3.1.2 ABNORMAL EVENTS

Potential impacts include:

- Catastrophic well failure.
- Gas release.

- Jet fires.
- Equipment failure.
- Pressure control system failure.

The QRA concluded that well-related risks are spatially constrained and do not present significant off-site fatality risks.

9.3.16.4.3.2 GAS GATHERING PIPELINES

9.3.16.4.3.2.1 NORMAL OPERATIONS

Potential impacts include:

- Maintenance activities.
- Third-party damage.
- Traffic incidents during servicing.
- Occupational injuries.

9.3.16.4.3.2.2 ABNORMAL EVENTS

Potential impacts include:

- Pipeline rupture.
- Pipeline leaks.
- Flash fires.
- Jet fires.
- Vapour cloud explosions.

The QRA determined:

- Jet fire distance up to 68 m.
- Flash fire distance approximately 4 m.
- Vapour Cloud Explosion (VCE) distance approximately 9 m.

All impacts remain localised within the pipeline servitude.

9.3.16.4.3.3 GAS PROCESSING PLANT

9.3.16.4.3.3.1 NORMAL OPERATIONS

The gas processing plant represents the highest health and safety risk component of the project. Potential impacts include:

- Exposure to hazardous substances.
- CNG and LNG handling activities.
- Helium handling.
- Ammonia refrigeration systems.
- Equipment maintenance activities.
- Loading operations.

- Noise exposure.
- Confined-space activities.

9.3.16.4.3.3.2 ABNORMAL EVENTS

Potential abnormal events include:

- CNG Facilities
  - Catastrophic tank failure.
  - Flash fires.
  - Vapour cloud explosions.
  - High-pressure releases.
  - The QRA identified:
    - Flash fire distances between 206 m and 214 m.
    - VCE distances between 110 m and 117 m.
- **LNG Facilities**
  - Pool fires.
  - Flash fires.
  - Vapour cloud explosions.
  - Cryogenic injuries.
  - A catastrophic LNG tanker release may result in:
    - Pool fire distances of approximately 145 m.
    - Flash fire distances of approximately 206 m.
    - VCE distances of approximately 125 m.
- **Ammonia Refrigeration Plant**
  - Toxic releases.
  - Respiratory injury.
  - Emergency evacuation requirements.
  - The QRA determined:
    - PAC-2 endpoint approximately 3 km.
    - PAC-3 endpoint approximately 699 m.
    - 1% fatality boundary approximately 255 m.
  - The specialist confirms that no fatalities are expected outside the site boundary; however, ammonia presents the most significant off-site health risk.
- **Helium Systems**
  - Oxygen displacement.

- Asphyxiation hazards.
- Cryogenic burns.
- The maximum 1% fatality distance associated with catastrophic helium storage failure is approximately 62 m.

- **Flare System**
  - Thermal radiation.
  - Combustion emissions.
  - Operational noise.
  - These impacts remain confined within the facility boundary.

9.3.16.4.4 DECOMMISSIONING AND CLOSURE PHASE

9.3.16.4.4.1 NORMAL OPERATIONS

Potential impacts include:

- Demolition-related injuries.
- Heavy equipment operation.
- Traffic risks.
- Exposure to residual hazardous materials.
- Confined-space activities.

9.3.16.4.4.2 ABNORMAL EVENTS

Potential impacts include:

- Residual gas releases.
- Fires.
- Structural failures.
- Accidental damage to remaining infrastructure.

The magnitude of risks during closure is generally lower than during active production.

9.3.16.5 IMPACT RATINGS

The assessment indicates that:

- The well and pipeline risks are spatially constrained and, following mitigation, reduce to Low-Medium significance.
- Helium releases present limited off-site consequences and remain Medium-Low after mitigation.
- Ammonia releases represent the most substantial toxic hazard, with PAC-2 distances extending up to 3 km. Mitigation reduces the final significance to Medium-High, but the activity remains a key focus area for emergency planning.
- LNG and CNG failures present high-energy fire and explosion hazards. The post-mitigation significance remains Medium-High, driven by cumulative risk and the potential for irreplaceable loss of resources.
- No scenario results in High or Very High final significance, and no fatal-flaw conditions are identified.

The impact ratings associated with the proposed activities related to risk, health and safety are indicated in **Table 112**.

Table 112: Summary of impacts related to risk, health and safety (Riscom, 2026).

Project Phase	Activity		Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Planning / Establishment	Surveys and site preparation	Normal Operations	Occupational health and safety incidents and traffic-related risks	Medium to Low	Low	Low -
Construction	Seismic surveys	Normal Operations	Occupational injuries, vehicle incidents and noise exposure	Medium to Low	Low	Low -
Construction	Seismic surveys	Abnormal Events	Vehicle collisions, fires and fuel spills	Medium to High	Medium to Low	Medium to Low -
Construction	Drilling	Normal Operations	Drilling-related health and safety risks	Medium to High	Medium to Low	Medium to Low -
Construction	Drilling	Abnormal Events	Blowouts, gas releases and well fires	Medium to High	Medium to Low	Medium to Low -
Production	Production wells	Normal Operations	Workplace safety and maintenance hazards	Medium to Low	Low	Low -
Production	Production wells	Abnormal Events	Catastrophic well failure and jet fires	Medium to Low	Medium to Low	Medium to Low -

Project Phase	Activity		Impact	Significance Without Mitigation	Significance With Mitigation	Final Significance
Production	Gas gathering pipelines	Normal Operations	Maintenance and operational safety hazards	Medium to Low	Low	Low -
Production	Gas gathering pipelines	Abnormal Events	Pipeline rupture, flash fire and VCE	Medium to High	Medium to Low	Medium to Low -
Production	Helium systems	Abnormal Events	Asphyxiation and cryogenic release hazards	Medium to Low	Medium to Low	Medium to Low -
Production	LNG systems	Abnormal Events	Flash fires, pool fires and VCE	High	Medium to High	Medium to High -
Production	CNG systems	Abnormal Events	Flash fires, VCE and high-pressure releases	High	Medium to High	Medium to High -
Production	Ammonia refrigeration system	Abnormal Events	Toxic release and public health impacts	High	Medium to High	Medium to High -
Production	Flare system	Normal Operations	Thermal radiation and operational exposure	Medium to Low	Low	Low -
Decommissioning	Infrastructure removal	Normal Operations	Occupational injuries and demolition hazards	Medium to Low	Low	Low -
Decommissioning	Closure activities	Abnormal Events	Residual gas releases, fire and equipment failure	Medium to Low	Low	Low -

9.3.16.6 CUMULATIVE IMPACT ASSESSMENT

The cumulative risk profile must be considered together with:

- Existing gas production and exploration activities.
- Existing agricultural activities.
- Existing road traffic.
- Existing mining activities.
- Existing and planned renewable energy developments.
- Existing electrical transmission infrastructure.

Potential cumulative impacts include:

- Increased heavy vehicle traffic.
- Increased exposure to hazardous materials transport.
- Combined emergency response demands.
- Multiple concurrent infrastructure developments.
- Incremental increase in public exposure to industrial activities.

The QRA concludes that:

- No fatality-level risks extend into neighbouring residential areas.
- Individual risk levels remain within acceptable thresholds.
- Risks remain localised and manageable with engineering controls.
- The project is environmentally viable from a risk and safety perspective.

The assessment concluded that cumulative risk, health and safety impacts are High negative without mitigations and reduced to Medium-High negative with mitigations.

9.3.16.7 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 H)**:

- 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 construction 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).
- 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.

New relevant management and mitigation measures identified as part of this assessment added to the EMPr:

- Compliance with all statutory requirements relating to the design, manufacture, installation, operation, inspection, testing, certification and maintenance of pressure vessels and pressure equipment. This includes compliance with the Occupational Health and Safety Act, 1993 (Act 85 of 1993), specifically the Pressure Equipment Regulations, 2009 (as amended), and all incorporated standards, including SANS 347 (Categorisation and Conformity Assessment Criteria for Pressure Equipment), applicable ASME Codes, and other prescribed SANS standards relevant to gas processing, storage, transportation and pressure systems.
- All pressure vessels must be designed, verified, tested, certified, marked, registered where required, and inspected by suitably qualified persons and approved inspection authorities prior to commissioning and throughout the operational life of the facility;
- Compliance with applicable SANS codes, i.e., SANS 10087, SANS 10089, SANS 10108, etc.;
- Incorporation of applicable guidelines or equivalent international recognised codes of good design and practice into the designs;
- Completion of a recognised process hazard analysis (such as a HAZOP study, FMEA, etc.) on the proposed facility prior to construction to ensure that design and operational hazards have been identified and that adequate mitigation is put in place;
- Application of IEC 61508 and IEC 61511 for safety instrumented systems, or equivalent recognised standards, where the process hazard analysis identifies instrumented protection, as necessary. The required safety functions, integrity targets, independence, reliability, testing, maintenance and management arrangements must be defined and maintained throughout the facility life cycle:
    - The designer must provide documented verification that the protective instrumentation is sufficient, suitably independent and reliable for the identified hazards and is correctly specified, installed, commissioned, proof-tested and maintained

- During detailed design, a Safety Basis Document (or equivalent process safety document) should be prepared and maintained. The document shall describe the principal design features, assumptions, engineered safeguards, safety instrumented systems, and management measures adopted to prevent and mitigate the consequences of fires, explosions, loss of containment events, flammable or toxic releases, and oxygen-deficient atmospheres. The document should be informed by the project's process hazard analyses, risk assessments, and applicable requirements of the OHS Act, relevant regulations, and recognised industry standards.
    - Demonstration of compliance with applicable legislation, codes and standards and recognised good engineering practice;
    - Including the listing of statutory and non-statutory inspections, giving frequency of inspections; and,
    - Prior to commissioning, an independent verification or commissioning readiness review should be undertaken to confirm that the as-built facility conforms to the approved design basis, safety philosophy, and critical safety requirements. Any deviations shall be identified, documented, appropriately risk assessed, and either rectified or formally accepted through the project management of change process before start-up;
- Noting that codes, such as IEC 61511 can be used to achieve these requirements.
- Verification during detailed design, using complete engineering information and final maximum hazardous-material inventories, that the aggregation value remains below the lower-tier threshold and that the gas gathering pipelines do not meet the Chapter 3 criteria. The assessment and supporting calculations must be documented and reviewed by a competent process-safety practitioner. If the final design, inventories, containment arrangements or operating conditions cause any applicable threshold or Chapter 3 criterion to be met or exceeded, the MHI Regulations (2022) must be applied and an MHI risk assessment must be undertaken by an Approved Inspection Authority before construction or operation, as applicable;
- Signature of all designs by a professional engineer registered in South Africa in accordance with the Professional Engineers Act, who takes responsibility for suitable designs.
- Completion of an emergency preparedness and response document for credible on-site and off-site scenarios before commissioning, with appropriate consultation with local emergency services and authorities;
- Prior to construction, the holder shall obtain all permits, approvals, authorisations and consents required by applicable legislation and the relevant authorities having jurisdiction, including, where applicable, land-use planning, building control, emergency services, water use, environmental and petroleum regulatory approvals. Where facility risk assessments or emergency response plans are required by legislation or permit conditions to be submitted to a competent authority, evidence of such submission, review or approval shall be retained and made available for audit purposes. Construction may only commence once all legally required approvals and authorisations have been obtained. Construction may only commence once all required approvals, permits, and authorisations have been issued and are available for audit purpose; and
- Submission of the final design safety basis and documented tier-reassessment outcome to the relevant local government authority as part of the applicable approval process (where applicable). Based on the current design information, the facility falls below the lower-tier threshold and is not classified as a Major Hazard Establishment. An MHI risk assessment and registration will therefore only be required if the final design, maximum hazardous-material inventories, containment arrangements, operating conditions or pipeline design trigger an applicable threshold or Chapter 3 criterion:

- The final verification must be based on the completed design and maximum credible inventories and must account for all engineering safeguards and mitigations.

9.3.17 SOCIAL IMPACT ASSESSMENT

The proposed D3 Energy PR Application comprises seismic surveys, drilling up to 43 production wells (plus 5 contingent wells), gathering pipelines, a central helium recovery and methane processing facility (CNG and/or LNG), access roads and associated infrastructure within the Matjhabeng and Masilonyana Local Municipalities. The project is located in a socio-economic environment characterised by high unemployment, poverty, declining mining employment, strong dependence on commercial agriculture, and increasing renewable-energy development pressure. The Social Impact Assessment undertaken by Equispectives Research and Consulting Services (**Appendix F11**) identified both positive and negative social and economic impacts. The primary positive impact relates to local economic stimulation, skills development, procurement opportunities and local economic development programmes, while the primary negative impacts relate to farming livelihoods, land-use conflict, security concerns, pressure on infrastructure, cumulative development impacts and social perceptions

9.3.17.1 DESCRIPTION OF IMPACTS

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).

Each impact is described below, the project phases in which it is likely to occur are identified, and mitigation measures are provided. A compact significance table accompanies each impact, and a consolidated rating table is provided at the end of the section. Unless otherwise indicated, the “Responsible party” is D3 Energy (typically acting through its Community Liaison Officer (CLO)).

Relating impacts to project activities. In response to the requirement to relate impacts to specific project activities, each impact below is annotated with its principal contributing activity or activities – seismic survey, drilling of production wells, the production (processing) plant, and associated infrastructure (gathering pipelines, servitudes, access roads and vehicle movement) – and the phase in which it mainly arises. Consistent with social-impact-assessment methodology, impacts are assessed by their effect on social receptors rather than by engineering activity alone, because a given social impact is typically produced by several activities acting together and is experienced cumulatively by the affected party. Where significance differs materially by activity or phase this is stated; where a single significance is retained, it is because the impact arises from the activities in combination. A cumulative-impact note is provided for each impact that has a cumulative dimension.

A social sensitivity analysis of the production right area is summarised in **Figure 154** below, which maps areas of low, medium and high social concern together with social no-go areas. This spatial picture informs the siting of wells, pipelines and infrastructure and the prioritisation of mitigation.

The sensitivity mapping **(Figure 154**) distinguishes areas of low, medium and high social sensitivity together with social no-go areas. Areas of high social sensitivity are driven by occupied homesteads and dwellings and their immediate surrounds; by settlements and social infrastructure (such as schools, clinics and community facilities); and by the authorised renewable-energy footprints within the production right area. The renewable-energy footprints are treated as socially sensitive because they represent committed land uses and investment and are a principal locus of potential land-use conflict and cumulative impact; the sensitivity figure is being updated to depict these footprints as areas of social sensitivity. Areas of medium sensitivity comprise actively farmed agricultural land – cultivated fields and grazing – and associated farm infrastructure on which local livelihoods depend. Social no-go areas are those where the social cost of intrusion would be unacceptable, such as the

immediate surrounds of homes, schools and other sensitive social receptors. This spatial pattern of sensitivity informs the siting of wells, pipelines and infrastructure and the prioritisation of mitigation, and should be read together with the biophysical sensitivity mapping.

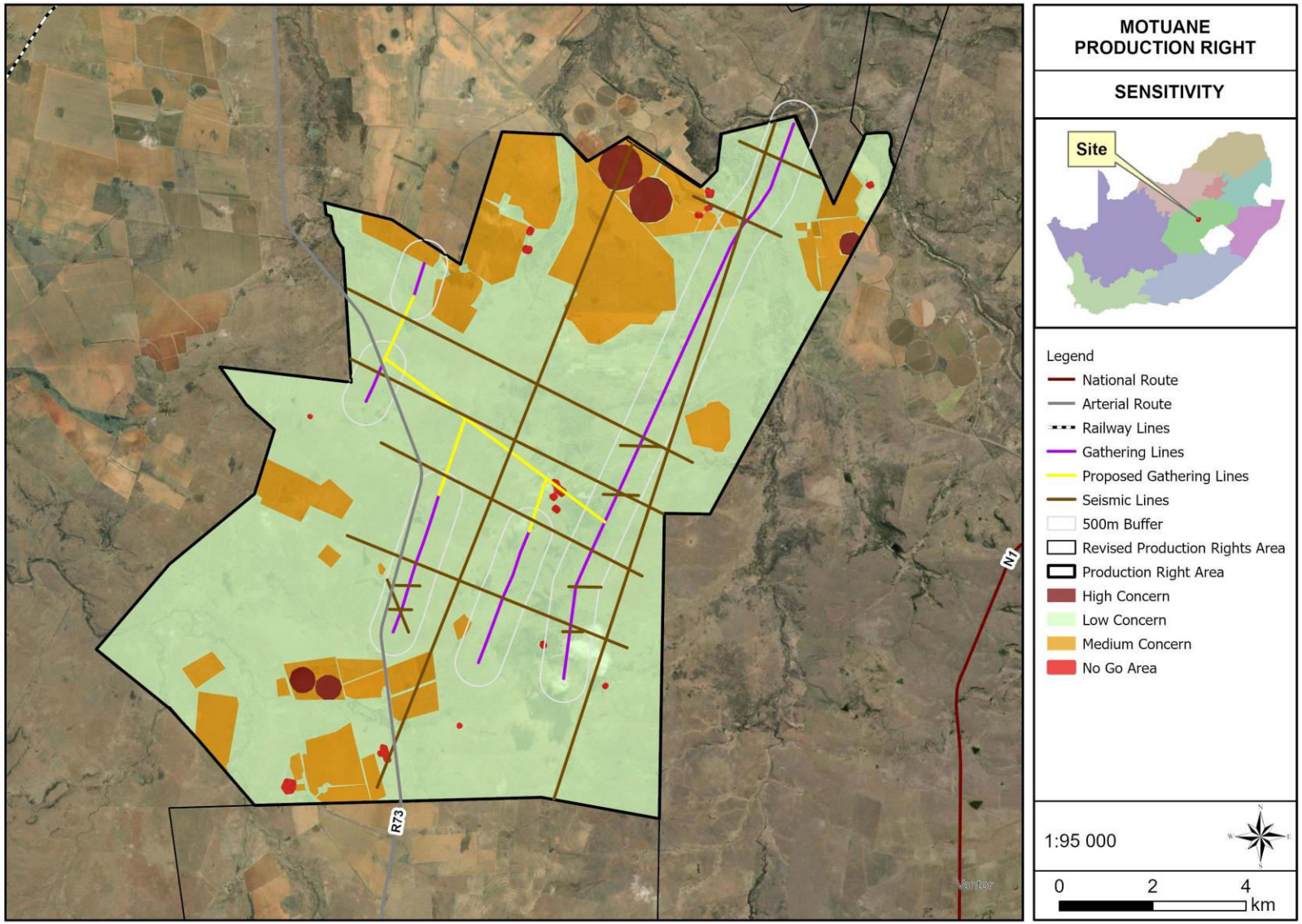


Figure 154: Social sensitivity of the production right area (areas of concern and social no-go areas) (Equispectives Research and Consulting Services, 2026).

9.3.17.1.1 IMPACT ON FARMING LIVELIHOODS AND INTERFERENCE WITH EXISTING LAND USES

The proposed activities – drilling of up to 43 production wells (plus 5 contingent wells), gathering pipelines, access roads, a processing facility and ongoing development – will take place on land that is actively farmed. A livelihood refers to the way a household makes a living and secures the basic necessities of life (Vanclay et al., 2015). The project area is characterised by commercial agriculture (maize, soya, cattle and game) and, on some properties, hunting and tourism. These activities depend on the sustainable use of land, soil quality, water availability and uninterrupted seasonal access. Affected communities include not only farmers but also farm workers who earn their livelihoods on and call the farm their home.

Stakeholders stressed that agricultural land is used cyclically and that disturbance during planting, growing, harvesting or grazing periods can cause substantial financial loss. Each well, pipeline servitude and access road removes land from production; soil compaction from heavy machinery can render land unproductive for one or more seasons and reduce yields even after rehabilitation. Game and hunting operations are particularly sensitive, as hunts are booked months in advance and cannot be relocated at short notice, and loss of grazing reduces stocking rates and therefore the number of farm workers required.

Because the project's operational footprint persists for at least 30 years, and because farm workers have limited ability to diversify their livelihoods, impacts on livelihoods are among the most significant from a social perspective. (Livelihood diversification refers to engaging in both on-farm and off-farm activities to spread risk; farm workers typically have few such options.)

Contributing activities and phase: Drilling of production wells (well pads), gathering pipelines, servitudes and access roads, and the production plant remove land from production, while seismic survey lines and vehicle movement cause temporary disturbance; land-take is greatest during construction and persists through operation. The impact arises from these activities in combination on each affected property. *Cumulative dimension:* Land taken by the gas project adds to land already committed to renewable-energy developments on the same properties, further reducing the productive area available to the affected farmer.

9.3.17.1.2 WATER CONTAMINATION AND GROUNDWATER SAFETY

Farmers in the area rely almost entirely on groundwater abstracted from boreholes for domestic use, livestock watering and farming, and some hold water rights in the Sand River. Stakeholders repeatedly identified water contamination and the long-term sustainability of groundwater as primary concerns, noting that the area is already water-stressed and that boreholes sometimes run dry. Drilling, the handling of hydrocarbons, fuels and chemicals, and the operation of the processing facility all carry a risk of spills, leaks or cross-contamination of aquifers and watercourses.

Landowners hosting the existing solar development reported oil residues associated with project activities near a watercourse, heightening anxiety that the gas project could affect water quality. Poorly managed sanitation on site (spillages or overflowing ablution facilities) was also raised as a contamination pathway that could affect groundwater, livestock and people. Because contamination of a shared aquifer can affect multiple properties and may be difficult and costly to reverse, this impact has a high potential for cumulative effect and irreplaceable loss. The post-mitigation rating already assumes correctly designed, constructed and managed wells and infrastructure; the residual significance nonetheless reflects the social dimension of this impact – community perception, the fear of contaminating a sole water source, and the associated loss of trust and sense of security – which persists to a degree irrespective of engineering controls and is what this social assessment measures.

Contributing activities and phase: Drilling of production wells is the principal contributing activity, together with the handling of hydrocarbons, fuels and chemicals at the production plant and on-site sanitation and waste; the risk is present during construction and operation. *Cumulative dimension:* Contamination of a shared aquifer can affect multiple properties and combines with abstraction and pollution pressures from other land uses in an already water-stressed area, giving this impact a high cumulative and potentially irreversible dimension.

9.3.17.1.3 DAMAGE TO FARM ROADS, SERVICES AND INFRASTRUCTURE

The project will use existing local and farm gravel roads and may require new access roads. Landowners were emphatic that the existing dirt and other local roads are in poor condition, deteriorate badly after rain, and cannot carry heavy machinery or large trucks without upgrading. Experience with the nearby solar development was cited directly: project-related heavy vehicles accelerated road deterioration to the point that, in one case, a family relocated their children's schooling, and accidents increased. Water pipes and other buried services could also be damaged during earthworks.

Damage to roads and services imposes real costs on farmers, who must then repair infrastructure they rely on daily and which is essential to moving produce and livestock. Heavy-vehicle movement also raises road safety concerns on rural roads shared with farm workers travelling by taxi.

Contributing activities and phase: Heavy-vehicle movement associated with the seismic survey, drilling-rig mobilisation, construction of the plant and pipelines, and operational traffic; concentrated in construction but continuing through operation. *Cumulative dimension:* Project traffic adds to heavy-vehicle movement from neighbouring renewable-energy and other developments on the same local and farm roads, compounding road deterioration and safety risk

9.3.17.1.4 UNCERTAINTY AROUND SERVITUDES, PROPERTY VALUES AND LAND-USE RIGHTS

The need to register servitudes for gathering pipelines connecting wells to the processing facility, together with the long operational life of the project, creates uncertainty for landowners about future land access, land-use rights and property values. Landowners noted that the production right does not change ownership of the land and stressed that infrastructure requirements must be clearly communicated and formalised through proper agreements. Some requested an agricultural economist to determine any loss of property value.

Uncertainty is itself a social impact: not knowing where infrastructure will be placed, for how long, or how it will affect resale and financing causes anxiety and can sour relationships before any physical activity occurs. Game and tourism operations are especially sensitive to servitudes and visual intrusion that could affect their marketability.

Contributing activities and phase: Registration of servitudes for gathering pipelines is the principal contributing activity, together with the wells, the plant and the long tenure of the production right; the uncertainty arises mainly in planning and persists through operation. *Cumulative dimension:* Gas servitudes overlie land already subject to renewable-energy rights and leases on several properties, compounding uncertainty about overlapping land-use rights and future property values

9.3.17.1.5 IMPACTS ON SAFETY AND SECURITY OF LOCAL RESIDENTS

Safety and security were the single most consistently raised concern among landowners. The area already experiences stock theft, cable theft, break-ins and poaching, and farmers are largely responsible for their own security. Stakeholders feared that an influx of outside workers and increased vehicle movement would put “more eyes on the farm”, increase familiarity with farm layouts, and raise the risk to the safety of families, farm workers, livestock, visitors and hunting clients. The experience with the solar development – where theft increased because people perceived “more money in the area” – reinforced these fears. Unfenced excavations and equipment left unguarded were specifically cited as risks.

Community-side safety issues were also raised: prostitution along the N1 (exacerbated by truck traffic), and the risk of protest action (tyre burning, road blockages) where recruitment is perceived as unfair, which can threaten the safety of residents and personnel and disrupt both farming and project activities.

Contributing activities and phase: The presence and movement of personnel and vehicles across all activities – seismic survey, drilling, plant and pipeline construction and operation – together with recruitment-related community tensions; greatest during construction. *Cumulative dimension:* Added outsider presence and vehicle movement combine with those of other developments in the area, increasing the overall risk of theft, poaching and unrest beyond that of the gas project alone.

9.3.17.1.6 INCREASE IN POACHING INCIDENTS AND STOCK THEFT

Increased access to, and presence of people in, the project area raises the risk of poaching and stock theft on properties used for cattle and game farming. Landowners reported that poaching incidents (including hunting with dogs and the setting of snares) increased after the establishment of the nearby solar development and attributed this partly to greater activity in the area and proximity to townships. Game fences and snares were identified as particular concerns on hunting properties.

Poaching and stock theft directly erode farming income and the viability of game and hunting operations and can have cumulative effects where multiple developments increase the number of outsiders moving through the area.

Contributing activities and phase: Increased access and personnel presence across all activities (seismic, drilling, construction and operation) on properties used for cattle and game; greatest where access control is weakest during construction. *Cumulative dimension:* Multiple concurrent developments increase the number of outsiders moving through the area, raising poaching and stock-theft risk cumulatively.

9.3.17.1.7 VELD FIRE RISK

Veld fires were highlighted as a serious risk. Farmers reported recurrent veld fires (some losing assets to fire around six times since 2000), limited municipal firefighting support, and reliance on neighbours and trained farm workers to fight fires. Project activities – vehicles, hot works, equipment and a larger human presence – introduce additional ignition sources. A fire could damage farming operations, grazing, wildlife, infrastructure and neighbouring energy developments, with potentially severe financial consequences given the gas and solar infrastructure in the area.

Because fire can spread across property boundaries, the risk has a clear cumulative dimension that requires coordination with neighbouring landowners and fire-management structures.

Contributing activities and phase: Hot works and equipment during drilling and construction, vehicle movement (seismic and operational) and the larger human presence introduce ignition sources; the risk is present in construction and operation and peaks in the fire season. *Cumulative dimension:* Fire can spread across property boundaries and threaten neighbouring farming and energy infrastructure (gas and solar), giving the risk a clear cumulative dimension that requires joint fire management

9.3.17.1.8 NUISANCE FACTORS (DUST, NOISE, VISUAL INTRUSION AND SENSE OF PLACE)

Construction and drilling generate dust and noise, and the introduction of wells, pipelines, a processing facility, lighting and increased traffic alters the rural character and sense of place valued by farming, game and tourism operations. While individually these nuisances are usually localised and of low intensity, they can disturb residents, livestock, wildlife and hunting/tourism guests, and contribute to a perception that the area is becoming industrialised, particularly where they add to disturbance from existing solar developments.

Sense of place is especially important for game farms and hunting lodges whose marketability depends on an undisturbed rural setting; visual markers, lighting and noise can therefore have economic as well as amenity effects.

Contributing activities and phase: Dust and noise from drilling and construction, and visual intrusion from wells, pipelines, the plant, lighting and traffic; concentrated in construction, with visual and sense-of-place effects persisting through operation. *Cumulative dimension:* These nuisances add to disturbance from existing solar developments, reinforcing a perception that the rural area is becoming industrialised

9.3.17.1.9 COMMUNITY PERCEPTIONS AND FEARS REGARDING GAS SAFETY

Gas production, gathering pipelines and a processing facility with CNG/LNG capability give rise to community perceptions and fears about safety – including methane leaks, explosions and pipeline incidents. Whether or not such fears are technically justified, perceived risk is a genuine social impact that can generate anxiety, opposition and reputational harm if not addressed through clear, accessible information. MEJCON-SA specifically raised

environmental health concerns and requested detailed briefings, illustrating the importance of proactive, factual communication. Managing these perceptions is largely a matter of transparent information, visible safety management and responsiveness; with appropriate mitigation the residual impact is low.

Contributing activities and phase: The production (processing) plant with CNG/LNG capability, the gathering pipelines and the producing wells; perceptions arise principally in the operation phase. *Cumulative dimension:* Perceived risk combines with the presence of other industrial and energy infrastructure to heighten a general sense of a changing, higher-risk environment, even where individual facilities are managed safely

9.3.17.1.10 SOCIAL PATHOLOGIES ASSOCIATED WITH A TEMPORARY WORKFORCE AND CONTRACTOR BEHAVIOUR

The presence of a temporary construction workforce and contractors can be associated with social pathologies such as prostitution, sexually transmitted infections, substance abuse and antisocial behaviour, and with nuisance behaviour such as leaving gates open, littering and off-road driving. Councillors noted that prostitution is already a concern along the N1, exacerbated by truck traffic, and that young women are particularly exposed. Although the project's permanent workforce is very small, construction peaks and contractor activity can still introduce these risks.

These impacts fall disproportionately on vulnerable groups and on host communities, and are best managed through a code of conduct, awareness programmes and a preference for local labour that reduces the influx of outsiders.

Contributing activities and phase: The temporary construction workforce and contractors (drilling crews and plant and pipeline construction, with seismic crews earlier); concentrated in the construction phase and at construction peaks. *Cumulative dimension:* The project's temporary workforce adds to labour influx from other developments along the N1 corridor, compounding pressures associated with prostitution, substance abuse and antisocial behaviour.

9.3.17.1.11 OVERLAPPING LAND USE AND CUMULATIVE IMPACTS WITH RENEWABLE-ENERGY PROJECTS

A defining feature of the receiving environment is the concentration of approved and applied-for renewable-energy developments (predominantly solar PV) over the same land as the production right. A review of renewable-energy environmental applications on record for the Matjhabeng and Masilonyana Local Municipalities identified more than forty such applications in the broader area, several of them overlapping or immediately adjacent to the production right (Figure 4). This creates overlapping land-use rights and significant potential for cumulative social impacts – on roads, safety, water, sense of place and community expectations – over and above those of the gas project alone.

Directly affected landowners are, in several cases, already hosting or neighbouring solar developments and have experienced road damage, stormwater problems, theft and disputes. For these landowners the gas project represents a cumulative burden. Conflict between developers (for example over road condition and stormwater) has already occurred in the area, and overlapping construction programmes could compound disturbance and confusion about land access. The cumulative dimension of this impact is therefore high. The residual significance remains **Medium-High after mitigation because this is a cumulative impact driven substantially by factors outside the proponent's control** – third-party renewable-energy developments, overlapping surface and sub-surface rights, and regional land-use planning. Project-level mitigation reduces the proponent's own contribution to the cumulative effect (reflected in the lower project residual), but the interaction with independent developments cannot be fully mitigated by this proponent alone; reducing the cumulative rating to Low would imply a degree of control the proponent does not have.

Contributing activities and phase: All land-using activities – wells, gathering pipelines, servitudes, access roads and the plant – over land also subject to renewable-energy developments; relevant across all phases. *Cumulative dimension:* This impact is inherently cumulative: it arises from the interaction of the gas project with the numerous approved and applied-for renewable-energy developments over the same land, and is assessed and rated as a cumulative impact.

9.3.17.1.11.1 ROUTE ALTERNATIVES

Where a linear-infrastructure route alternative (for a gathering pipeline, servitude or access road) traverses an authorised renewable-energy facility such as the Virginia Solar Park, the alternatives cannot carry the same social significance. A route passing through the authorised solar facility entails direct interaction with a committed land use and therefore carries higher land-use-conflict and cumulative significance, whereas the alternative that deviates around the facility avoids that direct interaction and is assessed as lower social significance for land-use conflict and cumulative overlap. The alignment that avoids the authorised facility is accordingly the socially preferred alternative. For this impact the significance should therefore be read as two scenarios – route through the authorised facility (higher; Medium-High) and route deviating around it (lower; Medium-Low) – rather than as a single rating; the other rated impacts are not materially affected by the route choice

9.3.17.1.12 DISTRUST ARISING FROM PREVIOUS DEVELOPMENT PROJECTS

Communities and landowners brought to the consultation a reservoir of distrust built up through experience with previous projects in the area. Community members referred to earlier gas and mining projects perceived to have delivered few local benefits and to solar projects that employed outsiders, leading to protests. Landowners described unmet commitments, road damage and disputes associated with an existing solar development. This history means that the same activity may be experienced as a new impact by one group and as a cumulative grievance by another, and that promises will be treated with scepticism.

Distrust is a subjective but powerful social impact: it shapes how every other impact is perceived and can escalate into opposition or protest. It is best mitigated through honest, consistent communication, written commitments and visible follow-through.

Contributing activities and phase: The project as announced and experienced across all activities, layered on the community's experience of previous mining, gas and renewable-energy projects; arises from planning and through construction. *Cumulative dimension:* Distrust is cumulative across successive projects: unmet commitments and grievances from earlier developments carry over and shape how this project is received

9.3.17.1.13 GENDER AND SOCIAL INCLUSION IMPACTS

Without deliberate measures, the benefits of the project (employment, procurement, skills) risk being captured by those already better positioned, while women, youth and vulnerable groups are excluded. Stakeholders highlighted active women-led cooperatives (farming, baking) and youth programmes that could be supported, and councillors noted municipal databases of vulnerable households that can be used to ensure inclusion. Conversely, social pathologies linked to the project (e.g. prostitution) disproportionately affect young women.

Promoting gender and social inclusion is both a legislative expectation (MPRDA, employment equity) and a means of broadening and deepening local benefit. With deliberate inclusion measures the residual impact can be turned towards a positive outcome.

Contributing activities and phase: Recruitment, procurement and skills activities across all phases determine who benefits, while the construction workforce drives the social-pathology risks that fall disproportionately on young women. *Cumulative dimension:* Patterns of exclusion or inclusion combine with those of other projects in the area to entrench or to counteract existing inequalities in access to opportunity

9.3.17.1.14 JOB CREATION, LOCAL PROCUREMENT AND ECONOMIC EXPECTATIONS

The project's principal positive impact is local economic stimulation. Communities have very high expectations of employment, driven by deep unemployment and the decline of mining. It is essential, however, to manage these expectations realistically: gas production is capital-intensive rather than labour-intensive, and the proponent's Social and Labour Plan projects a small permanent workforce of approximately seven positions in Year 1 rising to about ten by Year 5. The realistic local benefit therefore lies less in direct employment than in secondary opportunities – local procurement and sub-contracting, enterprise and skills development, and the SLP's human resources development and local economic development programmes.

Stakeholders (councillors and the business forum) were clear that meaningful local participation – prioritising local labour, contracting local SMMEs, and transferring skills so people move beyond general labour – is both expected and necessary to secure a social licence. Failure to manage expectations or to deliver visible local benefit is itself a source of protest risk (see Impacts 5 and 12). With active enhancement, this impact can become a meaningful and lasting positive contribution to the local economy.

9.3.17.1.14.1 INDIRECT AND INDUCED EMPLOYMENT

Beyond direct posts, the project will generate indirect employment through local procurement and sub-contracting, and induced employment through local spending by employees and contractors, in addition to the enterprise- and skills-development opportunities noted above. Consistent with SIA practice these secondary and multiplier effects are described qualitatively and are not quantified here: employment multipliers are properly derived in an economic impact assessment, and presenting multiplier figures unsupported by primary data would risk over-stating the project's employment benefits.

9.3.17.1.14.2 NATIONAL-SCALE BENEFITS

At the national scale the project is also associated with wider benefits – royalties payable to the State, greater security of domestic gas supply (including substitution for imported gas) and energy-related employment sustained elsewhere in the economy. These are macro-economic and energy-security considerations that fall within the project's need-and-desirability motivation and the province of an economic impact assessment, rather than within this social impact assessment, which assesses social impacts on directly affected communities and stakeholders. They are acknowledged here but are not quantified, both to remain within the scope of the SIA and to avoid the bias that foregrounding national-scale benefits could introduce into a community-level social study.

Contributing activities and phase: Construction (drilling, and plant and pipeline construction) generates peak labour and procurement, while operation sustains the small permanent workforce and ongoing procurement and SLP programmes; benefit accrues across construction and operation. *Cumulative dimension:* Local procurement, enterprise development and skills transfer can combine with the region's other energy-sector activity to build a broader, more durable local economic base – a positive cumulative effect to be enhanced.

9.3.17.2 IMPACT RATINGS

Table 113 consolidates the pre- and post-mitigation significance of all assessed impacts, together with the prioritisation factor and the final significance. All scores are negative (adverse) except for job creation, local procurement and economic expectations, which is a positive impact to be enhanced.

Table 113: Consolidated impact rating table (Equispectives Research and Consulting Services, 2026).

Impact	Phase	Pre-mitigation significance	Post-mitigation significance	Final significance
Impact on farming livelihoods and interference with existing land uses	Construction / Operation	Medium-High negative	Medium-Low negative	Medium-Low negative
Water contamination and groundwater safety	Construction / Operation	Medium-High negative	Medium-Low negative	Medium-Low negative
Damage to farm roads, services and infrastructure	Construction / Operation	Medium-High negative	Medium-Low negative	Medium-Low negative
Uncertainty around servitudes, property values and land-use rights	Planning / Operation	Medium-High negative	Medium-Low negative	Medium-Low negative
Impacts on safety and security of local residents	Construction / Operation	Medium-High negative	Medium-Low negative	Medium-Low negative
Increase in poaching incidents and stock theft	Construction / Operation	Medium-High negative	Medium-Low negative	Medium-Low negative
Veld fire risk	Construction / Operation	Medium-High negative	Low negative	Medium-Low negative
Nuisance factors (dust, noise, visual intrusion and sense of place)	Construction / Operation	Medium-Low negative	Low negative	Low negative
Community perceptions and fears regarding gas safety	Operation	Medium-Low negative	Low negative	Low negative
Social pathologies associated with a temporary workforce and contractor behaviour	Construction	Medium-High negative	Low negative	Medium-Low negative
Overlapping land use and cumulative impacts with renewable energy projects	All phases	Medium-High negative	Medium-Low negative	Medium-High negative
Distrust arising from previous development projects	Planning / Construction	Medium-High negative	Medium-Low negative	Medium-Low negative
Gender and social inclusion impacts	Construction / Operation	Medium-Low negative	Low negative	Low negative
Job creation, local procurement and economic expectations	Construction / Operation	Medium-Low positive	Medium-High positive	Medium-High positive

9.3.17.3 CUMULATIVE IMPACT ASSESSMENT

The cumulative socio-economic impacts must be considered together with:

- Existing agricultural activities and commercial farming operations.
- Existing mining and post-mining socio-economic conditions.
- Existing gas activities.
- Approved and proposed renewable-energy developments within the Production Right Area.
- Existing infrastructure constraints and road conditions.

The Social Impact Assessment identifies cumulative pressures associated with:

- Multiple energy developments competing for access to the same agricultural land.
- Increasing land-use complexity and stakeholder uncertainty.
- Additional traffic on rural roads.
- Increased expectations regarding employment opportunities.
- Additional pressure on farming operations.
- Reduced rural sense of place resulting from multiple infrastructure developments.

However, cumulative positive impacts include:

- Enhanced local procurement opportunities.
- Economic diversification.
- Attraction of investment.
- Combined skills development opportunities.
- Increased economic resilience in an area experiencing declining mining employment.

The Social Impact Assessment assessed the cumulative social and economic impact High negative without mitigation and Medium-High negative with mitigation.

9.3.17.4 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 H**) (to be read in conjunction with mitigation measures in the above sections):

- 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 construction 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 construction sites before any field activity begins. Share results with landowners.
- Exploration and drilling be planned where feasible 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.
- To prevent conflicts between gas development 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 appropriate meetings with affected landowners to explain the exact scope and timing of construction 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 construction 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.

New relevant management and mitigation measures:

- Implement Local Economic Development (LED) projects identified through the approved Social and Labour Plan (SLP) and ensure that such projects are aligned with the relevant municipal Integrated Development Plans (IDPs) and community development needs..

- Implement the approved SLP Human Resource Development and Local Economic Development commitments and engage with the relevant municipalities and stakeholders during their planning and implementation.
- Disclose water-use requirements to affected landowners and agree abstraction arrangements to avoid placing additional pressure on local resources.
- Site wells and pipelines away from residences where feasible and implement and communicate emergency-response and safety procedures.
- Register servitudes only where strictly necessary (for productive wells/infrastructure), use temporary access arrangements until certainty is obtained, and de-register servitudes at closure.
- Where reasonably practicable, promote participation by women-, youth-, and locally owned enterprises in skills development and Local Economic Development initiatives implemented through the approved SLP, in consultation with relevant stakeholders and municipalities.
- Use municipal vulnerable-household databases to ensure vulnerable groups are not excluded from benefit-sharing (these are the indigent and vulnerable-household registers held by the local municipalities; access is to be requested through the municipality and used subject to the requirements of POPIA).
- Provide a full project information and engagement where reasonable to key community structures (e.g. MEJCON-SA, forums) on request.

10 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.

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. The compilation of this map has taken into consideration the individual ranking 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.

Table 114 below provides a breakdown of the sensitivity rating and weightings applied to determine the sensitivity score of each aspect. **Figure 155 to Figure 158** presents the combined sensitivity map for the project. Identified sensitivities indicated in **Figure 155 to Figure 158** include the following:

- High Heritage Sensitivity;
- 1:100-year floodline;
- Sensitive air quality receptors;
- Species of conservation concern;
- Natural habitats with high SEI; and
- Wetlands with high PES and SEI.

Desktop sensitivity areas (areas outside the site-specific areas assessed during this EIA) are indicated in **Figure 155 to Figure 158**. These areas were generated based on latest available datasets to inform the EMPr approach of the procedure to be implemented based on the **maximum environmental sensitivity** of the area should the final activities fall within the PR but outside the areas assessed in detail as part of this EIA:

- Should the gas plant, additional seismic surveys and/or drilling wells fall outside of the EA assessed footprint areas, but within PR16 then depending on the final location of the gas plant, 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 seismic transect and drill site and surroundings (100m corridor for seismic transect, 100m corridor for gathering pipelines, 1km radius for drill site and 1km radius for gas plant) 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 seismic transect and final drill sites and surroundings (100m corridor for seismic transect, 100m corridor for gathering pipelines, 1km radius for drill site and 1km radius for gas plant 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 activities.

Table 114: 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

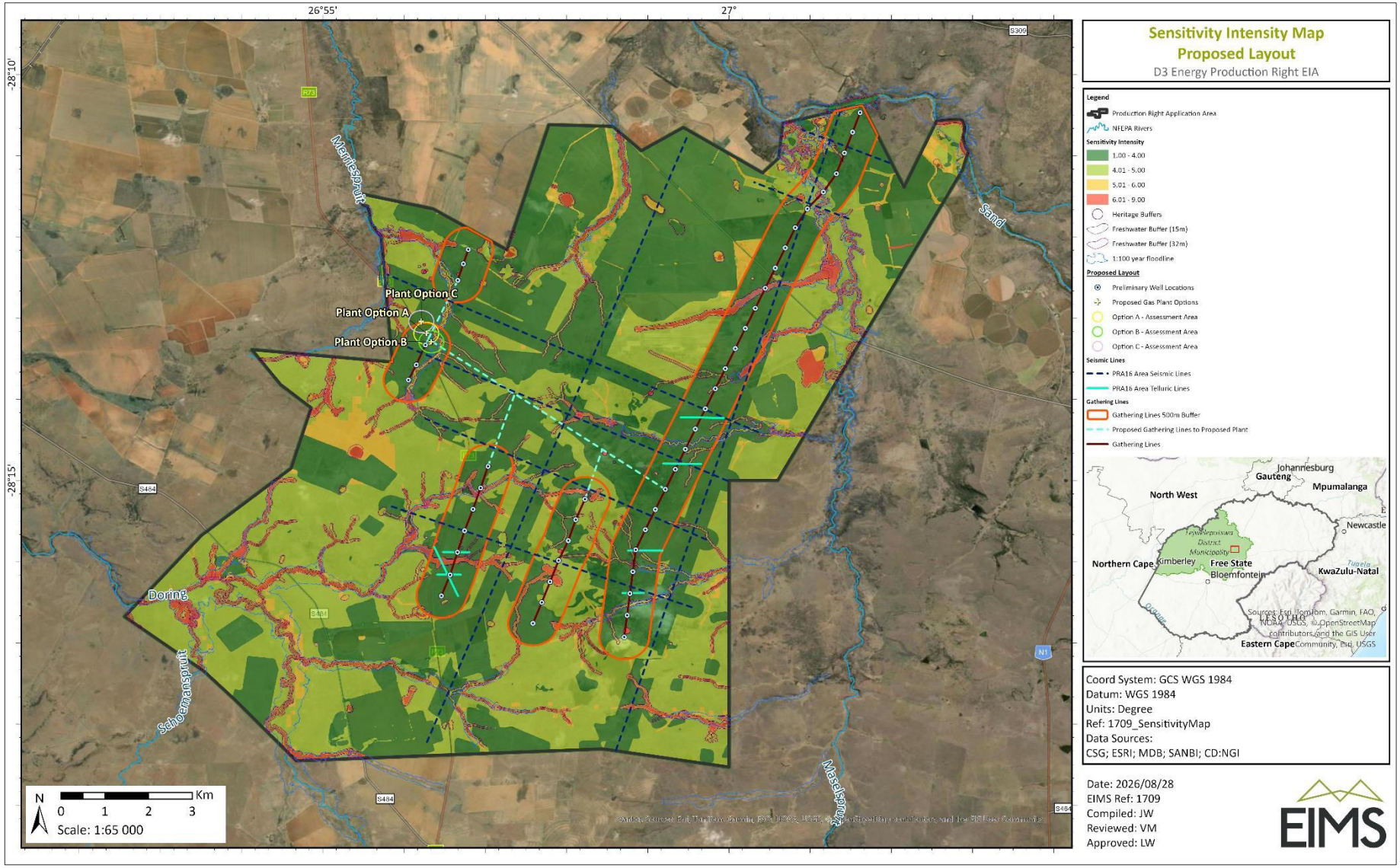


Figure 155: Sensitivity intensity map for the proposed layout.

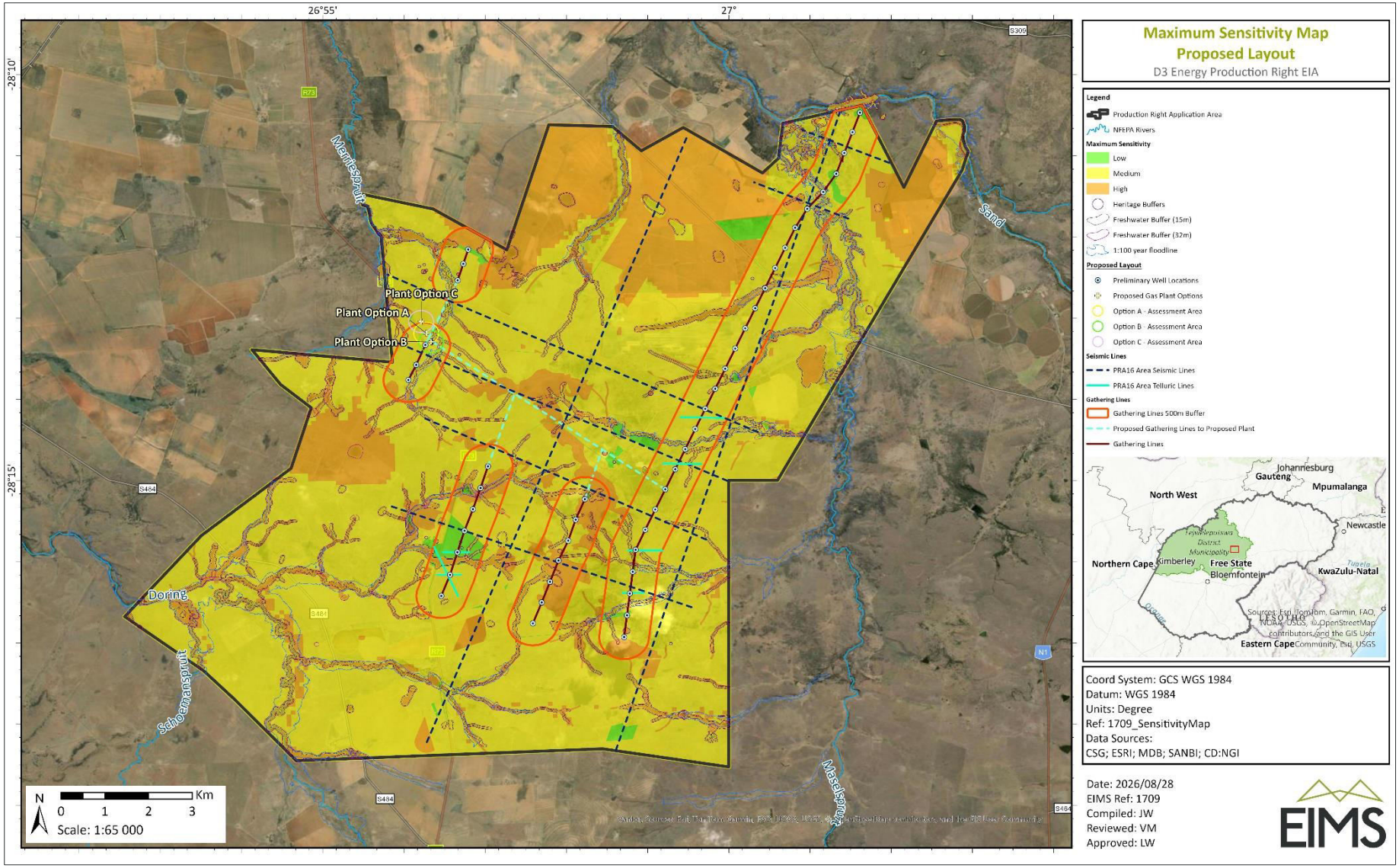


Figure 156: Maximum sensitivity for the proposed layout.

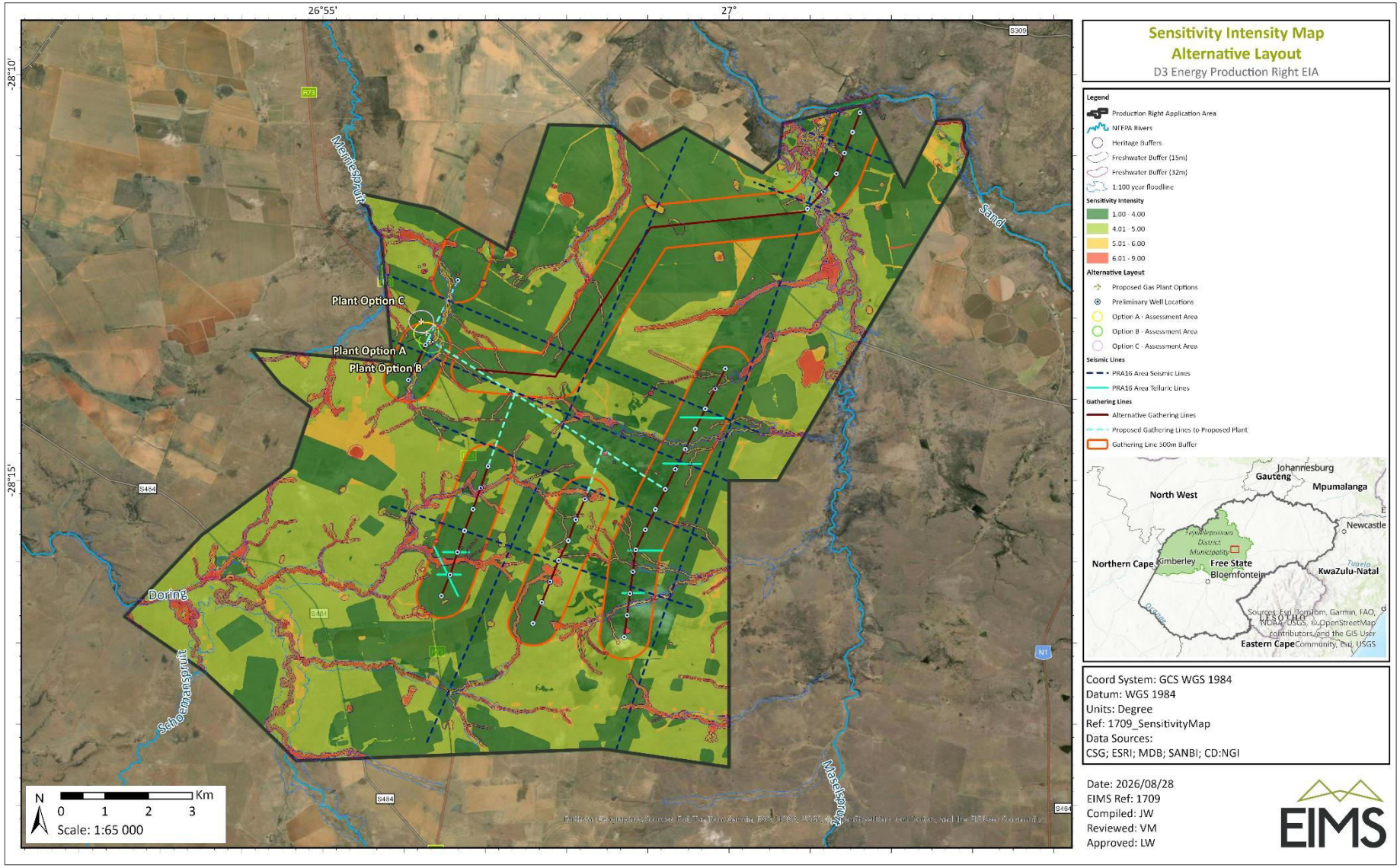


Figure 157: Sensitivity intensity for the alternative layout.

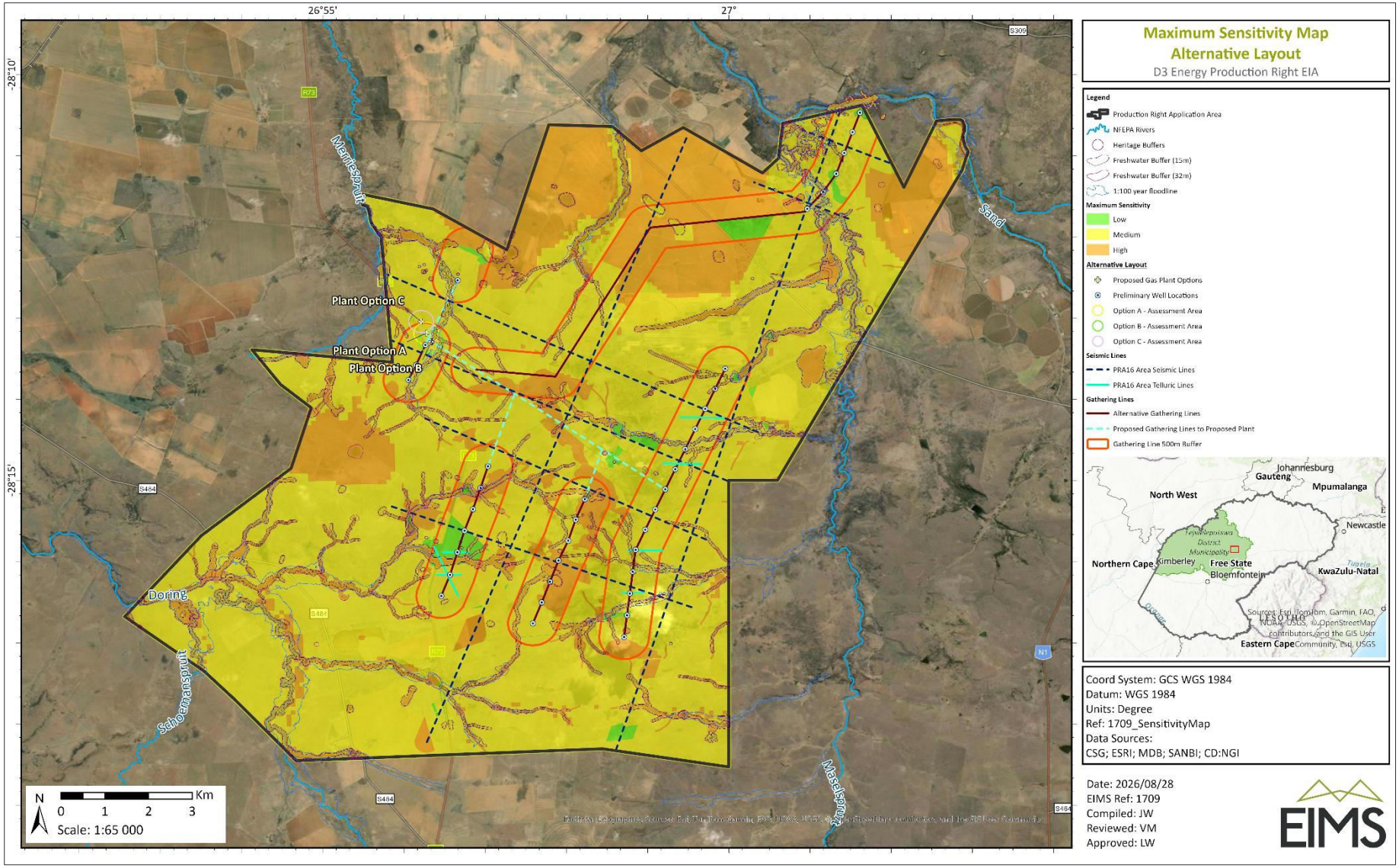


Figure 158: Maximum sensitivity for the proposed layout.

11 CLOSURE COSTING

Apart from the 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 PR. 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.

11.1 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 production and exploration activities will be undertaken include the following key land-uses:

- Agriculture – cultivated fields (mainly maize);
- Natural and Degraded Veld primarily utilised for livestock grazing;
- Gold mining areas to the south-west and the adjacent Tetra4 gas production right;
- Approved and proposed solar PV developments; and
- Low-density rural residential (farmsteads).

With reference to **Section 7.6**, the stakeholders consulted during the public participation process for the Scoping and EIA process (EIMS, 2026) raised concerns regarding, amongst others, the following:

- Groundwater and surface water contamination (water quality);
- impacts on farming, livestock, food security and farm security;
- wetlands and biodiversity;
- compatibility with solar PV developments and cumulative impacts with existing mining and energy projects; and

- climate change (greenhouse gas and methane emissions).

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-production land use at each site. Final well, pipeline and plant positions will only be fixed within the 500 m development corridors once landowner agreements and pre-construction surveys are complete, so this plan must be refined site by site as positions are confirmed. It does, however, set the closure objectives that will apply to all production and 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.
- Make the area safe for people and animals – plug and seal wells and refill excavations.
- Recreate a free-draining landform as close as possible to the original topography.
- Revegetate disturbed areas by reseeding or natural succession, as the site requires.
- Manage stormwater and control erosion during and after rehabilitation.
- Verify rehabilitation success through monitoring.

These objectives are aligned with the rehabilitation plan in the EMPr. The targets for each objective are set out in the monitoring, auditing and reporting table in **Appendix H.** The proposed rehabilitation framework also integrates continuous, adaptive environmental management throughout the project lifecycle to ensure a safe, sustainable, and socio-economically valuable post-closure landscape, by applying the key principles below (after the LARRSA surface-rehabilitation guideline), adapted to the scale of gas exploration and production activities.

11.2 MOTIVATION FOR PREFERRED CLOSURE OPTION

Alternatives are assessed against their ability to meet the closure vision and objectives, their practicality and viability, and their fit with the local environmental and socio-economic context. The evaluated options for well abandonment and site closure, and the preferred option, are detailed in **Appendix F5**.

- 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.

The preferred and costed closure option is to retain the cemented casing downhole and remove only the wellhead and the top 1.5–5 m of casing (partial removal: cut and cap); to plug the full length of the well (cased and open hole) with API-class cement placed by the squeeze technique, in accordance with the Onshore Well

Decommissioning Guidelines and the petroleum design basis; to remove all surface infrastructure; to empty and backfill drill sumps; to rehabilitate access tracks unless a landowner asks in writing to keep them; and to revegetate by the hybrid approach. Effective abandonment depends on knowledge of the well construction, geology and hydrogeology.

Before closure of any well, a suitably qualified well engineer or P&A specialist prepares a site-specific decommissioning plan, informed by well-integrity testing, drilling/cement records, and the barrier-placement factors listed below, and submits it to the regulator for approval, together with the landowner consultation outcome.

With reference to the closure options and the cost assumptions, the preferred closure option is as follows:

- Retain the cemented casing (informed by a pre-closure casing-integrity inspection), place permanent barriers across the Witwatersrand reservoir, the Karoo section and the base of the fresh-water aquifers, verified by tagging and pressure testing. For costing, the full cased and open-hole length is conservatively assumed to be cemented until well-specific designs exist. The barriers must meet the minimum requirements of the guidelines, but their number, position and length depend on each well's condition and on the well engineer's or P&A specialist's design, so the full-length assumption is a cautious upper bound for costing.

- Remove the wellhead and cut all casing strings 1.5–5 m below ground level (below plough depth on cultivated land), set a surface cement plug across the stubs and weld on a marker plate and lay a buried marker tape above the stub; record the position on the title deed or SG diagram.

- Rehabilitate access tracks (as costed), unless a landowner asks in writing that they be kept; a minimum route to an abandoned well may be kept for post-closure monitoring only by landowner agreement.

- Purge and cap gathering pipelines (pigging only where liquids have collected); remove all above-ground components (markers, low-point drain pits, valves, any nodal compressors); leave the buried HDPE in situ at 0.75–1.0 m unless a landowner or solar developer requires removal (removal is not costed).

- Decommission, dismantle and remove all structures and foundations of the plant, workshop and evaporation pond, remove pond contents, residues and liner to a licensed facility; assess and remediate soil contamination; reshape and revegetate.

- Empty drill sumps and dispose of contents at a licensed facility and backfill.

- Active revegetation on pads, the plant footprint and other compacted or cut areas if regrowth is insufficient during rehabilitation; passive recovery with alien invasive control elsewhere.

- It is anticipated that the closure option presented above, together with monitoring of the post closure period, will achieve the required closure objective. This closure option is in line with industry best practice and the requirements of the MPRDA Regulations and the Onshore Well Decommissioning Guidelines.

- 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 a qualified well engineer or P&A specialist, supported by other specialists as needed. 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.[21]
- 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.

Table 115 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 11.1**.

Table 115: Threats, opportunities and uncertainties associated with preferred closure option.

[21] The development of an applicable well bore stress model would assist in planning the final specific barrier characteristics.

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.

11.3 CLOSURE PERIOD AND POST CLOSURE REQUIREMENTS

The closure period is defined as the period between the cessation (decommissioning) of exploration, production, 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.

Following the successful completion of the active closure actions, it is suggested that a further post-closure period be assigned to allow for rehabilitation, monitoring of the success of closure. This closure and post-closure monitoring will involve the following actions and durations:

- Surface and groundwater monitoring- as informed by the water monitoring plan bi-annually for five (5) years after decommissioning or until a long-term trend can be determined and verified by an independent groundwater specialist;

- Fugitive gas emissions using either soil vapour probes, efluxes, Flir Methane Cameras, or surface methanometers, every five years for a period of 50 years post-closure (i.e. 10 sampling events);
- Well plugging and abandonment verification (rehabilitation monitoring) 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 or EAP to monitor the rehabilitation progress with regards to flora for a period of 3 years after rehabilitation.

Certain residual and latent impacts 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. 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**.

11.4 FINAL POST-DEVELOPMENT 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-development. In order to inform this target, it is important to have a clear understanding of what the pre-development 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 PR 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-development 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 the FRDCP it is assumed that the post closure land use will be congruent with the agricultural, renewable energy developments and natural veld mix of land use and capability in the region. The proposed post-closure land-use is provided in **Table 116**.

Table 116: Proposed post-closure land use per activity or infrastructure.

Activity / infrastructure	Pre-disturbance land use	Proposed post-closure land use
Production and exploration wellsites, drill pads and sumps	Grazing or cropland	Same as pre-disturbance; abandoned wells marked and recorded on title deeds
Gas gathering pipelines and servitudes	Grazing, cropland or solar PV land	Unrestricted grazing or cropping over pipe left in situ at 0.75–1.0 m; servitude released
Helium recovery and gas processing plant, evaporation pond and workshop	Grazing	Grazing; buildings retained only by written landowner agreement
Access roads and tracks	Grazing or cropland (existing farm roads retained)	Rehabilitated to grazing or cropland, or retained as farm roads by agreement

11.5 CLOSURE ACTIONS

The closure actions apply to all infrastructure, activities and aspects for which the holder is responsible, and are grouped into the following phases:

- **Phase 1:** Preparation for Closure;
- **Phase 2:** Well Decommissioning, Plugging and Abandonment
- **Phase 3:** Rehabilitation;
- **Phase 4:** Monitoring, Maintenance and Relinquishment

11.5.1 PHASE 1: PREPARATION FOR CLOSURE

Before decommissioning a well, a suitably qualified professional confirms pre-closure site conditions, undertakes a site-specific closure risk assessment and consults the affected landowner; a well engineer or P&A specialist assesses the specific well (condition, casing and grouting integrity, and informed by the operational-phase cement-bond logs, the plugging method) and prepares the technical decommissioning plan. A consolidated site-specific closure and decommissioning plan is submitted to the regulator for approval before closure begins.

Well-integrity regime: a cement bond log is run on each well once the 5½" production casing is set, and the open hole is logged at total depth. As every production well will have produced for more than 10 years by closure, cement logging (CBL/USIT) is repeated during P&A planning, together with clean-out, calliper logging and pressure testing. The three existing wells need their construction and cement records verified before they are brought into the PR. The latent-risk provision assumes a 3.4% barrier-failure and re-intervention rate.

11.5.2 PHASE 2: DECOMMISSIONING, PLUGGING AND ABANDONMENT

Guided by the approved decommissioning plan, wells are plugged and made safe, surface infrastructure is dismantled and removed, sumps are emptied and waste disposed at licensed facilities, and disturbed areas are re-profiled to the original landform, ripped, topsoiled and re-vegetated. Permanent abandonment provides permanent isolation of every formation with flow potential penetrated by the well, preventing outflow of fluids/hydrocarbons and contamination of any fresh-water aquifer, and leaves the location safe for other users. Temporary abandonment (suspension) provides a combination of permanent and temporary barriers to prevent migration between formations while facilitating future re-entry or subsequent permanent abandonment.

11.5.3 PHASE 3: REHABILITATION

Phase 3 restores the disturbed areas to the agreed land use once wells are plugged and infrastructure is removed. The component actions are in the closure-actions table above (general surface rehabilitation). Project-specific requirements are:

- Landform: shape all disturbed areas to be free-draining and consistent with the gently undulating surroundings (slopes about –2.5% to +3.5%); remove hardstanding, road base and foundations.
- Soils: replace stockpiled subsoil and topsoil by soil form; rip compacted pads, the plant footprint and tracks; handle vertic and duplex soils only when dry; ameliorate where soil tests show deficiencies.
- Revegetation: seed with a locally indigenous grass mix suited to Vaal-Vet Sandy and Central Free State Grassland after the first spring rains (October to December); actively revegetate pads, the plant and pond footprint; allow natural recovery on lightly disturbed verges, with alien invasive control.
- Erosion control: install contour banks or energy dissipaters before the summer thunderstorm season; keep rehabilitation outside the 32 m / 15 m watercourse and wetland buffers unless authorised under the NWA.
- Heritage and palaeontology: maintain the 30 m and 50 m heritage buffers during closure earthworks and apply the Chance Find Procedure.

- Livestock: exclude livestock from newly rehabilitated areas until vegetation is established, unless controlled grazing is prescribed by the rehabilitation specialist

11.5.4 PHASE 4: MONITORING, MAINTENANCE AND RELINQUISHMENT

Post-closure monitoring confirms that objectives are met, on the durations defined in closure period. Post-decommissioning environmental reports must be submitted to the regulator and stakeholders at intervals dictated by the monitoring frequency. Specifically, submissions will occur annually for the first five years, and every five years thereafter (unless otherwise agreed). All reports must include comparative before-and-after photographic records and will continue until the relinquishment criteria outlined in **Appendix F5** are successfully achieved. The following actions, to be adjusted based on the completion of the pre-closure site assessment as well as the Onshore Well Decommissioning Guidelines prepared by PASA, are proposed:

- **Groundwater and surface water monitoring (production and exploration wells):** The post-closure monitoring should take place bi-annually for five (5) years, in line with the closure costing, or until a long-term acceptable trend can be determined. The extent of the monitoring is to be determined in the site-specific closure and decommission plan (provision has been made for bi-annual monitoring for five years). This monitoring aims to confirm that abandoned wells are safe and do not result in a pollution or contamination hazard.

- **Rehabilitation monitoring:** Monitoring to be undertaken by a qualified Ecologist 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 construction, operational and decommissioning phases. The following aspects require monitoring during these phases:

    - 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 alien and 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;
    - Restoration of native vegetation covers and ecology;
    - Minimize the area of vegetation clearing for drilling and construction;
    - 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 issues at source; and
- The need for long-term monitoring must be reduced.

- **Gas emissions (production and exploration wells):** The well site must be monitored for the release of gas from the decommissioned well site. This can be undertaken through appropriate sampling techniques, either soil vapour probes, efluxes, Flir Methane Cameras, or surface methanometers. Methane/natural gas monitoring to be conducted every 5 years for 50 years, or until a long-term acceptable trend can be determined, during the post closure period.

The monitoring reports shall include a list of any remedial action necessary to ensure that infrastructure that has not been removed remains safe and pollution-free and that rehabilitation of project sites is in a stable, weed-free condition. Electronic/digital photographs will be taken before and after rehabilitation. Please refer to **Appendix F5 and Appendix H** for further detail on the required auditing and monitoring requirements

11.6 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 117**. The key rehabilitation and closure components, their actions and schedule drivers are set out below. Permits and licences that may be required before closure (e.g. water-use licences, environmental authorisations) should be initiated early, as lead times are long. The schedule is linked to D3 Energy's development programme (greenfields):

- 2027–2028: drilling of the 13 new wells on the Virginia fault (phased as ~7 in late 2026 and 6 in 2027 in the Development Plan), construction of the initial gathering pipelines to these and the 3 existing wells, and commissioning of the plant by early 2028. Drill pads are rehabilitated within six months of drilling and exploration wells not converted to production are plugged as they occur (ARP, Section 5).
- Operational phase (at least 30 years): the 27 wells on the Ventersburg fault drilled as needed to sustain sales volumes; wells and pipeline sections decommissioned progressively as they stop producing.
- Final decommissioning (after cessation of production, not before ~2058 on the stated life): plugging and abandonment of the remaining wells, followed by pipeline, plant, pond and road closure, then rehabilitation and post-closure monitoring until relinquishment.

Spatial progression is from the Virginia-fault corridors near the plant to the Ventersburg-fault corridors. Schedule drivers are gas deliverability per well, landowner and solar-developer agreements, and the time needed for regulatory approval of well-specific P&A programmes.

Table 117: Closure schedule drivers.

Activity	Closure schedule driver
Ongoing activities.	Ongoing decommissioning and closure of abandoned exploration and production 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, licences, 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 production and/or exploration activities.

Activity	Closure schedule driver
Rehabilitation of access roads.	Cessation of production 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. drill pads, plant and pond footprint, 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). Natural re-establishment of indigenous vegetation, with alien invasive control, is preferred; active revegetation is applied wherever natural recovery is not succeeding.
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.
Ground and surface water monitoring	Ongoing throughout rehabilitation activities and into the closure and post closure periods.
Fugitive gas emissions monitoring	Ongoing throughout rehabilitation activities and into the closure and post closure periods.
Decommissioning of gas gathering pipelines	Each section is decommissioned when the wells it serves are abandoned; the trunklines at the end of production, after the last wells are plugged.
Decommissioning of the helium recovery and gas processing plant and workshop	Cessation of production; follows well and pipeline decommissioning and precedes final surface rehabilitation of the plant footprint.

11.7 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.

11.7.1 APPROACH TO FINAL CLOSURE COST DETERMINATION

Financial provision must at any time equal the sum of the costs of implementing the plans and reports for a period of at least the next 10 years (Regulation 7 of the Financial Provisioning Regulations, 2015). The regulations set a required cost-estimate accuracy that improves as the operation approaches closure. The closure cost has been calculated through the following steps:

- Review of available information to inform the closure battery limits for the D3 Energy Production operation;
- Verify unit rates for infrastructure dismantling and demolition as well as associated rehabilitation of disturbed areas, taking into account 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 at five-yearly intervals for a period of 50 years during the post closure period.
- Vegetation monitoring to be undertaken once per year for three (3) years during post-closure phase as part of the rehabilitation monitoring.

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.

11.7.2 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.

Table 118: Financial provision quantum summary.

	2025		2026	
	Unscheduled	Scheduled	Unscheduled	Scheduled
Final Decommissioning and Closure Cost	**n/a**	**n/a**	**R 29 797 125.73**	**R 29 760 753.97**
- Well Closure	n/a	n/a	R 15 906 491.31	R 15 906 491.31

	2025		2026	
	Unscheduled	Scheduled	Unscheduled	Scheduled
- General Surface Rehabilitation	n/a	n/a	R 6 569 341.76	R 6 569 341.76
- P&Gs and contingencies	n/a	n/a	R 7 321 292.66	R 7 284 920.90
Annual Rehabilitation Cost	**n/a**	**n/a**	**R 181 858.80**	**R 0.00**
Post closure Phase - Residual and Latent Cost	**n/a**	**n/a**	**R 13 153 584.51**	**R 13 153 584.51**
- Monitoring	n/a	n/a	R 11 606 015.59	R 11 606 015.59
- Latent and residual risk provision (redrill and plugging of wells)	n/a	n/a	R 1 547 568.92	R 1 547 568.92
Total quantum of Financial Provision (Excl. VAT)	**n/a**	**n/a**	**R 43 132 569.04**	**R 42 914 338.48**

Further 49A (1c) of NEMA states that it is an offence to fail to comply with an approved EMPr- on conviction the person is liable to a fine not exceeding R10 million or to imprisonment for a period not exceeding 10 years, or to both such fine or such imprisonment. Compliance with the conditions of the EMPr and EA is monitored through independent compliance audits as is required by Regulation 34 of the NEMA EIA Regulations. The EMPr sets out the monitoring and auditing obligations for the project, which includes compliance audit to be undertaken by an independent environmental specialist. In the unlikely event that despite these controls there is an impact on the environment (including the soil and water resources) then there remains a legal obligation for the polluter to stop the pollution and remedy such.

In addition, Section 24P of the NEMA provides for the obligation that an applicant has to ensure adequate financial provision for the remediation of environmental damage, even beyond the closure and decommissioning of the activity. The determination of this quantum must be independently assessed and must be updated on an annual basis. Further, even after the issuance of the closure certificate the financial provisions must still ensure that long term residual and latent risks are accounted for. NEMA Section 24R states that the holder remain responsible for any environmental liability, pollution or ecological degradation, the management and sustainable closure thereof notwithstanding the issuing of a closure certificate.

12 CONCLUSION 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 D3 Energy PR project and associated infrastructure.
- Identify and recommend appropriate mitigation measures for potentially significant environmental impacts

12.1 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.

12.1.1 AIR QUALITY IMPACT ASSESSMENT

An air quality impact assessment was conducted for the project activities. The main objective of this study was to determine the significance of the predicted impacts from the project activities on the surrounding environment and on human health. Emission rates were quantified for the project activities and dispersion modelling executed.

The main findings from the baseline assessment were as follows:

- The predominant wind direction is from the northeastern sector.
- Numerous individual homesteads and residential areas are located within the study area.

The main findings from the impact assessment due to project activities were as follows:

- Construction and Development:
    - Maximum daily PM_{10} ground level concentrations due to land clearing exceeds the daily PM_{10} NAAQS for an area of approximately 1 km by 1 km around the plant and 130 m from the drill sites respectively.
    - Annual average VOC ground level concentrations due to development activities are well within the comfort level of 200 µg/m³.
    - Significance rating:
        - Without and with mitigation: medium-low negative significance rating.
        - Overall significance rating: medium-low negative significance rating.
- Operation:

- Maximum hourly NO_2 ground level concentrations due to combustion sources, are well within the hourly NO_2 NAAQS, with maximum levels at the power plant of around 50 µg/m³. As the three options for the site are close to each other, and because the impact is simulated to be below NAAQS, from an air quality perspective there is no preferred site option.
- Annual average VOC ground level concentrations due to production activities, are well within the comfort level of 200 µg/m³.
- Significance rating:
  - Without and with mitigation: medium-low negative significance rating.
  - Overall significance rating: medium-low negative.

- Closure:
  - Assuming impacts due to rehabilitation activities to be similar to construction (i.e. land clearing), maximum daily PM_{10} ground level concentrations may exceeds the daily PM_{10} NAAQS for a limited area around the plant and well sites.
  - The testing wells must be capped and sealed and should not have any gaseous releases if properly managed.
  - Significance rating:
    - Without and with mitigation: medium-low negative significance rating.
- Overall significance rating: medium-low negative

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 (fatal flaw) on the surrounding potentially sensitive receptors, provided that the following recommendations are taken into account:

- During construction of target areas, the exposed areas must remain moist through water spraying during dry, windy periods.
- All residents within 600 m of drilling areas and 300 m of seismic surveys should be notified before project activities take place.
- 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.
- Mitigation and monitoring measures as discussed in Section 6 should be considered.

12.1.2 ARCHAEOLOGICAL AND CULTURAL HERITAGE IMPACT ASSESSMENT

A Phase 1 Heritage Impact Assessment was undertaken. As part of this assessment, a desktop as well as an on-site evaluation of heritage impacts was conducted. Following a desktop assessment and field survey, a total of 18 potential heritage features were identified within the area, of which 13 were in proximity and intersecting the development footprint. The following is a categorised description of the different potential heritage features identified through the desktop assessment:

- MPR003, MPR004, MPR006, MPR021 – Burials and cemeteries
- MPR001, MPR005, MPR007, MPR008, MPR009, MPR010, MPR017, MPR018 – Historical Farmsteads and structures
- MPR019 – Stone Age Site

Through the methodology adopted as part of this assessment, heritage features were identified which can all be avoided during the implementation of the proposed activities. All identified heritage resources can be avoided, provided that the prescribed buffers, final micro-siting requirements and pre-construction heritage walkdown (where required) are implemented. Apart from unassessed chance finds, a Low to Medium impact on heritage features can be expected should the proposed mitigation measures be followed. Therefore, from an Archaeological perspective, the development will not have any significant foreseeable impacts and can proceed as long as the recommended mitigation measures are implemented.

12.1.3 AQUATICS AND WETLAND IMPACT ASSESSMENT

Within the PR, a diverse suite of Hydrogeomorphic (HGM) wetland units were delineated during the field and desktop assessment, comprising channelled valley-bottom, unchannelled valley-bottom, seep, depression and floodplain wetland systems, together with associated drainage features. A number of artificial or highly modified water features also occur within the PR; however, these are dependent on induced drivers and were not considered to represent natural wetland systems for sensitivity and risk assessment purposes.

A quantitative risk assessment was undertaken in accordance with the relevant freshwater impact assessment approach for activities associated with the construction, operation and decommissioning phases of the proposed development. Under a conservative assumption that some freshwater features and/or associated buffers may not be fully avoided, the post-mitigation risk profile is dominated by Low to Moderate risks. These risks are primarily driven by:

- Potential disturbance to natural hydrological flow paths;
- Erosion and sedimentation resulting from vegetation clearing, vehicle movement and infrastructure installation;
- Episodic water quality impacts associated with hydrocarbon leaks, spills or contaminated runoff, and;
- Disturbance to wetland habitat and associated ecological functioning.

Where avoidance measures, buffer restrictions, rehabilitation requirements and construction controls are fully implemented, residual risks are expected to reduce to Low for most activities and freshwater features, with Moderate risks potentially persisting only in more sensitive or hydrologically connected systems where disturbance cannot be entirely avoided.

The D3 Energy PR Application is situated within a landscape containing numerous natural wetland systems and associated freshwater features that remain functionally important despite ongoing catchment-level pressures. The assessment has shown that these systems retain ecological value and continue to provide relevant ecosystem services, and that the proposed development is not considered to present a fatal flaw from a freshwater perspective, provided that strict avoidance and mitigation principles are applied.

In the specialist's opinion, the project may be favourably considered for authorisation from a freshwater ecological perspective, provided that:

- The final layout if possible, should be refined to avoid delineated wetlands, riverine features and associated buffers as far as reasonably practicable, with preference given to the avoidance of higher sensitivity and more hydrologically connected systems;
- Any unavoidable wetland or drainage crossings are appropriately designed and implemented to maintain hydrological and ecological functioning;
- All recommended mitigation, rehabilitation and monitoring measures contained in this report are strictly implemented for the duration of the project;
- Erosion, sedimentation, stormwater and spill prevention controls are effectively implemented and maintained; and

- All works within or adjacent to freshwater features are undertaken under the supervision of a suitably qualified Environmental Control Officer and/or freshwater specialist, with monitoring undertaken to support adaptive management where required.

12.1.4 CLIMATE CHANGE IMPACT ASSESSMENT

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. Locally published literature was referenced, to understand the projected changes to climate for the area.

Based on information provided, the project is likely to result in an estimated total GHG emissions as follows:

- Scope 1 direct emissions:
    - 809 057 t CO_2e over a 30-year period
    - 29 221 t CO_2e per annum
- Scope 2 indirect emissions:
    - None
- Scope 3 indirect emissions:
    - 1 930 635 t CO_2e over a 30-year period
    - 191 915 t CO_2e per annum

The GHG emissions from the project was calculated to represent 0.009% of the remaining South African annual budget for 2035. 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 moderate negative risk rating for GHG emissions. The calculated CO_2e emissions from the project operations in the area (cumulative) for Scope 1 is estimated at a total of 197 189t CO_2e per annum.

Cumulative projects in the area would contribute approximately 0.06% of the remaining carbon budget per year and represent a contribution of 0.04% to the 2022 National GHG inventory total. The impact of the cumulative projects on climate change was assessed to have a high negative risk rating for GHG emissions.

The CCA identified no climate-related reasons that would preclude consideration to obtaining Environmental Authorisation (EA). The assessment does not say there is no climate impact. It recognises the contribution while assessing whether the requested EA can be considered. However, as climate change results in a multidisciplinary impact (including, but not limited to, socio-economic, fauna and flora, ground and surface water, air quality), the CCA cannot be evaluated in isolation. Other disciplinary specialist impact assessments thus need to be taken into consideration to understand the full impact of the project.

In the event that this project is allocated a carbon budget, it will need to provide a greenhouse gas mitigation plan. The project will also be required to report CO_2e emissions annually via the SAGERS

12.1.5 HYDROLOGICAL / FLOODLINE ASSESSMENT

The D3 Energy Hydrological Assessment evaluated the hydrological conditions within the proposed Production Right Area (approximately 15 000 ha) southeast of Virginia in the Free State Province. The study focussed on major drainage systems including the Sand River, Maselspruit, Doring River and Merriespruit, and assessed catchment hydrology, flood risk, climate change impacts and stormwater management requirements. Hydrological modelling was undertaken using multiple accepted South African flood estimation methods and a detailed GeoHEC-RAS hydraulic model to delineate the 1:100-year floodlines. The assessment found that the project area is traversed by several significant watercourses and that areas within the 1:100-year floodlines constitute very high hydrological sensitivity zones. Approximately eight proposed well locations are situated within or close to these sensitive floodline areas and will require further assessment during detailed design.

Climate change projections indicate increased rainfall and runoff in the future, resulting in an estimated 46% increase in runoff volumes being incorporated into the floodline modelling to ensure a conservative assessment.

The study concluded that the proposed development presents manageable hydrological and stormwater risks, provided that strict mitigation and design controls are implemented. Key recommendations include locating all permanent infrastructure, production wells and processing facilities outside the 1:100-year floodline wherever feasible, protecting all watercourses and wetlands as no-go areas, implementing stormwater attenuation and erosion control measures, utilising horizontal directional drilling (HDD) at sensitive river crossings where possible, maintaining separation between clean and dirty water systems, and conducting rehabilitation throughout the project lifecycle. The hydrology specialist concluded that the anticipated impacts are generally low and acceptable if mitigation measures are effectively implemented and incorporated into the detailed design, EMPr and future stormwater management plans. Consequently, from a hydrological perspective, the project is considered suitable to proceed through the environmental authorisation process and may be supported by the relevant authorities, subject to the implementation of the recommended mitigation measures and compliance with the requirements of the National Water Act and associated approvals where required.

12.1.6 GEOHYDROLOGICAL IMPACT ASSESSMENT

The assessed the baseline groundwater conditions and potential groundwater impacts associated with the proposed D3 Energy South Africa (Pty) Ltd Production Right Area. The study area covers approximately 144.4 km² and is underlain by a shallow alluvial aquifer, a shallow intergranular weathered aquifer, and a deeper fractured aquifer associated with the Beaufort Group and Karoo Dolerite Suite. Groundwater is critically important in the area because it serves as the primary and, in many cases, sole source of water for domestic, livestock and agricultural use. The hydrogeological investigation included a hydrocensus survey of 62 groundwater and surface water receptors, drilling and testing of four monitoring boreholes, water quality analysis, aquifer characterization, and development of a calibrated numerical groundwater flow and contaminant transport model. The study found that groundwater generally flows towards local drainage systems, with strong interaction between groundwater and surface water, especially within alluvial aquifers associated with the Sand River, Maselspruit and associated tributaries. The aquifer system was classified as a "Minor Aquifer" with moderate vulnerability and medium susceptibility, requiring a medium level of groundwater protection.

Groundwater quality was found to be generally good, with most parameters complying with SANS 241:2015 standards, although isolated elevated nitrate and fluoride concentrations occur due to agricultural activities and natural geological conditions. Numerical modelling assessed worst-case scenarios involving leakage from gas production wells and migration of saline groundwater and methane from deeper fractured aquifers into shallow potable aquifers. The modelling indicated that contaminant plumes would generally remain within the Production Right Area and are unlikely to affect neighbouring boreholes. Simulated saline groundwater plumes could migrate up to approximately 180 m to 350 m during operations and up to 250 m to 450 m during post-closure conditions, particularly where wells are located within riparian zones. Methane migration distances were shorter, and predicted methane concentrations remained well below international safety thresholds. The study identified the most significant groundwater risk as the creation of preferential pathways through poorly constructed or inadequately sealed production wells that could allow saline groundwater or gas migration into shallow potable aquifers.

The hydrogeologist concluded that although groundwater impacts may be significant if uncontrolled, the risks can be effectively managed through proper well construction, sealing, monitoring, stormwater management, pollution control measures and long-term groundwater monitoring. The report specifically recommends avoiding development within alluvial and riparian aquifers wherever possible, implementing the proposed groundwater monitoring network, conducting regular groundwater quality assessments, updating the groundwater model as new data become available, and ensuring that all production and decommissioned wells are appropriately cemented and sealed. The specialist opinion states that with implementation of the recommended mitigation measures, groundwater management plan and monitoring programme, the project can be authorised from a hydrogeological perspective. However, the applicant must demonstrate that it has the technical and financial capacity to protect groundwater resources because the local aquifers are effectively a

sole source of water for landowners and surrounding rural communities. Consequently, the study supports approval by the competent authorities, subject to strict implementation of the recommended groundwater protection, monitoring and mitigation measures and incorporation of these requirements into the EMPr and closure plans.

12.1.7 NOISE IMPACT ASSESSMENT

The D3 Energy Noise Impact Assessment assessed the potential noise impacts associated with the proposed D3 Energy PR activities. The study evaluated existing ambient sound conditions, identified noise-sensitive receptors (NSRs), and modelled worst-case construction, operational, decommissioning and rehabilitation scenarios. Ambient sound monitoring undertaken over four nights showed that the area is predominantly rural, with daytime average ambient noise levels of approximately 47.7 dBA and night-time levels of 37.1 dBA, largely influenced by natural sounds such as birds and insects. The assessment identified scattered residential receptors throughout the project area and established recommended noise limits of 52 dBA during the day and 42 dBA at night for residential receptors.

The modelling results found that most project activities would generate low noise impacts at surrounding receptors. Daytime activities such as transportation, site preparation, seismic surveys, trenching, processing plant operations, decommissioning and rehabilitation were all rated as having low significance. Certain activities could result in medium significance impacts before mitigation, particularly night-time site preparation, seismic surveys within 800 to 1,000 metres of residences, drilling activities within approximately 1,000 metres of receptors, and night-time logistics near dwellings. Emergency gas venting or flaring was also identified as a potential medium-significance impact because of its high noise levels and unpredictable nature. However, the proposed processing plant and gas-to-power facilities are located more than 2 km from the nearest receptor, and the study concluded that operational noise from the plant would remain low due to the distance and use of containerised equipment.

The study recommends the implementation of mitigation measures including traffic management, notification of nearby residents, restrictions on night-time activities near receptors, use of low-noise drilling equipment, installation of silencers and acoustic controls, optimization of seismic survey layouts, and implementation of a complaint response mechanism and adaptive monitoring programme. The specialist concluded that while some project-related noise, particularly from drilling, will be audible or clearly audible at nearby receptors, noise impacts are not considered a fatal flaw. With the proposed mitigation and management measures in place, all significant noise impacts can be reduced to low significance levels. Consequently, the specialist recommends that the D3 Energy PR project be authorised from a noise perspective, subject to implementation of the Environmental Management Programme (EMPr), complaint management system, and ongoing monitoring and mitigation commitments.

12.1.8 PALAEONTOLOGICAL IMPACT ASSESSMENT

The D3 Energy Palaeontological Heritage Impact Assessment identified that the project area is underlain mainly by the fossil-bearing Adelaide Subgroup of the Beaufort Group, which is classified as having **Very High palaeontological sensitivity**, while smaller portions are underlain by moderately sensitive Quaternary sediments and unfossiliferous Jurassic dolerite. The region is scientifically important because it contains rocks known elsewhere to preserve significant Permian-Triassic fossils, including vertebrates associated with the Daptocephalus Assemblage Zone.

A field investigation undertaken in June 2026 verified the desktop assessment and found no fossiliferous outcrops or exposed fossil material within the project footprint. However, the study noted that much of the potentially fossil-bearing bedrock is covered by soil, grassland and cultivated land, meaning fossil material could still occur below the surface and may only be exposed during construction activities. The assessment concluded that seismic surveys would have a low impact on palaeontological resources, while drilling, trenching, pipeline installation and gas plant construction could have higher impacts because they involve deeper and more permanent disturbance of the subsurface. Nevertheless, the probability of encountering fossils is considered relatively low because no fossils were observed during the field survey and fossil occurrence within the formation is sporadic rather than continuous.

The study determined that, with appropriate mitigation measures, the residual palaeontological impact would range from **Low to Medium-High significance**, which is considered acceptable. The specialist therefore concluded that the project is **not fatally flawed from a palaeontological perspective** and recommended that environmental authorisation be granted. The way forward is for the relevant authorities to approve the project subject to implementation of the recommended mitigation measures, particularly the inclusion of a **Chance Find Protocol** in the EMPr, training of site supervisors to identify fossil material, immediate reporting of any fossil discoveries to SAHRA, and obtaining permits for any fossil collection if required. These measures should be incorporated as conditions of Environmental Authorisation to ensure that any significant fossil heritage encountered during construction is properly protected and documented.

12.1.9 QUANTITATIVE RISK ASSESSMENT

The D3 Energy Quantitative Risk Assessment evaluated the potential safety, health and environmental risks associated with the proposed D3 Energy PR right activities. The assessment covered production wells, gas gathering pipelines, a helium recovery and gas processing plant, and associated CNG/LNG facilities. Using internationally recognised quantitative risk assessment methodologies, the study modelled credible worst-case incidents such as gas releases, fires, vapour cloud explosions (VCEs), ammonia releases, and asphyxiation hazards. The key hazardous substances identified were natural gas, compressed natural gas (CNG), liquefied natural gas (LNG), helium, ammonia refrigeration systems, and flare gas operations.

The results showed that risks associated with the wellfield and buried gas gathering pipelines are highly localised and do not present significant off-site fatality risks. A catastrophic well failure would result in a jet fire with a 1% fatality distance of approximately 4 m, while a full-bore pipeline rupture could produce a maximum jet fire distance of 68 m, remaining within pipeline servitudes. The highest consequence scenarios were associated with LNG and CNG storage and loading operations, where flash fires and vapour cloud explosions could extend between approximately 110 m and 214 m from the source, although these impacts remain largely confined to the processing plant area. Ammonia refrigeration presented the largest off-site consequence footprint, with a PAC-2 emergency planning zone extending up to 3 km under worst-case meteorological conditions; however, the study determined that no residential receptors would be exposed to life-threatening concentrations and that all 1% fatality zones remain within the facility boundary.

The assessment concluded that the proposed development does **not present any fatal flaws from a risk and safety perspective** and that no unacceptable off-site risks to neighbouring properties or communities were identified. The individual risk contours remain within internationally acceptable criteria, with residential and public receptors falling within acceptable or trivial risk zones. Furthermore, the gas processing facility and gathering system were found **not to qualify as a Major Hazard Installation (MHI)** under the 2022 MHI Regulations because hazardous inventories remain below regulatory thresholds. The study therefore supports approval of the project, subject to implementation of key mitigation measures during detailed design and construction, including compliance with applicable SANS standards, completion of HAZOP and process hazard analyses, implementation of IEC 61508/61511 safety instrument systems, emergency preparedness planning, engineering sign-off by registered professional engineers, and a final MHI risk assessment based on detailed engineering designs. On this basis, RISCOM recommends that the project proceed to the detailed engineering and authorisation phase.

12.1.10 SOCIAL IMPACT ASSESSMENT

The D3 Energy Social Impact Assessment found that the area has been severely affected by the long-term decline of the gold mining industry, resulting in high unemployment, poverty, infrastructure deterioration and dependence on social grants. Stakeholder engagement with councillors, landowners, business forums and community groups revealed strong support for economic development and job creation, but also high expectations regarding employment opportunities. The assessment notes that while the project will create some direct employment, the long-term workforce is relatively small, with the greatest benefits expected to come through local procurement, enterprise development, skills training and implementation of the project's Social and Labour Plan (SLP).

The study identified several potentially significant social risks, including impacts on farming livelihoods, groundwater and water security, damage to roads and farm infrastructure, uncertainty regarding servitudes and land rights, safety and security concerns, poaching and stock theft, veld-fire risks, nuisance impacts such as dust, noise and visual intrusion, community perceptions regarding gas safety, and cumulative impacts associated with multiple renewable energy projects already approved in the region. Most of these impacts were initially rated as Medium-High negative but were found to reduce to Medium-Low or Low significance after implementation of mitigation measures. The only impact that remained Medium-High after mitigation was the cumulative impact associated with overlapping land uses, because this is driven largely by other developments and regional planning factors outside the control of D3 Energy.

The assessment concludes that the project has **no fatal social flaws** and can proceed, provided that robust social management measures are implemented. The recommended way forward includes appointing a dedicated Community Liaison Officer, entering into fair compensation and access agreements with landowners, implementing groundwater monitoring, maintaining roads, establishing security and fire-management plans, supporting local procurement and skills development, ensuring participation of women, youth and vulnerable groups, maintaining transparent communication, and implementing an effective grievance mechanism. The study finds that the main positive impact is local economic stimulation through procurement, training and enterprise development, with a final significance rating of **Medium-High positive**. Based on the findings, the specialist recommends that the project be authorised, subject to inclusion of the recommended mitigation measures, Social Impact Management Plan, Stakeholder Engagement Plan and grievance procedures in the Environmental Management Programme (EMPr) and project implementation processes.

12.1.11 SOILS & AGRICULTURAL IMPACT ASSESSMENT

The D3 Energy Soils Impact Assessment assessed the soil resources, agricultural potential and land capability. Field investigations and desktop studies identified a range of soil types, including higher-potential agricultural soils such as the Dundee, Griffin, Hutton and Clovelly soil forms, which are currently used for rainfed maize and soybean cultivation, as well as lower-potential soils such as Swartland, Glen, Arcadia, Rustenburg, Glenrosa and Mispah. The study found that the project area contains a mix of low, medium and limited areas of high agricultural sensitivity, with some overlap occurring within the Virginia Protected Agricultural Area (PAA). However, much of the broader production right area consists of soils with moderate to low agricultural value, and the project footprint itself is relatively small compared to the overall agricultural landscape.

The assessment evaluated the impacts of seismic surveys, drilling activities, gathering pipelines and gas-processing infrastructure on agricultural resources. The main potential impacts identified were loss of cultivated land, soil compaction, increased erosion risk and possible soil contamination from fuels, lubricants and drilling-related substances. Seismic survey impacts were assessed as generally low and temporary, while drilling activities had a higher potential impact due to localized land disturbance and the possibility of affecting active crop fields. Nevertheless, the study concluded that these impacts can be significantly reduced through mitigation measures such as avoiding sensitive agricultural areas where feasible, careful topsoil stripping and stockpiling, erosion-control measures, restricting vehicle movement, rehabilitation of disturbed areas, spill prevention and response plans, and compensating landowners for verified agricultural losses.

The study concluded that the proposed development will result in only limited land fragmentation and a relatively small footprint within the agricultural landscape. While active maize and soybean fields occur within portions of the project area, the overall impact on agricultural productivity is expected to be negligible if the recommended mitigation measures are implemented. No irreplaceable loss of agricultural resources was identified, cumulative impacts were assessed as low to medium, and disturbed areas can be rehabilitated to restore soil function and productivity. The specialist therefore stated that the proposed D3 Energy PR and associated infrastructure **can be considered for authorisation** by the competent authority, subject to incorporation of all recommended mitigation measures into the EMPr, protection of higher-value agricultural areas where possible, appropriate rehabilitation, and ongoing soil and agricultural management throughout the project lifecycle.

12.1.12 TERRESTRIAL BIODIVERSITY IMPACT ASSESSMENT

The D3 Energy Terrestrial Biodiversity Impact Assessment evaluated the terrestrial ecology associated with the proposed D3 Energy PR. Desktop and field assessments identified a landscape comprising a mixture of modified agricultural land, grasslands, alluvial vegetation, rocky grasslands, Winberg Grassy Shrubland and water-associated habitats. The study confirmed that the project overlaps with several biodiversity planning features, including Critical Biodiversity Areas (CBA 1 and CBA 2), Ecological Support Areas (ESA 1 and ESA 2), NPAES priority areas, and portions of the threatened Vaal-Vet Sandy Grassland ecosystem, which is classified as Endangered. Habitat sensitivity ranged from Very Low in heavily modified agricultural areas to High in rocky grasslands, river systems and certain wetland-associated habitats.

The field investigations identified nine provincially protected plant species, including *Ammocharis coranica, Boophone disticha, Eucomis autumnalis* and several other protected flora species occurring across natural habitat areas. No fauna species of conservation concern were directly observed during surveys, although suitable habitat exists for several threatened mammals, birds and amphibians. Potential ecological risks associated with the project include habitat loss and fragmentation, disturbance to fauna from drilling and seismic activities, increased spread of alien invasive species, soil erosion, pollution from hydrocarbons and disruption of ecological corridors. The highest biodiversity sensitivities were associated with the Sand River, rocky grasslands, seep wetlands and other aquatic habitats, while degraded grasslands and already transformed agricultural areas were considered less sensitive.

The assessment concluded that **no fatal biodiversity flaws were identified** and that the overall residual biodiversity impact of the project is expected to be low after mitigation. The specialist recommends that development proceed with strict application of avoidance and mitigation measures, particularly within High Site Ecological Importance (SEI) areas, Critical Biodiversity Areas and water-associated habitats. Key requirements include pre-construction site walkdowns to identify protected flora and sensitive fauna, avoidance of wetlands and watercourses, minimisation of habitat disturbance, alien invasive species management, rehabilitation of disturbed areas, and ongoing environmental monitoring. The study therefore supports authorisation of the proposed production right by the competent authority, provided all biodiversity mitigation measures, wetland recommendations and environmental management commitments are incorporated into the EMPr and implemented throughout the project lifecycle.

12.2 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 in **Table 119** below.

Based on the comparative assessment of the development footprint alternatives, specialist findings, environmental sensitivity mapping and stakeholder inputs, the preferred development footprint comprises the proposed production wells, gathering pipelines, helium recovery and gas processing facility, access routes and associated infrastructure located within the assessed production corridors of the approximately 14 440 ha Production Right area. The proposed layout and pipeline alignment are preferred, subject to detailed micro-siting, as they provide the most appropriate balance between access to the target gas resource, avoidance of identified environmental and social sensitivities, and continued coexistence with agricultural, mining and authorised renewable-energy land uses. The final siting of infrastructure must avoid designated no-go areas, wetlands and applicable buffers, the 1:100-year floodline, sensitive heritage and social receptors, and other identified high-sensitivity features.

Where interaction with committed renewable-energy footprints cannot be avoided, site-specific coexistence agreements and the mitigation measures contained in the EMPr must be implemented prior to commencement. On this basis, the proposed development footprint within the Production Right area is regarded as the preferred

and environmentally acceptable alternative, provided that all prescribed avoidance, mitigation, monitoring and rehabilitation measures are implemented.

Table 119: Summary of alternative assessment

Alternative Category	Alternatives Considered	Recommended Alternative	Motivation
Activity Alternative	Gas production vs alternative land uses (renewable energy only, conservation, etc.)	**Gas production integrated with existing agricultural and mining land uses**	The target methane and helium resources occur only within the Production Right area. Mixed land use between gas production, agriculture, mining and renewable energy developments is considered feasible and has already been demonstrated elsewhere in the region.
Production Corridor / Location Alternatives	L1: Production within predefined corridors; L2: Production within corridors excluding directly affected renewable energy projects; L3: Production outside corridors	**L1 Preferred, L2 Second Preference, L3 Least Preferred**	L1 maximizes access to the resource, keeps activities within assessed areas, allows implementation of site-specific mitigation and facilitates coexistence with renewable energy projects through agreements. L2 is acceptable but may unnecessarily restrict access to gas-bearing structures. L3 is least desirable due to increased uncertainty and environmental risk.
Gas Plant Location Alternatives	Gas Plant Options A, B and C	**Option C is most preferred; Option A acceptable; Option C least preferred**	Option B is least preferred because it falls within 32 m of a wetland and within the 1:100-year floodline. Options A and C avoid these constraints and are considered environmentally more suitable.
Pipeline Route Alternatives	Proposed Route vs Alternative Route	**Proposed Route Preferred**	The proposed route results in less fragmentation of renewable energy developments, fewer constraints on future solar layouts, better land-use compatibility and lower cumulative impacts. The alternative route has greater interaction with solar development areas and associated land-use conflicts.
Drilling Method Alternatives	Rotary, Percussion, Rotary-Percussion, Diamond Core, Rotary Directional Drilling	**Flexible Multi-Technique Approach** (with percussion generally having the lowest environmental footprint and directional drilling considered where feasible)	Selection should be based on geological requirements identified during seismic investigations. Percussion drilling generally has lower environmental impacts, while directional drilling may be beneficial at specific locations if technically feasible.
Seismic Survey Alternatives	Vibroseis, Accelerated Weight Drop (AWD), Magnetotelluric Survey (MT)	**Multi-Survey Approach**	Each method has strengths and weaknesses. Vibroseis provides good data quality, AWD offers operational flexibility, and MT provides deeper geophysical information with limited disturbance. A combination is recommended depending on site conditions and survey objectives.

Alternative Category	Alternatives Considered	Recommended Alternative	Motivation
Gas Testing Alternatives	Gas Venting vs Gas Flaring	**Gas Flaring Preferred**, venting only where necessary	Flaring is preferred because it reduces methane emissions and associated climate impacts while improving operational safety. Venting may be utilised only where flaring presents a safety concern.
Drill Fluid Management Alternatives	Traditional lined sump pits vs aboveground tanks with secondary containment	**Lined Sump Pits Preferred**, with supplementary aboveground containment where required	Sump pits are considered practical, cost-effective and appropriate for the proposed air-drilling programme, provided they are limited to approximately 4 m × 4 m × 1.5 m and properly lined and rehabilitated. Aboveground tanks may be used for additional emergency containment.
Wellhead Placement Alternatives	Aboveground wellhead vs Below-ground wellhead	**Aboveground Wellhead Preferred**	Aboveground wellheads provide easier inspection, maintenance, leak detection and lower environmental risk. Below-ground installations are only preferred where security or agricultural operational requirements justify their use.
No-Go Alternative	No development	**Not Recommended**	The No-Go Alternative would forgo development of domestic methane and helium resources, undermine energy-security objectives and fail to realise economic benefits. The EIA concludes that project impacts can be mitigated to acceptable levels and no fatal flaws have been identified.

12.3 ENVIRONMENTAL IMPACT STATEMENT

The EIA evaluated the anticipated biophysical, social, economic and safety impacts associated with the development, production and processing of helium and methane resources within the proposed Production Right area. The assessment included specialist investigations into biodiversity, wetlands, groundwater, soils and agricultural resources, air quality, climate change, heritage resources, social impacts and quantitative risk. The proposed development comprises up to 43 production wells (plus 5 contingent wells), gas gathering pipelines, seismic surveys, a helium recovery and gas processing facility (CNG and/or LNG), access roads and associated infrastructure. The proposed development area occurs within a region already characterised by mining, agriculture, existing gas activities and renewable energy developments and therefore required detailed consideration of cumulative impacts, land-use compatibility and long-term environmental sustainability.

The specialist assessments collectively concluded that the majority of identified impacts are localised in extent, predictable in nature and capable of being mitigated through a combination of avoidance, engineering controls, operational management, rehabilitation and monitoring measures. While environmentally sensitive features occur within the Production Right area, including wetlands, Critical Biodiversity Areas, Ecological Support Areas, protected species habitats, productive agricultural land and cultural heritage resources, no specialist identified a fatal flaw that would prevent the project from proceeding, provided that the recommended mitigation and management measures are implemented throughout the project lifecycle.

The terrestrial biodiversity assessment confirmed the occurrence of modified agricultural land, disturbed grasslands, alluvial vegetation, rocky grasslands and sensitive aquatic-associated habitats. Although portions of the project area overlap with areas of elevated ecological importance, the assessment found that the most sensitive habitats can largely be avoided through detailed infrastructure micro-siting and specialist pre-construction walkdowns. Furthermore, the limited footprint of production wells, underground gathering pipelines and the processing facility substantially reduces the overall area of direct habitat transformation. Rehabilitation commitments and invasive species control measures further support the conclusion that ecological impacts can be maintained at acceptable levels and do not constitute a reason to withhold authorisation.

The agricultural assessment similarly concluded that the proposed activities will result in localised impacts on soils and agricultural productivity, particularly where infrastructure overlaps cultivated land. However, the affected footprint is small relative to the overall Production Right area, agricultural activities can continue across the majority of the project area during operations, and disturbed areas can be rehabilitated to restore productive capability. Importantly, the assessment concluded that no irreplaceable agricultural resources would be permanently lost and that coexistence between agricultural activities and gas production infrastructure is feasible.

From a social perspective, stakeholders expressed concerns regarding groundwater protection, farming operations, safety, security, infrastructure damage, cumulative impacts and equitable access to project benefits. These concerns were considered in detail and informed the development of project-specific mitigation and monitoring measures. While certain social impacts remain of moderate significance, the assessment concluded that no social fatal flaws were identified and that the project is capable of delivering positive local economic benefits through procurement opportunities, enterprise development, skills transfer, local economic development programmes and implementation of the Social and Labour Plan in an area experiencing prolonged economic decline associated with reduced mining activity

The EIA identified a limited number of residual impacts that remain Medium-High negative following mitigation, namely groundwater, palaeontological heritage, risk and safety, cumulative social impacts and cumulative climate change impacts (see **Table 119**). These residual ratings require careful consideration and should not be disregarded. However, it is important to distinguish between an impact that is significant and an impact that is unacceptable. The purpose of the EIA process is not to identify developments that are entirely impact-free, as virtually all development activities result in some degree of environmental change. Rather, the purpose is to determine whether the identified impacts can be avoided, minimised, managed and monitored to a level that is

acceptable when viewed in the context of legal requirements, specialist findings, cumulative considerations, alternatives and broader public interest considerations.

The Medium-High groundwater rating is primarily associated with the potentially serious consequences that could arise from well integrity failures, migration of saline groundwater, migration of methane or groundwater contamination. However, the significance rating is driven largely by consequence rather than likelihood. The specialist assessment concluded that properly designed, cemented and cased wells constructed according to recognised industry standards, together with ongoing groundwater monitoring and closure requirements, significantly reduce the probability of these impacts occurring. Groundwater modelling further indicated that potential contamination pathways would remain localised and would not extend beyond the Production Right area under the assessed scenarios. Accordingly, the groundwater impact represents a risk that requires rigorous management rather than a fatal flaw

The residual Medium-High palaeontological impact similarly reflects the irreplaceable nature of fossil resources rather than evidence of unavoidable significant destruction. No significant palaeontological resources were identified during the field assessment, and the residual rating reflects the possibility that fossils could be encountered during excavation activities within a palaeontologically sensitive geological formation. The implementation of chance-find procedures, specialist oversight and statutory heritage requirements ensures that any discoveries can be appropriately managed should they occur.

The Medium-High risk and safety rating is associated primarily with low-probability but potentially high-consequence events involving LNG, CNG and ammonia handling systems. However, the D3 Energy Production Right Quantitative Risk Assessment concluded that individual and societal risks remain within internationally acceptable thresholds and that the majority of credible incident consequences remain confined to operational areas. No unacceptable off-site risks to neighbouring communities were identified, and no residences fall within fatal consequence zones associated with the assessed scenarios. The assessment therefore concluded that the project does not present a fatal safety flaw provided that detailed engineering design, emergency planning, monitoring and regulatory compliance requirements are maintained.

The cumulative climate change impact remains Medium-High due to the additive nature of greenhouse gas emissions and the fact that climate change impacts are global, long-term and only partially reversible. Nevertheless, the specialist concluded that the project's contribution to South Africa's national greenhouse gas inventory and remaining carbon budget is relatively small and does not, on its own, constitute a reason to prevent the development. Furthermore, the assessment acknowledged that climate change impacts are being addressed through methane management measures, leak detection programmes, flaring controls, greenhouse gas monitoring and reporting requirements. The specialist specifically concluded that the cumulative climate impact does not constitute a fatal flaw to the development.

Similarly, the residual cumulative social impact rating reflects broader regional land-use pressures, overlapping renewable energy developments and stakeholder perceptions that cannot be fully addressed by a single project. The significance rating therefore reflects cumulative regional dynamics rather than unacceptable impacts directly attributable to the proposed development alone. The assessment nevertheless concluded that coexistence arrangements, stakeholder engagement, compensation mechanisms, access protocols and coordinated planning provide a reasonable basis for managing these cumulative pressures.

Importantly, the EIA findings demonstrate that following mitigation, the majority of identified impacts are reduced to Medium-Low or Low significance. The remaining Medium-High impacts are well understood, spatially constrained, subject to established mitigation and monitoring measures and do not represent impacts that are unavoidable, irreversible at a regional scale, or incompatible with the receiving environment. Furthermore, specialist assessments consistently concluded that these impacts can be managed within acceptable limits and do not constitute fatal flaws.

Alternative assessments undertaken as part of the EIA further demonstrate that reasonable efforts have been made to avoid and minimise environmental impacts through the selection of preferred infrastructure locations, pipeline routes and development corridors. The preferred alternatives were specifically selected because they provide the best balance between resource recovery, environmental protection, technical feasibility and coexistence with existing land uses. The No-Go Alternative would avoid project-related impacts but would also forego the development of a strategically important domestic helium resource, associated natural gas resources, local economic benefits, investment opportunities and broader energy-security benefits without materially improving the management of existing cumulative environmental pressures in the region.

Table 120 is a consolidated impact significance summary showing only the final significance level for each impact category. Following mitigation, the majority of impacts are rated Medium-Low, with the key residual impacts remaining Medium-High being Groundwater, Palaeontological Heritage, Risk/Health & Safety, Social Impacts, and Cumulative Climate Change.

Table 120: Impact significance summary showing only the final significance level for each impact category

Final Impact Significance	Impact Categories
Low	Noise, Mining Activities, Renewable Energy L2, Pipeline Alternative 1
Medium-Low	Agriculture, Renewable Energy L1, Pipeline Alternative 2, Infrastructure & Services, Livestock Displacement, Sense of Place, Air Quality, Surface Water, Soils, Vegetation, Natural Habitat, Fauna, Cultural Heritage
Medium-High	Groundwater, Palaeontology, Risk & Safety, Social Impacts, Cumulative Climate Change
High	None after mitigation

Based on the findings of the specialist investigations, stakeholder consultation process, alternatives analysis and cumulative impact assessment, it is the opinion of the EAP that the proposed D3 Energy PR Application is **environmentally acceptable and can be authorised**, notwithstanding the presence of several residual Medium-High impacts. These impacts have been comprehensively assessed, are not considered fatal flaws, can be managed through legally enforceable mitigation and monitoring measures, and do not result in unacceptable environmental, social or safety consequences when viewed in the context of the receiving environment and the broader public interest.

12.4 PRE-COMMENCEMENT VERIFICATION AND APPROVAL SCHEDULE

The final positions and alignments of the production wells, seismic survey lines, gathering pipelines, access routes, processing facility and associated infrastructure shall be subject to pre-commencement verification. The purpose of this verification is to confirm that the final activity footprint remains within the authorised and assessed development envelope, avoids designated no-go areas and sensitive environmental or social features as far as reasonably practicable, and incorporates all applicable specialist mitigation, permitting and stakeholder requirements.

No site establishment, vegetation clearance, earthworks, drilling, trenching, survey activity or construction may commence at a specific site until the applicable requirements in the schedule below (**Table 121**) have been completed and the site has been released in writing by the Environmental Control Officer or other designated responsible person.

Completion of the verification schedule shall not, by itself, authorise activities outside the footprint or development envelope authorised in the EA. Where the final layout differs materially from the assessed layout, falls outside an assessed corridor, affects a designated no-go area, or triggers an additional permit, licence or authorisation, the EAP shall determine the appropriate regulatory process in consultation with the relevant authority before the affected activity commences. All verification records, specialist findings, approvals and site-release certificates shall be retained by the Holder and made available for compliance monitoring and auditing.

Table 121: Pre-commencement Verification and Approval Schedule

No.	Verification or deliverable	Applicability and minimum requirements	Responsible party	Evidence or close-out record	Hold point
1	**Confirmation of authorised footprint**	Confirm that the final site, route or activity is located within the authorised Production Right area and the footprint or corridor assessed in the EIAr. Record the coordinates and overlay the final footprint against the approved layout and sensitivity mapping.	Applicant's project manager and GIS specialist, verified by ECO	Signed layout-verification form, coordinates and GIS map of site/s	Final layout may not be released for construction until verified
2	**Sensitivity-screening classification**	Classify the final activity footprint as low, medium, high or no-go sensitivity using the consolidated sensitivity maps and relevant specialist spatial data. No-go areas must be excluded.	ECO with EAP and relevant specialists, where required	Site sensitivity screening form and annotated map	Determines the level of specialist verification required
3	**ECO appointment and initial walkdown**	Appoint a suitably qualified independent ECO before construction. The ECO must undertake a walkdown of all final sites and routes and identify additional management, specialist or permitting requirements.	Applicant	ECO appointment letter and signed walkdown report	Mandatory before physical disturbance
4	**Specialist verification based on sensitivity**	For low-sensitivity areas, an ECO walkdown must be completed as a minimum. For medium- and high-sensitivity areas, the relevant specialists (determined by the applicable theme) must inspect the final footprint and prescribe any additional site-specific mitigation. Where required by the authorisation, site-specific measures for high-sensitivity areas must be submitted to PASA for approval before commencement. The report currently identifies assessment areas of 100 m around seismic and pipeline corridors and 1 km around drill sites and the gas plant.	ECO, EAP and applicable specialist	Specialist walkdown report, site-specific mitigation schedule and proof of submission or approval where applicable	No commencement until required specialist sign-off and approval are obtained
5	**Terrestrial biodiversity walkdown**	Confirm the presence or absence of protected plants, floral and faunal species of conservation concern, sensitive habitats and ecological corridors. Micro-site infrastructure to avoid	Qualified SACNASP Registered ecologist	Ecological walkdown report, marked-up layout, permit record and	Vegetation clearance prohibited until close-out

No.	Verification or deliverable	Applicability and minimum requirements	Responsible party	Evidence or close-out record	Hold point
		identified features. Obtain applicable permits before disturbance or relocation of protected species.		relocation plan where applicable	
6	**Aquatic and wetland verification**	Confirm delineated wetlands, watercourses, riparian areas, applicable buffers and hydrological connectivity against the final footprint. Avoid wetlands, watercourses and buffers as far as reasonably practicable. Identify and approve the design of unavoidable crossings and confirm applicable water-use authorisation requirements.	Freshwater specialist, or ECO	Aquatic verification memorandum, crossing schedule, final design drawings and authorisation record	No work in or adjacent to a water resource until the applicable authorisation and controls are in place
7	**Floodline and stormwater verification**	Confirm that permanent infrastructure, wells and the processing facility avoid the 1:100-year floodline wherever feasible. Verify crossing designs, clean and dirty water separation, erosion protection and stormwater-control measures against the final layout.	ECO	Floodline overlay, stormwater plan and engineering sign-off	Earthworks may not commence until design controls are accepted
8	**Heritage walkdown and buffer demarcation**	A qualified archaeologist must inspect final project sites and routes where required. Identified archaeological or historical structures must be retained and protected by the prescribed 30 m buffer, and graves by the prescribed 50 m buffer. The Chance Find Procedure must be incorporated into the site documentation and induction.	Qualified archaeologist and ECO	Heritage walkdown report, buffer-demarcation plan, photographic record and Chance Find Procedure	No disturbance until heritage clearance is issued
9	**Palaeontological readiness**	Confirm that the Chance Find Protocol is included in the method statements and that site supervisors and relevant personnel have received training on fossil recognition, work stoppage and reporting requirements.	ECO and appropriately qualified palaeontologist, where required	Approved protocol, attendance register and training material	No excavation, trenching or drilling until induction is complete

No.	Verification or deliverable	Applicability and minimum requirements	Responsible party	Evidence or close-out record	Hold point
10	**Groundwater and water-user baseline**	Conduct baseline water-quality assessment of identified boreholes and surface-water sources near the relevant activity before fieldwork begins. Record borehole use and condition and provide the relevant results to affected landowners.	Hydrogeologist or suitably qualified water specialist	Baseline monitoring report, laboratory certificates, photographic record and proof of communication	Drilling or site establishment may not commence until baseline data are recorded
11	**Well design and integrity controls**	A site-specific well design must be prepared by a suitably qualified professional and submitted to PASA for approval before commencement of the relevant drill site. Confirm casing, cementing, aquifer-isolation, pressure-control and contingency requirements.	Well or reservoir engineer and Applicant	Approved well design, professional sign-off and PASA submission or approval record	Drill-site hold point
12	**Drilling-fluid, sump and containment verification**	Confirm that the selected drilling-fluid system, lined sump or aboveground containment arrangement is appropriate to the site sensitivity. Pitless drilling or aboveground containment must be used within riparian zones. Verify liner specification, capacity, secondary containment and spill equipment.	Drilling manager and ECO	Method statement, inspection checklist and photographic record	Drilling may not commence until containment is accepted
13	**Landowner access and land-use agreement**	Complete written access, rehabilitation and, where applicable, compensation or servitude agreements with each affected landowner. Confirm the work area, access route, programme, biosecurity controls, rehabilitation obligations and landowner-specific conditions.	Applicant and landowner liaison officer	Signed agreement and property-specific conditions register	No access to the property before agreement or written authorisation while agreement is being finalised
14	**Renewable-energy and other rights-holder coordination**	Where the final layout interacts with an authorised or proposed renewable-energy footprint, mining activity, servitude or other infrastructure, conclude the necessary coexistence or coordination arrangements before on-site activity.	Applicant and affected rights holder	Signed coexistence agreement, interface plan or meeting record	No work within an overlapping area before issue / conflict is resolved

No.	Verification or deliverable	Applicability and minimum requirements	Responsible party	Evidence or close-out record	Hold point
15	**Asset and services baseline**	Record the condition and location of roads, fences, gates, drains, irrigation infrastructure, pipelines, cables and other services that may be affected within 50 m of the work area. Provide the property-specific baseline to the landowner or service provider and retain a master copy.	Applicant, contractor and landowner liaison officer	Dated photographic condition survey and signed baseline record	Site establishment prohibited until completed
16	**Noise and receptor notification**	Identify nearby noise-sensitive receptors and confirm applicable operating restrictions. Notify residents within the distances prescribed in the specialist recommendations before drilling or seismic activities commence and communicate complaint channels.	Applicant, ECO and landowner or community liaison officer	Receptor map, notification register and copies of notices	Activity may not commence until notification is completed
17	**Traffic, access and road-protection planning**	Confirm approved access routes, traffic controls, road-condition baseline, maintenance responsibilities, gate protocols and scheduling relative to farming activities. Avoid critical planting and harvesting periods where reasonably practicable and agreed with landowners.	Contractor, Applicant and liaison officer	Traffic management, route map and landowner consultation record	Mobilisation hold point
18	**Emergency preparedness and public safety**	Finalise applicable emergency-response, fire-management, spill-response and security arrangements. Confirm emergency contacts, equipment, trained personnel, evacuation arrangements and coordination with neighbouring landowners or emergency services where relevant.	Applicant's health and safety manager and ECO	Approved plans, drill or training records and equipment inspection	Site establishment may not commence until readiness is verified
19	**Permits, licences and approvals register**	Confirm that all activity-specific permits, licences and approvals required for the final location and method have been obtained, including any water-use, biodiversity, heritage or other approvals.	Applicant and EAP	Updated legal register and copies of approvals	Hold point before commencement of the activity to which the relevant permit, licence or approval applies

No.	Verification or deliverable	Applicability and minimum requirements	Responsible party	Evidence or close-out record	Hold point
20	**Construction environmental documentation**	Approve the site-specific method statements, environmental induction material, vegetation-clearance plan, waste controls, erosion and stormwater controls, Chance Find procedures, grievance mechanism and incident-reporting arrangements.	ECO and Applicant	Approved method-statement register and induction records	Contractor may not mobilise until documents are accepted
21	**Final pre-commencement inspection and release**	Conduct a joint inspection to confirm that sensitive areas and buffers are demarcated, access is controlled, required controls are installed and all preceding actions are closed. Any outstanding item must be recorded and closed before release.	ECO, Applicant, contractor and relevant specialist where required	Signed pre-commencement release certificate or report with associated photographic record	Written release required before commencement

12.5 RECOMMENDATIONS FOR INCLUSION IN THE ENVIRONMENTAL AUTHORISATION

As indicated in **Section 12.4**, it is the opinion of the EIA project team that the environmental impacts associated with the application for the proposed D3 Energy PR 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 proposed infrastructure (specifically technical specifications) as well as the MPRDA regulations are adhered to.
- 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.
- A well design must be developed by a suitably qualified professional (such as a well/ reservoir engineer). The design shall comply with recognised petroleum industry standards and any requirements of PASA, the approved work programme, exploration or production right, and applicable legislation. Relevant well planning and drilling information shall be submitted to PASA in accordance with regulatory and reporting requirements prior to commencement of drilling.
- 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 to reduce the risk of contamination from the drill sump.
- The evaporation pond must be suitably lined with an impermeable barrier (i.e., High-Density Polyethylene or PVC Damtarp (Tarpaulin)).
- 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 proposed activities should be limited to the assessed areas. Should the gas plant, additional seismic surveys and/or drilling wells fall outside of the EA assessed footprint areas, but within PR16, then

depending on the final location of the gas plant, seismic survey / drill site with respect to the locations sensitivity as defined by the maximum environmental 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 seismic transect and drill site and surroundings (100m corridor for seismic transect, 100m corridor for gathering pipelines, 1km radius for drill site and 1km radius for gas plant) 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 seismic transect and final drill sites and surroundings (100m corridor for seismic transect, 100m corridor for gathering pipelines, 1km radius for drill site and 1km radius for gas plant 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 activities.

- A walkdown by a qualified independent ECO must be undertaken at final project sites 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 at final project sites 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 project sites 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.
- The final exploration positioning must consider mining activities and existing / planned renewable energy infrastructure where such information is available.

13 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations relating to this EIA phase assessment should be noted:

- The application is limited to the proposed D3 Energy PR16 footprint and associated infrastructure in Welkom within the Matjhabeng and Masilonyana 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.
- The assessment identified the presence of numerous approved, existing and proposed renewable energy developments within portions of the D3 Energy PR. However, at the time of undertaking the assessment:
    - Detailed engineering layouts, final panel footprints, internal road networks, collector substations, cable routes and future expansion plans were not available for all renewable energy developments within the Production Right area.
    - For several renewable energy projects, only publicly available approval information, application boundaries, publicly available GIS datasets and satellite imagery were available to the EAP.
    - Construction schedules, final infrastructure positioning and development sequencing for certain approved renewable energy projects were unknown at the time of assessment.
    - Formal coexistence agreements between D3 Energy and all affected renewable energy developers had not yet been concluded.
    - Information regarding future amendments, expansions, optimisation layouts or phased development plans for renewable energy facilities was not available.
- The assessment therefore assumed that:
    - Approved renewable energy developments would generally be developed within the approved development footprints available to the EAP at the time of assessment.
    - Additional production well locations provided within the proposed layout would allow flexibility to relocate or exclude wells that may conflict with future or authorised renewable energy infrastructure.
    - Coexistence arrangements between gas infrastructure and renewable energy developments are technically achievable based on the limited footprint of wells, buried pipelines and existing precedents for overlapping land-use rights.
    - Renewable energy developers would continue to participate in engagement processes during detailed design and implementation phases to facilitate infrastructure optimisation and conflict avoidance.
- The D3 Energy PR overlaps portions of the FS 10005 MR Sibanye Stillwater Robijn Project. However, the EAP experienced significant limitations regarding the availability of mine planning and infrastructure information. Specifically:
    - The only information provided by Sibanye Stillwater to the EAP was the mining right footprint and project names.
    - No mine plans, shaft locations, exploration drilling data, underground development plans or future infrastructure layouts were provided.

- No information relating to planned shaft sinking, decline development, ventilation infrastructure, service corridors or future mining infrastructure was made available for assessment.
- No detailed information relating to future mining schedules, extraction sequencing or future development programmes within the mining right area was supplied.
- No information relating to active or abandoned underground workings potentially occurring within the overlap area was available to the EAP.
- The EAP was therefore unable to verify potential future interactions between proposed production wells and future mining activities beyond the information available from publicly accessible sources.

- The assessment consequently assumed that:
  - Based on publicly available information, the Robijn Project remains an advanced exploration-stage mining project and does not currently contain active shafts, underground workings or mining infrastructure within the overlap area.
  - No active underground mining operations currently occur within the overlapping portions of the D3 Energy PR.
  - Any future mining infrastructure development would be subject to separate regulatory authorisation processes and stakeholder engagement procedures.
  - Future coexistence arrangements between mining and gas activities would be investigated and implemented should mining progress to development and operational phases.
- 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**).

14 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: 2026/09/29

15 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: 2026/09/29

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