DRAFT EIA REPORT FOR THE CLEARING OF VEGETATION ON FOR EXPANDING EXISTING PIVOTS ON THE REMAINDER OF THE FARM TWEEFONTEIN 373 AND PTN 4 (PTN OF PTN 2) OF THE FARM KALKFONTEIN 374, PRIESKA

TEMDALE BOERDERY

OCTOBER 2026

Reference: **NC/EIA/02/PIX/SIY/PRI1/2026**

DSA
Digital Soils Africa

+27 82 414 0472
www.dsafrica.co.za
natalie@dsafrica.co.za
Walmer
Port Elizabeth

Directors:
Dr Darren Bouwer
Prof Johan Van Tol
Prof George Van Zijl

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This report has been prepared exclusively for **Temdale Boerdery (Pty) Ltd** and for submission to the Competent Authority. It may not be used for any other purpose without written consent.

BACKGROUND

Digital Soils Africa (Pty) LTD (DSA) was tasked by Temdale Boerdery (Pty) Ltd to conduct environmental investigations and complete the Environmental Authorisation Application for the authorisation of clearing of about 46Ha of vegetation for the expansion of existing pivots on the Remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska in the Northern Cape, to establish pecan nut orchard.

In terms of the National Environmental Management Act 107 of 1998 ("NEMA"), environmental authorisation must be obtained before any person can conduct activities that cause damage to the environment.

DSA was appointed by Temdale Boerdery (Pty) Ltd (also referred to as the Applicant) as the independent environmental assessment practitioner (EAP) to undertake the Environmental Authorisation Application for the commencement of a listed activity in terms of the Environmental Impact Assessment Regulations 2014, as amended in 2017.

The proposed project entails the expansion of existing centre pivot irrigation areas by approximately 46 hectares on the Remainder of Farm Tweefontein No. 373 and Portion 4 (portion of Portion 2) of Farm Kalkfontein No. 374 for the establishment of a pecan nut orchard. The properties are currently utilised for irrigated agriculture, with four existing centre pivots already established on the site prior to 1998, comprising a 50 ha and 25 ha pivot on the Kalkfontein property and two 10 ha pivots on the Tweefontein property. The areas proposed for expansion are located predominantly within the undeveloped portions situated between and around the existing pivots, which currently still support indigenous vegetation and remnant outfall areas associated with the existing agricultural layout.

The vegetation assessment identified a combination of disturbed agricultural areas and near-natural Nama Karoo vegetation units on the Tweefontein and Kalkfontein properties. Soil samples were taken and analysed to investigate if the soil is suitable for establishing crops on Tweefontein as the areas between Kalkfontein pivots are old crop lands.The soil study found that the area is predominantly underlain by well-drained Oakleaf soil, which are considered highly favourable for both irrigation and cultivation.

An application to cultivate virgin soil (commonly known as a plough certificate) will also be applied for at the Department of Agriculture to ensure all legal requirements for such a development are met.

The Applicant has existing water use rights and therefore do not require additional applications for a Water Use Right. In the future, they might apply for an increase in usage, however, at this stage, it is not required.

PERSONAL PARTICULARS OF APPLICANT AND LANDOWNER

Temdale Boerdery (Pty) Ltd (1999/023793/07)
Att: Mr. Jaco Gous

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P. O. Box 303
Prieska
8940
Cellphone: 082 948 2382
Email: temdale@gmail.com

ENVIRONMENTAL CONSULTANT

Digital Soils Africa (Pty) Ltd
45 Church Street
Walmer
6070
Cell: 082 414 0464
Email: natalie@dsafrica.co.za
Attention: Natalie Sharp

DETAILS OF THE AUTHOR

Natalie Sharp is the project manager and senior Environmental Assessment Practitioner leading this project and is registered as an Environmental Assessment Practitioner (EAP) with the Certification Board for Environmental Assessment Practitioners of South Africa (EAPSA) (Registration Number: 2020/230) and as a Professional Natural Scientist (Pri.Sci.Nat) with the South African Council for Natural Scientific Professions (SACNASP) (Registration Number: 123443) (see Appendix A). Natalie Sharp has worked in the environmental industry for over twenty years.

CURRICULUM VITAE

NATALIA SHARP

Personal Details	Date of birth: 12 August 1979 Nationality: South African Identity number: 790812 000 7080 Gender: Female Languages: English / Afrikaans
Qualifications:	BSc (2000) UFS – Zoology and Botany BSc Honors (2001) UFS - Limnology

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Experience (Seventeen years' experience in environmental law and environmental management)	Masters in Environmental Management (2003) UFS - Evaluation of Phytoplankton as an indicator in a biomonitoring program, with special reference to the Modder River. During the 2 years associated with the Centre for Environmental Management intense training was provided for equipping Natalia Sharp with adequate knowledge in terms of biomonitoring water systems and scientific report writing for research done by her through the Centre. Various scientific contributions were made during these few years which included formal reports to Bloem Water and seminars providing management principles for polluted water bodies, thus providing her with additional regulatory and environmental skills. During the 5 years associated with the DME, now changed to the Department of Mineral Resources (DMR), vast knowledge was gained in terms mine environmental management, the development, rehabilitation and closure of mining and prospecting areas. Environmental Management Programmes, Environmental Performance Assessment Reports, and Closure Reports were scrutinized continually. Therefore, adequate expertise was gained to assist the applicants with relevant environmental and mining advice and providing her with adequate knowledge to evaluate environmental impacts relating to mining. During the 11 years associated with SES (Stellenryck Environmental Solutions), Natalia Sharp has obtained immense understanding in completing environmental impact assessments, not only associated with mining projects, but also for a wide variety of different developing projects such as Light Industrial developments, Road upgrade projects, bush clearing for agricultural developments, and applications for exemptions, and so forth. She has excellent experience in writing environmental reports, which ranges from Scoping Reports, Environmental Management Plans, Environmental Awareness Plans, Mining Work Programs, Closure Plans, Risk Assessments, Performance Evaluations on projects, and Plan of Study reports. She has also been involved in performing biomonitoring on river systems associated with some of the projects, completing it by obtaining all the data and writing the Biomonitoring Report for the relevant Department. This is mainly attributed to her Limnology background and she is competently able to add value to this field in her current position.
Previous Employment	Centre for Environmental Management University of the Free State: Lab Assistant [2001 – 2003] Mine Environmental Management [2003-2005] at the Department of Mineral Resources: Environmental Officer Mine Environmental Management [2005-2008] at the Department of Mineral Resources: Senior Environmental Officer Stellenryck Environmental Solutions: Senior Environmental Practitioner [2008-2019]

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Current Employment Digital Soils Africa Pty Ltd: Senior Environmental Practitioner [2020-currently]

Digital Soils Africa Pty Ltd (DSA) is an independent environmental consulting firm that is also soil specialists, focussing on all soil solutions in the agricultural and environmental fields. The specialists are SACNASP registered and recognized leaders in their fields of study.

The soil specialist services provided include soil surveys, soil erosion mitigation, fertilization management, soil and land capability studies, and wetland delineation amongst others, while the fields of specialization are hydropedology and digital soil mapping. Together the directors have 45 years of experience.

Prof. Johan van Tol is a leading researcher on hydropedology. He is a NRF rated researcher, who boasts more than 100 peer reviewed scientific publications and has put his research to work in more than more than 130 consultancy reports. He is a SACNASP registered scientist and a full Professor in soil science at the University of the Free State.

Dr. George van Zijl is Africa's foremost Digital Soil Mapper. For his PhD he developed a DSM protocol for use in southern Africa, and has subsequently improved the methodology to include machine learning such as shown in the mapping of Ntabelanga catchment and City of Joburg Hydropedological mapping. He has served on the scientific committee for international DSM conferences. George has conducted more than 60 consultancy projects and is a SACNASP registered scientist.

Dr. Darren Bouwer boasts 15 years' experience as a soil scientist. His PhD incorporated chemical measurements into hydropedological assessments, which improves flow path determination. He has also completed a post doctorate at Ghent University, Belgium, where he specifically worked on hydropedological modelling. Darren is a SACNASP registered scientist, and has completed more than 45 consultancy reports.

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TITLE DEED DESCRIPTION

Remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska in the Northern Cape

REGIONAL SETTING

SITE LOCATION

The site is situated north-east of Prieska in the Northern Cape (29° 24' 42.00"S; 23° 01' 36.31"E) most centre point of the site) on the Remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, within the Siyathemba Municipal area. The site is located on the banks of the Orange River approximately 38km northeast of Prieska and 20 km southeast of Niekerkshoop (Figure 1).

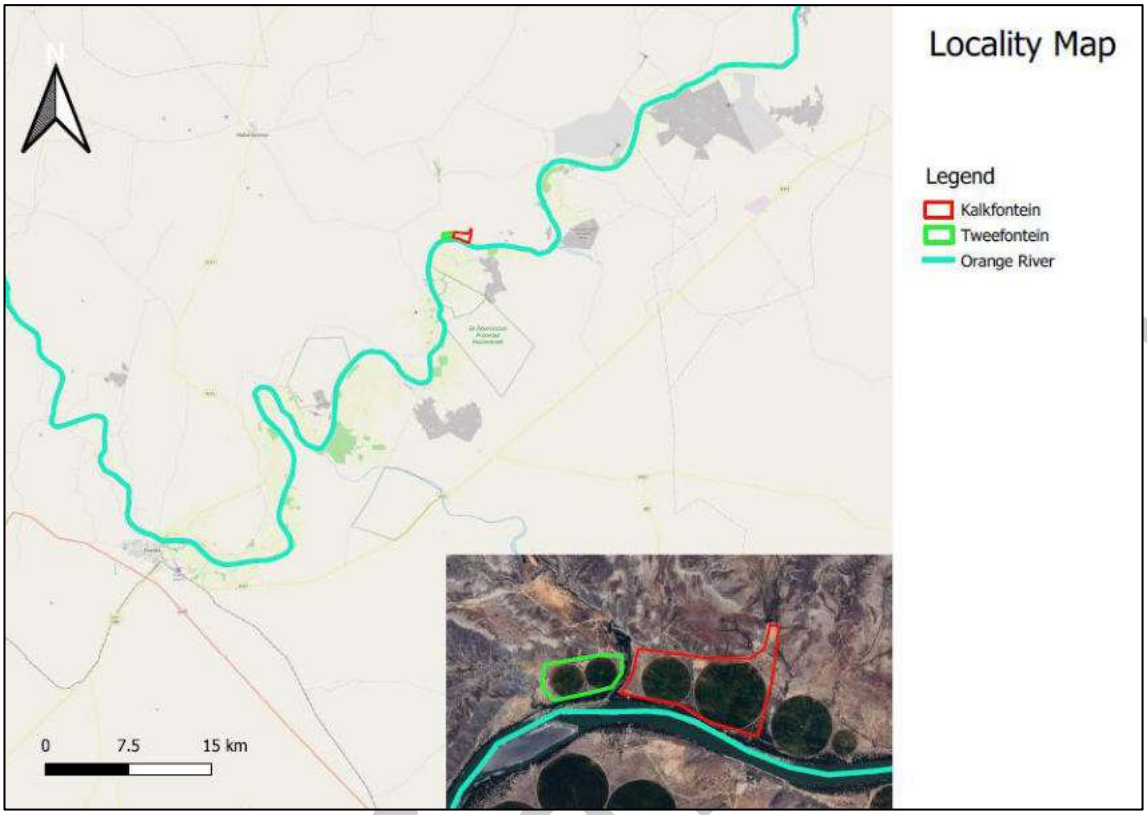

FIGURE 1: SITE LOCATION. THE ORANGE RIVER IS THE BLUE LINE AND THE PROPOSED SITE IS REPRESENTED BY THE RED AND GREEN POLYGONS.

PROJECT DESCRIPTION

In terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), an Environmental Authorisation (EA) must be obtained from the relevant competent authority before commencing with any listed activity that may impact the environment. The Applicant would like to clear more than 20Ha of vegetation between existing central pivots to establish pecan nut orchard for agricultural purposes.

The Applicant already has a Water Use License, for the abstraction of water for irrigation and has a ploughing certificate for cultivating virgin soil from the Directorate Land Use and Soil Management of the Department of Agriculture.

The vegetation assessment identified the site as ecologically important due to the presence of relatively intact Nama Karoo and Upper Gariep Alluvial Vegetation, including natural and near-natural vegetation units associated with the Orange River system. The riparian vegetation units were regarded as having a high conservation priority due to their ecological functioning, habitat diversity and the presence of protected plant species. Additional medium to medium-high sensitivity areas were identified within the natural and karroid shrubland vegetation units, which support indigenous shrubland, scattered trees and several protected succulent and bulb species. Although portions of the site have already been disturbed by existing agricultural activities, pivots and associated infrastructure, the assessment confirms that sections of the site still retain important ecological characteristics and contribute to the broader functioning of the surrounding Nama Karoo ecosystem.

TABLE 1: DESCRIPTION OF LISTED ACTIVITIES ASSOCIATED WITH THE PROJECT

Act. No.	Listings	Coordinates of listed activities (centre point coordinates of the listed activity location)
GNR 325: Activity 15	The clearance of an area of 20 hectares or more of indigenous vegetation.	29°24'42.00"S 23°01'36.31"E

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PLANNING PHASE

From an environmental planning perspective, the proposed expansion represents a consolidation of an existing agricultural footprint rather than the establishment of a new, separate 141 ha cultivated area in previously undisturbed veld. Approximately 95 ha has already been transformed under existing centre-pivot irrigation, and the proposed additional 46 ha largely comprises infill areas between and around these established pivots. This approach makes more efficient use of land that is already fragmented by agricultural infrastructure, access tracks, irrigation systems and historic disturbance, and avoids the need to open up a separate, intact area elsewhere on the farms.

The vegetation assessment confirms that the site contains a mix of sensitivities. The riparian vegetation associated with the Orange River is of high conservation importance and should, as far as reasonably practicable, be retained and excluded from clearance because it functions as a corridor for fauna and flora movement and is linked to watercourse functioning. However, several of the areas between existing pivots have already been degraded by agricultural and anthropogenic influences, contain alien invasive and pioneer species, and were assessed as having low to low-medium conservation value / very low biodiversity importance. In this context, concentrating the proposed orchard expansion within the already fragmented pivot landscape is considered environmentally preferable to clearing a new, continuous and less-disturbed 141 ha area elsewhere, even where such an alternative may appear less constrained on a desktop CBA map.

It is acknowledged that some near-natural vegetation units within the proposed infill footprint retain medium to medium-high conservation value and contain protected plant species. The proposed development should therefore not be presented as having no ecological impact. Rather, the impact is considered more acceptable because it is confined to a transformed agricultural landscape, is supported by confirmed soil and irrigation suitability, does not require new bulk irrigation infrastructure or new farm buildings, and allows the higher-value riparian corridor along the Orange River to be retained as the main ecological corridor. Where small, isolated riparian or natural vegetation fragments occur within the pivot configuration and cannot practically be retained without materially compromising the agricultural layout, their loss is motivated as part of the consolidation of the existing agricultural footprint, subject to the rescue/relocation of protected species, alien invasive plant control, retention of larger protected trees where practicable, and strict exclusion of the main Orange River riparian zone from disturbance.

The soil report and findings were also in favour for development on Tweefontein. No soil suitability study was conducted for Kalkfontein as the pivots existed prior to ploughing certificates being required and historically been used for crop lands.

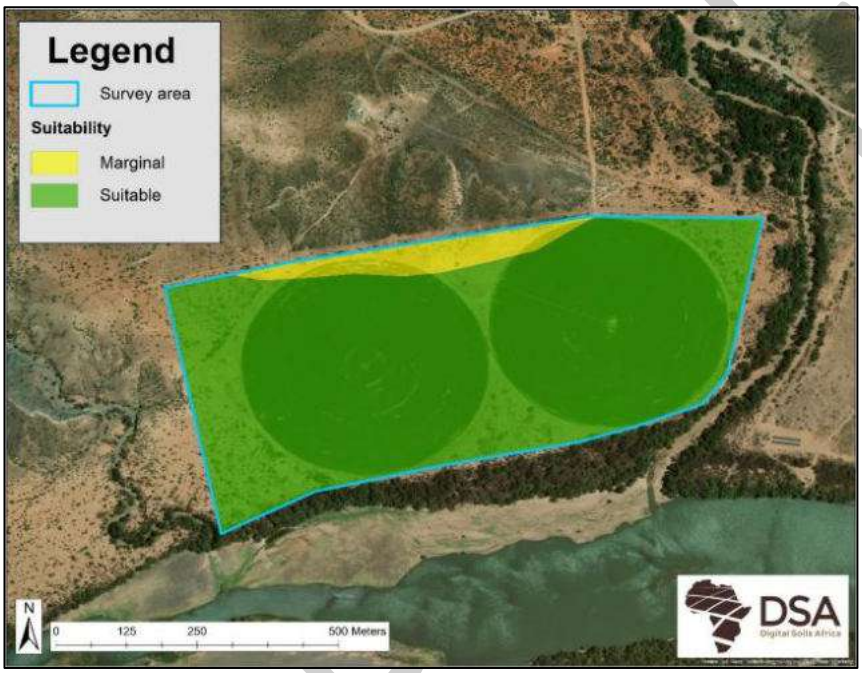

FIGURE 2: SOIL SUITABILITY MAP FROM THE SOIL REPORT

Ultimately, the study area under application is 141 Ha of which 95Ha is already transformed under existing centre-pivot irrigation and the proposed additional 46Ha is the fill-in areas between the existing pivots.

The clearance of vegetation will take place immediately if an environmental authorisation has been issued. The construction phase will result in the clearing of natural veld after the seasonal crops have been harvested on the allocated between the existing central pivots. There will thus be a transition from the existing agricultural operation to irrigated pecan nut orchards to be a total of 141Ha.

In terms of the general soil requirements for pecan nut production, the irrigation suitability assessment confirmed that the majority of the site is underlain by deep, freely drained Oakleaf and Ermelo soils which are considered highly suitable for irrigated pecan nut production. The soils exceed 2.5 m in depth, exhibit good drainage characteristics and have favourable physical and chemical properties.

Pecan nut trees grow optimally in fertile, well-drained soils with a moderate to loose structure, while feeder roots generally occur within the upper 40–60 cm of the soil profile. The report states that lime or carbonate-rich horizons should not occur within the upper 60 cm of the soil profile, as elevated pH conditions may reduce the availability of important micro-nutrients.

The Oakleaf soils identified across most of the site were found to contain no lime-rich horizons within the upper 60 cm, with measured pH(KCl) values generally ranging between 6.0 and 6.8, which the specialist considered suitable for pecan nut production.

The soils furthermore contain clay percentages ranging between approximately 22% and 34%, which fall within the acceptable range for pecan nut production and provide suitable drainage and water-holding capacity.

A small northern portion of the site consists of Prieska/Augrabies soils containing free lime and carbonate-rich horizons. These soils were regarded as marginal for pecan nut production due to the potential for reduced micro-nutrient uptake; however, the report states that cultivation of these soils is unlikely to result in soil degradation and that micro-nutrient deficiencies can be managed through foliar applications and appropriate fertility management.

The report further concluded that the soils exhibit acceptable salinity and sodicity levels, with no significant limitations identified for irrigation suitability, provided that appropriate irrigation and fertility management practices are implemented.

Most of the workforce will be sourced locally or provincially.

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OPERATIONAL PHASE

Within one year after the commencement of the project the entire 141Ha area applied for should be cleared and the orchard should be established. It will be managed and maintained by the farmer and will be a permanent establishment.

As with the operational phase, the workforce (upkeep of the land) will be sourced locally.

DECOMMISSIONING PHASE

This is a permanent change from natural area between existing pivots and annual crop production to orchard. Should the activity be authorized, it is highly unlikely that the proposed development will be decommissioned.

Should the Applicant elect to decommission the orchard at any point in the future, the necessary authorization must be obtained and the correct decommissioning protocol must be followed. The relevant Government Departments (those applicable at the time of decommissioning) should be consulted before decommissioning.

Following the decommissioning, the site should be rehabilitated back to a predetermined state, e.g. sufficient for grazing or a near-natural state with natural vegetation cover. A qualified botanical specialist should be contacted for more information on rehabilitation techniques.

LEGISLATION, POLICIES AND/OR GUIDELINES

Title of legislation, policy and/or guideline:	Administering authority:	Compliance
National Environmental Management Act (Act No 107 of 1998).	Department of Agriculture, Environmental Affairs, Rural Development and Land Reform in the Northern Cape	Application for GNR 325 (15) was made and a Scoping Report, EIA, and EMP must be supplied to ensure management of such development and was subjected to Public Participation.
Environmental Impact Assessment Regulations: 324, 325, 326 & 327	Department of Agriculture, Environmental Affairs, Rural Development and Land Reform in the Northern Cape	Application for GNR 325 (15) was made.
Northern Cape Nature Conservation (Act 09 of 2009)	Department of Agriculture, Environmental Affairs, Rural Development and Land Reform in the Northern Cape	A Soil, Fauna & Flora and Heritage/Palaeontology specialist study was completed, Scoping and EIA & EMP to ensure sustainability is improved in terms of balancing natural resource usage and protection or conservation thereof.
National Water Act (No. 36 of 1998).	DWS	The Applicant has an existing water use right, DWS was

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		however consulted during the public participation process.
National Environmental Management: Protected Areas Act	DEA	A Flora and ecological sensitivity study was completed to establish if any protected areas apply to this application.
National Environmental Management Waste Act, 2008 (Act 59 of 2008)	DEA and Provinces	Waste management was discussed in the EMP.
Conservation of Agricultural Resources Act (Act 43 of 1983):	Department of Agriculture, Environmental Affairs, Rural Development and Land Reform in the Northern Cape	Application for cultivating virgin soil was submitted to the Agriculture department (Mr. H. Roux) from the Northern Cape office.
The Provincial Spatial Development Framework for the Northern Cape	Office of the Premier of the Northern Cape	Application for GNR 325 (15) was made and a Scoping Report, EIA, and EMP will be supplied to ensure management of such development and was subjected to Public Participation.
National Heritage Resources Act (No 25 of 1999):	SAHRA	Application to SAHRA was made and a Heritage Assessment Study was completed and submitted on SAHRIS.
Alien and Invasive Species Regulations, 1 August 2014	DEA	A flora study was completed to establish if any alien or invasive species occurred at the site. The EMP provides alien control mitigation measures.
List of Protected Tree Species under the National Forest Act, 1998 (Act No. 84 of 1998)	Department of Environment, Forestry and Fisheries	A flora study was completed to establish if there are any protected tree species on site.
National Road Traffic Act, 1996 (Act 93 of 1996)	South African National Road Agency Limited	The Northern Cape Department of Roads and Transport was consulted

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		during the Public Participation Phase.
Occupational Health & Safety Act, 1993 (Act No. 85 of 1993)	Department of Labour	Health and safety protocols for workers were prescribed in the EMP.

See Appendix D (EMP) for a full discussion on applicable Legislation

ALTERNATIVES INVESTIGATED FOR THE PROPOSED DEVELOPMENT & MOTIVATION FOR THE PREFERED DEVELOPMENT FOOTPRINT

Alternative sites/land use/layout are chosen based on the outcome of the site investigation and proposed activities, which determine the social and environmental impacts. In the process, each environmental parameter and the possible impact of bush clearing is considered and investigated to determine any alternative location/land use/layout or method that could reduce the environmental and social impact and improve the sustainability of the project.

From an alternative site location perspective, no preferable alternative site was identified for the proposed development. The preferred site represents the logical expansion and consolidation of an existing irrigated agricultural footprint already associated with lawful water use infrastructure and suitable soils for pecan nut production. Establishing the proposed orchard in an alternative location elsewhere on the farms would likely require the disturbance of larger areas of intact natural vegetation and the creation of a new agricultural footprint, which from an environmental planning perspective is considered less desirable than concentrating the expansion within the already transformed and fragmented pivot landscape.

Alternative land uses, instead of agriculture will not be considered, since it involves an application for change of land use and the landowner does not wish to change the land use of the property.

In terms of layout alternatives, limited flexibility exists due to the location and configuration of the existing centre-pivot irrigation systems, existing lawful water supply infrastructure, topography and the distribution of suitable soils. The proposed layout therefore follows the logical expansion of the existing pivots by incorporating the infill areas located between and around the current irrigated circles.

The investigation into layout alternatives considered whether portions of the proposed expansion could be shifted or reconfigured to avoid all natural vegetation areas entirely. However, this was found to be impractical as it would either:

- result in fragmented and inefficient orchard blocks;
- compromise the operational functioning of the irrigation systems;
- sterilise otherwise suitable agricultural land between the pivots; or

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- shift the development footprint into other undisturbed areas of the property.

From both an agricultural and environmental planning perspective, the preferred layout is therefore regarded as the most practical and least environmentally disruptive option, as it consolidates development within an already transformed and fragmented agricultural landscape rather than creating a separate or disconnected cultivation footprint elsewhere on the property.

The layout has nevertheless been informed by the findings of the vegetation assessment, with the intention of retaining the main riparian corridor associated with the Orange River as far as reasonably practicable and limiting disturbance to the most sensitive vegetation areas where feasible.

In terms of the 'no-go' option; if the site is not developed there will be no change (good or bad) to the status of the site; it will remain as-is: areas that have been severely impacted due to past agricultural practices and areas that are fairly intact and used for grazing. Considering that the proposed study area is directly adjacent to established pivot areas, it will be a continuation of the development on the farm.

From an economic and agricultural point of view, it is better to develop the area and improve the agricultural potential of the land and from a soil management perspective to allow for the best crop production. Therefore, in the EIA no alternative site, no alternative land use, and the 'no-go' option will not be considered or evaluated. The EIA will assess the impacts of the area under application only.

NEED AND DESIRABILITY OF THE PROJECT

The proposed development entails the expansion of an existing irrigated agricultural operation through the incorporation of approximately 46 ha of infill areas located between and around the existing centre-pivot irrigation systems on the farm Tweefontein and Kalkfontein, near Prieska. The proposed development will increase the total irrigated footprint from approximately 95 ha to approximately 141 ha for the establishment of irrigated pecan nut orchards.

From a spatial and environmental planning perspective, the proposal represents the consolidation and optimisation of an existing agricultural footprint rather than the establishment of a new agricultural node within previously undisturbed areas. The proposed expansion area is already associated with existing irrigation infrastructure, lawful water supply, historic agricultural transformation and fragmented agricultural landscapes. The proposed development therefore makes use of existing agricultural infrastructure and confirmed suitable soils, while avoiding the need to establish a separate irrigation area elsewhere on the property.

The Northern Cape Province plays an important role in the South African agricultural sector, particularly along the Orange River irrigation corridor where intensive irrigation agriculture supports the cultivation of table grapes,

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cereals, cotton, dates and nut crops. The Prieska region is recognised as an established irrigation farming area associated with the Orange River system.

About 45 000 people are employed in agriculture in the Northern Cape, which represents approximately 16% of employment. The province supports livestock farming (mainly goats and sheep with cattle in the north), table grapes, dates, cotton, cereal crops, and vineyards along the banks of the Orange River and large varieties of crops including cotton, groundnuts, wheat, and maize on irrigated lands (including the large Vaalharts scheme) (Young, 2017).

In terms of pecan nut production, according to Global Africa Network (2020), production of pecan nuts grew from 5 000 tons in 2010 to 10 500 tons in 2015, and the figure continues to rise as world markets react positively to the South African product. At one time it was thought that pecan nuts were better suited to tropical and subtropical climates, but the consensus is now that the Northern Cape is ideal for the cultivation of the versatile and healthy nut.

It costs around R140 000/ha to establish and grow the trees (at 100/ha), which includes soil preparation, hiring of equipment such as bulldozer and tractor disc, contractors, trees, labour, installing an irrigation system, etc. Thus there is an initial outlay of costs with benefits to employees, contractors and nurseries but no economic benefit to the farmer, as it takes six to eight years for a tree to start producing nuts, and around 10 years until a farmer can start turning a profit. According to Dugmore (2011), it takes one mature pecan nut tree of about eight years old to produce an average of 20kg/year of pecan nuts at the average nut-in-shell (NIS) price paid to the farmers producing larger nuts from the hotter, drier regions above R80/kg (Botha, 2018). Or, alternatively, the income from 50kg of pecan nuts harvested from two trees is equivalent to that from 1t of maize. According to SAPPA records, the pecan nut industry in South Africa is expanding by 2 000ha/year and therefore holds large economic benefit to the farmer and employment opportunities to the community.

Most of the agricultural economy consists of extensive farming of sheep and goats, as well as game farming. However, there is intensive agriculture along the Orange Riet Canal System, along the upper Orange River (Coleberg-Hopetown area), and along the middle Orange River area. Prieska is a centre of irrigation farming.

The soil and irrigation suitability assessment undertaken for the site confirmed that the majority of the proposed expansion area is underlain by deep, freely drained Oakleaf soils regarded as highly suitable for irrigated pecan nut production. The report concluded that the soils exhibit suitable depth, drainage characteristics and acceptable chemical properties for sustainable irrigation agriculture.

The proposed development is furthermore expected to contribute positively to the local rural economy through the creation of additional permanent and seasonal employment opportunities associated with orchard establishment, irrigation maintenance, harvesting, transport and general farming operations. Although the employment opportunities generated by the development may appear limited at a regional scale, they remain important within the local rural context and would contribute to household income generation and local economic activity within the Siyathemba Local Municipality.

The development is also considered desirable from an agricultural land-use perspective because it expands an existing lawful agricultural enterprise within an established irrigation farming area, without requiring additional bulk irrigation infrastructure or new farm buildings. The proposal therefore represents the intensification and optimisation of existing agricultural land use within an area already characterised by irrigation agriculture along the Orange River corridor.

NO DEVELOPMENT OF THE SITE ('NO-GO' OPTION)

The "no-go" option refers to the scenario where the proposed development does not proceed.

Under the no-go alternative, the existing agricultural activities associated with the current pivots would continue, while the proposed infill areas between and around the pivots would remain undeveloped. Portions of these areas currently comprise disturbed and fragmented vegetation associated with historic agricultural activities, while other portions contain near-natural vegetation and riparian habitat.

From an environmental perspective, the no-go option would avoid the direct loss of approximately 46 ha of vegetation associated with the proposed orchard expansion and would maintain the current ecological functioning of the undeveloped portions of the site. Potential impacts associated with vegetation clearance, habitat transformation and operational agricultural activities would therefore not occur.

However, from an agricultural and land-use planning perspective, the no-go option would result in the continued underutilisation of land already situated within an established irrigated agricultural footprint and already associated with existing irrigation infrastructure and lawful agricultural activities. The infill areas between the pivots would remain fragmented and isolated between cultivated areas, despite much of the surrounding landscape already being transformed by irrigation agriculture.

The proposed development represents the consolidation and optimisation of an existing agricultural footprint rather than the expansion of agriculture into a separate undisturbed landscape unit. In this context, the preferred alternative is considered more appropriate than the no-go option, provided that sensitive areas such as the riparian corridor are appropriately managed and retained where feasible, and that mitigation measures identified during the EIA process are implemented through the Environmental Management Programme (EMPr).

PUBLIC PARTICIPATION PROCESS

All the details of the public participation process undertaken so far (Scoping Phase), including copies of the supporting documents and inputs and the summary of the issues raised by Interested and affected parties, can be viewed in Appendix C.

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In conclusion, all stakeholders, abutting neighbours, and other authorities were directly consulted, and any potential I&AP was notified via a local newspaper advertisement in the Noordwes Karroo Nuusblad and one notice board was placed at the boundary of the property along the public gravel road. During the public participation of the Scoping Phase, no person raised any objections to the project.

No person/entity/governmental office registered as a result of the public notices.

Therefore no public input was provided to establish any alternative options. Since public participation is underway for the Draft EIA, if any comments are received it will be considered and if needed it will be incorporated into the final EIA.

ENVIRONMENTAL ATTRIBUTES ASSOCIATED WITH THE DEVELOPMENT

The environmental attributes associated with the proposed development were investigated through the Scoping Phase, site verification and specialist studies undertaken for the Remainder of Farm Tweefontein No. 373 and Portion 4 (portion of Portion 2) of Farm Kalkfontein No. 374. The proposed development entails the clearance of approximately 46 ha of vegetation within the infill and fall-out areas between and around four existing centre-pivot irrigation areas for the establishment of pecan nut orchards. The existing irrigated agricultural footprint comprises approximately 95 ha, which will increase to approximately 141 ha.

The environmental attributes considered include the regional climate, topography, geology and palaeontology, soils and agricultural land capability, terrestrial vegetation and flora, fauna, biodiversity sensitivity, surface water resources, air quality, noise, waste generation, visual and aesthetic character, transport, socio-economic considerations and heritage/archaeological resources. These attributes are discussed below in relation to the proposed development and the findings of the specialist investigations.

Topography

The site has a relatively gentle topography and generally slopes southwards towards the Orange River. The establishment of the proposed orchard does not require substantial cut-and-fill operations or modification of the existing landform, as vegetation clearance, soil preparation and orchard establishment will generally follow the natural slope of the land. Consequently, no significant alteration of the overall topographical character of the site is anticipated. The primary consideration will be the prevention of localised erosion following vegetation clearance and soil disturbance.

Geology, Palaeontology and Archaeology

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The site occurs on the floodplain margin along the right bank of the Orange River and is predominantly underlain by unconsolidated Holocene alluvium and locally reworked aeolian sands. Regionally, the geological setting includes Early Permian Dwyka sediments, Late Tertiary to Quaternary calcretes, aeolian sands and other superficial deposits.

The specialist field investigation determined that the development footprint is predominantly associated with relatively young and reworked alluvial and sandy deposits that have been influenced by floodplain processes and historical agricultural disturbance. The site was consequently assessed as having low palaeontological sensitivity. No fossils, fossil-bearing horizons, archaeological artefacts, graves or heritage structures older than 60 years were identified within the proposed development footprint during the field investigation. The site was therefore assigned a Generally Protected C (Low significance) palaeontological and archaeological field rating.

Although no significant heritage resources were identified, the possibility of subsurface or previously unidentified heritage or palaeontological material cannot be completely excluded. A chance-find procedure should therefore be incorporated into the EMPr and implemented during vegetation clearance and soil preparation.

Soils and Agricultural Land Capability

The soil suitability assessment confirmed that the majority of the proposed expansion area on Tweefontein is underlain by deep, freely drained Oakleaf and Ermelo soils associated with alluvial deposits of the Orange River system. These soils are considered highly suitable for irrigation and cultivation and generally provide the depth, drainage characteristics and physical and chemical properties required for pecan nut production.

The suitable portions of the site are characterised by freely drained soil depths exceeding 2 m, clay contents of approximately 22–34%, generally favourable pH conditions of approximately 6.0–6.8, and low salinity and sodicity risks. A limited northern portion contains Prieska/Augrabies-type soils associated with free lime and carbonate-rich horizons. These soils are considered marginal for pecan nut production, principally because elevated carbonate levels may affect micronutrient availability. However, the specialist did not identify an unacceptable soil degradation risk associated with cultivation of these areas, provided that appropriate irrigation and fertility management is implemented.

The properties are already utilised for irrigated agricultural production and contain approximately 95 ha under existing centre-pivot irrigation. The proposed development therefore does not introduce an unrelated land use but represents the consolidation and intensification of the existing agricultural use. The transition from annual cropping to permanent pecan orchards may also reduce the frequency of long-term soil disturbance associated with repeated ploughing, planting and harvesting once the orchard has been established.

The soil forms have a moderate susceptibility to wind erosion and low susceptibility to water erosion. Appropriate soil conservation, irrigation management and erosion-control measures will therefore remain important, particularly during the establishment phase when vegetation cover is temporarily removed.

Terrestrial Vegetation and Flora

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The terrestrial vegetation assessment identified a mosaic of vegetation types and ecological sensitivities across the properties. The site is not uniformly sensitive and includes areas ranging from historically transformed and disturbed agricultural land to near-natural Nama Karoo shrubland and riparian vegetation associated with the Orange River. The Scoping Report accordingly recognises that, despite extensive existing agricultural disturbance, portions of the site retain important ecological characteristics and contribute to the functioning of the surrounding Nama Karoo ecosystem.

The riparian vegetation associated with the Orange River represents the most ecologically sensitive component of the site and was assigned a High conservation value by the vegetation specialist due to its ecological functioning, structural diversity, habitat value and occurrence of protected plant species. This vegetation also provides an important ecological corridor along the Orange River. The principal and continuous riparian corridor along the river boundary should therefore be retained and protected from disturbance.

Near-natural and karroid shrubland vegetation occurring outside the main riparian corridor was generally assigned a Medium to Medium-high conservation value. These areas retain indigenous shrubland vegetation and support a number of protected plant species. Protected succulent and geophytic species recorded or identified within the study area include *Mesembryanthemum coriarium*, *M. guerichianum*, *M. noctiflorum*, *M. junceum*, *Aizoon plinthoides*, *Ammocharis* sp. and *Nerine* sp. *Boscia albitrunca* (Shepherd's Tree), which is a nationally protected tree species, was also recorded within portions of the natural vegetation.

Conversely, areas associated with the existing pivots, old cultivated fields and previously disturbed agricultural areas were generally assessed as having Low to Low-medium conservation value, reflecting previous transformation, fragmentation, bare soil exposure, invasive plant occurrence and reduced ecological functioning. These areas support a greater proportion of pioneer and disturbance-associated species.

The development layout is largely concentrated within the infill and fall-out areas between and around the existing pivots. This approach consolidates the agricultural footprint within an already fragmented agricultural landscape rather than establishing a separate cultivation footprint within a larger continuous area of intact natural vegetation. The principal Orange River riparian corridor is intended to remain excluded from development as far as reasonably practicable.

The loss of natural and near-natural vegetation within portions of the proposed 46 ha expansion footprint nevertheless remains an important environmental impact and should not be regarded as negligible. Prior to clearing, the approved footprint should be demarcated and a plant search-and-rescue exercise undertaken. Protected species occurring within the footprint should be retained where practicable or rescued and relocated under the applicable permits and in accordance with the recommendations of the botanical specialist.

Fauna

The site occurs within the Nama-Karoo biome and provides habitat for a range of fauna associated with arid shrubland, riparian habitat and agricultural landscapes. The broader area potentially supports mammals, reptiles,

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amphibians and a diverse assemblage of avifauna. Faunal observations made during the site investigations included kudu, blesbok, gemsbok, springbok, ground squirrel, mongoose, vervet monkey and several bird species, including guineafowl, falcons, finches and Northern Black Korhaan. Burrows and evidence of digging around old termite mounds were also recorded, potentially indicating the presence of aardvark.

The primary faunal impact associated with the proposed development will arise from the permanent loss and modification of habitat within the additional cultivation footprint and temporary disturbance and displacement of animals during vegetation clearance and orchard establishment. The fragmented nature of the development footprint and the presence of existing agricultural activities reduce the ecological integrity of portions of the site; however, remaining natural vegetation and particularly the Orange River riparian corridor continue to provide habitat and movement opportunities.

The gradual nature of vegetation clearance should allow most mobile fauna to move into adjacent habitat. A pre-clearance fauna search should nevertheless be undertaken, and animals encountered within the footprint should be allowed to escape or be appropriately relocated. Hunting, trapping, poisoning and intentional killing of fauna should be prohibited.

Biodiversity and Ecological Sensitivity

Desktop biodiversity information and the site-specific specialist investigations must be considered together when determining the ecological sensitivity of the development footprint. The terrestrial specialist assessment demonstrates that ecological sensitivity varies substantially across the site, with the highest sensitivity associated with the Orange River riparian system, followed by relatively intact natural and near-natural shrubland, while historically disturbed agricultural areas have considerably lower ecological value.

The development therefore presents a trade-off between the loss of remaining indigenous vegetation within the infill footprint and the environmental advantage of consolidating agricultural expansion around existing pivots and infrastructure rather than establishing a new agricultural footprint elsewhere. The principal management objective should be to confine disturbance to the authorised footprint, retain the main Orange River riparian corridor, protect or relocate protected plant species where required and prevent secondary disturbance to adjoining natural vegetation.

Surface Water

The site falls within the Lower Orange Water Management Area and quaternary catchment D71D, with the Orange River situated immediately south of the agricultural properties. A drainage line/perennial watercourse also occurs between the Tweefontein and Kalkfontein sections.

The relevant sub-quaternary catchment is identified as a Fish Support Area, including habitat relevant to *Barbus anoplus*. The proximity of the Orange River and associated drainage features therefore increases the importance of

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preventing sediment, agrochemical, hydrocarbon or other contaminated runoff from entering the aquatic environment.

The development does not require a new bulk irrigation water source. The Applicant has existing lawful water-use rights associated with the agricultural operation. Development should remain outside the applicable watercourse buffers, and no vegetation clearance, material storage, refuelling or other potentially contaminating activity should occur within these areas. Particular attention should also be given during the operational phase to irrigation efficiency and the responsible application of fertilisers, herbicides and pesticides.

Air Quality

The existing air quality is characteristic of a rural agricultural environment and is generally considered good. Temporary dust generation is expected during vegetation clearance, soil preparation, ripping, planting and vehicle movement on unpaved farm roads. The semi-arid climate, low rainfall, high evaporation and periodic strong winds increase the potential for exposed soils to generate dust.

This impact will principally occur during establishment and should decrease substantially once the orchard has been established and permanent vegetation cover is present. Phased clearance, rapid establishment of the orchard, appropriate irrigation and dust suppression on frequently travelled roads should minimise the impact. Since there are very limited receptors, this impact would be very low.

Operational air-quality considerations also include the application of pesticides and other agrochemicals. These substances should be applied strictly in accordance with registered agricultural requirements and under suitable meteorological conditions to minimise spray drift beyond the orchard footprint.

Noise

The existing acoustic environment is typical of a rural agricultural setting. Noise will primarily be generated by earthmoving and agricultural machinery during vegetation clearance and orchard establishment, followed by routine agricultural activities during operation. Given the existing farming activities and the distance between the development footprint and surrounding receptors, significant noise impacts are not anticipated. Noise-generating equipment should nevertheless be properly maintained and unnecessary idling, hooting and other avoidable noise should be restricted.

Waste

Waste generation during establishment is expected to be relatively limited and will consist principally of domestic waste generated by workers, vegetation residues, occasional oversized stones and potentially small quantities of hydrocarbon-contaminated material arising from emergency equipment repairs. No permanent hydrocarbon storage is proposed within the development footprint, with routine servicing and maintenance of machinery undertaken at the existing farm workshop.

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Vegetation material suitable for incorporation into the soil may be utilised as organic matter where appropriate. Domestic and other non-biodegradable waste should be collected in suitable containers and removed to an authorised waste disposal facility. Chemical toilets should be provided where required and serviced by an appropriate service provider.

Visual and Aesthetic Character

The Orange River landscape retains aesthetic value due to its rural setting, riverine vegetation and agricultural character. However, the immediate landscape has already been substantially modified by existing centre pivots, cultivated fields, irrigation infrastructure, access roads, electricity infrastructure and other agricultural activities.

The proposed orchard expansion will therefore occur within an established agricultural landscape rather than introducing an entirely new land use. The additional approximately 46 ha will occupy areas directly adjoining and between existing irrigated areas. During vegetation clearance, the visual texture and colour of these areas will temporarily change as natural vegetation is replaced by exposed soil. As the pecan orchards establish, the new agricultural footprint is expected to become increasingly integrated with the existing agricultural character of the properties.

The visual impact is consequently expected to remain predominantly localised, although the permanent conversion of remaining natural vegetation to orchard must be recognised as a change in the existing landscape character.

Transport

Existing farm roads and the R357 will continue to provide access to the properties. The establishment phase is not expected to generate substantial additional regional traffic, as earthmoving machinery will primarily operate within the site.

During operation, additional vehicle movements will occur during harvesting and transportation of pecan nuts to markets. This will represent an increase in agricultural traffic during seasonal periods but remains consistent with the existing agricultural use of the area. Appropriate vehicle maintenance, driver awareness, road signage and traffic management should be implemented where required.

Socio-economic Environment

The development represents an expansion and diversification of an existing agricultural enterprise and is anticipated to provide positive socio-economic benefits through employment, agricultural production and expenditure within the local economy. Employment opportunities will occur during vegetation clearance, orchard establishment and irrigation works, with longer-term employment associated with orchard maintenance, harvesting, processing and transportation.

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The proposed pecan operation could support approximately 70 employment opportunities, sourcing labour locally. Potential negative social impacts are primarily associated with temporary dust, noise, increased seasonal traffic and farm safety/security considerations. These impacts are considered manageable through implementation of the EMPr and normal farm management practices.

CONCLUDING STATEMENT

The environmental attributes of the site demonstrate that the proposed development occurs within an existing and substantially modified irrigated agricultural landscape, but one which still contains areas of meaningful ecological sensitivity. The most important environmental constraints are the Orange River and associated riparian vegetation, remaining natural and near-natural Nama Karoo shrubland, protected plant species, faunal habitat and the need to protect soil and water resources.

The environmental acceptability of the development therefore depends strongly on consolidating the additional agricultural footprint within the existing pivot landscape while avoiding and protecting the principal Orange River riparian corridor and limiting unnecessary disturbance of remaining natural vegetation. The site also possesses soils that are predominantly suitable for irrigated pecan production, while the proposed development makes use of existing irrigation infrastructure and lawful water supply rather than requiring the establishment of an entirely new agricultural operation.

The EIA should therefore assess the permanent loss of indigenous vegetation and habitat against the agricultural and socio-economic benefits of the proposal, taking into consideration the existing transformation of the properties, the specialist-defined ecological sensitivities and the effectiveness of the proposed avoidance and mitigation measures. All identified impacts, their significance before and after mitigation, and the required management and monitoring measures should be addressed in detail in the impact assessment and EMPr.

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RECEIVING ENVIRONMENT

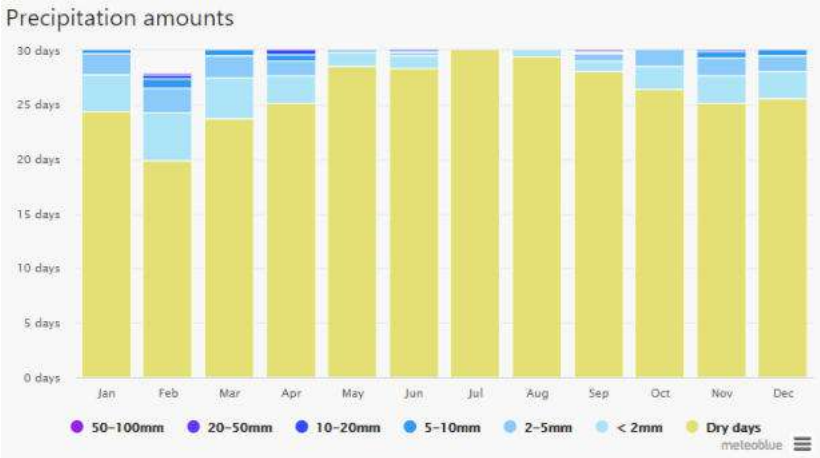
REGIONAL CLIMATE

Climatic conditions such as temperature, rainfall, and wind velocity influence for example plant growth, erosion level of disturbed areas, dust generation, and air pollution levels as well as social impact in terms of quality of life. Climatic conditions can, therefore, influence the significance of impacts caused by developments. It is important to understand the role thereof when determining the impacts of specific development and the remedial measures that need to be implemented.

The study site falls within the Hot Desert Climatic (BWh) Region of South Africa, according to the Köppen Climate Classification System. Mild Desert Climate is characterised by warm to hot summers, high evaporation, and dry warm winters.

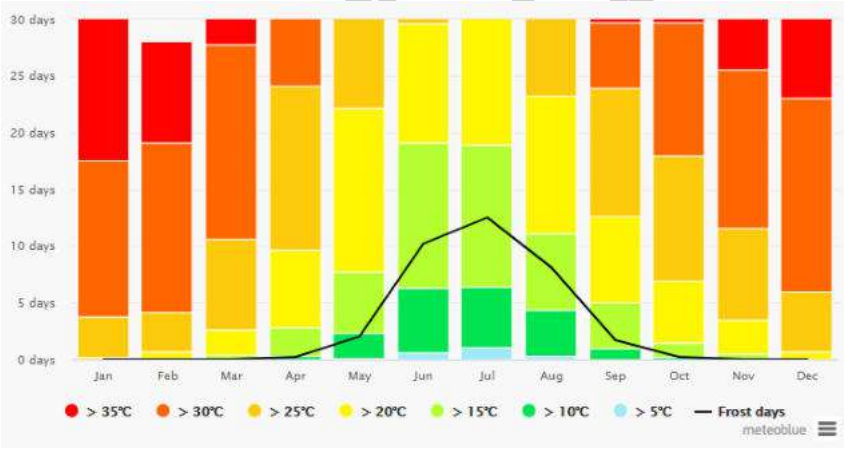
The site is situated in a rainfall area that receives about 201-400mm per annum according to the AGIS Comprehensive Atlas, which is a general classification. Prieska has a summer rainfall between October to May.

TABLE 2: PRECIPITATION AMOUNTS (SOURCE METEOBLUE)



Daily mean maximum temperatures range between 30°C and 35°C and daily mean minimum temperatures between 0.1°C and 2°C. January is the hottest month of the year and July the coldest.

TABLE 3: AVERAGE TEMPERATURES (SOURCE METEOBLUE)



The proposed farm area falls within an area where the annual evaporation is very high, more than 2400mm.

The moisture availability is the ratio of actual to potential evapotranspiration. Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil, other surfaces (e.g. rivers,

dams, wetlands, etc.), and by transpiration from plants. The moisture availability of the area is classified as being very severe. In other words, the evapotranspiration of the area is very high.

This is important for irrigation strategies. The low rainfall combined with the high evapotranspiration rates will result in a higher amount of water required for irrigation per hectare than a farm situated for example in the sub-tropics, where the rainfall is higher and the evapotranspiration is low. The Applicant will consider working out an irrigation scheduling to establish and maintain the orchard.

WIND REGIMES

The prevailing wind directions are predominantly westerlies and north-north-easterlies, with wind speeds, recorded highest during August to October (>38km/h but <50km/h).

There is a distinct seasonal variation between summer and winter wind direction with predominant winds in summer being westerlies (west and west-south-west) and predominant winds in winter being north-north-easterlies. Generally, wind speeds are also stronger during night-time compared to daytime conditions.

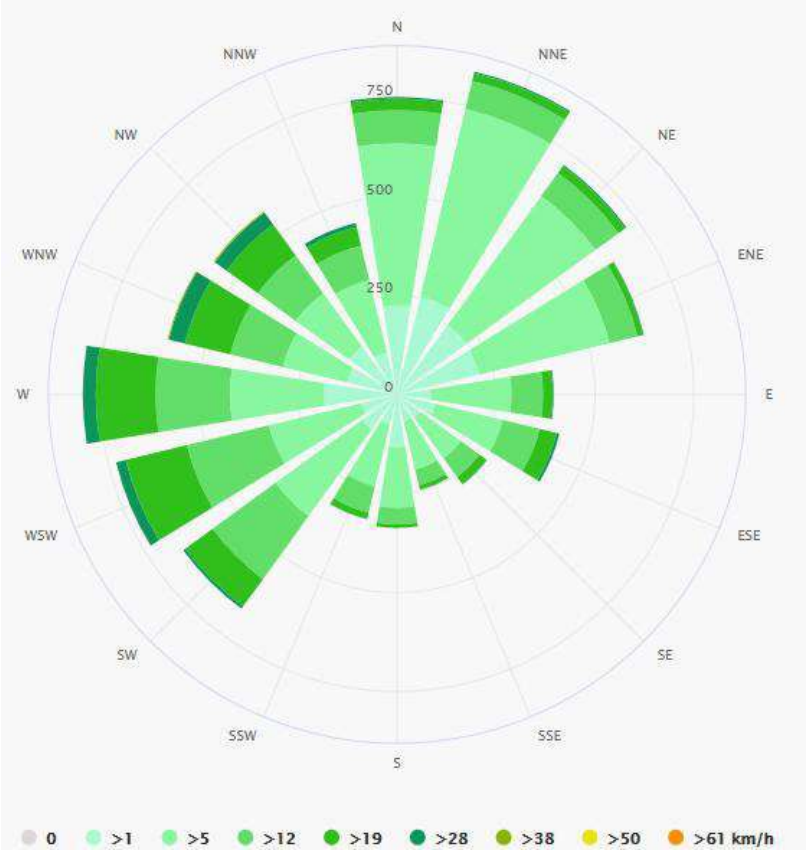


FIGURE 3: WIND ROSE OF PRIESKA AREA (SOURCE METEOBLUE)

TABLE 4: WINDSPEED OF PRIESKA AREA (SOURCE METEOBLUE)

ENVIRONMENTAL IMPACT ASSESSMENT

METHODOLOGY OF IMPACT ASSESSMENT

The impact assessment was undertaken in accordance with the methodology contained in the Environmental Impact Assessment and is informed by the findings and recommendations of the specialist studies conducted for the proposed development. The assessment considers the potential environmental and socio-economic impacts associated with the Planning, Design and Development Phase, Construction Phase and Operational Phase of the proposed activity.

Each identified impact was assessed for Alternative 1 (no alternative layout will be assessed during the EIA phase, as the proposed development represents the logical infill and consolidation of the existing centre-pivot irrigation footprint, with the layout largely constrained by the location and configuration of the existing pivots, irrigation infrastructure and suitable agricultural soils) and the No-Go Alternative, where applicable. The assessment considered the extent and duration of the impact, probability of occurrence, reversibility, potential for irreplaceable loss of resources, cumulative impacts and overall significance both before and after mitigation.

The specialist investigations identified biodiversity, fauna habitat, and heritage resources as the primary environmental considerations relevant to the proposed development. The No-Go Alternative would avoid the direct impacts associated with the proposed development but would also result in the loss of the anticipated socio-economic and agricultural benefits associated with the project.

The following assessment criteria are applied:

Nature of the impact

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The nature of the impact describes the environmental or socio-economic effect that may result from the proposed activity. The impact is identified as either positive, negative or neutral and describes what environmental aspect or resource may be affected and the manner in which it may be affected.

Extent of the impact

The spatial extent of the impact is considered in terms of whether the effect is:

- Site-specific – restricted to the development footprint or site;
- Local – extending beyond the site into the immediate surrounding area;
- Regional – affecting a broader geographical area; or
- National or greater – where impacts extend beyond the regional scale.

Duration of the impact

The anticipated duration of the impact is assessed as:

- Short-term – generally 0–5 years;
- Medium-term – approximately 5–15 years;
- Long-term – approximately 16–30 years; or
- Permanent – where the impact is expected to remain for the foreseeable future or cannot reasonably be reversed.

Consequence of the impact or risk

The consequence describes the likely environmental or socio-economic outcome should the identified impact occur. Consideration is given to the sensitivity and importance of the affected resource, the magnitude of the potential change and the implications for ecological functioning, environmental quality, land use or socio-economic conditions.

Probability of occurrence

The likelihood of the impact occurring is assessed as:

- Improbable – unlikely to occur;
- Probable – there is a distinct possibility that the impact may occur;
- Highly probable / high probability – the impact is considered likely to occur; or
- Definite – the impact will occur as a consequence of the activity.

Degree of irreplaceable loss of resources

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Consideration is given to the extent to which the impact may result in the permanent or irreplaceable loss of an environmental resource, habitat, ecological function, heritage resource or other valued feature. The potential for irreplaceable loss is rated qualitatively from Very Low to High, or regarded as Not Applicable where relevant.

Reversibility of the impact

The degree to which the affected environment or resource could reasonably return to its pre-impact condition is assessed. Reversibility is rated qualitatively from Very Low to High depending on the nature of the affected resource and the ability for natural recovery, rehabilitation or restoration to occur.

Indirect impacts

Indirect or secondary impacts that may arise as a consequence of the primary impact are identified and considered as part of the assessment. These may include, for example, habitat fragmentation, displacement of fauna, erosion, downstream impacts, increased pressure on surrounding resources or secondary socio-economic effects.

Cumulative impacts

Potential cumulative impacts are considered in the context of the proposed development together with existing and reasonably foreseeable activities within the surrounding environment. Cumulative impacts may be positive or negative and are assessed both before and following mitigation.

Significance of the impact prior to mitigation

An overall significance rating is assigned to each impact before mitigation, taking into consideration the nature, extent, duration, consequence, probability, reversibility, potential for irreplaceable loss and cumulative effects of the impact.

Significance is expressed qualitatively as:

Very Low, Low, Medium-Low, Medium, Medium-High, High or Very High, with the impact identified as positive (+), negative (-) or neutral where appropriate.

Degree to which the impact can be avoided, managed and mitigated Following determination of the unmitigated significance, consideration is given to the extent to which the impact can reasonably be:

- avoided through changes to the location, layout, design or implementation of the activity;
- managed through appropriate environmental controls and management measures; and/or
- mitigated to reduce the magnitude, duration, probability or consequence of the impact.

The effectiveness of avoidance, management and mitigation is qualitatively rated according to the circumstances of each impact.

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Residual impacts

Residual impacts are those impacts that are expected to remain following the effective implementation of the recommended avoidance, management and mitigation measures. Residual impacts are described to provide an indication of the environmental effect that cannot reasonably be eliminated.

Cumulative impact following mitigation

The cumulative impact is reconsidered following implementation of the proposed mitigation measures in order to determine whether the contribution of the proposed development to cumulative environmental effects would be reduced.

Significance of the impact after mitigation

A final significance rating is assigned after consideration of the proposed mitigation measures and residual impacts. The post-mitigation significance therefore represents the anticipated significance of the impact provided that the prescribed mitigation and management measures are effectively implemented.

The significance ratings presented in the Impact Assessment therefore represent the professional judgement of the EAP, informed by the findings and recommendations of the relevant specialist studies, the sensitivity of the receiving environment, the characteristics of the proposed development and the effectiveness of the proposed mitigation measures. The same assessment approach has been applied consistently to the applicable alternatives to allow for comparison between the development options.

The definition of indigenous vegetation is defined in the NEMA Regulations as: "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 10 years." Considering that vegetation and soil of the area under application have not been disturbed, through ploughing or clearing for more than 10 years, the current state of the vegetation is therefore regarded as 'indigenous vegetation'. This application will also require an application with the Department of Agriculture for a ploughing certificate.

Please note that all management of impacts and proposed mitigation measures have been discussed in detail in the Environmental Management Plan (Appendix D), under the heading "Management Objectives" of this report, and will therefore not be repeated in this section of the document.

Significance colour legend:

Very High	High	Medium-High	Medium	Medium-Low	Low	Very Low

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PLANNING, DESIGN AND DEVELOPMENT PHASE		
	Alternative 1:	**No-Go Option**
Nature of impact:	Failure to obtain and comply with all applicable statutory approvals and associated conditions could lead to delays in project implementation, increased financial costs and potential legal consequences arising from regulatory non-compliance.	No development-related impact would occur under the No-Go Alternative.
Extent and duration of impact:	Site Specific and Short Term	Site-specific; permanent
Consequence of impact or risk:	Delays in implementation, increased project costs, potential legal penalties, reputational damage, and possible environmental impacts resulting from non-compliance with specialist recommendations and regulatory conditions.	The impact associated with development would not occur.
Probability of occurrence:	Probable	Highly unlikely
Degree to which the impact may cause irreplaceable loss of resources:	Low	None
Degree to which the impact can be reversed:	High	Not applicable
Indirect impacts:	Potential disturbance to sensitive vegetation, protected species, heritage resources or soil resources through failure to implement specialist recommendations and permit conditions.	No development-related indirect impact.
Cumulative impact prior to mitigation:	Medium	Negligible
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium-High (-)	Negligible
Degree to which the impact can be avoided:	High	Not applicable

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Degree to which the impact can be managed:	High	Not applicable
Degree to which the impact can be mitigated:	High	Not applicable
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Obtain all applicable approvals prior to commencement; • Maintain a compliance register; • Ensure all permit and authorisation conditions are incorporated into project planning and EMPr implementation; • Appoint a responsible person to monitor compliance; • Undertake environmental awareness training; • Maintain records of approvals and compliance audits.	No mitigation required.
Residual impacts:	Minor administrative burden associated with ongoing compliance monitoring and reporting.	None.
Cumulative impact post mitigation:	Low	Negligible
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-)	Negligible
	Alternative 1:	**No-Go Option**
Nature of impact:	Economic viability and project implementation timeframe.	No development-related impact would occur under the No-Go Alternative.
Extent and duration of impact:	Local; medium to long term	Local; long term
Consequence of impact or risk:	Poorly resolved design or unaffordable environmental requirements could delay implementation or undermine project viability.	The project would not be implemented and the associated agricultural expansion, associated investment, employment and economic opportunities would not occur.

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Probability of occurrence:	Possible	Definite
Degree to which the impact may cause irreplaceable loss of resources:	Low	Low
Degree to which the impact can be reversed:	High	High
Indirect impacts:	Delayed investment, procurement and employment; pressure to reduce environmental controls if costs are not adequately planned.	Loss of associated secondary local economic benefits.
Cumulative impact prior to mitigation:	Low	Low
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-)	Medium (-)
Degree to which the impact can be avoided:	Medium	Low
Degree to which the impact can be managed:	High	Low
Degree to which the impact can be mitigated:	High	Low
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Develop or design and implement economically viable options that would provide for appropriate pollution control and resource conservation.	No mitigation applicable to the No-Go Alternative.
Residual impacts:	Normal project cost and programme risks remain.	The socio-economic opportunity associated with the development would remain unrealised.
Cumulative impact post mitigation:	Low	Low
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Medium (-)

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CONSTRUCTION & OPERATIONAL PHASE

TOPOGRAPHY

Morphology or the Topography of an area can be described as the form and structure of the landscape. The structure is given by the underlying geology and the form is given by erosion factors such as the rivers cutting through the geology to form valleys, or the wind eroding the tops of the mountains and filling in the valleys to form rolling hills and plains.

The proposed development area is situated on the lower landscape position adjacent to the Orange River. The soil survey classifies the terrain unit as a footslope, with a very gentle slope of approximately 1%. The slope is described as straight in both planform and profile, with no notable micro-relief. Elevations recorded range from approximately 965 to 978 metres above mean sea level.

The generally flat to gently sloping topography is consistent with the site's position within the Orange River alluvial landscape, with the dominant Oakleaf and Ermelo soils having developed from deep alluvial deposits. The gentle gradient, together with the deep and freely drained nature of these soils, results in a low susceptibility to water erosion, although the specialist identified a moderate potential for wind erosion.

Overall, the topography does not present a significant physical constraint to the proposed establishment of the pecan nut orchard. The limited slope means that extensive earthworks or alteration of the natural landform should not be required. However, vegetation clearance and soil preparation will temporarily expose the soil surface, and appropriate erosion-control measures should therefore be implemented during orchard establishment, particularly to limit wind erosion.

Impact on the topography (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Negative: Vegetation clearing, soil preparation and establishment of the pecan orchard may result in minor localised alteration/disturbance of the existing ground surface. The site is located on a gently sloping footslope and no major alteration of the natural landform is anticipated.	Neutral: The existing topography would remain largely unchanged and no additional ground disturbance associated with orchard establishment would occur.
Extent and duration of impact:	Site-specific; long-term/permanent. Physical disturbance will be restricted to the proposed development footprint. Although most earth disturbance will occur during establishment, the conversion to an orchard represents a long-term change in land use.	Site-specific; long-term. Existing landforms would remain substantially unchanged.

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Consequence of impact or risk:	Low The site has a very gentle slope of approximately 1%, with straight planform and profile and no notable micro-relief. No extensive cut-and-fill or major earthworks are required.	Very Low/Neutral. No development-related alteration of the topography would occur.
Probability of occurrence:	Definite Some disturbance of the ground surface will necessarily occur during vegetation clearance, soil preparation and orchard establishment.	Improbable. No development-related disturbance would occur.
Degree to which the impact may cause irreplaceable loss of resources:	Low. No unique or irreplaceable topographical features have been identified within the development footprint.	None
Degree to which the impact can be reversed:	Moderate Minor surface disturbance could be rehabilitated; however, while the orchard remains operational, the agricultural modification of the site will persist.	N/A
Indirect impacts:	Localised soil erosion may occur where vegetation removal and soil disturbance leave soils exposed, particularly before orchard establishment. Wind erosion represents the greater erosion concern, as the specialist rated wind-erosion potential as moderate and water-erosion potential as low.	No development-related indirect topographical impacts are anticipated.
Cumulative impact prior to mitigation:	Low The development will contribute incrementally to modification of the local landscape associated with existing agricultural cultivation and centre-pivot irrigation, but will not materially alter the broader topographical character of the area.	Very Low/Neutral Existing agricultural influences would remain.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Neutral
Degree to which the impact can be avoided:	Moderate Ground disturbance cannot be completely avoided because vegetation clearance and orchard establishment are required, but unnecessary disturbance and alteration of the land surface can be avoided.	High Development-related impacts are avoided under the No-Go Option.
Degree to which the impact can be managed:	High The gentle terrain and low water-erosion potential allow the impact to be readily managed through appropriate site	N/A

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	preparation and erosion-control measures.	
Degree to which the impact can be mitigated:	High Limiting disturbance to the authorised footprint, minimising earthworks and implementing erosion-control measures will substantially reduce the impact.	N/A
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Restrict all vegetation clearing and soil disturbance to the authorised development footprint. • Avoid unnecessary levelling, excavation and alteration of the natural landform. • Minimise cut-and-fill and follow the existing terrain as far as practicable. • Undertake clearing and soil preparation progressively rather than exposing the entire footprint simultaneously. • Limit vehicle movement to designated access routes. • Stabilise disturbed areas as soon as practicable. • Implement erosion-control measures where signs of erosion occur. • Minimise the period for which soils remain exposed and establish the orchard/vegetative cover as soon as practicable following preparation	N/A
Residual impacts:	Minor permanent modification of the ground surface associated with the establishment and operation of the orchard will remain; however, the overall topographical form and gentle slope of the site will remain substantially unchanged.	None
Cumulative impact post mitigation:	Very Low No meaningful alteration of the broader topographical character of the area is anticipated.	Neutral
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Neutral

During the operational phase, no further material impact on the topography is anticipated. The physical disturbance and minor modification of the ground surface will have occurred during vegetation clearance, soil preparation and orchard establishment. Once established, the approximately 141 ha orchard will be maintained as a permanent agricultural land use, with no new bulk irrigation infrastructure or farm buildings proposed as part of the development.

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Routine orchard activities, including irrigation, maintenance and harvesting, are not expected to require significant excavation, cut-and-fill or further alteration of the existing landform. Given the gentle terrain and the nature of the proposed agricultural use, the overall topographical form of the site will remain substantially unchanged during operation. Any erosion-related impacts associated with irrigation or exposed soil are more appropriately addressed under the soil/erosion impact assessment, rather than as a separate operational topographical impact.

No significant additional impact on topography is anticipated during the operational phase and, accordingly, no separate operational-phase impact assessment is considered necessary.

GEOLOGY

The study area is situated on the floodplain margin along the right bank of the Orange River. Regionally, the geological setting comprises localised Early Permian Dwyka Group sediments, widespread Late Tertiary to Quaternary calcretes, aeolian sands and other superficial deposits. Dwyka-aged palaeovalleys in the broader region are potentially fossiliferous and may preserve evidence of glaciation, trace fossils, microfossils and fossil plant material. Rare vertebrate fossil remains are also known from older calcrete deposits in the wider area.

At the development site itself, however, the surface geology is dominated by unconsolidated Holocene alluvium and locally reworked aeolian sand, forming a near-level sandy plain. Riverbank exposures contain fine- to medium-grained structureless sands with scattered pebbles and cobbles derived from river bedload, together with occasional calcrete nodules. These deposits reflect an episodically active depositional environment associated with the Orange River floodplain. This is consistent with the soil assessment, which identified the dominant Oakleaf soils as having developed from deep alluvial deposits, while the underlying geological group is recorded as the Dwyka Formation.

From a palaeontological perspective, the Holocene alluvial deposits underlying the development footprint are considered to have low sensitivity, as they are geologically young and have been subjected to frequent reworking, which limits the potential for the accumulation and preservation of fossil material. The palaeontological field assessment found no fossil material within the inspected exposures or cuttings at either Tweefontein or Kalkfontein. Both sites were consequently assigned a Generally Protected C (Low significance) palaeontological field rating.

Accordingly, the proposed development is considered unlikely to result in the loss of significant or scientifically irreplaceable palaeontological resources. Nevertheless, as subsurface fossil material cannot be entirely excluded, a chance-find procedure should be implemented should any fossil material be exposed during vegetation clearance, soil preparation or other ground-disturbing activities. Full Palaeontology report can be found in Appendix E2.

Impact on the geology (Construction Phase)	**Alternative 1:**	**No-Go Option**

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Nature of impact:	Negative. Vegetation clearance, ripping, soil preparation and orchard establishment may disturb the unconsolidated Holocene alluvium and locally reworked aeolian sands underlying the development footprint. Although no fossils were recorded during the field assessment, previously unidentified subsurface palaeontological material could be exposed, damaged or destroyed.	Neutral. No development-related ground disturbance would occur and any palaeontological material that may be present below ground would remain undisturbed.
Extent and duration of impact:	Site-specific and permanent. Any disturbance or loss would be confined to the authorised development footprint; however, the destruction of fossil material, if encountered, would be irreversible.	Site-specific and long-term. Existing geological deposits would remain in their present condition.
Consequence of impact or risk:	Low The footprint is dominated by geologically young, frequently reworked alluvial and aeolian deposits of low palaeontological sensitivity. No fossils or fossil-bearing horizons were identified during the field assessment, and both sites received a Generally Protected C field rating of low significance.	Very Low / Neutral No development-related loss or disturbance of geological or palaeontological resources would occur.
Probability of occurrence:	Improbable Ground disturbance is definite, but the likelihood of significant fossils being present and affected is low, based on the mapped geology and negative field-survey findings.	Improbable No development-related ground disturbance would take place.
Degree to which the impact may cause irreplaceable loss of resources:	Low Fossils are inherently irreplaceable, but the likelihood of scientifically significant material occurring within the development footprint is low.	None.
Degree to which the impact can be reversed:	Low Disturbed geological deposits may be stabilised or rehabilitated, but any fossil material destroyed without recording or collection cannot be replaced.	Not applicable.
Indirect impacts:	Potential loss of scientific information if a chance fossil find is not recognised, reported and professionally assessed before work continues.	No development-related indirect impacts are anticipated.
Cumulative impact prior to mitigation:	Very Low The proposal would add a limited, site-specific increment to the disturbance of superficial deposits already influenced by historical and existing agricultural activities in the Orange River floodplain landscape.	Very Low / Neutral Existing agricultural disturbance would remain, with no additional contribution from the proposed development.

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Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Neutral
Degree to which the impact can be avoided:	Moderate. Ground disturbance cannot be avoided within the orchard footprint, but unnecessary excavation can be avoided and any chance find can be protected by stopping work locally.	High Development-related impacts would be avoided under the No-Go Option.
Degree to which the impact can be managed:	High The low site sensitivity and implementation of a clear chance-find procedure allow the risk to be effectively managed.	N/A
Degree to which the impact can be mitigated:	High Limiting disturbance and responding correctly to unexpected finds would substantially reduce the likelihood of palaeontological loss.	N/A
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Confine vegetation clearance, ripping, excavation and soil preparation to the authorised footprint. • Avoid unnecessary deep excavation and disturbance outside the approved development area. • Brief contractors and machine operators on the recognition and reporting of possible fossil material. • If fossils or potentially fossiliferous material are exposed, stop work immediately in the affected area, protect the find from further disturbance and notify the ECO and the relevant heritage authority. • Do not remove, disturb or collect a find unless authorised by a suitably qualified palaeontologist and the relevant authority. • Allow sufficient time for inspection, recording and, where required, collection before work resumes. • Record the location and circumstances of any chance find.	No mitigation required.
Residual impacts:	Minor disturbance of unconsolidated superficial deposits will remain within the orchard footprint. The residual risk of losing scientifically significant palaeontological material is very low, provided the chance-find procedure is implemented.	None associated with the proposed development.

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Cumulative impact post mitigation:	Very Low No meaningful cumulative effect on the region's geological character or palaeontological record is anticipated.	Very Low / Neutral.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Neutral

During the operational phase, no significant additional impacts on geology or palaeontological resources are anticipated. The ground-disturbing activities with the potential to affect geological deposits or expose palaeontological material will occur primarily during vegetation clearance, soil preparation, ripping and establishment of the orchard.

Once the orchard has been established, routine activities such as irrigation, maintenance and harvesting are not expected to involve significant excavation or disturbance of previously undisturbed geological material. The residual risk to palaeontological resources during operation is therefore considered negligible. Should any future maintenance activity involve deeper excavation and unexpectedly expose fossil material, the chance-find procedure specified in the EMPr must still be implemented.

SOILS

SOIL PROPERTIES AND EROSION:

Topsoil is a very precious, non-renewable resource with high conservation importance and is necessary for the production of grapes, pecan nuts and other crops that the topsoil be protected. The potential of soils to produce crops is dependent on its depth, structure, texture, and sequence of soil horizons.

The opposite of topsoil preservation is topsoil degradation, which involves the removal of soil, and alteration or damage to soil and soil-forming processes, usually due to human activity. Stripping of vegetation will impact negatively soil formation, natural weathering processes, moisture levels, soil stability, humus levels, and biological activity. It is therefore essential that where it occurs, it be preserved and protected or upgraded to improve the agricultural potential of the property.

According to the Soil Suitability Report (Appendix E3),the proposed development area is predominantly underlain by very deep, freely drained Oakleaf and Ermelo soil forms, with a smaller area of carbonate-rich Augrabies and Prieska soils occurring in the northern part of the site. The Oakleaf soils comprise an orthic topsoil horizon overlying a deep neocutanic horizon and have developed from alluvial deposits associated with the Orange River system. The Ermelo

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soils consist of an orthic horizon overlying a very deep, yellow-brown apedal horizon. Both soil forms have favourable physical properties for cultivation and irrigation.

The Oakleaf and Ermelo soils generally exceed 2.5 m in depth, while the Augrabies and Prieska soils are approximately 2.0–2.5 m deep. No depth-limiting layers were encountered within the Oakleaf soils. A hard carbonate horizon occurs at approximately 2.1 m within the Prieska soils, but its depth means that it is not expected to cause significant drainage problems. The soils across the surveyed area are freely drained to a depth of at least 2 m and show no evidence of waterlogging or prolonged saturation.

The clay content of the assessed topsoil and subsoil horizons ranges from approximately 22% to 34%, which falls within the preferred range for pecan nut production. The soils therefore provide an appropriate balance between drainage, aeration and water-holding capacity. Their relatively loose structure and substantial depth should also allow adequate root development. The soils have a low susceptibility to water erosion, owing to the gentle terrain and favourable drainage, but have a moderate susceptibility to wind erosion. Wind erosion will therefore require management when vegetation clearance and soil preparation temporarily expose the soil surface.

The chemical characteristics of the dominant Oakleaf soils are also favourable. Recorded soil pH values range from approximately 6.0 to 6.8, and no lime-containing horizons were identified within the upper 60 cm of the areas classified as suitable. These conditions are appropriate for nutrient availability and pecan production. The cation exchange capacity ranges from approximately 18 to 23 cmol(+)/kg, indicating that the soils have sufficient inherent fertility, although appropriate fertilisation will still be required to maintain optimum production. Existing phosphorus concentrations are comparatively low but can be addressed through a suitable fertilisation programme.

The laboratory results do not indicate an existing salinity or sodicity constraint. Electrical conductivity values of approximately 48–126 mS/m are below the stated pecan-production threshold of 200 mS/m, while the Exchangeable Sodium Percentage is below 3%. These results indicate that salts and sodium have not accumulated to levels that would restrict cultivation. Nevertheless, irrigation will introduce dissolved salts into the soil over time. Irrigation scheduling, drainage, soil salinity and sodicity should therefore be monitored and managed to prevent long-term soil degradation.

The northern Augrabies and Prieska soils are naturally more alkaline and contain carbonate-rich horizons. In the area classified as marginal, free lime occurs within the upper 60 cm of the soil profile. This may reduce the availability of micronutrients to pecan trees and could adversely affect orchard productivity unless micronutrients are supplied through foliar applications or other appropriate fertility-management measures. The limitation is primarily an agronomic and economic constraint, rather than an environmental soil-degradation risk, as the specialist concluded that planting pecan trees in this area is unlikely to cause soil degradation.

Overall, the surveyed area is considered suitable for cultivation and irrigation. The dominant Oakleaf and Ermelo soils are particularly well suited to pecan production due to their substantial depth, good drainage, suitable texture, favourable pH and low existing salinity and sodicity. The Prieska and Augrabies soils are less favourable and should be treated as marginal for pecan production, but remain suitable for cultivation provided that site-specific irrigation and nutrient-management measures are implemented. The soils have a low susceptibility to water erosion but a

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moderate susceptibility to wind erosion; consequently, exposed soils should be stabilised and the duration of exposure minimised during vegetation clearance, soil preparation and orchard establishment.

Impact on the soil & erosion (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Negative. Vegetation clearance, soil preparation, vehicle movement and orchard establishment may expose and disturb the soil, resulting in wind erosion, localised water erosion, compaction and the loss or mixing of topsoil. During operation, inappropriate irrigation or fertiliser application could result in salinisation, sodicity, nutrient imbalance or localised soil degradation.	Neutral. No additional soil disturbance associated with the proposed orchard would occur. Existing soil conditions and current agricultural influences would remain.
Extent and duration of impact:	Site-specific; short-term to long-term. The greatest erosion risk will occur during vegetation clearance and orchard establishment while soils are exposed. Soil compaction, topsoil loss or chemical deterioration could persist in the long term if not appropriately managed.	Site-specific; long-term. Existing soil conditions and land uses would continue without additional disturbance associated with the proposed development.
Consequence of impact or risk:	Low The site is characterised by deep, freely drained soils on gently sloping terrain. Water-erosion potential is low, while wind-erosion potential is moderate. Existing salinity and sodicity levels are within acceptable limits, and the specialist concluded that cultivation is unlikely to result in soil degradation if appropriately managed.	Very Low / Neutral No development-related soil disturbance, erosion or irrigation-related deterioration would occur.
Probability of occurrence:	Probable Temporary soil exposure and disturbance will occur during clearance and orchard establishment. Some wind erosion may occur if exposed soils are not stabilised, while significant water erosion, salinisation or sodicity is unlikely under appropriate management.	Improbable No additional development-related soil disturbance would occur. Natural erosion and impacts associated with existing agricultural activities may continue.
Degree to which the impact may cause irreplaceable loss of resources:	Low No unique or irreplaceable soil resources were identified. The dominant soils are extensive alluvial soil forms with favourable agricultural potential. However, uncontrolled topsoil loss or severe chemical degradation could reduce local soil productivity.	None No additional loss of soil resources would occur as a result of the proposed development.

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Degree to which the impact can be reversed:	Moderate to High Minor erosion, compaction and fertility imbalances can generally be rehabilitated or corrected. Severe topsoil loss, salinisation or structural deterioration would be more difficult and costly to reverse.	N/A
Indirect impacts:	• Sediment may be transported into adjacent drainage features or the Orange River if erosion is not controlled. • Soil compaction may reduce infiltration and increase runoff. • Poor irrigation management could cause salt accumulation, reduced soil fertility and declining orchard productivity. • Wind erosion may also contribute to localised dust generation.	No development-related indirect soil impacts are anticipated. Existing erosion and agricultural management influences would remain unchanged.
Cumulative impact prior to mitigation:	Low The proposal will contribute incrementally to soil disturbance within an existing irrigated agricultural landscape. The cumulative impact is limited by the favourable soil properties, gentle terrain and consolidation of development around existing agricultural infrastructure.	Very Low / Neutral Existing agricultural impacts would remain, with no additional contribution from the proposed orchard.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-)/ Neutral
Degree to which the impact can be avoided:	Moderate Soil disturbance within the orchard footprint cannot be completely avoided, but unnecessary clearance, compaction, topsoil loss and disturbance outside the authorised area can be avoided.	High Development-related soil and erosion impacts would be avoided under the No-Go Option.
Degree to which the impact can be managed:	High The soils are deep, freely drained and situated on gentle terrain. Erosion and soil-degradation risks can be effectively managed through appropriate clearance, irrigation, nutrient-management and soil-conservation practices.	N/A
Degree to which the impact can be mitigated:	High Phased clearing, rapid establishment of vegetative cover, erosion control and appropriate irrigation and fertility management can substantially reduce the impact.	N/A
Proposed mitigation:	• Restrict vegetation clearance and soil disturbance to the authorised development footprint.	No mitigation required.

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Refer to EMP for full list of mitigation	• Demarcate the approved footprint before clearing and prohibit disturbance outside this area. • Undertake vegetation clearance and soil preparation progressively to limit the extent and duration of exposed soil. • Avoid clearing during periods of strong winds, where reasonably practicable. • Retain or establish suitable ground cover between orchard rows as soon as practicable. • Prevent unnecessary soil compaction by restricting vehicles and machinery to designated access routes and working areas. • Strip and retain topsoil separately where excavation or trenching is required and replace it during rehabilitation. • Install appropriate erosion-control measures where runoff concentrates or signs of erosion develop. • Prevent sediment-laden runoff from entering drainage features or the Orange River. • Implement irrigation scheduling appropriate to the soil texture, drainage characteristics and water-holding capacity. • Avoid over-irrigation and monitor drainage to reduce the risk of salt accumulation and waterlogging. • Periodically monitor soil salinity and sodicity and adjust irrigation practices where required. • Implement a soil fertility programme based on soil and leaf analyses and avoid excessive fertiliser application. • Apply appropriate micronutrient management within the marginal Prieska and Augrabies soil areas where free lime may restrict nutrient availability.	
Residual impacts:	Minor localised soil disturbance and compaction may remain within the orchard footprint. A limited risk of wind erosion and gradual salt or nutrient accumulation will remain, but these impacts should be manageable through ongoing irrigation, ground-cover and soil-fertility management.	None associated with the proposed development.
Cumulative impact post mitigation:	Very Low With appropriate soil conservation, irrigation and fertility management, the	Very Low / Neutral.

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	proposed development is not expected to result in meaningful cumulative soil degradation or erosion.	
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-)/ Neutral

During the operational phase, the main potential impacts on soils will be associated with the long-term irrigation and management of the pecan orchard, rather than further physical disturbance. The soil assessment found that the dominant Oakleaf and Ermelo soils are deep, freely drained and suitable for irrigation, with no existing significant salinity or sodicity constraints.

However, irrigation introduces dissolved salts over time and, if irrigation and fertiliser application are not appropriately managed, there is potential for gradual salinisation, sodicity, nutrient imbalance and deterioration of soil productivity. Ongoing irrigation scheduling, maintenance of ground cover, monitoring of soil salinity and sodicity, and appropriate fertiliser and nutrient management will therefore be required. With these measures in place, significant long-term soil degradation is not anticipated.

Impact on the soil and erosion (Operational Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Negative Long-term irrigation and management of the pecan orchard may alter soil physical and chemical properties. Inappropriate irrigation scheduling or fertiliser application could result in gradual salinisation, sodicity, nutrient imbalance, localised compaction and deterioration of soil productivity. Localised erosion may also occur where ground cover is inadequate or runoff becomes concentrated.	Neutral The proposed pecan orchard would not be established and no additional irrigation- or orchard-management-related impacts on soils would occur. Existing soil conditions and impacts associated with the current agricultural land use would continue.
Extent and duration of impact:	Site-specific; long-term Potential impacts would be largely confined to the cultivated orchard footprint and would develop gradually over the operational life of the orchard. If poorly managed, chemical or structural soil deterioration could persist beyond individual growing seasons.	Site-specific; long-term Existing agricultural influences would continue, but no additional long-term soil impacts associated with the proposed orchard would occur.
Consequence of impact or risk:	Low	Very Low / Neutral

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	The dominant Oakleaf and Ermelo soils are very deep, freely drained and suitable for irrigation, with acceptable existing salinity and sodicity levels. The specialist concluded that cultivation is unlikely to cause soil degradation provided appropriate irrigation and fertility management is implemented.	No additional soil degradation associated with operation of the proposed orchard would occur.
Probability of occurrence:	Possible Irrigation and fertiliser application will occur throughout the operational phase and may cause gradual changes in soil chemistry if poorly managed. Significant salinisation, sodicity or soil degradation is not expected under appropriate management.	Improbable No impacts associated with operation of the proposed orchard would occur, although existing agricultural soil-management influences may continue.
Degree to which the impact may cause irreplaceable loss of resources:	Low No unique or irreplaceable soil resources were identified. However, substantial salinisation, sodicity, erosion or structural deterioration could reduce the long-term agricultural productivity of affected soils.	None No additional loss or degradation of soil resources would occur as a result of the proposed orchard.
Degree to which the impact can be reversed:	Moderate to High Nutrient imbalances and early-stage salinity or sodicity can generally be corrected through appropriate irrigation, drainage and soil-fertility management. Severe or prolonged chemical or structural degradation would be more difficult and costly to reverse.	N/A
Indirect impacts:	Poor irrigation management may reduce soil fertility and orchard productivity; compaction may reduce infiltration and increase runoff; localised erosion may transport sediment toward drainage features or the Orange River; and deterioration of soil condition may increase the need for corrective fertiliser or soil-management interventions.	No development-related indirect operational soil impacts are anticipated. Existing agricultural influences would remain.
Cumulative impact prior to mitigation:	Low The orchard would add to the existing irrigated agricultural footprint along the Orange River and could contribute incrementally to long-term irrigation-related soil modification if soil and water management practices are inadequate. The risk is moderated by the favourable soil properties and drainage characteristics.	Very Low / Neutral Existing agricultural impacts would remain, with no additional contribution from the proposed orchard.
Significance rating of impact prior to mitigation	Low (-)	Very Low (-) / Neutral

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(e.g. Low, Medium, Medium-High, High, or Very-High)		
Degree to which the impact can be avoided:	Moderate Irrigation and fertilisation are inherent to operation of the orchard and their influence on the soil cannot be completely avoided. However, over-irrigation, excessive fertiliser application, unnecessary compaction and loss of ground cover can be avoided.	High Operational impacts associated with the proposed orchard would be avoided under the No-Go Option.
Degree to which the impact can be managed:	High The soils are deep and freely drained, and the identified operational risks can be effectively managed through appropriate irrigation scheduling, maintenance of ground cover, soil monitoring and a suitable fertility-management programme.	N/A
Degree to which the impact can be mitigated:	High Appropriate irrigation, drainage, ground-cover and nutrient-management practices, supported by periodic soil monitoring, can substantially reduce the likelihood of long-term soil degradation.	N/A
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Implement irrigation scheduling appropriate to soil texture, drainage characteristics, climatic conditions and crop requirements. • Avoid over-irrigation and monitor drainage to minimise the risk of waterlogging and salt accumulation. • Periodically monitor soil salinity and sodicity and adjust irrigation practices where required. • Implement a soil-fertility programme informed by soil and leaf analyses and avoid excessive fertiliser application. • Apply appropriate micronutrient management within the marginal Prieska and Augrabies soil areas where free lime may restrict nutrient availability. • Maintain suitable vegetative or other protective ground cover between orchard rows, where practicable, to limit erosion and exposed soil. • Restrict routine vehicle and machinery movement to established access routes and working areas to minimise unnecessary soil compaction. • Monitor the orchard for signs of erosion, compaction, declining infiltration or soil	No additional mitigation required for impacts associated with the proposed orchard. Existing good agricultural soil-management practices should continue.

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	deterioration and implement corrective measures where required. • Prevent sediment-laden runoff from entering drainage features or the Orange River.	
Residual impacts:	A limited risk of gradual salt or nutrient accumulation, localised compaction and erosion will remain over the operational life of the orchard. These residual impacts are expected to remain very low provided irrigation, ground cover and soil fertility are appropriately managed and monitored.	None associated with the proposed development.
Cumulative impact post mitigation:	Very Low With appropriate soil conservation, irrigation and fertility management, the proposed orchard is not expected to result in meaningful cumulative soil degradation or erosion within the wider irrigated agricultural landscape.	Very Low / Neutral.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-) / Neutral

SOIL POLLUTION:

Soil pollution can occur during hydrocarbon spills occur, or when 1) used oils and lubricants are purposefully drained into the soil, 2) storage facilities are destabilized or 3) if ablution facilities contaminate soils. Also when pesticides are used.

During the clearing of vegetation, a bulldozer will be used which will require some quantities of diesel fuel, oils, and hydraulic fluids and in return, it produces used oils and lubricants. It is essential that these substances are handled correctly and that workers/contractors are properly trained in this regard; otherwise, they could inadvertently cause unwanted environmental impacts, such as draining used oils into the soil. If needing to drain hydrocarbons on-site due to emergency repair work on the machine, it must be drained into drip pans and immediately siphoned into appropriate containers and dispose of on the same day. The servicing of all vehicles and machines will be restricted to the offsite workshop. Considering that it will only be one bulldozer and possible truck, no impact on soil is anticipated in terms of pollution.

All of the trucks and earthmoving equipment should be well maintained, fuel storage or establishment of a sewage system will not take place at the proposed study area. No bulk diesel fuel, oils, and lubricants will be stored at the site. No chemicals or hazardous substances will be stored at the site, and any fertilizers or pesticides will be stored off-site at the farm shed.

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In the event of small spills, the natural bio-degradation of hydrocarbons could be slightly slower than in well-aerated soils, but the use of fertilizers or oil surfactants could assist in breaking down limited spills in a short space of time.

Due to the limited amount of vehicles that will be used on the site the worst-case scenario would lead to very small hydrocarbon spills that will penetrate the soil immediately and will percolate to lower levels. The use of fertilizers could assist in breaking down limited spills in a short space of time which will preclude them from reaching the drainage lines if lateral drainage occurs. The impact is rated low under worst-case scenario conditions and insignificant under normal circumstances due to the limited spills anticipated in the study area.

In terms of sewage, a chemical toilet should be provided at the study site once clearance commences, to prevent the surroundings from being used for ablutions. Due to the small number of people anticipated to be onsite during the construction phase limited soil pollution is expected and a similar impact on the coliforms count in the soil and water is anticipated. The chemical toilet system must be maintained according to specifications stipulated by Municipal by-laws or by a local health inspector. Due to the absence of ablution facilities, no effluent will be generated that could affect soils and groundwater sources inside or outside the study area. The anticipated soil pollution risk due to sewage spills is rated low under worst-case scenario conditions and insignificant under controlled conditions.

Domestic waste will be produced at the site but the waste streams (tins, paper, food) will be limited to the driver of the bulldozer and truck. Waste can be kept in the vehicles and must not be dumped outside. The contractor and farm owner must take responsibility, since littering of the surroundings through wind action, could affect livestock and the surrounding environment. During the construction phase, this will be a negligible impact. Ultimately the waste production will be very limited at the site and the impact on soils and surroundings is rated very low with mitigation.

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Impact on the soil pollution (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Negative Accidental leaks or spills of diesel, oils or hydraulic fluids from the bulldozer, truck or other machinery; inappropriate handling of used oils; leakage from temporary ablution facilities; and poor management of domestic waste could result in localised soil contamination. No bulk fuel, oils, hazardous substances or chemicals will be stored within the development area, and routine servicing will take place off-site.	Neutral No vegetation clearance or construction-related machinery would be introduced for the proposed development and no additional construction-related soil-pollution risk would occur.
Extent and duration of impact:	Site-specific/localised; short-term. Any contamination is expected to be confined to the immediate spill or incident area during the vegetation-clearance and	Site-specific; long-term existing condition.

	orchard-establishment period. If a spill is not promptly contained and remediated, contamination could persist for longer.	No additional construction-related contamination would occur.
Consequence of impact or risk:	Low. Only limited machinery is expected to operate on site and no bulk hydrocarbons, hazardous substances or sewage infrastructure will be stored or established within the development footprint. The likely volume of an accidental spill is therefore expected to be small and readily containable, provided appropriate controls are implemented.	Very Low / Neutral. No development-related source of construction-phase soil pollution would be introduced.
Probability of occurrence:	Possible. Minor leaks or accidental spills from machinery or temporary ablution facilities can occur during construction, although significant contamination is unlikely where equipment is well maintained and pollution-prevention measures are implemented.	Improbable. No construction activities associated with the proposed development would take place.
Degree to which the impact may cause irreplaceable loss of resources:	Low. Small, localised contaminated areas can generally be remediated and no unique soil resource is expected to be permanently lost. The risk would increase only if a spill were left unmanaged and allowed to spread.	None.
Degree to which the impact can be reversed:	High. Minor hydrocarbon, sewage or waste-related contamination can generally be contained, removed and remediated if identified and addressed promptly. Heavily contaminated soil, if generated, can be excavated and disposed of at an appropriately authorised facility.	N/A
Indirect impacts:	Uncontained pollutants could infiltrate deeper soil horizons or be transported by runoff toward nearby drainage features and ultimately the Orange River. Litter may be dispersed by wind and could affect livestock or the surrounding environment.	No development-related indirect soil-pollution impacts are anticipated.
Cumulative impact prior to mitigation:	Low. The proposed construction activities would add a small and temporary pollution risk within an existing agricultural landscape. Given the limited machinery and absence of bulk fuel or hazardous-material storage on site, the contribution to cumulative soil contamination is expected to be limited.	Very Low / Neutral. Existing agricultural influences would remain, with no additional construction-related contribution from the proposed development.

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Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Neutral
Degree to which the impact can be avoided:	High. Most soil-pollution incidents can be avoided through preventative maintenance, off-site servicing and refuelling controls, correct waste handling, appropriate temporary ablution facilities and immediate response to leaks or spills.	High. Development-related soil-pollution impacts would be avoided under the No-Go Option.
Degree to which the impact can be managed:	High. The limited number of vehicles and machinery, absence of bulk hazardous-material storage and implementation of basic pollution-control procedures allow the risk to be readily managed.	N/A
Degree to which the impact can be mitigated:	High. Prompt containment, clean-up and appropriate disposal of contaminated material can substantially reduce the extent and duration of any accidental pollution event.	N/A
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Ensure all vehicles and machinery are maintained in good working order and free from significant leaks. • Routine servicing and maintenance of vehicles and machinery must take place off-site at the designated workshop. • No bulk diesel, oils, lubricants or hazardous substances may be stored within the development footprint. • Where emergency repairs are unavoidable on site, use drip trays or suitable containment to capture hydrocarbons and transfer them immediately to appropriate sealed containers. • Keep suitable spill-response materials readily available during vegetation clearance and soil preparation. • Immediately contain and clean up all hydrocarbon spills. Contaminated soil must be removed and handled/disposed of appropriately; spills must not be deliberately treated by adding fertiliser or surfactants unless specifically directed by an appropriately qualified person.	No mitigation required for impacts associated with the proposed construction activities.

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	• Do not discharge used oils, fuels, chemicals or contaminated water onto the ground. • Provide an appropriate chemical toilet during vegetation clearance/construction and maintain it in a hygienic, leak-free condition in accordance with applicable requirements. • Position and manage temporary ablution facilities to prevent contamination of soil and water resources. • No littering or dumping may occur. Domestic waste must be collected in suitable containers and removed from site for appropriate disposal. • Fertilisers, pesticides and other agricultural chemicals must be stored at the designated off-site farm storage area and not within the construction footprint. • Any pollution incident must be reported to the responsible site manager/ECO and remediated promptly.	
Residual impacts:	A very small residual risk of isolated soil contamination from accidental leaks or spills will remain while machinery is operating on site. With appropriate preventative controls and immediate clean-up, any residual impact is expected to be minor and localised.	None associated with the proposed development.
Cumulative impact post mitigation:	Very Low. With appropriate machinery maintenance, pollution prevention, waste management and spill-response measures, the construction phase is not expected to make a meaningful contribution to cumulative soil pollution in the area.	Very Low / Neutral.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Neutral

During the operational phase, the principal soil-pollution risk will be associated with the use and handling of agricultural inputs, particularly fertilisers and pesticides, as well as minor accidental hydrocarbon leaks or spills from

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vehicles and machinery used for orchard maintenance and harvesting. Unlike the construction phase, no bulk fuel, oils or hazardous substances are proposed to be stored within the orchard area, with agricultural chemicals to be stored at the farm shed.

Incorrect application, over-application or accidental spillage of fertilisers and pesticides could result in localised contamination of soils and, where pollutants are mobilised by irrigation or runoff, could potentially affect nearby drainage features. Hydrocarbon contamination may also occur through isolated machinery leaks or spills, although the quantities involved during routine orchard operations are expected to be limited.

These risks can be effectively managed through appropriate storage and handling of agricultural chemicals, application in accordance with product requirements and crop needs, maintenance of vehicles and machinery, immediate clean-up of spills, and proper management of waste and chemical containers. Provided these measures are implemented, the operational soil-pollution impact is expected to remain low to very low.

Impact on the soil pollution (Operational Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Negative. Routine orchard operations will involve the use of fertilisers and pesticides and the operation of farm vehicles and machinery. Incorrect handling, over-application or accidental spills of agricultural chemicals, or isolated hydrocarbon leaks, could result in localised soil contamination. Improper disposal of chemical containers or other operational waste could also contaminate soils.	Neutral. The proposed orchard would not become operational and no additional soil-pollution risk associated with its agricultural inputs, maintenance or harvesting activities would occur. Existing agricultural influences would remain.
Extent and duration of impact:	Site-specific/localised; long-term. The risk would persist for the operational life of the orchard but individual pollution incidents are expected to be localised. Unmanaged contamination could persist in affected soil for a longer period.	Site-specific; long-term. Existing land-use influences would continue, but no additional operational pollution risk associated with the proposed orchard would occur.
Consequence of impact or risk:	Low. Agricultural chemicals will be stored off-site at the farm shed and no bulk fuel or oils are proposed to be stored within the orchard area. Potential contamination is therefore expected to be localised and manageable, provided products are correctly applied and spills are promptly addressed.	Very Low / Neutral. No additional operational soil-pollution source associated with the proposed orchard would be introduced.
Probability of occurrence:	Possible. Fertilisers and pesticides will be used during orchard operation and vehicles and machinery will access the site. Minor	Improbable. No operational activities associated with the proposed orchard would occur.

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	accidental spills or leaks are therefore possible, although significant soil contamination is unlikely under appropriate management.	
Degree to which the impact may cause irreplaceable loss of resources:	Low. Localised contamination would not normally result in the permanent loss of the soil resource if identified and remediated promptly. Severe or repeated unmanaged contamination could, however, impair soil quality and agricultural productivity.	None.
Degree to which the impact can be reversed:	High. Minor localised contamination can generally be contained and remediated. Contaminated soil can be removed or treated where necessary, although repeated or severe chemical contamination would be more difficult to reverse.	N/A
Indirect impacts:	Pollutants may be mobilised through irrigation or runoff and transported toward drainage features or the Orange River. Repeated inappropriate chemical application may also adversely affect soil organisms, soil quality and long-term agricultural productivity.	No development-related indirect operational soil-pollution impacts are anticipated.
Cumulative impact prior to mitigation:	Low. The orchard would contribute an additional long-term source of agricultural chemical use within an existing irrigated farming landscape. Poor management across agricultural areas could cumulatively affect soil quality and downstream water resources, although the contribution from the proposed orchard is expected to remain limited.	Very Low / Neutral. Existing agricultural pollution risks would remain, with no additional contribution from the proposed orchard.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-) / Neutral
Degree to which the impact can be avoided:	Moderate to High. The use of fertilisers and pesticides forms part of orchard management and cannot necessarily be avoided, but spills, over-application, inappropriate disposal and unnecessary soil contamination can largely be prevented.	High. Development-related operational soil-pollution impacts would be avoided under the No-Go Option.
Degree to which the impact can be managed:	High. Appropriate chemical storage, application procedures, machinery maintenance,	N/A

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	waste management, staff training and spill-response measures allow the risk to be effectively managed.	
Degree to which the impact can be mitigated:	High. Correct application and handling of agricultural inputs, together with immediate containment and remediation of spills, can substantially reduce the likelihood and severity of soil contamination.	N/A
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Store fertilisers, pesticides, fuels, oils and other hazardous substances at the designated farm storage facilities and not within the orchard footprint, except for quantities required for immediate use. • Apply fertilisers and pesticides strictly in accordance with product instructions, crop requirements and applicable legal requirements. • Avoid over-application of fertilisers and pesticides and implement application rates informed by appropriate soil, leaf and crop-management requirements. • Do not mix, decant or dispose of agricultural chemicals or wash contaminated equipment where residues could enter the soil, drainage features or the Orange River. • Ensure vehicles, tractors and other machinery are maintained in good working order and free from significant leaks. • Immediately contain and clean up hydrocarbon, pesticide, fertiliser or other chemical spills using appropriate spill-response procedures. • Remove contaminated soil where necessary and manage/dispose of it appropriately. • Do not dispose of empty pesticide, fertiliser or chemical containers within the orchard. Containers must be managed in accordance with the relevant product and waste-management requirements. • Maintain suitable waste collection arrangements and prohibit littering or dumping. • Train workers involved in chemical handling and application in correct	No additional mitigation required for impacts associated with the proposed orchard. Existing good agricultural and pollution-prevention practices should continue.

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	handling, application and spill-response procedures. • Avoid chemical application where weather conditions create an unacceptable risk of spray drift or mobilisation into adjacent drainage features. • Maintain records of significant spills and corrective actions where applicable.	
Residual impacts:	A very small residual risk of isolated contamination from accidental chemical or hydrocarbon spills will remain throughout operation. With appropriate chemical management, machinery maintenance and spill response, the residual impact is expected to remain localised and very low.	None associated with the proposed development.
Cumulative impact post mitigation:	Very Low. With appropriate agricultural chemical management, pollution prevention and spill-response measures, the proposed orchard is not expected to make a meaningful contribution to cumulative soil pollution in the surrounding agricultural landscape.	Very Low / Neutral.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-) / Neutral

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FLORA

Vegetation plays an important role in maintaining ecosystems, stabilizing soils, maintaining the aesthetics of an area and in providing income for landowners. Therefore, when development is anticipated the vegetation structure needs to be analyzed, and rare or endangered plant species must be identified. Vegetation structure is mostly determined by the geology and climatic factors.

There are an estimated 5 400 plant species in the Northern Cape that occur in six large biomes: the Nama Karoo Biome, Succulent Karoo Biome, Savanna Biome, Grassland Biome, Fynbos Biome, and Desert Biome. More than 30% of the plants found in the Northern Cape are endemic and most of these occur in the Succulent Karoo along the West Coast of South Africa. Many of these plants are rare or threatened, with very limited distribution.

A tree aloe that is a typical landscape feature of the Northern Cape is the kokerboom, or quiver tree (*Aloe dichotoma*). This tree aloe is found growing mainly on the rocky habitat of the hills along the Orange River. In places it occurs in dense “forests”, and good examples of these occur just south of Kenhardt and between Pofadder and Pella. The

Doringberg hiking trails near Prieska pass by these gentle aloe giants, and close to 4 000 trees can be seen in the Kokerboom forest on the Kokerboom hiking trail near Kenhardt. Necessitated by the harsh climatic conditions, the kokerboom has adapted to survive. Low air humidity, low soil moisture and intense sunshine levels have made it necessary for it to absorb every available scrap of moisture. It, therefore, has a superficial root system enabling it to absorb moisture quickly.

The proposed development will result in the direct and permanent loss of indigenous vegetation within the authorised orchard footprint during vegetation clearance and site preparation. The significance of this impact varies across the development area because the vegetation is not uniform in condition or ecological value.

The vegetation types present at the proposed site occurs within the Nama Karoo Biome, namely a very small section in the Northern Upper Karoo (NKu3) considered as least threatened and the majority of the site falls within the Upper Gariep Alluvial Vegetation (Aza4) type.

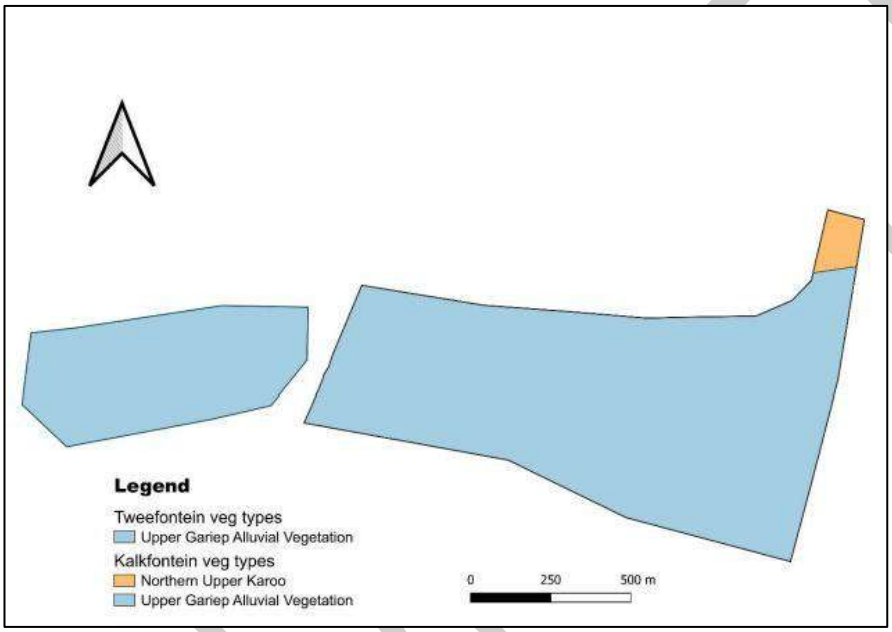

FIGURE 4: VEGETATION TYPES OF THE SITE (SPARAXIS ENVIRONMENTAL, 2025).

On Tweefontein, the flora specialists (Sparaxis Environmental) identified three (3) vegetation units (see report in Appendix E4):

1) Riparian vegetation unit occurs on the southern boundaries of the site and host protected species such as *Mesembryanthemum junceum, M. coriarium* and *M. geurichianum* listed under the Northern Cape Ordinance, Schedule 2.

2) Disturbed pivot vegetation unit is situated between existing pivots and has already been degraded by agricultural and anthropogenic disturbance. It contains several alien invasive species and is considered to have very low biodiversity importance. However, the protected tree *Boscia albitrunca* is present within this vegetation unit.

3) The natural vegetation unit, according to the botanical report, is near-natural, has moderate species richness and retains ecological functionality and connectivity with natural vegetation to the west. The specialist considers this unit to have high biodiversity importance and records several *Boscia albitrunca* individuals.

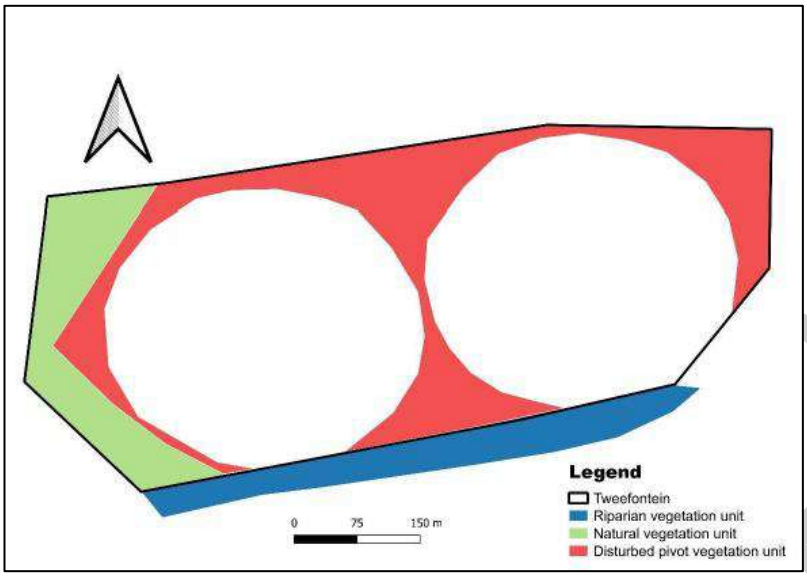

FIGURE 5: VEGETATION UNITS ON TWEEFONTEIN (SPARAXIS ENVIRONMENTAL, 2025)

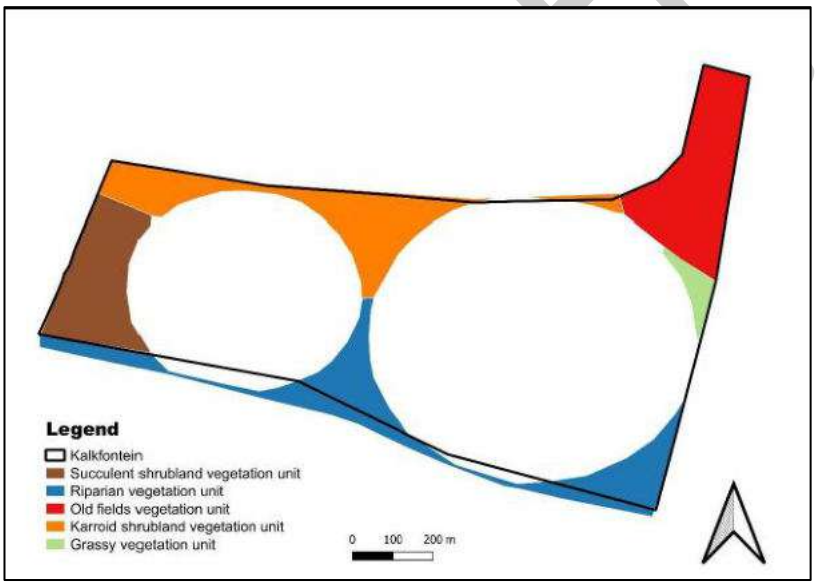

FIGURE 6: VEGEATION UNITS ON KALKFONTEIN (SPARAXIS ENVIRONMENTAL, 2025).

On Kalkfontein, five (5) vegetation units were classified.

1) Riparian vegetation unit

2) Succulent shrubland vegetation unit

3) Karroid shrubland vegetation unit

4) Grassy vegetation unit

5) Old fields vegetation unit

Vegetation Units 2 and 3 comprise near-natural vegetation with moderate species richness and medium to medium-high conservation value, while Vegetation Units 4 and 5 are disturbed or transformed and have substantially lower conservation value and biodiversity importance.

No threatened plant species or suitable habitat for threatened species were identified during the specialist survey. Protected plant species were, however, recorded within the vegetation units. The specialist therefore recommends that the required permits be obtained prior to their removal and that affected protected plants be replanted into suitable habitat outside the development footprint under the supervision of a suitably qualified plant ecologist. Larger *Boscia albitrunca* individuals within Tweefontein Vegetation Units 2 and 3 should be retained as far as practically possible.

The construction-phase impact will therefore principally comprise the permanent loss and transformation of indigenous vegetation, disturbance or loss of protected plant species, reduction in local plant diversity and potential further spread of alien invasive plants following disturbance. The impact should be reduced by strictly limiting clearing to the authorised footprint, retaining higher-value vegetation and protected trees wherever practically possible, obtaining the necessary permits, undertaking plant rescue/translocation before clearing, and controlling alien invasive species.

Alien invasive plant species were recorded across several of the vegetation units on both Tweefontein and Kalkfontein. Their occurrence is particularly associated with areas that have previously been disturbed by agricultural activities, including areas between existing centre pivots and previously cultivated land. The presence and abundance of these species are therefore also indicative of the existing level of transformation and disturbance within portions of the study area.

On Tweefontein, Vegetation Unit 2, which occurs between the existing pivots and has been degraded by previous agricultural and anthropogenic activities, contains several alien invasive species, including *Datura* species, *Salsola kali*, *Xanthium spinosa*, *Argemone ochroleuca* and *Neltuma glandulosa* (previously *Prosopis glandulosa*). The specialist notes that the occurrence of these species is characteristic of transformed vegetation with low conservation value and species richness. Alien species, including *Salsola kali* and *Boerhavia cordobensis*, were also recorded within the more natural Vegetation Unit 3, where their removal is recommended to prevent further encroachment and displacement of indigenous vegetation.

On Kalkfontein, alien invasive species were similarly recorded within both the near-natural and disturbed vegetation units. *Datura ferox* and *Salsola kali* occur within Vegetation Units 2 and 3, and the specialist recommends that these plants be removed where possible. Vegetation Unit 4, situated between existing pivots and already substantially degraded, contains *Argemone ochroleuca* and *Neltuma glandulosa*. The latter also occurs within the riparian vegetation associated with both properties.

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The proposed clearing will remove vegetation, including existing alien invasive plants, from within the approved orchard footprint. Care should nevertheless be taken during clearing to ensure that alien plant material, particularly material capable of regenerating or dispersing seed, is appropriately managed and is not inadvertently spread into the surrounding natural vegetation through machinery, vehicles or the movement of cleared material.

Once the pecan orchard has been established, the development footprint will be maintained as actively managed agricultural land. Alien plants and agricultural weeds occurring between the pecan trees would therefore be controlled as part of routine orchard management. Natural vegetation outside the authorised orchard footprint should remain undisturbed, and clearing activities, stockpiling of vegetation or movement of machinery should not extend into these areas.

Impact on the clearing of vegetation (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Negative. Clearing for establishment of the pecan orchard will result in the direct and permanent removal of vegetation within the authorised development footprint. The affected areas include a mixture of previously disturbed/degraded vegetation and near-natural vegetation of higher ecological value. Protected plant species occur within the vegetation units, including *Boscia albitrunca*. No threatened plant species or suitable habitat for threatened species were identified by the flora specialist. Clearing may also facilitate the dispersal of existing alien invasive plants if plant material and disturbed areas are not appropriately managed.	Neutral / Positive for vegetation conservation. The proposed clearing would not occur and the existing indigenous and recovering vegetation would remain. Existing ecological processes and habitat connectivity would be retained, although existing agricultural disturbance and alien invasive plants would continue to require management.
Extent and duration of impact:	Site-specific to local; permanent. Direct vegetation loss will occur within the authorised orchard footprint and will persist for the life of the agricultural land use. Effects on local vegetation continuity and ecological function may extend to immediately adjoining retained vegetation if clearing is not strictly controlled.	Site-specific to local; long-term. Existing vegetation would remain and could continue natural succession, subject to existing land-use pressures and alien plant management.
Consequence of impact or risk:	Medium. The specialist identified both low-value disturbed vegetation and near-natural vegetation with medium to high conservation/biodiversity importance. Riparian vegetation is of high conservation priority and sensitivity and must remain protected from unnecessary disturbance. No riparian vegetation will be cleared.	Low / Beneficial from a flora perspective. No additional indigenous vegetation would be lost and existing vegetation structure, protected plants and ecological function would be retained.

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	Protected species are present, but no threatened plant species or suitable habitat for threatened species were identified. The consequence is moderated by the existing agricultural transformation and the location of portions of the proposed clearing between existing pivots.	
Probability of occurrence:	Definite. Vegetation clearance is required to establish the proposed orchard and the direct loss of vegetation within the approved footprint will therefore occur if the development proceeds.	Improbable / None. Development-related vegetation clearing would not occur.
Degree to which the impact may cause irreplaceable loss of resources:	Moderate. Indigenous vegetation and ecological function within the cleared footprint will be permanently lost for the duration of the agricultural land use. The specialist did not identify threatened plant species, which reduces the likelihood of loss of irreplaceable botanical resources. Protected plants can, where feasible, be retained or rescued/translocated under the required permits.	Low / None in relation to the proposed development. Existing indigenous vegetation and protected plants would remain in situ.
Degree to which the impact can be reversed:	Low. Once indigenous vegetation has been cleared and the land converted to an irrigated pecan orchard, the original vegetation composition and ecological function cannot readily be restored. Rehabilitation would require cessation of the agricultural use and long-term ecological recovery.	N/A
Indirect impacts:	Potential indirect impacts include edge effects on adjoining retained vegetation, accidental clearing beyond the authorised footprint, disturbance or loss of protected plants, and dispersal of alien invasive plant propagules through machinery or movement of cleared material. Uncontrolled disturbance could also reduce the ecological integrity of adjoining natural vegetation.	No development-related indirect vegetation impacts are anticipated. Existing alien invasive plants and historical agricultural disturbance may continue in the absence of active management.
Cumulative impact prior to mitigation:	Medium. The proposed clearing will add to historical agricultural transformation along the Orange River and will result in a further permanent reduction of indigenous vegetation within an already cultivated landscape. The cumulative effect is moderated by the fact that parts of the footprint are already disturbed or degraded	Low / Neutral. No additional contribution to vegetation loss from the proposed development would occur, although existing agricultural transformation in the wider landscape would remain.

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	and occur between existing agricultural pivots, but near-natural vegetation will also be affected.	
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium-High (-)	Low (-) / Neutral
Degree to which the impact can be avoided:	Low to Moderate. The vegetation loss within the orchard footprint is inherent to the proposed development and cannot be avoided if the orchard is established. However, impacts can be partially avoided by confining clearing to the approved footprint, excluding sensitive areas outside the footprint, and retaining larger protected *Boscia albitrunca* individuals as far as practically possible.	High. Development-related vegetation loss would be avoided under the No-Go Option.
Degree to which the impact can be managed:	High. The spatial extent of clearing can be controlled through pre-construction demarcation, environmental supervision, permit compliance, plant rescue/translocation and strict protection of vegetation outside the authorised footprint.	N/A
Degree to which the impact can be mitigated:	Moderate. Mitigation can reduce impacts on protected species, adjoining vegetation and ecological integrity, but cannot fully mitigate the permanent loss of indigenous vegetation within the cultivated orchard footprint.	N/A
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Clearly survey and demarcate the authorised clearing/orchard footprint before vegetation clearance commences. • No clearing, vehicle movement, stockpiling or construction-related disturbance may occur outside the approved development footprint. • Retain riparian vegetation and other sensitive natural vegetation outside the approved footprint and prevent unnecessary disturbance to these areas. • Obtain all required permits before removing, damaging or transplanting protected plant species. • Undertake a pre-clearance walk-through/search-and-rescue by a suitably qualified plant ecologist where required	No development-related mitigation is required. Existing alien invasive plants should nevertheless continue to be controlled as part of responsible land management.

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	to identify protected plants within the clearing footprint. • Protected plants that cannot be retained in situ must be rescued and replanted into suitable habitat outside the development footprint in accordance with permit requirements and under the supervision of a suitably qualified plant ecologist. • Larger *Boscia albitrunca* individuals, particularly within Tweefontein Vegetation Units 2 and 3, must be retained as far as practically possible. Where retention is not possible, the required permit must be obtained before removal. • Clearing must be limited to the minimum area required for establishment of the approved orchard. • Workers and machine operators must be informed of the development boundaries and the prohibition on disturbing vegetation outside the authorised footprint. • Alien invasive plants occurring within the clearing footprint must be appropriately managed during clearance so that seeds or viable plant material are not spread into surrounding natural vegetation. • Cleared alien invasive plant material must be handled and disposed of in a manner that prevents re-establishment or dispersal. • Machinery and vehicles should be inspected/cleaned where necessary to minimise transfer of alien plant seeds or propagules between disturbed and natural areas. • No indigenous vegetation outside the authorised footprint may be used for firewood or otherwise removed by workers. • Any accidental disturbance outside the approved footprint must be reported to the ECO and rehabilitated as soon as practicable.	
Residual impacts:	Permanent loss of indigenous vegetation and associated ecological function will remain within the orchard footprint after mitigation. Mitigation can reduce impacts on protected plants and prevent unnecessary disturbance outside the	No residual vegetation-loss impact associated with the proposed development.

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	footprint, but cannot replace the vegetation communities removed for cultivation.	
Cumulative impact post mitigation:	Low to Medium. Strict footprint control, retention/rescue of protected plants and protection of adjoining natural vegetation will reduce unnecessary cumulative effects. However, the authorised vegetation loss will remain a permanent contribution to agricultural transformation in the local landscape.	Low / Neutral. No additional cumulative vegetation loss from the proposed development would occur.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-). The significance remains Medium because the direct loss of vegetation is permanent and cannot be fully mitigated, although mitigation substantially reduces avoidable impacts on protected species and vegetation outside the approved footprint.	Low (+) / Neutral

No significant additional impacts on indigenous vegetation or protected plant species are anticipated during the operational phase. The direct and permanent loss of vegetation associated with the establishment of the pecan orchard will occur during the construction/establishment phase and has therefore been assessed under that phase. Once established, the development footprint will be maintained as an operational pecan orchard, with routine control of weeds and unwanted vegetation forming part of normal agricultural management.

Natural vegetation outside the authorised development footprint will not be disturbed during orchard operations. Operational activities must remain within the approved agricultural footprint and no further clearing of indigenous vegetation may take place without the necessary environmental and/or permit requirements being considered. Accordingly, a separate operational-phase flora impact assessment is not considered necessary.

FAUNA

Animals play an important role in maintaining the functioning of any ecosystem, for example, pollination, spreading of seeds, removing of pests, trimming of vegetation, etc. The largest part of the Northern Cape falls within the Nama-Karoo biome with a vegetation of low shrubland, grass and trees limited to watercourses. The region is typically an arid environment and the terrain and general landscape do not represent much topographical variation. Therefore faunal species are generally widespread across the region, although some key biotopes such as rivers or pans, or the presence of a particular plant species can become an obvious niche for particular animal species that can result in a concentration of species at a certain location.

The occurrence of faunal species within the proposed area is likely, however, it is farm properties and generally fenced-in camps, which will hinder the mobility of some of the larger wildlife that cannot jump a fence or the smaller wildlife that cannot borrow. Typically, many of the species encountered in the region are species such as the Common Duiker (*Sylvicapra grimmia*), Springbok (*Antidorcas marsupialis*), Steenbok (*Raphicerus campestris*), Blesbok, (*Damaliscus pygargus phillipsi*), Smiths red rock rabbit (*Pronolagus rupestris*), Scrub Hare (*Lepus saxatilis),* Spring Hare (*Pedetes capensis*), Meerkat (*Suricata suricatta*), Ground Squirrel (*Xerus inauris*), Rock elephant shrew (*Elephantulus myurus*), Suricate or Stokstertmeerkat (*Suricata suricatta*), Rock dassie (*Procavia capensis*), Yellow Mongoose (*Cynictis penicillata*), and Aardvark (*Orycteropus afer*).

Some reptiles can include the Leopard tortoise (*Stigmochelys pardalis*), Cape Cobra (*Naja Nivea*), Puff adder (*Bitis arietans),* Mole snake (*Pseudaspis cana*), Bibron's gecko (*Pachydactylus bibronii*), Southern rock agama (*Agama atra*), Ground agama (*Agama aculeata*), Striped skink (*Plestiodon fasciatus*), Cape skink (*Trachylepis capensis*). Amphibians such as the Common caco (*Cacosternum boettgeri),* Giant bullfrog (*Pyxicephalus adspersus*), Karoo Toad (*Bufo gariepensis),* Common platanna (*Xenopus laevis)* might also occur in the region.

This arid region hosts at least 215 bird species of which 68 species are endemic or near-endemic species, 18 red-listed species, and 5 red-listed endemic species. Several large terrestrial bird and raptor species, of which the most important are Ludwig's Bustard (Neotis ludwigii), Kori bustard (Ardeotos kori), Secretarybird (Sagittarius seppentarius), Karoo Korhaan (Eupodotis vigorsii), Verreaux's Eagle (*Aquila verreauxii),* the Tawny eagle (*Aquila rapax)* and Martial Eagle (*Polemaetus bellicosus*), Lanner falcon (*Falco biarmicus*).

The Northern Cape is home to an assemblage of arid sone adapted smaller bird species including larks, such as Spike-heeled Lark (*Chersomanes albofasciata*), sparrow-larks, and others. From a conservation perspective, the Red Lark (*Calendulauda burra)* and Sclater's Lark (*Spizocorys sclateri)*, who are both listed as regionally threatened species (vulnerable and near-threatened respectively). They have very restricted ranges. Other species can include the Spotted Eagle-owl (*Bubo africanus*), Martial Eagle (*Polemaetus bellicosus*).

Other potential birds include the Sociable weaver (*Philetarius socius*) which builds huge grass nests to the critical infrastructure of developments which can cause problems.

BioBase Environmental conducted a terrestrial fauna assessment. The specialist rates overall site sensitivity as High, since Kori Bustard, Lanner Falcon and Aardvark were confirmed in or adjacent to the study area; other species of conservation concern (SCC) are considered likely or possible, rather than confirmed on the development footprint.

During construction, clearing and soil preparation will permanently replace natural or near-natural habitat in the infill areas, reduce food and prey resources, disturb animals and potentially damage burrows, nests or individual slow-moving animals. The specialist assigns High impact to Tawny Eagle, Ludwig's Bustard, Kori Bustard, Black-footed Cat, African Striped Weasel, Aardvark and Tent Tortoise in its species-specific orchard-development assessment. These ratings must not be interpreted as confirmation that every species occupies the footprint. Pre-clearance surveys and the avoidance of occupied sensitive features are therefore critical. If Black-footed Cat, African Striped Weasel or an active Tawny or Verreaux's Eagle nest is confirmed within the footprint, the affected portion must be suspended and

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the relevant authorities consulted before proceeding, including applicable permit requirements identified by the specialist.

Impact on fauna (Construction Phase)	**Alternative 1**	**No-Go Option**
Nature of impact	Negative. Clearance and soil preparation of infill vegetation between existing pivots will permanently transform remaining natural/near-natural fauna habitat. Machinery and human activity can disturb, displace, injure or kill animals, destroy burrows and ground nests, and reduce food and shelter. The specialist identifies particular concern for open-habitat birds, Black-footed Cat, African Striped Weasel, Aardvark and Tent Tortoise.	Neutral in relation to the proposed works. No additional infill clearance, soil preparation or associated construction disturbance would occur; existing agricultural activity and its effects would remain.
Extent and duration of impact	Primarily site-specific, with local implications for fauna moving between the remaining veld and the Orange River corridor. Clearance activity is short-term, but the loss of habitat within the converted footprint is permanent for the life of the orchard.	Site-specific; existing land-use conditions continue. No additional construction-related habitat loss.
Consequence of impact or risk	High for susceptible species and occupied habitat: permanent loss of open Karoo habitat, burrows, nesting/foraging areas and possible direct mortality. The specialist assigns high overall orchard-development impacts to Tawny Eagle, Ludwig's Bustard, Kori Bustard, Black-footed Cat, African Striped Weasel, Aardvark and Tent Tortoise; these are species-level ratings, not a construction-phase score.	No additional consequence from the proposed construction. Existing fragmentation and farming effects are not removed.
Probability of occurrence	Definite for habitat transformation within the approved clearance footprint; possible for direct injury/mortality or disturbance of individual SCC, depending on their presence and timing of works.	No proposed construction impact; existing fauna pressures may continue.
Degree to which the impact may cause irreplaceable loss of resources	High where occupied habitat, nests, burrows or individuals of SCC are lost. The specialist identifies a high-	No additional loss attributable to the proposed clearance.

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	sensitivity site and requires surveys before the infill area is disturbed.	
Degree to which the impact can be reversed	Low for habitat conversion within the permanent orchard footprint; direct mortality cannot be reversed. Temporary disturbance outside the cleared footprint may cease after construction.	Not applicable to proposed construction.
Indirect impacts	Reduced prey and forage, displacement into adjacent veld, disruption of movement and habitat connectivity, and greater exposure to existing agricultural pressures. Soil disturbance may destroy Aardvark burrows and tortoise food plants.	No additional indirect impacts from the proposed works; existing agricultural influences remain.
Cumulative impact prior to mitigation	High negative. The proposed infill area would add to approximately 95 ha of existing transformed pivot habitat, further reducing remaining infill veld in the agricultural landscape. The specialist identifies habitat loss/fragmentation as a principal orchard impact.	No additional contribution from the proposed clearance; existing transformed land remains.
Significance rating of impact prior to mitigation	High (–). This reflects certain permanent habitat conversion in a specialist-verified High-sensitivity site and high species-level impacts for several SCC; it does not imply every species will occur in the clearance footprint.	Neutral for the proposed construction; existing impacts persist.
Degree to which the impact can be avoided	Partial. Excluding the main Orange River riparian corridor and retaining sensitive habitat, burrows, nests and movement routes can avoid some impacts. Habitat conversion inside the approved infill footprint cannot be avoided if the development proceeds.	High: proposed clearance and its additional impacts would not occur.
Degree to which the impact can be managed	Moderate to High for construction disturbance and direct mortality, subject to competent pre-clearance surveys, footprint control, stop-work triggers and supervision; low for managing away the permanent loss of cleared habitat.	Not applicable.
Degree to which the impact can be mitigated	Moderate overall. Targeted avoidance and pre-clearance procedures can materially reduce injury and mortality, but cannot restore the cleared habitat or	N/A

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	eliminate all residual species-level impacts.	
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Undertake specialist-led pre-clearance surveys across all 46 ha infill areas before any earthworks, including SCC, active raptor and ground-bird nests, Aardvark burrows and tortoises. • Suspend work in any affected area if Black-footed Cat, African Striped Weasel or an active Tawny Eagle/Verreaux's Eagle nest is confirmed; consult the appropriate authority and obtain any required authorisation before proceeding, as specified by the specialist. • Identify and protect Aardvark burrows; establish the specialist-recommended no-insecticide buffer around known burrows. • Check for and protect/appropriately relocate tortoises under specialist direction and applicable permits before soil preparation. • Clearly demarcate the authorised footprint and no-go areas; retain the main Orange River riparian corridor and avoid unnecessary clearance of remaining veld. • Conduct documented fauna awareness training before construction; prohibit persecution, trapping and collection; establish a dead-animal reporting protocol. • Implement the specialist's rodenticide controls and prohibit gin traps.	No project-specific construction mitigation required. Existing fauna protection and lawful farm management continue.
Residual impacts	Permanent loss of cleared infill habitat and its foraging/burrowing/nesting functions; possible continued displacement and loss of connectivity. Even with surveys and avoidance, an irreversible residual habitat impact remains.	No additional residual impact from the proposed clearance.
Cumulative impact post mitigation	Medium–High negative: retention of the main riparian corridor, avoidance of occupied SCC features and control of direct mortality reduce additional pressure, but the permanent infill area habitat	No additional cumulative impact from the proposed construction.

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	conversion remains cumulative with the existing 95 ha transformed footprint.	
Significance rating of impact after mitigation	Medium–High (−). The specialist does not provide a consolidated post-mitigation construction score; high species-level sensitivities are not downgraded by this phase rating. Thus this rating is based on the EAP consolidated construction assessment, conditional on full implementation of specialist measures and avoidance/authorisation of confirmed SCC features.	Neutral for the proposed construction.

During operation, permanent orchard cover and ongoing management may continue to reduce habitat suitability and ecological connectivity for open-veld species. The specialist identifies depletion of prey and invertebrate food sources and primary or secondary poisoning from pesticides, insecticides and rodenticides as particular concerns. The African Striped Weasel and Black-footed Cat warrant explicit rodenticide controls, while Aardvark burrows require avoidance and no-insecticide buffers. Impacts on birds and bats may arise through reduced prey and chemical exposure; the Caspian Tern is primarily exposed indirectly through potential agricultural chemical transport into the Orange River food chain. Operational controls can reduce these risks but cannot restore the natural habitat removed by the infill expansion.

The No-Go Option would avoid the additional area of development-related habitat clearance and orchard-related faunal risks. It would not reverse the historical transformation of the existing pivots or eliminate the effects of existing agricultural activities. The assessment below therefore distinguishes the incremental effects of this proposal from the existing agricultural baseline.

Impact on fauna (Operational Phase)	**Alternative 1**	**No-Go Option**
Nature of impact	Negative. Continued operation of the pecan nut orchard maintains the permanent conversion of infill veld to irrigated agriculture. Loss of open-veld foraging and shelter habitat, altered prey availability and exposure to rodenticides or insecticides may affect fauna, particularly the species of conservation concern (SCC) identified by the specialist.	Neutral in relation to the proposed orchard. The additional infill orchard would not operate; existing pivot farming and associated fauna pressures would continue.
Extent and duration of impact	Site-specific habitat conversion with local implications for animals using	Site-specific existing land use continues over the long term; no

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	adjacent veld and the retained Orange River corridor; long-term/permanent for the operational life of the orchard. Chemical exposure may extend beyond the treated area through prey and food chains.	additional operational impact from the proposed orchard.
Consequence of impact or risk	High for susceptible SCC and habitat functions. The specialist identifies high overall orchard-development impacts for Tawny Eagle, Ludwig's Bustard, Kori Bustard, Black-footed Cat, African Striped Weasel, Aardvark and Tent Tortoise. This is a species-level finding, not a separate operational-phase rating.	No additional consequence attributable to the proposed orchard. Existing agriculture may continue to affect fauna.
Probability of occurrence	Definite continuation of habitat conversion if the orchard operates. Additional impacts from agricultural chemicals, prey depletion and conflict are possible and depend on management and the actual presence of susceptible fauna.	Improbable for impacts specifically attributable to operation of the proposed additional orchard; existing agricultural impacts remain possible.
Degree to which the impact may cause irreplaceable loss of resources	High where persistent habitat loss or chemical-related mortality affects SCC or occupied habitat. Individual mortality is irreversible; the specialist does not establish occupation of every part of the footprint by every SCC.	No additional irreplaceable loss attributable to the proposed orchard; existing pressures are not reversed.
Degree to which the impact can be reversed	Low for permanent habitat conversion while the orchard remains operational; mortality cannot be reversed. Chemical exposure and some disturbance can be reduced through changes to management.	Not applicable to additional orchard impacts; the existing landscape remains as it is.
Indirect impacts	Reduced prey and invertebrate availability; secondary poisoning of predators and scavengers through contaminated prey; reduced suitability of infill areas for open-veld species; possible displacement and movement constraints between retained habitats.	No additional indirect operational effects from the proposed orchard. Existing farming-related indirect effects continue.
Cumulative impact prior to mitigation	High negative (EAP assessment). The additional converted infill veld would compound the approximately 95 ha of existing pivot transformation and add long-term chemical-use pressures in the agricultural landscape. The specialist does not	Neutral additional contribution from the proposed orchard; existing agricultural fragmentation and chemical-use risks remain.

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	provide a distinct operational cumulative rating.	
Significance rating of impact prior to mitigation	High (−), Consolidated operational assessment, based on permanent habitat conversion and the specialist's high species-level orchard-development impacts for several SCC. This is not a specialist-issued phase-specific rating.	Neutral in relation to the proposed orchard; existing land-use impacts persist.
Degree to which the impact can be avoided	Partial. Retain and protect the main Orange River riparian corridor and other excluded sensitive features; avoid or strictly control harmful chemical use and avoid disturbance of known SCC habitat. Conversion within the approved infill orchard cannot be avoided while the orchard operates.	High for additional orchard-related impacts because the proposed expansion does not proceed.
Degree to which the impact can be managed	Moderate to High for chemical exposure, direct disturbance and wildlife conflict through enforceable farm procedures, buffers, staff training and monitoring; low for managing away permanent habitat loss.	Not applicable to the proposed orchard. Continue responsible management of existing farming activities.
Degree to which the impact can be mitigated	Moderate overall. Targeted chemical controls, burrow and habitat buffers and staff awareness can reduce avoidable injury, poisoning and conflict, but cannot restore original open-veld habitat beneath the permanent orchard.	Not applicable to additional orchard impacts.
Proposed mitigation (refer to EMP for full list)	• Implement a documented rodenticide management protocol that prohibits or strictly controls anticoagulant and acute rodenticides in known or potential African Striped Weasel habitat and addresses Black-footed Cat secondary-poisoning risk. • Retain and manage the specialist-recommended habitat buffers for Black-footed Cat and avoid disturbance of identified SCC habitat. • Maintain an explicit no-insecticide buffer around known Aardvark burrows; accommodate Aardvark movement in farm infrastructure and avoid persecution.	No additional mitigation for the proposed orchard. Existing agricultural activities should continue to apply relevant fauna-protection practices.

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	• Protect the retained Orange River riparian corridor and prevent operational encroachment into excluded habitat. • Train workers before work and annually thereafter, keeping signed attendance records; cover SCC identification, rodenticides and gin traps, Aardvark burrows, tortoise obligations and dead-animal reporting. • Display the specialist-recommended laminated SCC identification cards at the farm office, workshop and worker accommodation. • Maintain reporting and response procedures for injured or dead wildlife and seek specialist/authority direction where required.	
Residual impacts	Permanent loss of original infill habitat and associated foraging, shelter and prey resources remains. Some residual risk of chemical exposure, wildlife conflict and reduced connectivity persists despite management.	No additional residual impact from the proposed orchard; existing farming impacts continue.
Cumulative impact post mitigation	Medium–High negative (EAP assessment). Protection of retained habitat and species-specific chemical controls reduce avoidable cumulative pressures, but the additional 46 ha of long-term habitat conversion remains alongside the existing approximately 95 ha of pivot transformation.	Neutral additional contribution from the proposed orchard; existing cumulative agricultural pressures remain.
Significance rating of impact after mitigation	Medium–High (−), Consolidated operational assessment conditional on full, documented implementation of the specialist's recommendations. Permanent habitat conversion remains; this phase-wide rating does not replace or downgrade the specialist's high impacts for individual SCC.	Neutral in relation to the proposed orchard; existing land-use impacts remain.

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The National Protected Area Expansion Strategy (NPAES) was developed to expand protected areas in South Africa to increase ecological sustainability and adaptation to climate change. The proposed study area does not fall within any National Protected area, nor is close to any formal or informal protected area. The Gariep Focus area is about 32.5km west and about 23km south of the proposed site.

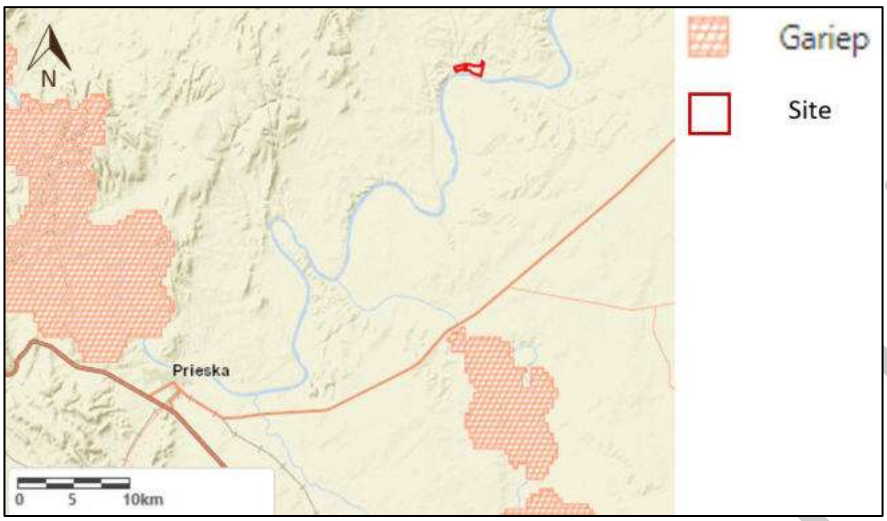

FIGURE 7: THE NATIONAL PROTECTED AREAS EXPANSION STRATEGY (NPAES) INDICATES THAT THE GARIEP FOCUS AREA, IS SITUATED MORE THAN 10KM FROM THE SITE.

The Northern Cape has a full Protected Area Expansion Strategy developed by the Northern Cape Department of Environment with support from the National Department of Environmental Affairs. The PAES priorities are largely a subset of the Critical Biodiversity Areas from the systematic conservation plan that were identified on implementation priority. SANParks priorities were fully included in the provincial PAES.

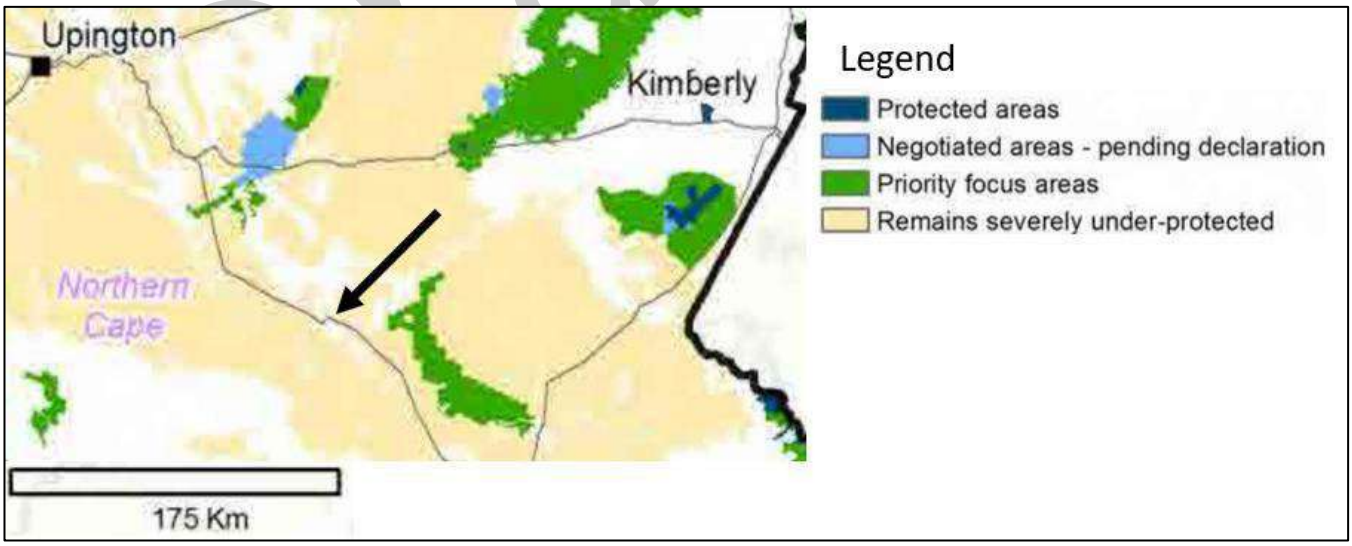

FIGURE 8: PRIORITY AREAS FOR THE PROTECTED AREA EXPANSION IN THE NORTHERN CAPE (BELFOUR ET AL, 2016).

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The priority areas in the Northern Cape are in the Succulent Karoo areas of the Namakwa District, Bushmanland, the southern Nama-Karoo as well as in the expansion areas of the existing national parks in the province. The main biodiversity features are the Succulent Karoo and southern Nama-Karoo priorities, as well as river and wetlands. Arid Savanna and some Desert ecosystems are currently not fully included in these priorities. As indicated in the map above, the site does not fall within a focus area.

According to the Northern Cape Biodiversity Conservation Plan, 2024, the site does not fall within a Terrestrial CBA 1 area. Critically Biodiversity Areas (CBA) play an important role in supporting ecological processes. This is particularly the case with riparian areas, some key catchment areas, and key pieces of corridors, all of which will be avoided in this development.

FIGURE 9: THE SITE DOES NOT FALL WITHIN CBA 1 ACCORDING TO THE BGIS OF THE NORTHERN CAPE BIODIVERSITY CONSERVATION PLAN, 2024.

According to the Spatial Development Framework, the key issue in the Siyathemba Municipality is the long-term sustainability of all land development practices which is the key factor in the environmental and economic future of this predominantly agricultural region. In terms of land conservation, there are various areas along the Orange River that are well suited for tourism and agricultural development alike. These areas are however sensitive to overutilization and pollution and will have to be protected and conserved to ensure long-term benefits thereof.

The SDF identified amongst others mixed agriculture (livestock & crops), with the following impacts associated with such activities:

- The destruction of biodiversity;

- Indigenous flora being substituted with exotic species;
- The loss of herbaceous annuals;
- Exposure of bare soil and subsequent erosion;
- Areas are homogenized and ecosystem functioning on cultivated land is essentially simplified to the production of bio-mass;
- Depletion and degradation of soils may lead to unproductive soils; or

The Siyathemba Municipality has mapped the environmental sensitivity of the municipal area in the SDF. The sensitivity is rated from 0-6 (0 being no sensitivity, 1 being low sensitivity, 6 being high sensitivity). Unfortunately, the ecological sensitivity map of the SDF is a bit unclear, but it does seem to appear that the site falls within an environmental area that is rated 2 and thus low sensitivity (see Figure 10).

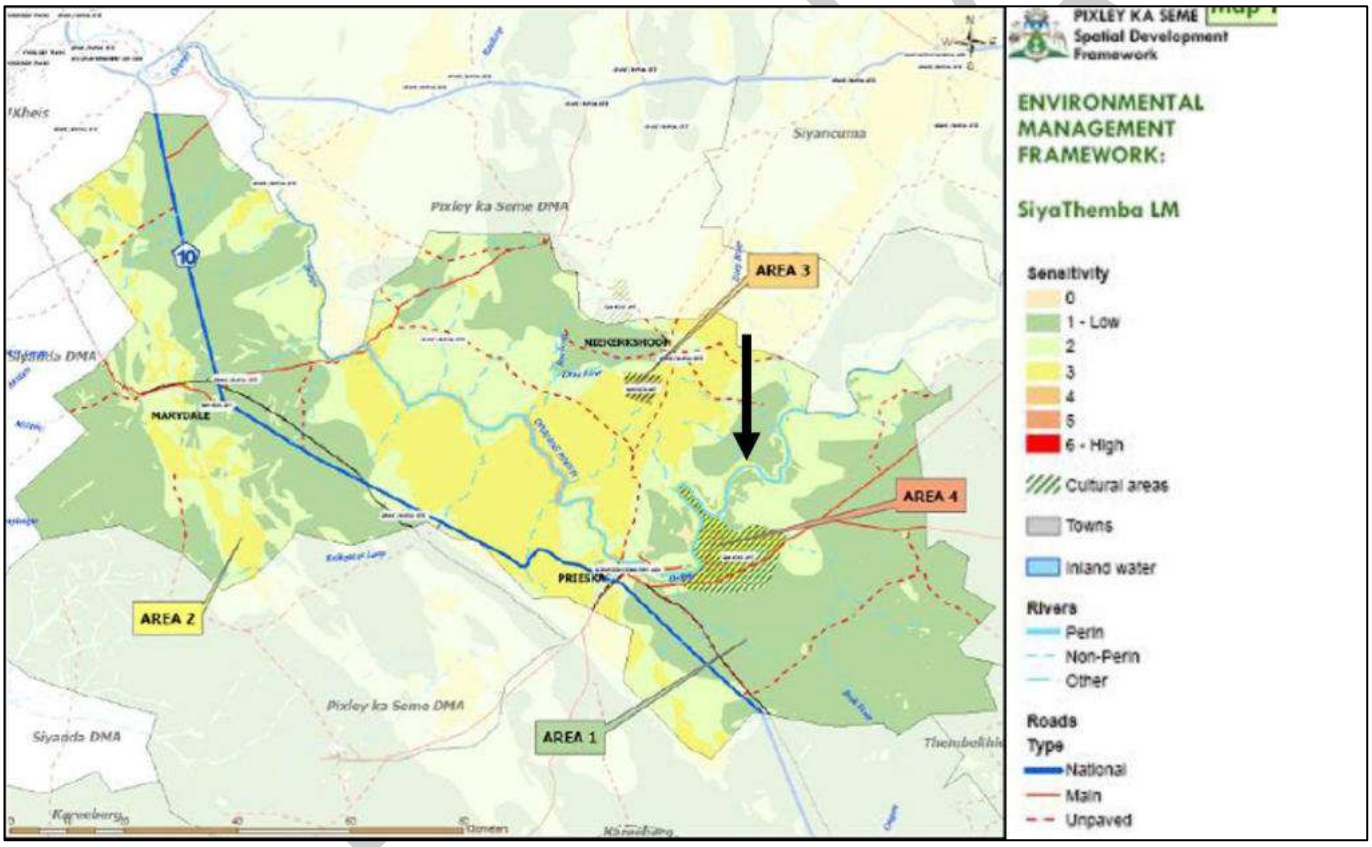

FIGURE 10: SDF OF THE SIYATHEMBA MUNICIPALITY, THE BLACK ARROW INDICATE THE POSITION OF THE SITE.

Considering all the maps available and data presented, it must be concluded that the NPAES, the Northern Cape PAES, and the Siyathembe SDF all indicate that the proposed site does not fall within any biodiversity-sensitive area. While most of these plans are broad-based, regional/national plans are wide-scale plans and do not consider the land-use of the area and surround or site-specific features and locations. Others are more regionally specific like the Siyathemba Municipality SDF is a localised plan. Thus broad-based, regional/national plans might indicate that a site is not sensitive, but localised plans might indicate otherwise, or *vice versa*.

To assess the sensitivity of the environment onsite verification is therefore essential. The Site Ecological Importance (SEI) of the proposed development area was evaluated with reference to the terrestrial biodiversity assessment undertaken by Sparaxis Environmental and the terrestrial fauna assessment undertaken by BioBase Environmental. The assessments confirm that the ecological sensitivity of the study area is not uniform, as the properties comprise existing cultivated land, previously disturbed vegetation, near-natural shrubland and riparian vegetation associated with the Orange River.

The Sparaxis Environmental assessment identified the following differences in ecological importance across the two properties:

- High ecological importance: The riparian vegetation units on both Tweefontein and Kalkfontein have high conservation priority due to their ecological functioning, habitat diversity and role as movement corridors for fauna and flora. These areas will be retained and are excluded from vegetation clearance.
- Medium to high ecological importance: The near-natural vegetation units, including vegetation unit 3 on Tweefontein and vegetation units 2 and 3 on Kalkfontein, retain indigenous vegetation, moderate species richness and important ecological functions. Protected plant species, including *Boscia albitrunca*, were recorded in these areas and will be searched and rescued prior to clearance.
- Low to very low ecological importance: The previously disturbed vegetation between the existing pivots has been affected by agricultural activities and supports pioneer vegetation and alien invasive species. These areas generally have reduced conservation value, although individual protected plants may still occur.

The fauna specialist's assessment further confirms the importance of considering species of conservation concern and their associated habitats when evaluating the proposed development. The existing agricultural transformation does not necessarily eliminate the ecological importance of the remaining natural vegetation, particularly where it provides habitat, foraging opportunities or connectivity with surrounding natural areas.

The proposed development entails the clearance of approximately 46 ha of vegetation within and around the existing centre-pivot irrigation areas, which currently occupy approximately 95 ha. Although the proposed expansion represents the consolidation of an existing agricultural footprint, the clearance of remaining natural and near-natural vegetation will result in permanent habitat loss within the affected areas.

Thus, the findings of the specialist assessments indicate that the ecological importance of the development footprint must be considered at vegetation-unit level rather than assigning a single sensitivity rating to the entire property. The existing agricultural disturbance provides an opportunity to concentrate development within areas of lower ecological importance. However, this does not negate the ecological value of the remaining natural vegetation or the need to protect sensitive habitats and species of conservation concern.

The proposed development should therefore be implemented in accordance with the specialist recommendations, with particular emphasis on retaining the Orange River riparian corridor, limiting vegetation clearance to the authorised footprint, protecting or relocating protected plant species where required, and implementing the fauna mitigation measures.

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Impact on biodiversity sites (Construction Phase)	Alternative 1:	No-Go Option
Nature of impact:	Negative. Clearance of vegetation and soil preparation for approximately 46 ha of infill orchard expansion between/around existing pivots. Loss and fragmentation of remaining natural/near-natural habitat; potential damage to protected plants and fauna habitat; construction disturbance to adjacent sensitive vegetation and ecological corridors. Sensitivity differs by vegetation unit.	No project-related clearance or construction disturbance; existing cultivated areas and pre-existing disturbance remain.
Extent and duration of impact:	Predominantly site-specific, with possible local effects on connectivity and adjacent habitat. Clearing and earthworks are short-term construction activities; habitat conversion within the authorised orchard footprint is long-term/permanent.	No additional construction-phase impact. Existing land uses and their effects continue.
Consequence of impact or risk:	Reduction in indigenous vegetation cover, habitat structure and ecological functioning within the cleared footprint; possible harm to protected *Boscia albitrunca* and fauna species of conservation concern if sensitive areas and pre-clearance requirements are not respected. Riparian areas are especially sensitive.	Avoids the proposed additional habitat conversion and construction disturbance; does not restore areas already transformed by existing agriculture.
Probability of occurrence:	Definite for vegetation removal within the approved clearance footprint; probable for associated disturbance without controls. Effects on particular species or protected individuals depend on their presence and the final demarcated footprint.	None for impacts attributable to the proposed expansion.
Degree to which the impact may cause irreplaceable loss of resources:	Potentially high where near-natural vegetation, protected plants, species-of-conservation-concern habitat or riparian corridors are affected. Lower in heavily disturbed pivot/old-field units, but these are not necessarily devoid of protected individuals.	No additional irreplaceable loss attributable to this proposal.
Degree to which the impact can be reversed:	Limited for land permanently converted to orchard; temporary disturbance outside the footprint may be rehabilitated if promptly addressed. Replacement of mature protected trees or intact habitat is not assured.	Not applicable: no proposed clearance.
Indirect impacts:	Edge effects, dust, erosion, alien plant spread, disturbance/displacement of fauna and possible reduction in movement	No additional indirect effects from the proposed construction; existing

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	between retained habitats. Uncontrolled access could affect the Orange River riparian corridor.	agricultural edge effects remain.
Cumulative impact prior to mitigation:	Medium–High: proposed infill clearance adds to approximately 95 ha of existing cultivated/pivot areas and may further reduce remnant habitat and connectivity, particularly where near-natural vegetation is affected.	No additional cumulative impact from this proposal; existing agricultural transformation remains.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	High (-) This precautionary consolidated rating reflects permanent additional habitat conversion, variable but locally high ecological importance and the fauna specialist's high overall site sensitivity. It is not a specialist-assigned single biodiversity rating.	Low / no additional project-related impact existing disturbance remains.
Degree to which the impact can be avoided:	Partly. Avoid high-priority riparian vegetation, near-natural habitat and identified protected plants/SCC features through final footprint demarcation and micrositing; clearance of the approved orchard footprint cannot be avoided if the project proceeds.	Fully avoids additional construction-phase impacts of this proposal.
Degree to which the impact can be managed:	Moderate to high for construction disturbance through demarcation, ECO oversight, pre-clearance checks, controlled access and stop-work procedures; permanent habitat loss cannot be managed away.	Not applicable to the proposed construction.
Degree to which the impact can be mitigated:	Moderate for avoidable disturbance and individual-species risks; limited for permanent loss of natural/near-natural habitat within the cleared footprint.	No project mitigation required; existing farm management continues.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Finalise and demarcate the approved footprint and no-go areas before clearance; exclude the Orange River riparian corridor and other retained sensitive units. • Prioritise previously disturbed areas and minimise clearance of near-natural vegetation; retain mature *Boscia albitrunca* where practicable. Obtain required permits before disturbing protected plants and undertake specialist-supervised relocation where authorised. • Conduct fauna pre-clearance surveys before any earthworks, including checks for SCC, active eagle nests and aardvark burrows; suspend work in affected areas and consult the relevant authorities	No expansion-related mitigation. Retain and manage existing natural and riparian vegetation under ongoing farm management.

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	where specialist trigger conditions are met. • Undertake a fauna sweep immediately before vegetation removal; use competent handlers for dangerous/venomous reptiles; prohibit hunting and snaring. • Restrict vehicles, stockpiles and personnel to demarcated areas; control dust, erosion and alien invasive plants; rehabilitate temporary disturbance; implement ECO monitoring and environmental awareness training.	
Residual impacts:	Permanent loss of habitat within the authorised infill orchard footprint and some reduction in local ecological connectivity, even after sensitive areas and individual species are protected. Temporary construction disturbance should be reduced by compliance with the EMP.	No additional project-related residual impact; existing agricultural impacts persist.
Cumulative impact post mitigation:	Medium, conditional on avoiding riparian and higher-sensitivity features, implementing pre-clearance surveys and keeping clearance strictly within the authorised footprint. Permanent additional habitat conversion remains cumulative with existing agriculture.	No additional cumulative impact from this proposal.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-). Avoidance and controls reduce disturbance and risk to sensitive features, but do not reverse permanent loss of natural/near-natural habitat. Reassess if the final 46 ha footprint overlaps riparian or other high-priority areas or if SCC are confirmed.	Very Low (-) / no additional project-related impact.

No significant additional impacts on biodiversity or environmentally sensitive areas are anticipated during the operational phase, provided that all activities remain within the authorised agricultural footprint. The direct loss of vegetation, associated fauna habitat and ecological functions resulting from the establishment of the pecan orchards will occur during the construction/establishment phase and has therefore been assessed under that phase.

Once established, the orchards will be managed as part of the existing agricultural operation. Natural vegetation and environmentally sensitive areas outside the authorised development footprint, particularly the Orange River riparian corridor, must be retained and protected from further disturbance. No additional clearance or expansion into these areas may take place without consideration of the applicable environmental and permit requirements. The operational EMPr must also provide for appropriate management of alien invasive plants and agricultural activities to prevent impacts extending beyond the approved footprint.

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Accordingly, a separate operational-phase impact assessment for biodiversity and environmentally sensitive sites is not considered necessary, as the permanent habitat loss has been assessed during the construction/establishment phase and no significant additional operational impacts are anticipated.

WATER

The proposed site falls within the Orange River Catchment area. The Orange River originates in the Lesotho Highlands and flows in a westerly direction 2 200 km to the west coast where the river discharges into the Atlantic Ocean (ORASECOM, 2007). The Orange River basin is one of the largest river basins south of the Zambezi with a catchment area of approximately 1 million km^2.

It has been estimated that the natural runoff of the Orange River basin is in the order of 11 300 million m^3/a of which approximately 4 000 million m^3/a originates in the Lesotho Highlands and approximately 800 million m^3/a from the contributing catchment downstream of the Orange/Vaal confluence which includes a small portion in Botswana feeding the Nossob and Molopo rivers. The remaining 6 500 million m^3/a originates from the areas contributing to the Vaal, Caledon, Kraai and Middle Orange rivers

The Northern Cape is divided into the following four Water Management Areas:

- Lower Orange;
- Upper Orange;
- Olifants/Droon; and
- Lower Vaal.

More specifically the proposed site falls within Lower Orange Water Management Area, in the D71D. The National Freshwater Ecosystems Priority Areas (NFEPA) identifies important catchments based on the presence of important biota or the degree of riverine degradation.

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Walmer
6070

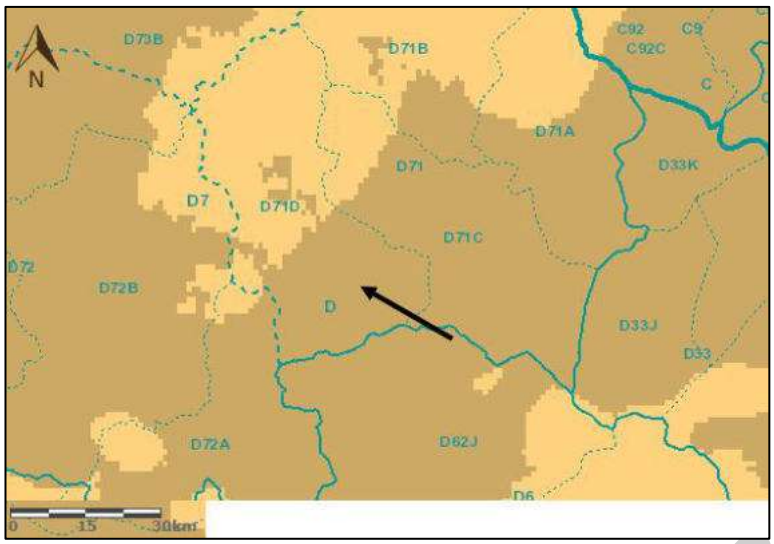

FIGURE 11: QUATERNARY CATCHMENT OF THE SITE IS D71D

TABLE 5: PRESENT ECOLOGICAL STATE CATEGORIES USED TO DESCRIBE THE CURRENT AND DESIRED FUTURE CONDITION OF SOUTH AFRICAN RIVERS, FOR NFEPA, RIVERS IN AN A OR B CATEGORY WERE REGARDED AS BEING IN GOOD CONDITION.

Ecological category	Description
A	Unmodified, natural
B	Largely natural
C	Moderately modified
D	Largely modified
E	Seriously modified
F	Critically/Extremely modified

Fish sanctuaries in a good condition (A or B ecological category) were identified as FEPAs, and the whole associated sub-quaternary catchment is shown in dark green. The remaining fish sanctuaries in lower than an A or B ecological condition were identified as Fish Support Areas, and the associated sub-quaternary catchment is shown in medium green. Fish Support Areas also include sub-quaternary catchments that are important for the migration of threatened or near-threatened fish species – these are not marked with a fish symbol.

The site is located within a Fish Support Area of the *Barbus anoplus*. The back fish symbol on the map (see Figure 12) indicates the presence of vulnerable or near-threatened fish populations. If it was a red fish symbol, it would have indicated that there is at least one 13 population of a critically endangered or endangered fish species within that sub-quaternary catchment. Some fish sanctuaries are FEPAs, with their associated sub-quaternary catchments

shown in dark green; others are Fish Support Areas, with their associated sub-quaternary catchments shown in medium green, such as the proposed site.

A goal of NFEPA is to keep further freshwater species from becoming threatened and to prevent those fish species that are already threatened from going extinct. To achieve this, there should be no further deterioration in river condition in fish sanctuaries and no new permits should be issued for stocking invasive alien fish in farm dams in the associated sub-quaternary catchment. Since there is a drainage line or perennial stream that runs between Tweefontein and Kalkfontein sites and the Orange river are situated between 50-100m from the proposed orchard areas, there is a small, but unlikely possibility of impact on the *Barbus anoplus* fish sanctuary.

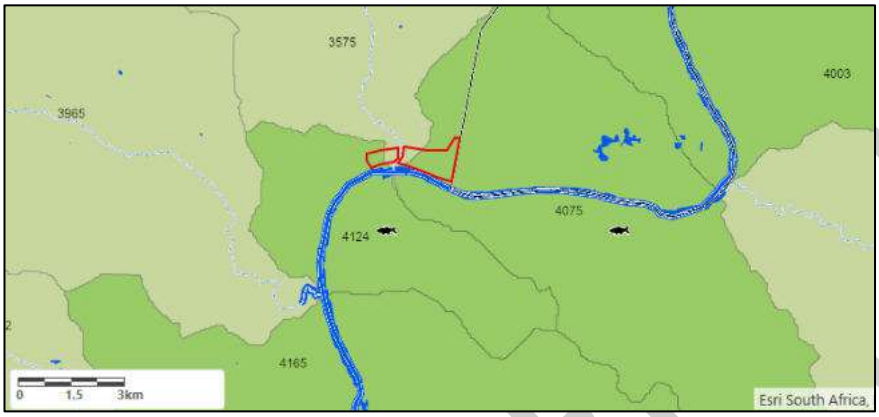

FIGURE 12: THE SITE FALLS WITHIN A FISH SUPPORT AREA

The Application already has a Water Use Right, therefore water abstraction has already been accounted for.

During the construction phase, the natural vegetation will be removed from the additional 46Ha and topsoil will be ploughed. It could lead to 1) the possible transport of silt and/or 2) drainage problems, which could potentially impact the water quality of the area, or specifically the Orange River.

In terms of the possible transport of silt, during the establishment of the orchard, for a time a portion of land will be bare which will expose it to wind erosion, which can increase dust and transport of silt. As pecan nut trees are planted, the soil remains vulnerable in terms of erosion potential, since many non-bearing orchards are maintained with clean tillage between rows, and the small trees have not yet developed a large canopy to intercept rainfall before it reaches the bare soil.

With the runoff generated in the bare areas, there is always a concern that the water quality can be affected by an increase in suspended and dissolved solids. The Orange River is between 50-100m from the study area and an existing drainage line 32m between Tweefontein and Kalkfontein sites. The general drainage of the area is towards the south, into the Orange River. A buffer zone of 32m will be kept from the drainage line. With the buffer zones, the silt transport that is expected due to the clearing of vegetation and ploughing of topsoil will simply be absorbed by the plants before the runoff eventually reaches the Orange River. It is unlikely that any TSS (Total Suspended Solids) and

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TDS (Total Dissolved Solids) increase will be experienced, considering the sandy soil with easy drainage and the low rainfall this area generally receives.

Impact on water quality (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Vegetation clearance and ploughing of ±46 ha will temporarily expose soil to wind and rainfall erosion. Sediment-laden runoff could enter the intervening drainage line and, ultimately, the Orange River, increasing suspended solids and affecting water quality. Accidental construction-related hydrocarbon or waste contamination is a secondary risk.	No proposed orchard establishment or associated new vegetation clearance; no additional construction-related sediment or contamination from this proposal. Existing agricultural activities and background catchment pressures continue.
Extent and duration of impact:	Primarily site-specific to local; potential downstream pathway via the drainage line to the Orange River. Short-term during clearing, soil preparation and early orchard establishment, while ground cover is limited.	No new construction impact; not applicable.
Consequence of impact or risk:	Temporary deterioration of runoff quality and possible sediment deposition in the drainage line or river if exposed soil is mobilised. The potential receptor is environmentally important because the site is within a Fish Support Area.	No additional consequence attributable to the proposed construction.
Probability of occurrence:	Possible without mitigation, particularly during exposed-soil periods and rainfall or concentrated runoff events. Actual delivery of sediment to the river is less likely given the proposed buffer, drainage characteristics and generally low rainfall.	Improbable / not applicable to the proposed construction.
Degree to which the impact may cause irreplaceable loss of resources:	Low for the anticipated short-term sediment impact; a severe uncontrolled pollution event could affect aquatic biota, but permanent or irreplaceable loss is not anticipated on the information supplied.	None attributable to the proposed construction.
Degree to which the impact can be reversed:	Largely reversible through cessation of the sediment source, erosion control and rehabilitation; recovery may take longer if material enters a watercourse.	Not applicable.
Indirect impacts:	Potential deterioration of aquatic habitat and water quality downstream; sediment may carry associated contaminants where present. Disturbance of drainage patterns could increase erosion.	No additional indirect impacts from this proposal.
Cumulative impact prior to mitigation:	Potential local contribution to sediment and contaminant loading in an Orange River catchment already affected by	No additional construction contribution; existing

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	agriculture and other land uses. The construction contribution is temporary and would be most relevant during runoff events.	cumulative catchment pressures remain.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-). Temporary and mainly local, but the exposed ±46 ha footprint drains toward a sensitive river system; uncontrolled runoff could affect the intervening drainage line.	Low (-) / no additional impact.
Degree to which the impact can be avoided:	High. Avoid disturbance in the 32 m drainage-line buffer and retained riparian areas; limit the extent and duration of exposed soil. The clearing-related source cannot be entirely avoided if the proposal proceeds.	Fully avoided in relation to this proposal.
Degree to which the impact can be managed:	High, through phased earthworks, runoff and erosion controls, demarcated exclusion areas and site inspections.	No project-specific construction management required.
Degree to which the impact can be mitigated:	High. Vegetated buffers, soil stabilisation and effective runoff controls can substantially reduce sediment reaching the drainage line or river.	N/A
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Demarcate and retain the proposed minimum 32 m buffer from the drainage line; exclude clearing, stockpiling, machinery and waste from buffers and riparian vegetation. • Confine clearing and ploughing to the authorised ±46 ha footprint and phase works to minimise bare soil exposure. • Retain or establish ground cover between rows as soon as practicable; stabilise disturbed areas and soil stockpiles. • Prevent concentrated runoff and sediment discharge by using suitable contouring, diversion or sediment-control measures where required. • Do not stockpile soil or excavated material where it can wash into drainage features; inspect and repair erosion after rainfall. • Do not store fuel on site; use drip trays for emergency servicing and promptly contain and clean spills. • Provide managed toilets and waste receptacles; prevent sewage, litter or chemicals entering runoff. • Monitor the drainage-line buffer and implement corrective measures if	No construction mitigation for this proposal. Continue existing lawful farm and watercourse management.

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	sediment transport or erosion is observed.	
Residual impacts:	Minor temporary erosion or localised sediment mobilisation may occur despite controls; significant deterioration of Orange River water quality is not anticipated if the buffer and EMPr are implemented.	No additional residual construction impact.
Cumulative impact post mitigation:	Low. The project's temporary additional sediment contribution should be substantially reduced; existing catchment-wide agricultural and other pressures remain.	No additional construction contribution.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-) / no additional impact.

As the pecan nut orchard are established the bare areas under the trees (or areas between the rows) will decrease and ultimately this potential will decrease (operational phase). With mitigation measures, the direct impact on the water quality during the construction & operational phase is low.

During the operational phase the following will also be applicable:

Sewage Facilities

Potentially, the toilet facilities (especially during harvest time) could cause coliform contamination of surface runoff but since the system (chemical toilet) is a closed system, will cause this impact to be of very low significance.

Hydrocarbons

Fuel will not be stored on-site and only emergency servicing of vehicles would be performed, therefore hydrocarbon spills should the very limited, in addition, the use of appropriate receptacles such as drip pans will cause this impact to be negligible. The impact is rated very low.

Waste

Very limited amounts of domestic or industrial waste would be generated and therefore management facilities would be restricted to waste bins and skips on the farm.

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In terms of indirect impact, the reduction in the ecological reserve for water is always a potential indirect impact if croplands are established. The Orange River system has reached its limit and the Department of Water and Sanitation in the Northern Cape has indicated that no new water use rights will be issued for irrigation on this water system. The applicant already has a Water Use Right, therefore water abstraction has already been accounted for.

Excessive amounts of dissolved salt in water can ultimately affect agriculture, drinking water supplies, and ecosystem health. In terms of agriculture, besides the obvious reduction in crop yields by impairing the growth and health of salt intolerant crops, excessive amounts of dissolved salt in water can also cause corrosion of machinery and infrastructure such as pipes, valves, and fences, roads, bridges, etc.

In terms of the ecosystem, it can lead to poor health or death of native vegetation and ultimately a decline in biodiversity through the dominance of salt-resistant species and potentially altering ecosystem structures. Reduced ground cover can also increase erosion risk, which can lead to increased sediment transport into aquatic systems and the loss of valuable topsoil. If pesticides or/and fertilizers have been applied, then eroded soil can pollute water threatening aquatic ecosystems, the plant and animal species they support, and the safety of water for both human and animal consumption.

Another indirect impact caused by salinization of water is the financial cost of the loss of crops, or the additional need for water treatment, and/or the more frequent maintenance or replacement of corroded civil and agricultural infrastructure.

The soil suitability assessment identified a low existing risk of salinisation and sodicity within the surveyed Tweefontein area. Electrical conductivity values ranged between 48 and 126 mS/m, below the 200 mS/m threshold identified by the agronomical specialist for pecan nut production, while exchangeable sodium percentages were below 3%. Although long-term irrigation may introduce salts and sodium into the soil profile, the predominantly deep and freely drained soils reduce the potential for accumulation. The specialist considers salinity and sodicity to be manageable through appropriate irrigation scheduling, soil fertility management and ongoing monitoring.

The Orange River basin is an important resource for South Africa, especially in arid areas. It is highly developed and the use of water for irrigation is one of the highest. A major problem along the Orange River is the unlawful water abstraction for irrigation use. The applicant already has a Water Use Right, therefore no contribution towards illegal abstraction will be made due to this project.

In terms of chemicals and fertilizers, a study completed by Bucas (2006) indicated that the results of the water chemistry of the Orange River were controlled naturally by chemical weathering of siliceous sediment, intrusive igneous rocks, and metamorphic rocks, and unnaturally from agricultural and urban activities.

This region along the Orange River is valuable irrigation land, and in terms of water chemistry, it is guaranteed that fertilizers and pesticides are applied on surrounding farms (cumulative impact). Pesticides in the aquatic environment have the potential to affect all end-users, including both humans and wildlife. This cumulative impact was discussed in full detail under the heading ‘Soil’ and will not be repeated in this section.

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Furthermore, the study completed by Bucas (2006) also found that:

- There was an increase from 1986-2006, in the concentration of cations and anion from the colder wetter climate to the drier hotter climate region along the Orange River, which was severely influenced by the stream runoff due to agricultural and urban input;
- Variation of the annual runoff affects the percentage of pollution, especially in the lower Orange River. Pollution shows a strong increase when the annual runoff is <2000 m^3 or around 10 000 m^3;
- At the time of the study, eutrophication of the Orange River was not a problem, however, the increase in phosphate input from agricultural and urban activities into the lower Orange River may lead to a potential eutrophication threat.

It is thus clear that cumulatively anthropogenic activities (e.g. agriculture, urban development, mining, dams, weirs, etc.) are placing increasing strain on the lower Orange River as a natural resource and it is clear that the river has been modified and is impacted.

The proposed development of 141Ha in total (95Ha of existing centre-pivot agricultural land with 46Ha of proposed additional infill areas between and around the pivots), will contribute to this potential cumulative impact if no mitigation measures are implemented. With the prescribed mitigation measures the potential cumulative impact on the surface water quality will be substantially reduced.

In addition, any possible groundwater pollution, as a result of pesticides, will not reach the groundwater table due to the vertical impeding of drainage. The lateral movement of drainage will however drain towards the drainage line before it will drain toward the Orange River, which will reduce the possible cumulative impact.

Impact on water quality (Operational Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Potential deterioration of surface-water quality from irrigation return flows and runoff carrying fertilisers, pesticides, dissolved salts or suspended sediment; accidental release of sewage, hydrocarbons or waste during orchard management and harvesting. The pathway is principally via the intervening drainage line towards the Orange River.	The proposed ±46 ha infill orchard is not established. Existing ±95 ha agricultural activities and associated irrigation, chemical-use and runoff risks continue under the current management regime; no incremental operational impact from the proposed expansion.
Extent and duration of impact:	Primarily site-specific to local, with a potential downstream effect on the drainage line and Orange River if pollutants reach the watercourses. Long term throughout orchard operation; individual pollution incidents may be short term.	Existing agricultural footprint and its receiving environment; ongoing baseline risks remain. No additional duration attributable to the proposed expansion.

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Consequence of impact or risk:	Possible increases in nutrient, pesticide, sediment or dissolved-salt loads, deterioration of water quality and effects on aquatic biota and downstream water users. Significant contamination would depend on the pollutant, exposure and transport pathway; no measured deterioration is established by the supplied discussion.	No additional consequence from the proposed orchard expansion. Existing farming may continue to contribute to the broader agricultural water-quality burden.
Probability of occurrence:	Possible without appropriate management over the long operational period; the likelihood of a material river-water impact is reduced by the proposed vegetated buffers, distance from the river and well-drained soils. Accidental spills remain possible.	No additional impact from the expansion; baseline agricultural contamination risks remain possible.
Degree to which the impact may cause irreplaceable loss of resources:	Low for the anticipated project-scale impact, but a severe or repeated pollution event could harm sensitive aquatic habitat or biota. The Orange River corridor and Fish Support Area warrant precautionary protection.	No incremental risk of irreplaceable loss from the proposed expansion; existing catchment pressures remain.
Degree to which the impact can be reversed:	Generally reversible where minor and promptly contained; persistent pesticide contamination, salt accumulation or ecological effects may require prolonged recovery and may not be fully reversible.	Not applicable to the unimplemented expansion; reversibility of existing agricultural impacts depends on their nature.
Indirect impacts:	Potential effects on aquatic organisms and downstream users; nutrient enrichment, changes in aquatic habitat quality and increased treatment or maintenance needs. Long-term salt accumulation could affect soil cover and indirectly increase erosion and sediment delivery if unmanaged.	No new indirect impacts from the expansion; existing agricultural operations retain their current indirect risks.
Cumulative impact prior to mitigation:	Medium Additional nutrient, pesticide and salt inputs could contribute incrementally to existing agricultural and other anthropogenic pressures on the Orange River, particularly if multiple farms experience runoff or irrigation-return-flow events. No site-specific cumulative load has been quantified.	Existing cumulative catchment pressures continue, but the proposed ±46 ha expansion adds no further operational load.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-). The receiving river corridor is sensitive and the operational exposure is long term, although the proposed footprint is set back from the watercourses and the soil study indicates low existing salinity risk.	No additional impact from the proposed expansion (not rated); existing agricultural baseline remains.

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Degree to which the impact can be avoided:	High for direct disturbance of the watercourses and for preventable spills through exclusion of operations from buffers and good handling practices; diffuse irrigation and chemical-related risks cannot be eliminated entirely.	The additional impact is avoided by not establishing the proposed orchard.
Degree to which the impact can be managed:	High, through irrigation and nutrient scheduling, integrated pest management, equipment maintenance, protected buffers, spill controls and periodic soil and water-quality monitoring where warranted.	Existing risks remain manageable through the current farm management and applicable requirements.
Degree to which the impact can be mitigated:	High for routine diffuse inputs and minor incidents if measures are consistently implemented; effectiveness is lower for major accidental releases or repeated non-compliance.	No mitigation required for an expansion that does not proceed; ongoing agricultural activities still require normal pollution prevention.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Retain and demarcate the approved vegetated buffers, including the stated minimum 32 m drainage-line buffer; prohibit cultivation, chemical application, storage and waste disposal within no-go areas. • Schedule irrigation according to crop demand and soil conditions; avoid excessive application, waterlogging, runoff and unnecessary leaching towards watercourses. • Monitor soil EC and ESP periodically and manage any salinity/sodicity trends; assess irrigation-water quality as needed. Do not extrapolate Tweefontein laboratory results to Kalkfontein. • Use soil/leaf testing and calibrated fertiliser application; avoid application before heavy rain or when runoff is likely. • Apply integrated pest management; use approved products at label rates, maintain spray equipment and avoid spray drift or runoff into buffers and watercourses. • Maintain inter-row ground cover where practicable and stabilise erosion-prone areas and drainage pathways. • Provide serviced, contained sanitation; manage waste in secure receptacles and dispose of it through authorised services. • Do not store fuel near watercourses; use drip trays for emergency servicing, keep spill kits available and promptly contain and remediate spills.	No new orchard-specific mitigation is required. Continue pollution-prevention and water-use controls for existing agriculture; maintain riparian vegetation and drainage-line protection.

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	• Inspect buffers, irrigation infrastructure and pollution controls regularly; record incidents and implement corrective action.	
Residual impacts:	Low. A limited possibility of diffuse nutrient, pesticide, salt or sediment transport and isolated accidental contamination remains despite controls. The supplied material does not establish a measured change in Orange River water quality.	No additional residual impact from the proposed expansion; existing agricultural baseline impacts persist.
Cumulative impact post mitigation:	Low incremental contribution is anticipated if buffers and operational controls are effective. Existing agricultural and other catchment-wide pressures remain and cannot be eliminated by this project alone.	No additional cumulative contribution from the proposed expansion; pre-existing catchment pressures continue.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-) Conditional on consistent implementation of the EMPr and maintenance of the approved buffers.	No additional impact from the proposed expansion (not rated); existing agricultural baseline remains.

AIR QUALITY

The air quality of the immediate surroundings is good due to its rural status. During windy periods a limited amount of dust will be deposited into the atmosphere causing a slight rise in air pollution levels during the clearing of vegetation or harvesting. Since the property involved is still zoned agricultural and rural, it would cause tolerable ambient levels to be higher than those for residential areas.

Exhaust emissions are caused by a fair amount of vehicles entering and exiting the site at regular intervals. Vehicular emissions during the project will be related to approximately one bulldozer during the construction phase, and a few trucks/bakkies, which is hardly an amount that will cause excessive exhaust emissions. The closest receptor is the applicant's farmhouse which is more than 1km from the site. The distance to people and the very limited amount of exhaust emissions generated will preclude any detrimental impact on people and the impact is negligible.

In terms of smoke generation, the workforce will not reside on the property, therefore no cooking fires will be permitted and no burning of waste generates harmful smoke. To control alien trees, a fire might be a method as part of an integrated management plan but will be controlled and limited. No odours should be generated by the farming operation.

The amount of dust generated on a site is directly linked to the type of material that is extracted, mechanical processes involved, traffic volumes, wind speed and soil moisture content. The finer the material (more easily

airborne) and the higher the clay and silt concentrations, the more severe the impact is. Mechanical processes that will generate dust will be the clearing of vegetation, harvesting, and ploughing.

In terms of the potential dust generation source at the pecan nut orchard, it will mainly be during the clearing of vegetation until the orchard is established, thus during the operation phase dust should be limited.

The impact of dust was discussed in full detail under the heading 'Soil' (sub-heading: 'Soil Erosion') and would therefore not be repeated in this section. The impact on air quality due to the impact of dust generation is rated low (calm days) to low-moderate (windy days).

Impact on air quality (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Temporary dust emissions from vegetation clearance, ploughing, exposed soils and construction traffic; minor exhaust emissions from approximately one bulldozer and a few trucks/bakkies.	No construction-related dust or exhaust from the proposed 46 ha expansion; existing farming-related dust and vehicle emissions continue.
Extent and duration of impact:	Primarily site-specific and immediate surroundings; short-term during clearance and orchard establishment. Wind may carry dust beyond the working area.	No additional construction-phase impact; background agricultural emissions remain local and intermittent.
Consequence of impact or risk:	Temporary deterioration in ambient air quality, nuisance dust deposition on nearby vegetation and agricultural land, and limited worker exposure. Exhaust contribution expected to be negligible.	Avoids the incremental dust and exhaust associated with the proposed expansion.
Probability of occurrence:	Dust generation is likely during clearing and ploughing, especially on windy, dry days; material exhaust-related impacts are unlikely.	No additional construction impact occurs.
Degree to which the impact may cause irreplaceable loss of resources:	Very low; short-term dust and limited exhaust are not expected to cause irreplaceable loss.	None attributable to the proposed construction.
Degree to which the impact can be reversed:	High. Airborne dust generally dissipates after activities cease, and deposited dust can be removed by natural processes.	Not applicable to the proposed expansion.
Indirect impacts:	Dust deposition on vegetation and crops; temporary nuisance and possible respiratory irritation for workers during high-dust activities.	No additional indirect construction impacts.
Cumulative impact prior to mitigation:	Low to Medium during windy periods when combined with existing agricultural dust and vehicle activity in the rural area.	Existing agricultural dust and emissions persist; no incremental construction contribution.

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Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-) (allowing for windy conditions and exposed soils); low (-) on calm days.	No additional impact (existing agricultural background remains).
Degree to which the impact can be avoided:	Partly. Avoid unnecessary clearing and suspend dust-generating work during strong winds where practicable.	Fully avoids the proposed construction contribution.
Degree to which the impact can be managed:	High, through phasing, traffic control and dust suppression.	Existing agricultural operations remain subject to routine management.
Degree to which the impact can be mitigated:	High Exposure and dust mobilisation can be substantially reduced.	Not applicable to the proposed expansion.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Limit clearing and ploughing to the approved footprint and phase work; minimise the duration of exposed soil; • Retain or establish ground cover where practicable; • Apply water for dust suppression when necessary without causing runoff or water wastage; • Reduce vehicle speeds on unpaved routes; • Maintain machinery and prevent unnecessary idling; • Avoid burning waste and prohibit uncontrolled fires; • Provide suitable worker PPE when dusty; • Inspect and respond to dust complaints.	No expansion-specific measures; continue normal dust, vehicle and fire management on existing agricultural land.
Residual impacts:	Intermittent, localised dust during dry or windy work periods; negligible exhaust emissions.	Existing background agricultural dust and exhaust continue.
Cumulative impact post mitigation:	Low. Limited incremental contribution to rural agricultural dust levels.	No additional construction contribution.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-).	No additional impact.

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Another potential impact on air quality is during the application of pesticides, which can have health impacts on workers and abutting farms if the application is applied incorrectly. Ultimately, the impact on air quality due to the impact of pesticides being used is rated to be low-moderate with mitigation and can increase to moderate-high without mitigation. Although pesticides will most likely not be applied regularly (but rather seasonal or when

needed), the occurrence will be less compared to the occurrence of dust, but since pesticides have a higher risk of pollution and environmental impact if used incorrectly, the intensity and extent of the impact is more.

Impact on air quality (Operational Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Intermittent dust from harvesting, orchard traffic and exposed inter-row soil; limited vehicle exhaust. Potential pesticide aerosol/spray drift and associated worker or off-site exposure if applied incorrectly. No routine waste burning or cooking fires anticipated.	No incremental operational emissions from the proposed 46 ha orchard; existing pivot agriculture and its dust, machinery and agrochemical use continue.
Extent and duration of impact:	Mainly site-specific and immediate surroundings, intermittent throughout orchard operation; spray drift could extend beyond the application area in unsuitable wind conditions. Long-term activity with short-duration emission events.	Existing agricultural air-quality impacts remain local and ongoing.
Consequence of impact or risk:	Generally limited nuisance dust and exhaust; incorrectly applied pesticides could cause worker exposure, off-target deposition and effects on adjacent land or receptors.	Avoids the incremental orchard harvesting and pesticide application risks, but not those of existing farming.
Probability of occurrence:	Intermittent dust and vehicle emissions likely; significant spray drift is possible without controls but less likely with appropriate application procedures.	No incremental orchard-related risk; existing farming emissions continue.
Degree to which the impact may cause irreplaceable loss of resources:	Low for dust and exhaust; potentially greater for a serious off-target pesticide incident, although no irreplaceable loss is predicted on the information provided.	No incremental impact attributable to expansion.
Degree to which the impact can be reversed:	Dust and exhaust effects generally reversible once emissions cease; pesticide-related effects depend on the substance, exposure and affected receptor and may not be immediately reversible.	Not applicable to the proposed expansion.
Indirect impacts:	Off-target pesticide deposition on adjacent vegetation or agricultural areas, worker exposure, temporary nuisance dust and possible secondary effects on non-target organisms.	Existing agricultural activities may continue to produce comparable indirect effects.
Cumulative impact prior to mitigation:	Medium. Incremental seasonal dust and agrochemical use may add to emissions from surrounding irrigated agriculture; pesticide drift is the more consequential potential pathway.	Existing cumulative agricultural emissions continue without the additional 46 ha orchard contribution.

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Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium-High (-) for uncontrolled pesticide application; Dust alone Low (-) to Medium (-) depending on wind.	No additional impact from the proposed orchard; existing agricultural risks persist.
Degree to which the impact can be avoided:	Partly: avoid spraying in unsuitable weather and minimise bare ground and unnecessary traffic; routine orchard activities cannot be entirely avoided.	Avoids the proposed orchard contribution.
Degree to which the impact can be managed:	High with an integrated pest management programme, trained operators, weather-based spraying and routine dust controls.	Existing agricultural practices remain subject to routine management.
Degree to which the impact can be mitigated:	High if application protocols, equipment maintenance and exposure controls are consistently implemented.	Not applicable to the proposed expansion.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Use integrated pest management and apply pesticides only when justified; • Follow product labels and applicable requirements; • Use trained applicators and calibrated, maintained equipment; • Do not spray during strong winds or conditions favouring drift; • Use appropriate no-spray setbacks from property boundaries, occupied areas and sensitive habitats as determined for the product and site; • Provide PPE and prevent worker re-entry until safe; • Keep application records and respond to drift complaints or incidents; • Maintain ground cover between rows where practicable; • Control speeds on gravel roads and suppress dust when needed; • Maintain vehicles and prohibit waste burning and uncontrolled fires.	Continue existing agricultural air-quality, pesticide and fire controls; no expansion-specific mitigation.
Residual impacts:	Low, intermittent dust and vehicle exhaust; low residual likelihood of off-target pesticide drift if prescribed controls are followed.	Existing agricultural background emissions and agrochemical risks continue.
Cumulative impact post mitigation:	Low incremental contribution to regional agricultural emissions and spray-drift risk.	No additional cumulative contribution from the proposed expansion.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low–Medium (-) for pesticide-related air-quality risk, Low (-) for dust and negligible for exhaust.	Low(-) in current condition.

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NOISE

The impact of noise levels generated by farming activities is determined by the type of activity, the time of day, the consistency thereof, distance to people, whether it is a low or high-pitched noise and whether beneficiation is taking place. Noise levels are more intense in the morning and evening than during the rest of the day and are more irritating if it is high-pitched. The more continuous the noise is the higher the impact. In terms of SABS standards, noise levels for rural residential areas are 45dB during the day, 40dB in the early evening, and 35dB at night. Noise impact is rated against the following: 1) The average dB will result in no or sporadic complaints from communities whilst an increase between 5-10dB will result in widespread complaints, 3) An intruding noise is defined by National Noise Regulations as disturbing if it causes the ambient noise levels at the border of the property from which it emanates to increase with 7dB, 4) An average person will perceive such an increase in the ambient noise levels as a doubling of noise levels and very strong response will be expected from communities/residents.

The rural setting of the study area and the extensive agricultural activities characteristics of the area would, under normal circumstances, probably result in the ambient noise levels being between 40 and 45dB during the day. Since the site is more then 16km from the R375, cumulative impact concerning provincial roads will not be a factor. There are some small diamond mines on abutting properties and trucks might cause an intermittently increase in noise levels to approximately 65-70dB along the gravel road. Since there are no receptors it is not anticipated that the proposed development will impact the tranquility of the area, but rather fit in with the surrounding area.

The proposed development entails the clearing of approximately 46 ha of vegetation and the preparation of infill areas between and around the existing centre-pivot irrigation systems for the establishment of pecan nut orchards. Noise generated during this phase will primarily be associated with vegetation clearing, ploughing, soil preparation, the movement of agricultural machinery and the transport of equipment and materials to and from the site.

The principal noise sources are expected to include a bulldozer, tractors and a limited number of trucks and bakkies. These activities may temporarily increase ambient noise levels within the immediate development area. However, the site is situated within an established agricultural landscape, where approximately 95 ha of existing centre-pivot land is already cultivated and harvested twice annually. The operation of tractors, harvesting equipment and other agricultural machinery therefore constitutes an existing, long-standing source of noise on the properties. The closest identified residential receptor is the applicant's farmhouse, situated more than 1 km from the proposed development area.

The construction phase will result in a temporary increase in noise above this existing agricultural baseline, particularly during vegetation clearing and initial soil preparation. Although these activities may cause localised disturbance to fauna in the surrounding natural vegetation, the additional impact is expected to be limited by the temporary nature of the works and the existing agricultural noise environment. Noise levels associated with the proposed expansion will decrease once the establishment activities have been completed.

Construction activities should be restricted to normal daytime working hours, and all machinery and vehicles must be maintained in good working order. Unnecessary idling, excessive revving and the use of defective exhaust systems

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should be avoided. Where practicable, particularly noisy activities should be undertaken over the shortest reasonable period.

The significance of the construction-phase noise impact is assessed as Low before mitigation and Very Low after mitigation, given the limited number of machines, the rural agricultural setting, the distance to the nearest identified residential receptor and the temporary nature of the activities.

Noise Impact (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Temporary increase in noise from vegetation clearing, ploughing, soil preparation, machinery operation and vehicle movements associated with establishing the additional 46 ha of pecan orchards.	The proposed 46 ha expansion will not proceed. Noise associated with the existing cultivation and twice-yearly harvesting of approximately 95 ha of centre-pivot land will continue.
Extent and duration of impact:	Site-specific to local. Short-term, with the greatest noise levels occurring during vegetation clearing and initial soil preparation.	Site-specific to local. Existing agricultural noise will continue intermittently over the operational lifespan of the current farming activities.
Consequence of impact or risk:	Temporary increase above the existing agricultural noise baseline, with potential localised disturbance to fauna. Disturbance to residents is expected to be limited, given the distance to the nearest identified residential receptor.	No additional construction-related noise or associated disturbance. The existing agricultural noise environment will remain.
Probability of occurrence:	Definite during machinery-intensive establishment activities.	No additional construction noise will occur. Existing farming noise will continue.
Degree to which the impact may cause irreplaceable loss of resources:	Very low. Noise will not result in the permanent loss of environmental resources, although temporary fauna disturbance may occur.	None attributable to the proposed development.
Degree to which the impact can be reversed:	Fully reversible. The additional noise will cease when establishment activities are completed.	Not applicable to the proposed development.
Indirect impacts:	Temporary disturbance or displacement of fauna from areas adjoining active machinery operations.	No additional indirect noise impacts.
Cumulative impact prior to mitigation:	Low. The temporary construction noise will occur in addition to noise from the existing 95 ha farming operation and intermittent agricultural or mining-related vehicle movements in the wider area.	Existing agricultural noise and intermittent noise from other activities in the area will continue, without an additional contribution from the proposed development.
Significance rating of impact prior to mitigation	Low (-)	Low (-)

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(e.g. Low, Medium, Medium-High, High, or Very-High)		
Degree to which the impact can be avoided:	Partially avoidable. Noise from machinery cannot be eliminated, but unnecessary noise and disturbance outside normal working hours can be avoided.	Fully avoided in respect of the proposed construction activities.
Degree to which the impact can be managed:	High. Machinery use, working hours and vehicle movements can be controlled.	Existing farming noise remains subject to normal farm management practices.
Degree to which the impact can be mitigated:	High. Appropriate working hours, equipment maintenance and efficient scheduling can reduce the additional disturbance.	No construction-phase mitigation is required for the proposed expansion.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Restrict establishment activities to normal daytime working hours; • Maintain machinery and vehicles in good working order; • Avoid unnecessary idling, excessive revving and defective exhaust systems; • Limit particularly noisy activities to the shortest practicable period; and • Keep machinery and vehicles within approved working and access areas.	No additional construction-phase measures are required. Existing farming activities should continue to follow normal noise-management practices.
Residual impacts:	Very low, temporary and localised noise during machinery operation, with limited potential for disturbance to fauna.	No additional construction-related noise impact.
Cumulative impact post mitigation:	Very Low. The limited additional noise will remain temporary against the established agricultural noise baseline.	No additional cumulative contribution from the proposed construction activities.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-)

During the operational phase, noise will be generated by routine pecan orchard management, including irrigation system operation and maintenance, tractor and vehicle movements, mowing or vegetation management between orchard rows, pesticide application and seasonal harvesting. Harvesting activities may result in temporarily elevated noise levels due to the use of agricultural machinery and increased vehicle movements associated with the collection and transport of pecan nuts.

These activities will occur within an existing agricultural operation and are not expected to introduce a substantially different type of noise to the surrounding environment. Noise levels will vary according to the agricultural activity being undertaken, with the greatest potential for disturbance occurring during seasonal harvesting and other periods of increased machinery use. Routine orchard maintenance and irrigation activities are expected to generate comparatively limited noise.

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The potential impact on surrounding residents is considered limited due to the rural location of the site and the distance to the nearest identified residential receptor. However, noise may cause temporary disturbance to fauna within the natural vegetation and riparian areas adjoining the orchards, particularly where machinery operates close to the retained ecological corridors.

Operational noise should be managed through regular maintenance of agricultural equipment, limiting unnecessary vehicle movements and idling, and undertaking particularly noisy activities during normal daytime hours where practicable. Machinery should remain within the approved agricultural footprint, and the retained natural vegetation and Orange River riparian corridor should not be used for vehicle access or equipment storage.

The significance of the additional operational-phase noise impact is assessed as Very Low before and after mitigation. Noise associated with routine orchard maintenance, irrigation and seasonal harvesting will be intermittent and consistent with the existing agricultural land use. The proposed development is not expected to result in a noticeable increase in ambient noise levels beyond those already associated with the cultivation and twice-yearly harvesting of the existing 95 ha of centre-pivot land. The distance to the nearest identified residential receptor further limits the potential for disturbance.

Noise Impact (Operational Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Intermittent noise from routine pecan orchard management, irrigation system operation and maintenance, tractor and vehicle movements, mowing, pesticide application and seasonal harvesting of the additional orchard area.	Existing noise associated with cultivation, irrigation, machinery movements and twice-yearly harvesting of approximately 95 ha of centre-pivot land will continue. No additional orchard-related noise will be introduced.
Extent and duration of impact:	Predominantly site-specific, with limited potential for localised disturbance. Long-term but intermittent, occurring when orchard management and harvesting activities are undertaken.	Site-specific to local. Existing agricultural noise will continue intermittently over the lifespan of the current farming operation.
Consequence of impact or risk:	Very limited additional noise within an established agricultural environment. Temporary disturbance to fauna may occur when machinery operates near retained natural vegetation and riparian areas. A noticeable increase in noise at the nearest identified residential receptor is not anticipated.	No additional operational noise from the proposed 46 ha orchard expansion. The existing agricultural noise baseline will remain.
Probability of occurrence:	Definite during orchard management and harvesting activities, although the additional noise will be intermittent.	Existing agricultural noise will continue. No additional operational noise from the proposed expansion will occur.

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Degree to which the impact may cause irreplaceable loss of resources:	Very low. The intermittent noise is not expected to cause irreplaceable loss of environmental resources.	None attributable to the proposed development.
Degree to which the impact can be reversed:	Fully reversible at the level of individual activities, as noise ceases when machinery is switched off or leaves the area.	Not applicable to the proposed development.
Indirect impacts:	Possible temporary disturbance or displacement of fauna near active orchard operations, particularly adjoining retained natural vegetation and the riparian corridor.	No additional indirect noise impacts from the proposed expansion.
Cumulative impact prior to mitigation:	Very Low. Additional orchard noise will occur within an established farming operation where approximately 95 ha is already cultivated and harvested twice annually.	The existing agricultural noise environment and intermittent noise from other activities in the area will continue without an additional contribution from the proposed expansion.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-)
Degree to which the impact can be avoided:	Partially avoidable. Noise from necessary farming activities cannot be eliminated, but unnecessary machinery operation and vehicle movements can be avoided.	Fully avoided in respect of the proposed expansion.
Degree to which the impact can be managed:	High. Noise can be controlled through routine farm operating practices, machinery maintenance and activity scheduling.	Existing farming noise remains subject to normal farm management practices.
Degree to which the impact can be mitigated:	High. Routine operational controls can minimise unnecessary noise, although the impact is already assessed as Very Low.	No additional mitigation is required for the proposed expansion.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Maintain agricultural machinery and vehicles in good working order; • Avoid unnecessary idling and excessive revving; undertake particularly noisy activities during normal daytime hours where practicable; • Limit unnecessary vehicle movements; and restrict machinery to the approved agricultural footprint and access routes. Do not use retained natural vegetation or the Orange River riparian corridor for vehicle access or equipment storage.	Continue existing farm noise-management practices. No additional operational measures are required for the proposed expansion.
Residual impacts:	Very low, intermittent noise associated with necessary orchard management and seasonal harvesting.	No additional operational noise from the proposed expansion.

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Cumulative impact post mitigation:	Very Low. The additional noise will remain consistent with the established agricultural land use and is not expected to noticeably alter the ambient noise environment.	Existing cumulative agricultural noise will continue without an additional contribution from the proposed expansion.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-)

WASTE GENERATION

The proposed development entails the clearing of approximately 46 ha of vegetation and the preparation of infill areas between and around the existing centre-pivot irrigation systems for the establishment of pecan nut orchards. Waste generated during this phase is expected to consist primarily of cleared vegetation, general waste from workers, packaging materials and limited quantities of waste associated with the operation and maintenance of agricultural machinery.

Vegetation cleared from the proposed orchard areas will constitute the largest waste stream during establishment. Where practicable, suitable plant material should be chipped or mulched and reused on the farm, provided that it does not contain invasive alien plant material capable of regrowth or seed dispersal. Cleared vegetation must not be pushed into drainage lines, stockpiled within the Orange River riparian corridor or disposed of in surrounding natural vegetation. The burning of cleared vegetation or general waste should not be permitted as a routine disposal method.

General waste may include food packaging, plastic, paper and other refuse generated by workers. Additional waste may include empty containers, damaged irrigation components and packaging from equipment and materials delivered to the site. Although the quantities are expected to be limited, inappropriate disposal could result in littering, visual impacts and contamination of the surrounding environment.

Small quantities of potentially hazardous waste may arise from machinery servicing, including used oil, grease, oily rags, filters and contaminated absorbent material. Accidental fuel or oil spills could also generate contaminated soil requiring appropriate handling and disposal. These materials present a greater pollution risk than general waste, particularly where they are stored or discarded near drainage features or the Orange River. Routine machinery servicing should therefore be undertaken in a designated area away from watercourses, with suitable spill-response materials available.

Waste management during construction should follow the waste hierarchy of avoidance, reduction, reuse, recycling and appropriate disposal. Clearly identified waste containers should be provided, waste should be separated where practicable, and all non-reusable waste should be removed to an appropriately authorised waste facility. Hazardous

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waste must be stored separately in suitable containers and removed by an appropriate service provider. Waste disposal records should be retained where applicable.

The proposed expansion will result in a temporary increase in waste generation above that associated with the existing 95 ha agricultural operation. However, the quantities are expected to be manageable through standard site controls. The significance of the construction-phase waste impact is assessed as Low–Medium before mitigation and Low after mitigation, primarily because inappropriate disposal or accidental spills could affect surrounding vegetation, soil and water resources.

Waste Impact (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Temporary waste from clearing and preparing the additional 46 ha, including cleared vegetation, workers' general waste, packaging, damaged irrigation components and limited machinery-related hazardous waste.	No establishment of the additional 46 ha. Waste from the existing 95 ha agricultural operation will continue.
Extent and duration of impact:	Primarily site-specific, with potential local effects if waste reaches surrounding vegetation, drainage features or the Orange River. Short-term during establishment.	Existing farm waste generation remains site-specific and ongoing; no additional construction-phase waste.
Consequence of impact or risk:	Poor disposal could cause litter, visual impacts, soil or water contamination and disturbance of surrounding natural vegetation. Oil or fuel-contaminated waste presents the greater pollution risk.	No additional construction waste or associated pollution risk; existing farm waste still requires appropriate management.
Probability of occurrence:	Waste generation is definite; environmental contamination is possible if waste is improperly handled or spills occur.	No additional construction waste will arise.
Degree to which the impact may cause irreplaceable loss of resources:	Low under normal conditions; potentially greater if hazardous waste or contaminated soil reaches sensitive water resources.	No additional risk of irreplaceable loss from the proposed expansion.
Degree to which the impact can be reversed:	Litter and most localised contamination can be removed or remediated; severe water contamination may be more difficult to reverse.	Not applicable to the proposed construction activities.
Indirect impacts:	Windblown litter, fauna attraction or entanglement, and pollution transported by runoff into drainage lines or the Orange River.	No additional indirect impacts from construction of the expansion.
Cumulative impact prior to mitigation:	Low–Medium. Temporary additional waste arises alongside waste from existing farming; poor handling could add to local soil and water pollution pressures.	Existing agricultural waste and any related cumulative effects continue, without an additional construction contribution.

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Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low–Medium (-)	No additional construction impact (existing farm waste continues).
Degree to which the impact can be avoided:	High for unnecessary packaging, litter and avoidable spills; vegetation clearing and some machinery-related waste cannot be entirely avoided.	Fully avoidable for waste associated with the proposed establishment works.
Degree to which the impact can be managed:	High through waste separation, designated storage, regular removal, worker instruction and spill controls.	Existing waste remains manageable under current farm practices.
Degree to which the impact can be mitigated:	High, provided general and hazardous waste are handled separately and removed or reused appropriately.	No additional construction mitigation required.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Chip or mulch suitable cleared vegetation for reuse where practicable; manage invasive alien material to prevent regrowth or dispersal. • Do not burn waste or stockpile material in drainage lines, natural vegetation or the riparian corridor. Provide labelled waste bins; separate reusable, recyclable and hazardous waste; remove non-reusable waste to an appropriately authorised facility. • Service machinery in a designated area away from watercourses; provide spill kits. • Contain and appropriately dispose of oil, filters, oily rags and contaminated soil. Retain applicable disposal records.	No construction-specific mitigation for the proposed expansion. Continue appropriate waste management for the existing agricultural operation.
Residual impacts:	Low quantities of unavoidable waste and a low residual risk of isolated litter or spills after management.	No additional construction waste; existing agricultural waste persists.
Cumulative impact post mitigation:	Low. Proper handling and disposal limit any additional contribution to existing farm waste and pollution pressures.	No additional construction-related cumulative impact.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Low (-). No additional construction impact (existing farm waste continues).

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During the operational phase, waste will be generated through routine pecan orchard management, irrigation maintenance, pesticide application and seasonal harvesting. The main waste streams are expected to include pruning

material, grass and other vegetation from orchard maintenance, damaged irrigation components, general waste, pesticide and fertiliser packaging, and limited quantities of waste associated with machinery maintenance.

Organic waste from pruning and vegetation management may be chipped or mulched and reused within the orchards where suitable. This would reduce the volume of waste requiring removal and may contribute to soil cover and moisture retention. Organic material should nevertheless be managed to prevent the accumulation of waste in drainage lines, the riparian corridor or retained natural vegetation.

Pesticide containers, residual pesticide mixtures and contaminated packaging require particular attention because incorrect handling or disposal could result in soil and water contamination. Empty pesticide containers must be managed in accordance with the applicable product-label instructions and an appropriate container collection or disposal system. Pesticide residues, rinsate and contaminated materials must not be discharged onto bare ground, into drainage lines or into the Orange River. Similarly, fertiliser packaging and any unused agricultural chemicals should be stored and disposed of appropriately.

The proposed pecan orchards will form part of an established farming operation, where waste is already generated through the cultivation and twice-yearly harvesting of approximately 95 ha of centre-pivot land. The proposed expansion will therefore increase the quantity and introduce some additional types of agricultural waste, rather than introduce waste generation to a previously unused property. The most important operational risk is not the volume of waste itself, but the potential for pollution if agricultural chemicals and their containers are incorrectly stored, handled or disposed of.

Operational waste should be managed through designated storage areas, separation of general and hazardous waste, reuse or recycling of suitable materials, and regular removal of waste that cannot be managed on the farm. Waste storage areas should be located outside drainage lines, retained natural vegetation and the Orange River riparian corridor. Employees responsible for handling agricultural chemicals should be trained in the relevant storage, handling, spill-response and disposal procedures.

The significance of the additional operational-phase waste impact is assessed as Medium before mitigation and Low after mitigation. The pre-mitigation rating reflects the potential consequences of improper pesticide waste management and contamination of nearby water resources, rather than the anticipated quantity of general or organic waste. With appropriate waste handling, storage and disposal measures, the residual impact is expected to be limited.

Waste Impact (Operational Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Additional waste from pecan orchard management and harvesting, including pruning and mowing material, general waste, damaged irrigation components,	The additional 46 ha orchard will not operate. Waste from cultivation and twice-yearly harvesting of the existing 95 ha will continue.

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	pesticide and fertiliser packaging, and limited machinery-maintenance waste.	
Extent and duration of impact:	Predominantly site-specific; local impacts are possible if waste or contaminants enter drainage features or the Orange River. Long-term but intermittent throughout orchard operation.	Existing agricultural waste generation continues on an ongoing basis, without waste from the proposed additional orchard.
Consequence of impact or risk:	Incorrect handling of pesticide containers, residues or contaminated materials could contaminate soil and water. General and organic waste may cause litter, visual impacts or localised nuisance if poorly managed.	No additional waste-related consequence from the proposed expansion; existing agricultural waste risks remain.
Probability of occurrence:	Additional waste generation is definite. Pollution is possible if agricultural chemicals or waste are incorrectly stored, handled or disposed of.	Existing farm waste generation remains definite; no additional waste from the expansion.
Degree to which the impact may cause irreplaceable loss of resources:	Generally low for properly managed waste, but potentially significant if chemical waste contaminates sensitive water resources.	No additional risk of irreplaceable loss attributable to the proposed orchard.
Degree to which the impact can be reversed:	Most litter and localised impacts are reversible through collection and remediation; significant chemical contamination may be difficult to reverse.	Not applicable to the proposed expansion.
Indirect impacts:	Runoff may transport contaminants to drainage features or the Orange River; litter may affect fauna; poorly managed waste may attract animals.	No additional indirect impacts from the proposed orchard; existing farm waste impacts may continue.
Cumulative impact prior to mitigation:	Medium. Additional chemical packaging and orchard waste may add to existing farm waste streams and pollution pressures if not appropriately managed.	Existing agricultural waste and associated cumulative risks continue, without the proposed expansion's contribution.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (-)	No additional operational impact (existing farm waste continues).
Degree to which the impact can be avoided:	High for unnecessary packaging, avoidable spills and improper disposal; some pruning, chemical packaging and maintenance waste is unavoidable.	Fully avoidable for waste generated by the proposed additional orchard.
Degree to which the impact can be managed:	High through designated storage, segregation, employee training, routine collection and appropriate chemical-waste procedures.	Existing waste remains manageable through normal farm procedures.
Degree to which the impact can be mitigated:	High. Suitable storage, reuse, recycling and authorised disposal can substantially reduce pollution risk.	No additional operational mitigation required for the proposed expansion.

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Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Chip or mulch suitable pruning and vegetation waste for reuse where practicable. • Provide designated storage and separate general, recyclable and hazardous waste. • Manage pesticide containers, residues and rinsate according to product-label instructions and an appropriate collection or disposal system. • Do not discharge residues to soil, drainage lines or the Orange River. • Store agricultural chemicals and contaminated materials securely; train employees in handling and spill response. • Remove non-reusable waste appropriately. • Keep storage and disposal activities outside drainage lines, natural vegetation and the riparian corridor.	Continue appropriate waste separation, chemical-container handling, storage and disposal for the existing 95 ha agricultural operation.
Residual impacts:	Low volumes of unavoidable waste and a low residual risk of isolated litter or spills under routine farm management.	No additional waste from the proposed orchard; existing farming waste continues.
Cumulative impact post mitigation:	Low. Appropriate waste controls limit the proposed expansion's contribution to existing farm waste and pollution pressures.	No additional cumulative waste impact from the proposed expansion.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Low (-) No additional operational impact (existing farm waste continues).

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VISUAL IMPACT AND AESTHETIC ACCEPTABILITY

The proposed development is situated within an established rural agricultural landscape near Prieska, where approximately 95 ha of land is already under centre-pivot irrigation. The existing agricultural infrastructure, cultivated fields, farm roads and associated farming activities form part of the visual character of the properties. The surrounding landscape also includes areas of natural vegetation and the Orange River riparian corridor, which contribute to its rural character and visual diversity.

The proposed development entails the establishment of approximately 46 ha of pecan nut orchards within infill areas between and around the existing centre-pivot irrigation systems. The development will therefore represent an expansion of the existing agricultural land use rather than the introduction of an entirely new land-use type.

Nevertheless, the conversion of currently vegetated areas to orchards will result in a permanent change to the appearance of those portions of the properties.

The visual impact must be considered in relation to the existing agricultural landscape, the extent of vegetation clearing, the visibility of the proposed orchards from surrounding properties and access routes, and the retention of natural vegetation along the Orange River and associated drainage features. No dedicated visual impact assessment or verified viewshed analysis has been provided; the assessment below is therefore a qualitative EAP assessment based on the available project information.

During the construction phase, the principal visual impacts will arise from vegetation clearing, soil preparation, the movement and operation of agricultural machinery, and the temporary presence of vehicles, equipment and stockpiled materials. These activities will temporarily alter the appearance of the proposed 46 ha development area, particularly where indigenous vegetation is removed and bare soil is exposed before the orchards are established.

The visual change will be most noticeable during the initial clearing and soil preparation activities. However, the proposed development is located within an existing farming operation where cultivated land, centre-pivot irrigation infrastructure and agricultural machinery are already established features of the landscape. Construction activities are therefore expected to be visually consistent with the broader agricultural setting, although they will temporarily extend the area of visible disturbance.

The potential for visual disturbance to surrounding residents is considered limited by the rural location of the site and the distance to the nearest identified residential receptor, the applicant's farmhouse, which is situated more than 1 km from the proposed development area. The extent to which the works may be visible from other surrounding properties or access routes has not been confirmed.

Visual impacts during establishment can be reduced by restricting clearing and machinery movements to the approved development footprint, limiting unnecessary stockpiling, maintaining a tidy working area and removing waste and redundant equipment promptly. The retained natural vegetation and Orange River riparian corridor should be protected from disturbance, and exposed areas not required for orchard establishment should be rehabilitated as soon as practicable.

The significance of the additional construction-phase visual impact is assessed as Low before mitigation and Very Low after mitigation. Although the clearing of vegetation will result in a permanent land-cover change, the temporary visual disturbance associated with construction activities is expected to be limited within the existing agricultural landscape.

Visual Impact (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Temporary visual disturbance from vegetation clearing, exposed soil, soil preparation, agricultural machinery, vehicles and temporary stockpiles. The	The 46 ha expansion will not proceed. Existing cultivated fields, irrigation infrastructure and natural

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	clearing also initiates a permanent change in land cover within the approved footprint.	vegetation will retain their current visual character.
Extent and duration of impact:	Predominantly site-specific, with potential local visibility from surrounding properties or access routes that has not been verified. Construction-related disturbance is short-term; the associated land-cover conversion is permanent.	No additional construction-phase visual disturbance. The existing agricultural and natural landscape mosaic remains.
Consequence of impact or risk:	Temporary reduction in visual amenity due to exposed ground, equipment and clearing. The conversion of natural vegetation to orchards permanently changes the appearance of the footprint.	Avoids temporary construction disturbance and the proposed land-cover change; existing farming activities and infrastructure remain visible.
Probability of occurrence:	Definite within the development footprint during clearing and soil preparation. Visibility to off-site receptors is unconfirmed.	No visual impact attributable to construction of the proposed expansion.
Degree to which the impact may cause irreplaceable loss of resources:	Very low in visual terms. The natural landscape character within the cleared footprint will nevertheless be permanently altered; ecological loss is assessed separately.	No additional loss of visual landscape character attributable to the proposal.
Degree to which the impact can be reversed:	Temporary construction clutter and exposed working areas can be removed or stabilised. Conversion of the footprint to orchards is not reversible through routine construction mitigation.	Not applicable; the proposed construction activities do not occur.
Indirect impacts:	Potential temporary reduction in visual amenity for persons with views of the works; the extent of off-site visibility has not been established.	No additional indirect visual impacts from the proposed development.
Cumulative impact prior to mitigation:	Low. Construction disturbance adds temporarily to the existing visual presence of cultivated land, centre pivots, farm roads and agricultural machinery.	Existing agricultural visual impacts continue without an additional contribution from the proposed expansion.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-)
Degree to which the impact can be avoided:	Partially. Unnecessary disturbance outside the approved footprint and avoidable stockpiling can be prevented, but clearing within the footprint is integral to the proposal.	Fully avoided in respect of the proposed construction works.
Degree to which the impact can be managed:	High. Site housekeeping, access, and the extent of clearing can be controlled.	No additional construction management required for the proposed expansion.

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Degree to which the impact can be mitigated:	High for temporary construction disturbance; limited for the permanent land-cover change.	Not applicable to the proposed construction activities.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Restrict clearing, machinery and vehicle movements to the approved footprint and access routes; • Retain and protect natural vegetation and the Orange River riparian corridor; keep work areas tidy; • Remove waste and redundant equipment promptly; • Rehabilitate disturbed areas not required for orchard establishment.	No project-specific construction mitigation required. Existing farming areas should continue to be managed in an orderly manner.
Residual impacts:	Very low temporary visual disturbance following site management, together with the permanent visual change associated with conversion of the approved footprint to orchards.	No additional construction-related visual disturbance.
Cumulative impact post mitigation:	Very Low for temporary construction disturbance against the established agricultural landscape. The permanent orchard-related visual change is considered in the operational assessment.	No additional cumulative construction-phase visual impact.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-)

During the operational phase, the proposed development will result in the conversion of approximately 46 ha of currently vegetated land to pecan nut orchards. This will create a permanent change in land cover and landscape appearance, with the proposed orchards becoming part of the existing agricultural operation.

The visual character of the development will change as the pecan trees mature. During the initial establishment period, the orchard areas may appear relatively open, with young trees, exposed soil and irrigation infrastructure visible between planting rows. As the trees become established, the orchards will develop a more continuous vegetated appearance. Their seasonal appearance will also vary as the deciduous pecan trees lose and regain their leaves.

The proposed orchards will be visually compatible with the established agricultural character of the properties, particularly given the existing 95 ha of cultivated land and centre-pivot irrigation infrastructure. However, visual compatibility with the agricultural setting does not eliminate the permanent loss of the natural landscape character within the proposed development footprint. The retention of natural vegetation outside the approved orchard areas, particularly along drainage features and the Orange River riparian corridor, will therefore be important in maintaining the visual diversity of the properties.

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Routine orchard management, irrigation and seasonal harvesting are not expected to introduce significant additional visual disturbance beyond that associated with the existing farming activities. The proposed development does not include large industrial structures or other visually dominant infrastructure in the project description considered for this assessment.

Operational visual impacts should be managed by maintaining the orchards and associated infrastructure in an orderly condition, preventing the accumulation of waste or redundant equipment, and restricting agricultural activities to the approved footprint. Existing natural vegetation outside the development area should be retained, and the riparian corridor should remain free of orchard establishment, equipment storage and unnecessary vehicle access.

The significance of the additional operational-phase visual impact is assessed as Low before and after mitigation. The proposed orchards are expected to be aesthetically compatible with the established agricultural landscape, but the permanent conversion of the 46 ha development footprint from its existing vegetation cover to cultivated orchards cannot be reversed through routine operational mitigation.

Visual Impact (Operational Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Permanent conversion of approximately 46 ha of currently vegetated infill areas to pecan nut orchards, with associated seasonal changes in orchard appearance and intermittent visual activity from routine management and harvesting.	The 46 ha expansion will not proceed. The existing approximately 95 ha of cultivated centre-pivot land and its agricultural infrastructure will remain part of the landscape; vegetation within the proposed expansion footprint will be retained.
Extent and duration of impact:	Predominantly site-specific, with potential visibility from surrounding properties and access routes not verified. Long-term to permanent land-cover change over the lifespan of the orchards.	Site-specific to local. The existing combination of cultivated land and natural vegetation will remain for as long as the current land use continues.
Consequence of impact or risk:	Permanent alteration of the visual character of the 46 ha footprint. The orchards will be compatible with the established agricultural setting, but natural landscape character within the cleared areas will be lost.	Avoids the additional visual change and retains the natural vegetation within the proposed expansion areas; the existing agricultural visual character remains.
Probability of occurrence:	Definite if the proposed orchard expansion is implemented.	No visual change attributable to the proposed 46 ha expansion will occur.

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Degree to which the impact may cause irreplaceable loss of resources:	Low from a visual perspective: natural landscape character within the footprint will be replaced, but no unique visual resource has been identified. Ecological loss is assessed separately.	No additional loss of natural landscape character from the proposed development.
Degree to which the impact can be reversed:	Partially reversible in principle if orchards and infrastructure are removed and the land rehabilitated; restoration of the former natural landscape character would be uncertain and take time.	No reversal is required in relation to the proposed expansion.
Indirect impacts:	Potential alteration of views from surrounding properties and routes, and seasonal visual changes as deciduous pecan trees mature, lose and regain leaves.	No additional indirect visual impacts from the proposed expansion.
Cumulative impact prior to mitigation:	Low. The 46 ha expansion will increase the area under cultivation alongside the existing approximately 95 ha of centre-pivot land, incrementally changing the balance between agricultural land and natural vegetation.	Existing agricultural infrastructure and cultivated land will remain visible; no additional cumulative visual contribution from the proposed expansion.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-)
Degree to which the impact can be avoided:	Partially avoidable through restriction of orchards and infrastructure to the approved footprint and retention of surrounding natural vegetation; the land-cover change within the footprint cannot be avoided if development proceeds.	Fully avoided in respect of the proposed expansion.
Degree to which the impact can be managed:	High. Orchard maintenance, infrastructure placement, waste management and protection of retained vegetation can be controlled.	Existing agricultural visual impacts remain subject to normal farm management.
Degree to which the impact can be mitigated:	Moderate. Good site management and retention of natural vegetation can limit visual intrusion, but cannot eliminate the permanent conversion of the orchard footprint.	No mitigation is required for the unimplemented expansion.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Restrict orchards, machinery and infrastructure to the approved footprint and access routes. • Retain and protect natural vegetation outside the footprint, particularly along drainage features and the Orange River riparian corridor.	Continue existing farm housekeeping and maintenance. No additional mitigation is required for the proposed expansion.

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	• Maintain orchards and infrastructure in an orderly condition. • Remove waste and redundant equipment promptly. • Do not use retained natural vegetation or the riparian corridor for vehicle access or equipment storage.	
Residual impacts:	Permanent change from existing vegetation to cultivated orchard within approximately 46 ha, with seasonal changes in appearance; limited additional visual intrusion within the established agricultural setting.	No additional visual change attributable to the proposed expansion.
Cumulative impact post mitigation:	Low. The expanded cultivated area will remain a permanent addition to the established agricultural landscape, while retained natural vegetation and the riparian corridor preserve visual diversity.	Existing agricultural visual impacts continue, without an additional contribution from the proposed expansion.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-)

TRANSPORT IMPACT

The existing access roads on the farm and the R357 will be used. During the construction phase (vegetation clearing) a bulldozer will be at the site and will not add heavy vehicle traffic to the national and provincial road system. It is not anticipated that there will be any impact on the farm road infrastructure.

Once operational, the R357 will be used to transport harvest crops, dried fruit and nuts to the relevant markets. It is anticipated that during the harvest time, heavy vehicles will add to the traffic count on the R357, but since this road is built for heavy vehicles, the impact is anticipated to be low.

The R357 is suitable for all vehicles and constructed to carry frequent traffic and heavily loaded vehicles. It is anticipated that during the harvest time, heavy vehicles will add to the traffic count on the R357, but since this road is built for heavy vehicles, the impact is anticipated to be a very low impact.

During periods of high hauling rates which could occur during the harvest time, a flagman should secure access. The line of visibility on both sides of the junction is good and therefore poses no direct threat to the road users abiding by the speed limit. Making other motorists aware of the possibility of heavy vehicles on the road will create more awareness and caution the drivers. The overall impact on traffic and road infrastructure during the operational phase is rated low impact.

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Road safety for motorists is always a priority and of importance. Truck drivers should be informed accordingly and be sensitized towards displaying proper road etiquette. Despite the quality of the roads, the safety risks for motorists, cyclists, and pedestrians could increase due to human error, since heavy vehicles will slow down vehicles or reckless driving could cause accidents. Therefore all truck drivers will be sensitized on the matter and provided with the necessary transport training.

Furthermore, harvest material should be carted from the property from 07:00 to 17:00 during the week (winter) and 6:00 to 19:00 (summer) but this may result in the need to cart crops on Saturday mornings, this will reduce the small impact on being restrained to daylight, furthering increasing visibility, since visibility is better in the day than at night time. The impact is expected to be low with mitigation.

The current traffic volume on the gravel road or the R357 road is not known, however, they are provincial roads, and thus it is expected to carry sufficient volumes of traffic. Activities such as farming, mining and schools can cumulatively contribute to the vehicle load on the gravel road leading to the R357. Some of these activities will add heavy vehicle loads only during harvest time, thus there is a small possibility that the cumulative impact on the structural integrity of the road will increase if this site is approved. Considering the annual harvest, the possible cumulative impact is rated low-moderate to low.

Traffic Impact (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Limited additional vehicle movements on existing farm access roads and the R357 during vegetation clearing and orchard establishment. A bulldozer will remain on site and is not expected to generate regular heavy-vehicle trips.	The 46 ha expansion will not be established. Traffic associated with the existing 95 ha farming operation will continue.
Extent and duration of impact:	Site-specific to local; temporary during establishment, with occasional vehicle movements on the access road and R357.	Existing farm and harvest traffic will continue intermittently; no additional construction-period traffic.
Consequence of impact or risk:	Negligible change to traffic volumes and no anticipated material impact on farm road infrastructure. Limited potential for access-related safety incidents.	No additional construction-related traffic or road-safety risk; existing road use remains.
Probability of occurrence:	Occasional vehicle movements are certain; a material traffic or road-infrastructure impact is unlikely.	No construction traffic from the proposed expansion will occur.
Degree to which the impact may cause irreplaceable loss of resources:	Very low; No irreplaceable resource loss is anticipated from the limited additional traffic.	None attributable to the proposed expansion.
Degree to which the impact can be reversed:	Fully reversible: additional vehicle movements cease once establishment is complete.	Not applicable to the proposed construction activities.

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Indirect impacts:	Possible brief delays or safety risks where vehicles enter or leave the farm access road; otherwise negligible.	No additional indirect construction traffic impacts.
Cumulative impact prior to mitigation:	Very Low to Low. Limited additional movements may coincide with existing farming, mining and school-related traffic on the gravel access road and R357.	Existing traffic from farming, mining and schools continues without an additional construction contribution.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-)
Degree to which the impact can be avoided:	Largely avoidable through minimising deliveries and using existing access roads; essential establishment trips cannot be eliminated.	Fully avoided for the proposed construction activities.
Degree to which the impact can be managed:	High; Vehicle movements and access arrangements can be scheduled and supervised.	Existing traffic remains subject to normal road rules and farm management.
Degree to which the impact can be mitigated:	High; Safe driving, access control and vehicle maintenance can reduce the already limited risk.	No additional construction mitigation required.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Use existing farm roads and the R357; • Keep vehicles roadworthy and loads secured. • Brief drivers on speed limits and safe road etiquette. • Avoid unnecessary trips. • Maintain clear sightlines at the access junction. • Use a flagman if unusually high vehicle movements require access control.	No additional measures for the proposed construction phase; continue existing safe farm transport practices.
Residual impacts:	Occasional, short-term vehicle movements with negligible effect on traffic flow and road condition.	No additional construction-related residual impact.
Cumulative impact post mitigation:	Very Low; No material additional contribution to existing road traffic is anticipated.	Existing cumulative traffic remains unchanged by the proposed expansion.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Very Low (-)	Very Low (-)

Traffic Impact (Operational Phase)	**Alternative 1:**	**No-Go Option**

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Nature of impact:	Additional seasonal heavy-vehicle movements transporting pecan harvests and other agricultural produce to markets via existing farm roads and the R357; associated access and road-safety risks.	Traffic associated with cultivation and twice-yearly harvesting of the existing 95 ha operation will continue; no additional pecan-orchard haulage from the 46 ha expansion.
Extent and duration of impact:	Local along the farm access road and R357; long-term but intermittent, with the greatest additional movements during harvest periods.	Existing local farm and harvest traffic continues seasonally over the current operation's lifespan.
Consequence of impact or risk:	Small seasonal increase in traffic and potential for brief delays, access conflicts or road-safety incidents involving motorists, cyclists and pedestrians. Limited potential contribution to gravel-road wear.	No additional traffic or road wear from the proposed expansion; existing road-user risks remain.
Probability of occurrence:	Additional harvest-related trips are expected; accidents and material road damage are possible but not inevitable.	Existing harvest traffic will continue; no additional trips from the expansion.
Degree to which the impact may cause irreplaceable loss of resources:	Very low in relation to road resources; however, serious accidents could cause irreversible injury, making compliance with road-safety measures essential.	No additional resource loss or safety risk attributable to the proposed expansion.
Degree to which the impact can be reversed:	Traffic increases and minor road wear are reversible or manageable; consequences of a serious accident may not be reversible.	Not applicable to the proposed expansion.
Indirect impacts:	Potential temporary delays and heightened safety risks at the access junction and along the haulage route, particularly during harvesting.	Existing traffic-related delays and safety risks continue without the additional orchard haulage.
Cumulative impact prior to mitigation:	Low–Moderate. Seasonal haulage may coincide with farming, mining and school traffic on the gravel road and R357; current traffic volumes are not known.	Existing cumulative traffic from farming, mining and schools continues without an additional contribution from the expansion.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-)
Degree to which the impact can be avoided:	Partially avoidable: necessary harvest transport cannot be eliminated, but unnecessary trips, unsafe manoeuvres and night-time haulage can be avoided.	Fully avoided for the proposed additional orchard haulage.
Degree to which the impact can be managed:	High; Vehicle timing, driver conduct and access management can be controlled.	Existing traffic remains subject to normal transport management and road rules.
Degree to which the impact can be mitigated:	High;	No additional mitigation required for the proposed expansion.

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	Driver training, daylight transport, warning measures and access control can reduce traffic and safety risks.	
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Use the existing farm access roads and R357. • Maintain roadworthy vehicles and secure loads; • Train and brief drivers on safe driving, speed limits and road etiquette; • Schedule harvest transport for 07:00–17:00 on winter weekdays and 06:00–19:00 on summer weekdays, with Saturday-morning transport where necessary; • Avoid night-time haulage where practicable; • Maintain sightlines at the junction; • Use a flagman during periods of high hauling rates; • Provide appropriate warning of heavy-vehicle movements to other road users.	Continue existing safe transport and road-use practices for the current farming operation.
Residual impacts:	Low, Intermittent seasonal traffic increase and limited residual access-related safety risk during harvest transport.	No additional operational traffic impact from the proposed expansion.
Cumulative impact post mitigation:	Low. Seasonal movements remain a minor additional contribution to the traffic already generated by farming, mining and schools.	Existing cumulative traffic remains, without the proposed expansion's additional seasonal trips.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	Very Low (-)

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SOCIO-ECONOMIC IMPACT

The proposed development is situated on the Remainder of Farm Tweefontein No. 373 and Portion 4 (a portion of Portion 2) of Farm Kalkfontein No. 374, within the Siyathemba Local Municipality near Prieska. The properties are already used for irrigated agriculture, with four established centre-pivot irrigation areas covering approximately 95 ha. The applicant, Temdale Boerdery (Pty) Ltd, currently cultivates maize and wheat and proposes to expand the cultivated footprint by approximately 46 ha to establish pecan nut orchards. The development forms part of a transition from annual crop production to long-term pecan nut cultivation, using and optimising the existing agricultural infrastructure.

The socio-economic assessment must therefore consider the additional employment, expenditure and agricultural production associated with the proposed expansion, while recognising that the existing farming operation already supports economic activity and employment. The No-Go option would not result in the cessation of farming on the properties; the existing agricultural activities would continue.

During the construction phase, employment opportunities will arise from vegetation clearing, removal of stones where required, soil preparation, planting of pecan trees, and the installation or adaptation of irrigation and fencing infrastructure. The use of agricultural machinery and the procurement of equipment and materials may also generate expenditure for suppliers and service providers.

The application form estimates that the project will create 20 skilled and 50 unskilled employment opportunities during the construction phase. It records an expected employment value of approximately R40 000 per month during construction, with 100% of this value anticipated to accrue to previously disadvantaged individuals. These figures are applicant estimates and should be confirmed against the final implementation programme and labour requirements.

The development may also provide indirect economic benefits through the procurement of earthmoving equipment, irrigation components, fencing materials, agricultural supplies and other services. The extent to which these benefits accrue within the Siyathemba municipal area will depend on the availability of suitable local workers, contractors and suppliers.

Potential negative socio-economic impacts during establishment include temporary dust and noise nuisance, increased vehicle movements and occupational health and safety risks associated with machinery operation. These impacts are expected to be limited in extent and duration and should be managed through the relevant Environmental Management Programme (EMP) measures. Where suitably qualified workers and service providers are available, local procurement and employment should be encouraged.

Socio-Economic Impact (Construction Phase)	**Alternative 1:**	**No-Go Option**
Nature of impact:	Positive employment and local expenditure associated with clearing approximately 46 ha, preparing land, planting pecan trees and adapting irrigation and fencing infrastructure. The application estimates 20 skilled and 50 unskilled construction employment opportunities.	The proposed expansion will not proceed; no additional construction employment or procurement will arise. Existing farming and associated employment will continue.
Extent and duration of impact:	Local to municipal, with potential benefits to workers and suppliers in the Siyathemba area. Short-term, during the establishment phase.	No additional construction-phase benefit; existing agricultural economic activity continues.
Consequence of impact or risk:	Temporary income for workers and expenditure on equipment, materials and services. The application estimates an	Foregone additional employment and procurement associated with

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	employment value of approximately R40 000 per month during construction; actual benefits depend on recruitment and procurement.	the 46 ha expansion; no loss of existing farming employment is assumed.
Probability of occurrence:	High, provided the development proceeds. The number and duration of appointments depend on the final implementation programme.	Definite that the expansion-related construction benefits will not arise if the project does not proceed.
Degree to which the impact may cause irreplaceable loss of resources:	Not applicable to the positive socio-economic impact. Employment and procurement do not cause irreplaceable socio-economic resource loss.	Not applicable; no additional positive impact occurs.
Degree to which the impact can be reversed:	The direct employment benefit is temporary and will cease when establishment work is completed; income and skills gained may have lasting benefits.	Not applicable to the proposed construction benefit.
Indirect impacts:	Potential additional turnover for local equipment hire, agricultural suppliers, fencing and irrigation contractors, nurseries and transport providers; potential household spending from wages.	No additional downstream expenditure attributable to the expansion; existing supply-chain activity continues.
Cumulative impact prior to mitigation:	Low positive contribution to agricultural employment and procurement alongside existing farming and other economic activity in the municipality.	No additional positive cumulative contribution from the proposed construction; existing farming benefits continue.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (+)	Very Low (+) / no additional positive impact.
Degree to which the impact can be avoided:	Not applicable as an adverse impact. The benefit would be forgone if the development does not proceed; opportunities for local participation can be increased.	The additional benefit is not realised under the No-Go option.
Degree to which the impact can be managed:	High. Recruitment, contracting, procurement and worker conditions can be managed by the applicant and appointed contractors.	Existing employment and procurement remain subject to normal farm management.
Degree to which the impact can be mitigated:	High potential for enhancement through fair recruitment, suitable training and local procurement where capacity is available.	No expansion-related benefit to enhance.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Prioritise suitably qualified local workers and service providers where practicable. • Apply transparent recruitment and fair employment practices. • Provide appropriate induction, training and occupational health and safety measures.	No additional construction measures are required. Maintain existing employment and procurement practices for the current farming operation.

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	• Procure materials and services locally where feasible and maintain employment and procurement records.	
Residual impacts:	Temporary positive income and business opportunities during establishment; scale depends on actual employment and local procurement.	No additional construction-related socio-economic benefit.
Cumulative impact post mitigation:	Low positive contribution to local employment and business activity, potentially strengthened by local recruitment and procurement.	Existing agricultural economic activity continues without the proposed expansion's additional contribution.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (+).	Very Low (+) / no additional positive impact.

During the operational phase, the proposed orchards will require ongoing irrigation, orchard maintenance, vegetation management, pest and disease control, harvesting and transport. These activities may create employment opportunities and support expenditure on agricultural inputs and services over the lifespan of the development.

The application form estimates 30 skilled and 50 unskilled employment opportunities during the operational phase. It also records an expected labour value of approximately R20 000 per month during operation, increasing to approximately R60 000 per month during harvesting, with 100% of the stated employment value anticipated to accrue to previously disadvantaged individuals. The application does not clearly distinguish permanent positions from seasonal positions within these estimates. It would therefore be inappropriate to describe all 80 opportunities as permanent employment or to retain the draft's claim of more than 300 seasonal workers without further confirmation from the applicant.

The proposed development may also support indirect employment and expenditure through the supply of fertilisers, pesticides, irrigation equipment, machinery maintenance, harvesting services and crop transport. The scale of these benefits will depend on the orchard establishment programme, production volumes and the extent to which goods and services are sourced locally.

Pecan nut production will not generate its full anticipated income immediately after establishment. The application form records an estimated first-year expenditure of R350 000 per hectare, followed by R40 000–R50 000 per hectare in subsequent years. It also provides an indicative income progression of R0 per annum during Years 1–4, R30 000 in Year 5, R60 000 in Year 6, R120 000 in Year 7 and R160 000 in Year 8, with income expected to increase thereafter. The form does not specify whether these income figures are per hectare or for the development as a whole; they should therefore not be presented as a verified total annual project income until the applicant confirms their basis.

The delayed production period is an important consideration in assessing the project's economic benefits and risks. The applicant will incur establishment and ongoing management costs before the orchards reach commercial production. The financial performance of the development will depend on successful orchard establishment, irrigation reliability, crop yields, input costs and market conditions. Poor production or crop losses could affect the applicant's financial returns and the employment opportunities associated with the orchards.

Potential negative social impacts during operation include nuisance from agricultural machinery and harvesting traffic, occupational exposure to agricultural chemicals, and safety and security considerations associated with the movement of workers and contractors. These risks should be addressed through appropriate employment procedures, worker training, occupational health and safety measures, access control and the mitigation measures prescribed elsewhere in the EMP. Seasonal workers should have access to suitable sanitation and other facilities required for their work. No additional worker accommodation or relocation of residents is identified in the application form, and these should not be assumed to form part of the proposed development.

In terms of the cumulative impact, the proposed expansion may contribute positively to agricultural production, employment and expenditure within the Siyathemba municipal area. In combination with the existing farming operation and other agricultural activities in the area, the project may support demand for agricultural suppliers, contractors, transport operators and seasonal labour.

These benefits must, however, be considered alongside the cumulative demands of agricultural development on local infrastructure and resources, including roads and water. The socio-economic benefits should not be used to offset environmental impacts without separately assessing those impacts and their proposed mitigation.

Under the No-Go option, the proposed 46 ha expansion and its associated additional employment and expenditure would not occur. The existing 95 ha agricultural operation would nevertheless continue to generate agricultural production, employment and demand for goods and services.

Overall, the proposed development has the potential to generate positive socio-economic impacts through additional employment, agricultural investment, procurement and future pecan nut production. These benefits will develop over time and depend on successful orchard establishment and the availability of suitable workers and suppliers. The applicant's employment and financial projections provide a basis for the assessment but should be treated as estimates rather than guaranteed outcomes.

The principal negative socio-economic risks relate to temporary construction nuisance, occupational health and safety, seasonal traffic and the financial uncertainty associated with establishing a long-term orchard crop. With appropriate management, these risks are expected to be limited. The final impact significance ratings should distinguish the positive employment and economic effects from the potential negative social impacts, rather than assigning one rating to both.

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Socio-Economic Impact (Operational Phase)	Alternative 1:	No-Go Option
Nature of impact:	Positive: additional skilled and unskilled employment, agricultural investment, orchard production and expenditure on inputs, harvesting and transport as the proposed 46 ha pecan orchards become operational.	The 46 ha expansion and its additional employment, investment and pecan production would not occur. Existing farming and its associated employment and expenditure would continue.
Extent and duration of impact:	Primarily local (farm and Siyathemba municipal area), with potential regional supply-chain benefits. Long-term, although employment and income vary seasonally and increase as the orchards mature.	Existing local agricultural economic activity continues in the long term; no additional benefit attributable to the proposed expansion.
Consequence of impact or risk:	Positive contribution to household income, demand for agricultural services and diversification into long-term pecan production. The application estimates 30 skilled and 50 unskilled operational employment opportunities; these are estimates, not guaranteed permanent posts.	Foregone additional employment and investment associated with the proposed expansion; existing employment and production remain.
Probability of occurrence:	High for some additional operational expenditure and work if the orchards are established; the scale and timing of employment and income depend on successful production, market conditions and the final labour programme.	Definite that expansion-related opportunities would not arise under this option; existing agricultural activities would continue.
Degree to which the impact may cause irreplaceable loss of resources:	Not applicable to this beneficial socio-economic impact. Economic benefits do not negate any separate environmental resource losses.	No irreplaceable resource loss attributable to the absence of the additional socio-economic benefit.
Degree to which the impact can be reversed:	The beneficial impact may diminish or cease if production or employment is reduced. Skills and experience gained by workers may persist.	Not applicable; the additional beneficial impact would not arise.
Indirect impacts:	Positive demand for agricultural suppliers, irrigation and machinery maintenance, harvesting, packaging and transport services; potential increased spending by employed households.	No additional supply-chain or household-spending benefits from the expansion; existing farming-related benefits continue.
Cumulative impact prior to mitigation:	Low–Medium positive: the expansion may add to employment, agricultural output and procurement generated by the existing farm and other agricultural operations, subject to actual production and local sourcing.	Neutral additional impact: no further positive contribution beyond the existing agricultural economy.
Significance rating of impact prior to mitigation	Low–Medium (+).	Neutral / no additional positive impact.

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(e.g. Low, Medium, Medium-High, High, or Very-High)		
Degree to which the impact can be avoided:	The benefit would be avoided if the expansion does not proceed. Its scale may be reduced if local recruitment or procurement opportunities are not realised.	The additional benefit is avoided by definition.
Degree to which the impact can be managed:	High Recruitment, training, labour conditions, local procurement and operational planning can be managed by the applicant.	Existing employment and procurement remain subject to current farm management.
Degree to which the impact can be mitigated:	High potential to enhance the positive impact through fair recruitment, training and local procurement where suitable capacity exists.	No expansion-related benefit to enhance; maintain sound employment practices in the existing operation.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Prioritise suitably qualified local workers and service providers where practicable. • Apply fair, transparent recruitment and lawful employment conditions. • Provide appropriate training, PPE and occupational health and safety measures. • Plan seasonal recruitment and transport requirements; maintain records of actual employment and local procurement. • Support skills development and procure agricultural inputs and services locally where feasible.	Continue existing lawful employment, worker safety and procurement practices. No expansion-specific enhancement measures apply.
Residual impacts:	Positive employment, household income and local procurement opportunities during orchard operation, subject to the orchards reaching commercial production and actual staffing needs.	Existing socio-economic benefits remain; no additional expansion-related benefit.
Cumulative impact post mitigation:	Medium positive where local recruitment, training and procurement opportunities are realised; the extent of the benefit remains dependent on actual orchard performance and labour requirements.	Neutral additional impact; existing cumulative agricultural economic activity continues.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Medium (+), subject to implementation of enhancement measures and actual employment outcomes.	Neutral / no additional positive impact.

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A Phase 1 Palaeontological and Heritage Impact Assessment was undertaken by Dr Lloyd Rossouw of Paleo Field Services for the proposed development of the inter-pivot areas on the Remainder of Farm Tweefontein 373 and Portion 4 of Farm Kalkfontein 374, approximately 38 km north-east of Prieska. The assessment considered the potential effects of the proposed agricultural activities on archaeological, palaeontological and other heritage resources within the affected areas.

The specialist found that the study area is situated on a floodplain-margin landform along the right bank of the Orange River. The affected areas are underlain predominantly by unconsolidated alluvium and locally reworked aeolian sand. These geologically young deposits are generally considered to have low palaeontological sensitivity because they are frequently reworked and are unlikely to preserve fossil material. No fossils or fossil-bearing horizons were identified in the inspected exposures or cuttings. Both the Tweefontein and Kalkfontein sites were consequently assigned a Generally Protected C (low significance) palaeontological field rating.

Although the wider Prieska region contains evidence of Stone Age occupation and historical heritage, the field survey identified no archaeological or other heritage resources within the demarcated development footprints. In particular, no in situ Stone Age artefacts or artefact scatters, visible graves or burial grounds, or historical structures or infrastructure older than 60 years were recorded. The specialist noted that the affected areas have already been disturbed by the establishment and operation of the existing centre-pivot infrastructure. The archaeological significance of the assessed areas was therefore rated low, and the sites were assigned a Generally Protected C rating.

The specialist concluded that the likelihood of encountering scientifically significant fossil material or intact archaeological horizons during shallow agricultural activities is low. However, the assessment was based on visible surface features and inspected exposures; buried or obscured heritage material cannot be excluded entirely. The low-impact conclusion is also conditional on future activities remaining within the scope of existing shallow disturbance and not extending into deeper, previously undisturbed deposits.

The specialist does not require additional heritage mitigation or monitoring for activities within that assessed scope. Nevertheless, a precautionary chance-finds procedure should be incorporated into the EMP. Earthmoving operators should be briefed to stop work in the immediate area if suspected archaeological material, fossils or human remains are exposed, protect the find from further disturbance, and notify site management so that the appropriate heritage authority and a suitably qualified specialist can advise on the necessary steps before work resumes. This is an additional precautionary EMP measure, rather than a requirement expressly imposed by the specialist report.

On the basis of the specialist's findings, the anticipated palaeontological and archaeological impact is assessed as low, provided that the proposed activities remain within the assessed footprint and shallow-disturbance scope. No heritage-related constraint requiring an alternative layout was identified in the specialist assessment.

Impact on heritage sites and palaeontology (Construction Phase)	**Alternative 1:**	**No-Go Option**

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Nature of impact:	Potential disturbance of previously unrecorded buried archaeological or palaeontological material during vegetation clearing, shallow soil preparation and associated orchard-establishment earthworks. No such resources were identified within the assessed footprints.	The proposed 46 ha expansion and associated establishment earthworks would not take place. Existing agricultural activities and their previously disturbed surface contexts would remain.
Extent and duration of impact:	Site-specific; short-term exposure risk during establishment earthworks. Any physical damage to a heritage find, if encountered, could be permanent.	No additional construction-phase impact; existing agricultural activities continue.
Consequence of impact or risk:	Very limited anticipated effect on heritage resources, given the low-sensitivity Holocene alluvium, previous surface disturbance and absence of recorded finds. An unexpected find could nevertheless be damaged if work continued.	No additional loss of heritage resources attributable to the proposed expansion.
Probability of occurrence:	Low for archaeological material and very low for scientifically significant fossils, as indicated by the specialist. The occurrence of establishment earthworks is certain, but the presence of heritage material is not.	No occurrence of impacts from the proposed construction activities.
Degree to which the impact may cause irreplaceable loss of resources:	Low likelihood; no unique or scientifically irreplaceable resources were identified. If an unexpected intact find were destroyed, that particular loss could be irreplaceable.	No additional risk of irreplaceable loss arising from the proposed expansion.
Degree to which the impact can be reversed:	Disturbance can be stopped immediately, but destruction of an archaeological context or fossil cannot be reversed. The assessed likelihood of such loss is low.	Not applicable: no proposed construction disturbance.
Indirect impacts:	If an unexpected find is exposed, work in the affected area may be delayed pending specialist and heritage-authority advice; appropriate recording could add to knowledge of local heritage.	No additional indirect heritage impacts from the proposed development.
Cumulative impact prior to mitigation:	Low. Previous centre-pivot establishment and cultivation have already disturbed surface contexts; no additional significant heritage resources were recorded in the assessed footprints.	Existing agricultural disturbance remains; no additional cumulative contribution from the proposed construction activities.
Significance rating of impact prior to mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-) Consistent with the specialist's Generally Protected C / low-significance field rating and low residual archaeological and palaeontological risk.	No additional impact from the proposed development; existing agricultural baseline remains.
Degree to which the impact can be avoided:	High Provided earthworks remain within the specialist-assessed footprint and existing shallow-disturbance scope; work can be	Fully avoided for the proposed expansion.

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	stopped if a suspected find is encountered.	
Degree to which the impact can be managed:	High within the assessed scope through footprint control and a precautionary chance-finds response. Deeper excavation into previously undisturbed deposits requires reconsideration.	No project-specific construction management required.
Degree to which the impact can be mitigated:	High for preventing further disturbance of an unexpected find once recognised; irreversible damage already caused cannot be remedied. The specialist requires no additional mitigation or monitoring within the assessed scope.	Not applicable to the proposed construction activities.
Proposed mitigation: ***Refer to EMP for full list of mitigation***	• Keep vegetation clearing and earthworks within the assessed development footprint and existing shallow-disturbance scope. • Do not undertake deeper disturbance of previously undisturbed deposits without reconsidering heritage implications. • As a precautionary EMP measure (not an additional specialist requirement), brief earthmoving operators on chance finds. Stop work locally if suspected fossils, archaeological material or human remains are found. • Secure the area and obtain advice from the relevant heritage authority and suitably qualified specialist before resuming.	No additional mitigation required for the proposed expansion. Continue to comply with applicable heritage obligations during existing farming activities.
Residual impacts:	Low anticipated residual risk of unexpected buried material being exposed during shallow establishment activities. No resources were identified and no routine specialist monitoring is required.	No additional residual impact from the proposed construction activities.
Cumulative impact post mitigation:	Low. Footprint control and the precautionary chance-finds procedure limit additional disturbance against the existing agricultural baseline.	No additional cumulative impact from the proposed expansion.
Significance rating of impact after mitigation (e.g. Low, Medium, Medium-High, High, or Very-High)	Low (-)	No additional impact from the proposed development.

No additional palaeontological or archaeological impacts are anticipated during the operational phase, as routine orchard management, irrigation and harvesting will take place within the established agricultural footprint. This

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conclusion is conditional on operational activities not involving deeper excavation or disturbance of previously undisturbed deposits. Should such activities be proposed, the potential heritage implications must be reconsidered before work commences.

ENVIRONMENTAL STATEMENT

Summary of significant direct impacts with and without mitigation during the construction and operational phases in terms of Alternative 1.

Environmental parameter	CONSTRUCTION (no mitigation)	CONSTRUCTION (with mitigation)	OPERATIONAL (no mitigation)	OPERATIONAL (with mitigation)
Topography	Low(-)	Very Low (-)	-	-
Geology	Low (-)	Very Low (-)	-	-
Soil Properties & Erosion	Low (-)	Very Low (-)	Low (-)	Very Low (-)
Soil Pollution	Low (-)	Very Low (-)	Low (-)	Very Low (-)
Flora	Medium-High (-)	Medium (-)	-	-
Fauna	High (-)	Medium-High (-)	High (-)	Medium-High (-)
Ecologically Sensitive Areas	High (-)	Medium (-)	-	-
Water	Medium (-)	Low (-)	Medium (-)	Low (-)
Air quality	Medium (-)	Low (-)	Medium-High (-) for uncontrolled pesticide application; Dust alone Low (-) to Medium (-) depending on wind.	Low–Medium (-) for pesticide-related air-quality risk, Low (-) for dust and negligible for exhaust.
Noise	Low (-)	Very Low (-)	Very Low (-)	Very Low (-)
Waste	Low-Medium (-)	Low (-)	Medium (-)	Low (-)
Visual & Aesthetics	Low (-)	Very Low (-)	Low (-)	Low (-)
Traffic	Very Low (-)	Very Low (-)	Low (-)	Low (-)

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Socio-Economic	Low (+)	Low (+)	Low-Medium (+)	Medium (+)
Heritage / Archaeology	Low (-)	Low (-)	-	-

The proposed development entails the establishment of approximately 46 ha of pecan nut orchards within the inter-pivot areas of the existing agricultural operation on the Remainder of Farm Tweefontein 373 and Portion 4 of Farm Kalkfontein 374, near Prieska in the Northern Cape. The proposed orchards will be integrated with the existing approximately 95 ha of cultivated land, resulting in a combined agricultural area of approximately 141 ha. The assessment considered the potential impacts of Alternative 1 during the construction and operational phases, together with the No-Go Option, under which the proposed expansion would not proceed and existing agricultural activities would continue.

The assessment indicates that most of the anticipated physical and pollution-related impacts can be reduced to Low or Very Low negative significance through the implementation of the mitigation measures prescribed in the Environmental Management Programme (EMP). These include impacts on topography, geology, soils, erosion, soil pollution, water quality, noise, waste management, visual character and traffic. However, the biodiversity impacts are more significant because the development will result in the permanent conversion of indigenous vegetation and associated fauna habitat within the proposed orchard footprint.

Construction Phase

The principal environmental impacts during construction will arise from vegetation clearance, soil preparation, the movement of agricultural machinery and the establishment of the orchards. The site's gentle topography and generally deep, freely drained soils limit the potential for substantial landform alteration and water erosion. Wind erosion is of greater concern while soils are exposed. Progressive clearing, restriction of disturbance to the authorised footprint, retention or establishment of ground cover and appropriate erosion-control measures will be required.

The proposed development will result in the permanent loss of indigenous vegetation within the approved footprint. Although portions of the inter-pivot areas have been degraded by existing agricultural activities, the flora assessment also identified near-natural vegetation of higher ecological value and protected plant species, including *Boscia albitrunca.* The vegetation-clearing impact is assessed as Medium-High negative before mitigation and Medium negative after mitigation. The residual impact remains significant because the original vegetation communities and their ecological functions cannot be fully restored while the land is maintained as an orchard.

The fauna assessment identified High site sensitivity and potential impacts on several species of conservation concern. The construction-phase fauna impact is assessed as High negative before mitigation and Medium-High negative after mitigation. The permanent loss of habitat, potential disturbance of nests and burrows, and risk of injury or mortality cannot be fully mitigated through routine construction controls. Specialist-led pre-clearance surveys, avoidance of occupied sensitive features, protection of the Orange River riparian corridor and compliance with the specialist's species-specific requirements are therefore essential. Where the specialist's stop-work

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conditions are triggered, work in the affected area must not proceed until the relevant specialist and authority requirements have been addressed.

The assessment of ecologically sensitive areas similarly identifies a High negative impact before mitigation, reducing to Medium negative after mitigation, subject to the exclusion and protection of sensitive areas and strict control of the development footprint. The proposed clearing must not extend into the retained riparian corridor or other designated no-go areas.

The construction-phase water-quality impact is assessed as Medium negative before mitigation and Low negative after mitigation. The main risk is the mobilisation of sediment from exposed soils into the drainage line and potentially the Orange River. Maintaining the proposed drainage-line buffer, preventing disturbance of riparian vegetation, controlling erosion and ensuring appropriate management of machinery, waste and accidental spills will be necessary to protect downstream water quality.

The heritage and palaeontological assessment identified no archaeological resources or fossils within the assessed development footprints and assigned the sites a Generally Protected C (Low significance) rating. The construction-phase impact is therefore assessed as Low negative before and after mitigation. A precautionary chance-finds procedure will nevertheless be included in the EMP. This conclusion applies to activities within the assessed footprint and shallow-disturbance scope; deeper disturbance of previously undisturbed deposits would require reconsideration of the heritage implications.

The proposed development is also expected to generate positive socio-economic impacts through agricultural investment, employment and procurement during orchard establishment. The construction-phase socio-economic impact is assessed as Low positive before and after enhancement measures. Local recruitment and procurement should be prioritised where practicable.

Operational Phase

During operation, the principal ongoing environmental risks will relate to fauna, irrigation and soil management, agricultural chemical use, water quality and waste management. Routine orchard activities are not expected to result in significant additional impacts on topography, geology or heritage resources, provided that operations remain within the assessed footprint and do not involve substantial new ground disturbance.

The operational fauna impact is assessed as High negative before mitigation and Medium-High negative after mitigation. Although the direct habitat loss will occur during orchard establishment, the conversion of open habitat will persist throughout the operational life of the development. Ongoing risks include reduced habitat suitability and prey availability, disturbance of sensitive species, and primary or secondary poisoning associated with agricultural chemicals. The specialist's requirements concerning rodenticides, insecticides, sensitive-species habitat, burrows and retained ecological corridors must therefore be incorporated into operational farm management.

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The operational water-quality impact is assessed as Medium negative before mitigation and Low negative after mitigation. Appropriate irrigation scheduling, control of fertiliser and pesticide application, protection of drainage features and the Orange River, and prevention of contaminated runoff will be required. Soil-related impacts, including the potential for salinisation, sodicity, nutrient imbalance, compaction and erosion, are assessed as Low negative before mitigation and Very Low negative after mitigation, provided that soil conditions are monitored and irrigation and fertility management are adjusted where necessary.

Operational air-quality impacts associated with agricultural chemical application and dust generation require appropriate controls. Waste management, including the handling and disposal of agricultural chemical containers and other operational waste, must also comply with the EMP. With mitigation, the remaining operational impacts on noise, visual character and traffic are assessed as Low or Very Low negative.

The operational socio-economic impact is assessed as Low–Medium positive before enhancement measures and Medium positive after enhancement measures. The development has the potential to support additional employment, agricultural production and demand for local goods and services as the orchards mature. These benefits will develop over time and remain dependent on successful orchard establishment, production and market conditions.

Cumulative Impacts and the No-Go Option

The most important cumulative impact is the further permanent loss and fragmentation of indigenous vegetation and fauna habitat within an existing agricultural landscape. The proposed expansion will add to the approximately 95 ha already under cultivation. Although locating the orchards within inter-pivot areas makes use of existing agricultural infrastructure and includes previously disturbed land, this does not eliminate the impact on the remaining near-natural vegetation and habitat.

The No-Go Option would avoid the additional vegetation clearance, habitat conversion and environmental risks associated with the proposed 46 ha expansion. It would, however, not reverse the impacts of the existing agricultural operation, which would continue. The additional employment, investment and future pecan production associated with the proposed expansion would also not be realised.

Overall Environmental Conclusion

Based on the impact assessment, the proposed development has the potential to proceed with most physical, pollution-related and nuisance impacts reduced to Low or Very Low negative significance through implementation of the EMP. The principal residual environmental concern is biodiversity loss, particularly the permanent conversion of indigenous vegetation and fauna habitat. After mitigation, the vegetation impact remains Medium negative and the fauna impact remains Medium-High negative.

The acceptability of the proposed development is therefore dependent on the final authorised footprint avoiding the retained riparian corridor and other designated sensitive areas; the completion of the required pre-clearance

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surveys; compliance with protected-species permit requirements and specialist stop-work conditions; and the effective implementation of construction and operational biodiversity-management measures. The EMP must provide for clear responsibilities, environmental awareness, monitoring and corrective action where non-compliance or unexpected impacts occur.

The proposed development will also provide potential long-term socio-economic benefits. These benefits should be considered alongside, rather than as a substitute for addressing, the identified residual biodiversity impacts.

On the basis of the assessment presented, Alternative 1 may be considered for environmental authorisation subject to the above conditions and the mitigation and management measures contained in the EMP. The Medium-High residual fauna impact must remain clearly identified in the decision-making process; it should not be presented as having been reduced to a low or negligible impact.

RECOMMENDATIONS FROM SPECIALISTS

Soil Survey: Digital Soils Africa

The following recommendations are taken directly from the soil suitability assessment by Prof. Johan van Tol and the agronomical assessment by Prof. G.M. van Zijl, without adding additional management measures.

- Irrigation scheduling should be adapted according to the soil properties.
- Appropriate irrigation management practices should be implemented to mitigate potential salinity risks.
- Soil salinity and sodicity should be monitored during irrigation and managed as necessary through irrigation and fertility management.
- Fertility management should be implemented to support optimal pecan nut production.
- Where pecan nut trees are planted within the marginal area, foliar micronutrient fertilisation should be applied to address the reduced availability of micronutrients caused by free lime within the upper 60 cm of the soil.
- The economic implications of planting pecan nut trees within the marginal area should be considered, particularly the cost of foliar fertilisation relative to the expected yield.

Flora Survey: Sparaxis Environmental

The following recommendations are taken from the flora specialist report by Dr A.C. van Aardt of Sparaxis Environmental, specifically the Conclusion and Recommendations section (pages 44–47).

- The riparian vegetation unit along the Orange River should be regarded as an area of high conservation priority and high sensitivity due to its importance as an ecological corridor and its role in providing water.

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- Alien invasive species, including *Salsola kali* and *Boerhavia cordobensis*, occurring within Vegetation Unit 3 (near-natural vegetation) on Tweefontein should be removed as a high priority to prevent further encroachment and displacement of indigenous vegetation.
- Permits must be obtained for the removal of protected plant species from the different vegetation units.
- Protected plant species removed from the vegetation units should be replanted in suitable habitat outside the study area, under the supervision of a qualified plant ecologist.
- Larger individuals of the protected tree *Boscia albitrunca* occurring within Vegetation Units 2 and 3 on Tweefontein must be retained as far as practically possible.
- Where the removal of *Boscia albitrunca* cannot be avoided, permits must be obtained for their removal.

<u>Fauna Survey: BioBase Environmental</u>

The following recommendations are extracted from the Animal Species Specialist Assessment Report by Dr Hennie JB Butler and Prof. Edward Netherlands of BioBase Environmental (9 June 2026). They are limited to the recommendations made by the specialists.

Pre-construction and habitat protection

- All proposed infill expansion areas (approximately 46 ha) must be subject to pre-clearance surveys before any earthworks commence.
- Should pre-clearance surveys confirm the presence of Black-footed Cat, African Striped Weasel, or an active Tawny Eagle or Verreaux's Eagle nest within the development footprint, development of the affected portion must be suspended and the relevant authorities consulted before proceeding.
- A TOPS Section 57 permit must be obtained before undertaking development that would negatively affect the individuals or habitat of these species.
- An Aardvark burrow survey must be undertaken before soil preparation.
- An explicit no-insecticide buffer zone must be established around known Aardvark burrows.
- Farm infrastructure must be designed to accommodate Aardvark movement and minimise human–wildlife conflict.

Rodenticide management and species protection

- An explicit rodenticide management protocol must be implemented, prohibiting or strictly controlling anticoagulant and acute rodenticide use near known or potential African Striped Weasel habitat.
- The potential impacts of converting open Karoo shrubland to intensively managed orchards on Black-footed Cats must be explicitly assessed.
- A rodenticide management protocol and habitat buffer strategy for Black-footed Cats must be included as conditions of environmental authorisation.

Environmental awareness training

- Environmental awareness training must be conducted before construction begins, repeated annually and documented with a signed attendance register.

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- Training must cover the identification of all Species of Conservation Concern (SCC) listed in the report, their legal protection status and penalties under NEMBA, the prohibition of rodenticides and gin traps, Aardvark burrow avoidance, tortoise pre-clearance obligations and the dead-animal reporting protocol.
- Laminated SCC identification cards with photographs must be produced and displayed at the farm office, workshop and worker accommodation.

Heritage Impact Assessment: Paleo Field Service

The following recommendations are extracted from the Palaeontological and Heritage Impact Assessment by Lloyd Rossouw of Paleo Field Services (April 2026).

Palaeontology

- No palaeontological mitigation or monitoring is required.
- The study area is assigned a Generally Protected C (low significance) rating for palaeontology under Section 35 of the National Heritage Resources Act (NHRA).
- This rating is conditional on future activities remaining within the scope of existing shallow disturbance.
- No alternative layouts or cessation of operations are required on palaeontological grounds.

Archaeology and Heritage

- No archaeological mitigation or monitoring is required.
- The study area is assigned a Generally Protected C (low significance) rating for archaeology under Section 35 of the NHRA.
- This rating is conditional on future activities remaining within the scope of existing shallow disturbance.
- No alternative layouts or cessation of operations are required on archaeological grounds.

Important qualification: The specialist's recommendations are conditional on future activities remaining within the scope of existing shallow disturbance. The report does not provide a separate recommendation for deeper ground disturbance beyond the currently impacted areas.

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OPINION IF THE PROPOSED ACTIVITY SHOULD OR SHOULD NOT BE AUTHORIZED

Based on the findings of the Environmental Impact Assessment, the specialist assessments and the evaluation of the development alternatives, the Environmental Assessment Practitioner (EAP) is of the opinion that the proposed expansion of the existing agricultural operations on the Remainder of Farm Tweefontein 373 and Portion 4 (Portion of Portion 2) of Farm Kalkfontein 374 may be considered for environmental authorisation, subject to the implementation of the prescribed mitigation measures and compliance with the conditions outlined below.

The proposed development entails the clearing of approximately 46 ha of vegetation for the establishment of pecan nut orchards within and around the existing centre-pivot irrigation areas. The proposed expansion will consolidate the existing agricultural footprint of approximately 95 ha rather than establish a separate agricultural operation elsewhere on the properties. The development will utilise existing agricultural infrastructure and is supported by the findings of the soil suitability assessment for Tweefontein.

The EIA has identified that most of the anticipated physical, soil-related, water-quality, pollution and nuisance impacts can be reduced to Low or Very Low negative significance through the implementation of the mitigation measures contained in the Environmental Management Programme (EMP).

However, the EAP acknowledges that the proposed development will result in the permanent loss of indigenous vegetation and associated fauna habitat. Although portions of the proposed development footprint have been disturbed by previous agricultural activities, the flora assessment identified near-natural vegetation units of ecological importance, including protected plant species. The vegetation-clearing impact remains Medium negative after mitigation.

The fauna assessment identified High site sensitivity and potential impacts on species of conservation concern. The residual fauna impact remains Medium-High negative during both the construction and operational phases. These impacts cannot be fully mitigated because the conversion of natural habitat to agricultural land will be permanent. The EAP therefore considers the implementation of the fauna specialist's recommendations, particularly the pre-clearance surveys, protection of sensitive species and management of agricultural chemicals, to be essential conditions of authorisation.

The proposed development must also be restricted to the approved development footprint, with the main Orange River riparian corridor and designated no-go areas excluded from disturbance. Protected plant species must be managed in accordance with the flora specialist's recommendations, including the retention of larger protected trees where practicable and the obtaining of the necessary permits where removal cannot be avoided.

The palaeontological and heritage assessment identified no heritage resources within the assessed development footprints and assigned the sites a Generally Protected C (Low significance) rating. No archaeological or palaeontological mitigation or monitoring is required, provided that future activities remain within the scope of the existing shallow disturbance assessed by the specialist.

The No-Go Option would avoid the additional loss of indigenous vegetation and fauna habitat associated with the proposed expansion. However, the existing agricultural activities would continue, and the additional agricultural production, employment and economic benefits associated with the proposed development would not be realised.

Taking into consideration the existing agricultural land use, the proposed consolidation of the agricultural footprint, the findings of the specialist assessments and the anticipated socio-economic benefits, the EAP is of the opinion that Alternative 1 may be authorised, provided that:

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- The development is restricted to the approved footprint, and the retained riparian corridor and designated no-go areas are protected.
- All required pre-clearance surveys are completed, and the fauna specialist's species-specific requirements, including stop-work conditions, are implemented.
- All applicable permits for protected species are obtained before activities affecting those species commence.
- The mitigation and management measures contained in the specialist reports and EMP are implemented throughout the construction and operational phases.
- Appropriate environmental monitoring and corrective measures are implemented to ensure compliance with the conditions of authorisation.

The EAP's recommendation is conditional on these requirements being met. The residual Medium-High negative fauna impact and Medium negative vegetation impact must be taken into account by the Competent Authority when determining the environmental acceptability of the proposed development.

The EAP therefore recommends that environmental authorisation be granted for Alternative 1, subject to the conditions outlined above and the implementation of the approved EMP. This recommendation is based on the assessment presented in the Draft EIA Report and remains subject to consideration of comments received during the EIA public participation process.

CONDITIONS OF AUTHORIZATION

Should the Competent Authority grant Environmental Authorisation for the proposed development, the EAP recommends that the following conditions be included in the authorisation. These conditions are based on the findings of the EIA, the specialist assessments and the mitigation measures identified for the proposed development.

1. General conditions

1.1. Environmental Authorisation must be limited to the proposed clearing of approximately 46 ha of vegetation for the expansion of the existing agricultural operations and establishment of pecan nut orchards on the Remainder of Farm Tweefontein 373 and Portion 4 (Portion of Portion 2) of Farm Kalkfontein 374, in accordance with the approved development footprint.

1.2. The applicant must implement and comply with the approved Environmental Management Programme (EMP), including the mitigation and monitoring measures identified in the EIA Report and specialist assessments.

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1.3. The development footprint must be clearly demarcated before vegetation clearing commences. No clearing, cultivation, stockpiling or associated construction activities may take place outside the approved footprint or within designated no-go areas.

1.4. The applicant must obtain all applicable permits and approvals required for the proposed activities before commencing activities to which those permits or approvals relate.

2. Terrestrial biodiversity and vegetation

2.1. The main riparian vegetation corridor associated with the Orange River must be retained and protected from disturbance.

2.2. All designated no-go areas and retained natural vegetation must be clearly demarcated before vegetation clearing commences. Construction and agricultural activities must remain within the approved development footprint.

2.3. The recommendations of the flora specialist must be implemented, including the management of alien invasive plant species and the protection of protected plant species.

2.4. Permits must be obtained for the removal of protected plant species. Protected plants requiring removal must be relocated to suitable habitat outside the development footprint under the supervision of a qualified plant ecologist, in accordance with the specialist's recommendations.

2.5. Larger individuals of the protected tree Boscia albitrunca must be retained as far as practically possible. Where removal cannot be avoided, the necessary permits must be obtained before removal.

2.6. Alien invasive plant species must be managed in accordance with the flora specialist's recommendations, particularly within the near-natural vegetation units.

3. Fauna protection

3.1. Pre-clearance fauna surveys must be undertaken within the proposed development areas before vegetation clearing or earthworks commence, in accordance with the fauna specialist's recommendations.

3.2. Should the pre-clearance surveys confirm the presence of Black-footed Cat, African Striped Weasel, or active Tawny Eagle or Verreaux's Eagle nests within the development footprint, activities within the affected area must be suspended and the relevant authorities consulted before work proceeds.

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3.3. Where required, the necessary permits must be obtained before undertaking activities that may negatively affect protected fauna species or their habitat.

3.4. An Aardvark burrow survey must be undertaken before soil preparation. Known burrows must be protected in accordance with the fauna specialist's recommendations, including the establishment of no-insecticide buffer zones.

3.5. A rodenticide management protocol must be implemented to prevent or minimise impacts on species of conservation concern, particularly Black-footed Cat and African Striped Weasel.

3.6. Environmental awareness training must be provided to personnel before construction commences and repeated annually, in accordance with the fauna specialist's recommendations.

4. Soil protection and agricultural management

4.1. Irrigation scheduling must be adapted to the soil properties and crop requirements to minimise waterlogging, runoff and unnecessary leaching.

4.2. Soil salinity and sodicity must be monitored during irrigation, and appropriate irrigation and fertility management measures must be implemented where necessary.

4.3. Where pecan nut trees are established within the marginal soil areas identified on Tweefontein, foliar micronutrient fertilisation must be undertaken in accordance with the soil specialist's recommendations.

4.4. Vegetation clearing and soil preparation must be restricted to the approved development footprint. Exposed soils must be managed to minimise erosion and sediment transport.

4.5. Ground cover must be maintained between orchard rows where practicable, and erosion-prone areas must be stabilised.

5. Water resources and pollution prevention

5.1. The proposed development must comply with the applicable conditions of the existing Water Use Licence. Any water use not covered by the existing authorisation must be appropriately authorised before commencement.

5.2. The approved vegetated buffers associated with watercourses must be retained. A minimum 32 m buffer must be maintained along drainage lines, as identified in the EIA.

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5.3. No cultivation, chemical application, storage or waste disposal may take place within designated watercourse buffers and no-go areas.

5.4. Irrigation must be managed to prevent excessive runoff, waterlogging and the unnecessary movement of nutrients, pesticides and salts towards watercourses.

5.5. Fertilisers and pesticides must be applied in accordance with the management measures contained in the EMP. Pesticide application must be undertaken by trained personnel using appropriately maintained and calibrated equipment.

5.6. Fuel, chemicals and waste must be managed to prevent soil and water contamination. Spill-control equipment must be available, and accidental spills must be contained and remediated.

5.7. Irrigation infrastructure, watercourse buffers and pollution-control measures must be inspected regularly, with corrective action undertaken where necessary.

6. Archaeology, heritage and palaeontology

6.1. Ground-disturbing activities must remain within the scope of the development assessed in the Palaeontological and Heritage Impact Assessment.

6.2. The specialist's finding that no archaeological or palaeontological mitigation or monitoring is required applies to the assessed development and is conditional on activities remaining within the scope of existing shallow disturbance.

7. Construction and operational management

7.1. Vegetation clearing and soil preparation must be undertaken in accordance with the approved EMP, with measures implemented to minimise dust generation and soil erosion.

7.2. Construction and establishment activities must be restricted to normal daytime working hours. Machinery and vehicles must be maintained in good working order to minimise noise and exhaust emissions.

7.3. Waste generated during the construction and operational phases must be collected, contained and disposed of through appropriate waste-management services. Uncontrolled burning of waste must be prohibited.

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7.4. Agricultural chemicals must be applied in accordance with the manufacturer's instructions and the management measures contained in the EMP. Spraying must not be undertaken during weather conditions that favour spray drift.

7.5. Environmental incidents, including chemical spills, pollution events and unauthorised disturbance of natural vegetation, must be recorded and addressed through appropriate corrective measures.

8. Environmental monitoring and compliance

8.1. The applicant must ensure that the mitigation and monitoring measures contained in the approved EMP and specialist reports are implemented throughout the applicable phases of the development.

8.2. Environmental monitoring must include compliance with the approved development footprint, protection of designated no-go areas, implementation of the flora and fauna specialist's recommendations, soil management and pollution prevention.

8.3. Any non-compliance with the conditions of Environmental Authorisation or the approved EMP must be addressed through appropriate corrective measures.

8.4. The applicant remains responsible for ensuring that all contractors, employees and other persons undertaking activities associated with the development comply with the applicable conditions of Environmental Authorisation and the approved EMP.

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ASSUMPTIONS, UNCERTAINTIES, AND GAPS IN KNOWLEDGE

The following assumptions were made in undertaking the EIA:

- The project description, development layout, proposed activities and information supplied by the applicant are accurate and representative of the development that will be implemented.
- The development will be restricted to the approximately 46 ha assessed in the EIA and specialist reports. Any material changes to the development footprint or proposed activities may require further assessment.
- The findings of the specialist assessments are representative of the environmental conditions within the respective study areas, subject to the limitations identified by the specialists.
- The applicant will implement the mitigation, management and monitoring measures prescribed in the EMP and specialist reports.
- The existing agricultural activities will continue under the No-Go Option, without the proposed expansion.

Uncertainties and gaps in knowledge

In terms of the uncertainties and gaps in knowledge:

Fauna and species of conservation concern

The fauna specialist identified limitations associated with the detection of elusive, transient and seasonally occurring species. Although field surveys were undertaken and supplementary camera-trapping data from a nearby site were considered, the presence of all species of conservation concern within the development footprint could not be conclusively established.

The occurrence of certain species, including Black-footed Cat, African Striped Weasel and sensitive nesting birds, therefore remains uncertain. The fauna specialist has recommended pre-clearance surveys before earthworks commence, with further action required should sensitive species or active nests be identified.

Soil suitability and irrigation management

The soil suitability assessment provides information on the suitability of the surveyed areas for pecan nut production. However, the EIA acknowledges that the laboratory results obtained for Tweefontein cannot be extrapolated to Kalkfontein.

The long-term effects of irrigation on soil salinity and sodicity will depend on irrigation practices, water quality and ongoing soil management. These effects cannot be determined with certainty before the proposed orchards are established and operational.

The soil specialist's recommendations regarding irrigation scheduling, salinity and sodicity monitoring, and fertility management are therefore important for managing these uncertainties.

Vegetation and protected plant species

The flora assessment identified different vegetation units across the two properties, including previously disturbed vegetation, near-natural shrubland and sensitive riparian vegetation.

The EIA recognises that protected plant species occur within the study area, including *Boscia albitrunca*. The number of individuals that may ultimately require removal or relocation will depend on their occurrence within the final development footprint and the extent to which individual plants can be retained.

The implementation of the flora specialist's recommendations, including the necessary permits and supervised relocation of protected plants, will be required before vegetation clearing.

Archaeology, heritage and palaeontology

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The heritage and palaeontological assessment was based on surface observations and the inspection of accessible exposures. The specialist acknowledges that archaeological and palaeontological material may be obscured by soil, vegetation or previous disturbance and that subsurface resources may remain undetected.

The specialist's Low significance rating is conditional on future activities remaining within the scope of the existing shallow disturbance assessed. The findings should therefore not be extrapolated to substantially deeper ground disturbance or areas outside the assessed footprint.

Water quality and cumulative impacts

The EIA identifies the potential for irrigation return flows, fertilisers, pesticides and sediment to contribute to water-quality impacts in the Orange River.

However, no site-specific cumulative pollutant load has been quantified. The actual contribution of the proposed expansion to catchment-wide water-quality impacts will depend on irrigation management, chemical application, the effectiveness of the retained buffers and the activities of other agricultural operations within the catchment.

The assessment therefore relies on the identified pollution pathways and the effectiveness of the proposed mitigation measures rather than a quantified prediction of changes in Orange River water quality.

Public participation

At the time of preparation of the Draft EIA, no objections were received during the Scoping Phase. However, the public participation process for the Draft EIA remains underway.

Any substantive comments received from Interested and Affected Parties or commenting authorities will need to be considered and, where necessary, incorporated into the Final EIA Report.

Conclusion

The EAP considers that the available information and specialist assessments provide a basis for evaluating the anticipated environmental impacts of the proposed development. However, the identified uncertainties must be considered when interpreting the impact ratings and determining the environmental acceptability of the proposed activities.

In particular, the uncertainty regarding the occurrence of fauna species of conservation concern does not reduce the significance of the identified biodiversity impacts. The residual Medium-High negative fauna impact and Medium negative vegetation impact remain relevant to the decision-making process.

The EAP's opinion regarding environmental authorisation is therefore conditional on the implementation of the specialist recommendations, completion of the required pre-clearance surveys and compliance with the approved EMP.

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The findings of the assessment must also be reconsidered should material changes to the development footprint or new information arise that could alter the nature or significance of the identified environmental impacts.

EAP UNDERTAKING

The EAP herewith confirms

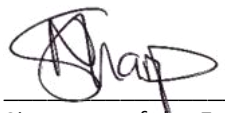
a) the correctness of the information provided in the reports; [X]

b) the inclusion of comments and inputs from stakeholders and I&AP's; [ ] (*To be completed with the Final EIA, once the public participation has been completed*).

c) the inclusion of inputs and recommendations from the specialist reports where relevant; [X]

d) that the information provided by the EAP to interested and affected parties and any responses by the EAP to comments or inputs made by interested and affected parties are correctly reflected herein. [ ] (*To be completed with the Final EIA, once the public participation has been completed*).

During the Scoping Phase Public Participation, no comment was received. Since this is a Draft EIA and currently under public review for public participation, any comments received will therefore be considered and included in the Final EIA.



Signature of the Environmental Assessment Practitioner/s

Digital Soils Africa (Pty) Ltd
Name of the company

30 September 2026
Date

Draft EIA

FINANCIAL PROVISION FOR REHABILITATION / CLOSURE

This is a permanent change from grazing/annual crops to pecan nut production and it is highly unlikely that the proposed development will ever or at least within the next 20 years be decommissioned, and therefore financial provision for rehabilitation and closure is not applicable at this stage.

However, should the Applicant elect to decommission the project at any point in the future, the necessary authorization must be obtained and the correct decommissioning protocol must be followed. The relevant State

Departments (those applicable at the time of decommissioning) should be consulted before decommissioning and appropriate financial provision is calculated.

Following the decommissioning, the site should be rehabilitated back to a predetermined state, e.g. sufficient for grazing or a near-natural state. A qualified botanical specialist should be contacted for more information on rehabilitation techniques.

DEVIATION FROM THE APPROVED SCOPING REPORT

There has been no deviation from the approved Scoping Report.

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Botha, L. 2018. PECAN NUT FARMING: HIGH COST, BIG RETURNS. Farmer's Weekly, 15 August 2018.

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EAP CV

CURRICULUM VITAE
NATALIA SHARP

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Personal Details	Date of birth: 12 August 1979 Nationality: South African Identity number: 790812 000 7080 Gender: Female Languages: English / Afrikaans
Qualifications:	BSc (2000) UFS – Zoology and Botany BSc Honors (2001) UFS - Limnology Masters in Environmental Management (2003) UFS - Evaluation of Phytoplankton as an indicator in a biomonitoring program, with special reference to the Modder River.
Experience (Twenty years' experience in environmental law and environmental management)	During the 2 years associated with the Centre for Environmental Management intense training was provided for equipping Natalia Sharp with adequate knowledge in terms of biomonitoring water systems and scientific report writing for research done by her through the Centre. Various scientific contributions were made during these few years which included formal reports to Bloem Water and seminars providing management principles for polluted water bodies, thus providing her with additional regulatory and environmental skills. During the 5 years associated with the DME, now changed to the Department of Mineral Resources (DMR), vast knowledge was gained in terms mine environmental management, the development, rehabilitation and closure of mining and prospecting areas. Environmental Management Programmes, Environmental Performance Assessment Reports, and Closure Reports were scrutinized continually. Therefore, adequate expertise was gained to assist the applicants with relevant environmental and mining advice and providing her with adequate knowledge to evaluate environmental impacts relating to mining. During the 11 years associated with SES (Stellenryck Environmental Solutions), Natalia Sharp has obtained immense understanding in completing environmental impact assessments, not only associated with mining projects, but also for a wide variety of different developing projects such as Light Industrial developments, Road upgrade projects, bush clearing for agricultural developments, and applications for

	exemptions, and so forth. She has excellent experience in writing environmental reports, which ranges from Scoping Reports, Environmental Management Plans, Environmental Awareness Plans, Mining Work Programs, Closure Plans, Risk Assessments, Performance Evaluations on projects, and Plan of Study reports. She has also been involved in performing biomonitoring on river systems associated with some of the projects, completing it by obtaining all the data and writing the Biomonitoring Report for the relevant Department. This is mainly attributed to her Limnology background and she is competently able to add value to this field in her current position. During the past 3 years of association with Digital Soils Africa (DSA) as an independent environmental consulting firm that are also soil specialists focussing on all soil solutions in the agricultural and environmental fields, Natalie Sharp has gained more exposure to projects involved with the Department of Agriculture and the Department of Water and Sanitation. This included applications for the cultivation of virgin soil and obtaining knowledge of the administrative processes in applying for these permits, assisting farmers with identifying suitable soils for cultivation and applying to the DWS for water use rights for irrigation. Natalie Sharp has also gained experience in GIS mapping with the free software QGIS because of working at DSA. In terms of management skills, DSA appointed Natalie Sharp as the lead project manager on all environmental-related projects: she managed the environmental authorisation projects and specialist team associated with such applications, including Section 24G applications, applications for protected plant species with the Department of Forestry, Water Use License Applications, Cultivation for virgin soil applications, SAHRIS applications, Civil Aviation approvals and correspondence with the Department of Defence. As the lead project manager, she has gained experience in proposals and cost analysis for projects and has established a network of professional connections in the Eastern Cape region and Northern Cape region.
Previous Employment	Centre for Environmental Management University of the Free State: Lab Assistant [2001 – 2003] Mine Environmental Management [2003-2005] at the Department of Mineral Resources: Environmental Officer Mine Environmental Management [2005-2008] at the Department of Mineral Resources: Senior Environmental Officer Stellenryck Environmental Solutions: Senior Environmental Practitioner [2008-2019]
Current Employment	Digital Soils Africa Pty Ltd: Senior Environmental Practitioner [2020-currently]
Professional affiliation/registration	Pri.Sci.Nat (Reg no. 123443) Reg. EAP (EAPASA) Member of IAIAsa (7237)

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www.dsafrica.co.za natalie@dsafrica.co.za

45 Church Street
Walmer
6070

References

Darren Bouwer 083 703 3002
Johan van Tol 083 387 6243
Maartje Weyers 082 375 3662

Projects Completed (Summary)

Project Manager for Projects (DMRE):	Number Completed
Amendments to Environmental Management Plans (EMP)	2
Environmental Management Plans (EMP) with impact assessment included in the document - completed **prior** to 8 December 2014	73
Scoping Reports completed **prior** to 8 December 2014	5
Closure Reports & Risk Assessments for quarries	27
Performance Assessment Reports/Environmental Audits	42
Public Participation	80
Environmental Applications to DMRE **post** 8 December 2014	15
Scoping Reports completed **post** 8 December 2014	5
EIA's completed **post** 8 December 2014	3
BAR's + EMP completed **post** 8 December 2014	9
Biomonitoring and Reporting	1
Environmental Awareness Program and Basic Training	5
Conversion Applications for Mining Rights	3
Project Manager for Projects (DEDEAT)	
Basic Assessment Reports completed	15
Scoping and EIA completed	6
Public Participation	25
Section 24G Application and documents	5
Compost Farm registration	1
Part 1 and/or Part 2 Amendment Reports	2

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Project Manager for Projects (DWS)	
eWULA applications and associated documentations	6
Rehabilitation Plans and Environmental Management Plans	8
Project Manager for Projects (DARDLR)	
Applications for cultivation of virgin soils	5
Project Manager for Projects (SAHRA)	
SAHRIS applications	9

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45 Church Street
Walmer
6070

Environmental Assessment Practitioners Association of South Africa

Registration No. 2020/230

Herewith certifies that

NATALIA SHARP

is registered as an

Environmental Assessment Practitioner

Registered in accordance with the prescribed criteria of Regulation 15. (1) of the Section 24H Registration Authority Regulations (Regulation No. 849, Gazette No. 40154 of 22 July 2016, of the National Environmental Management Act (NEMA), Act No. 107 of 1998, as amended).

Effective: 01 April 2026

Expires: 31 March 2027

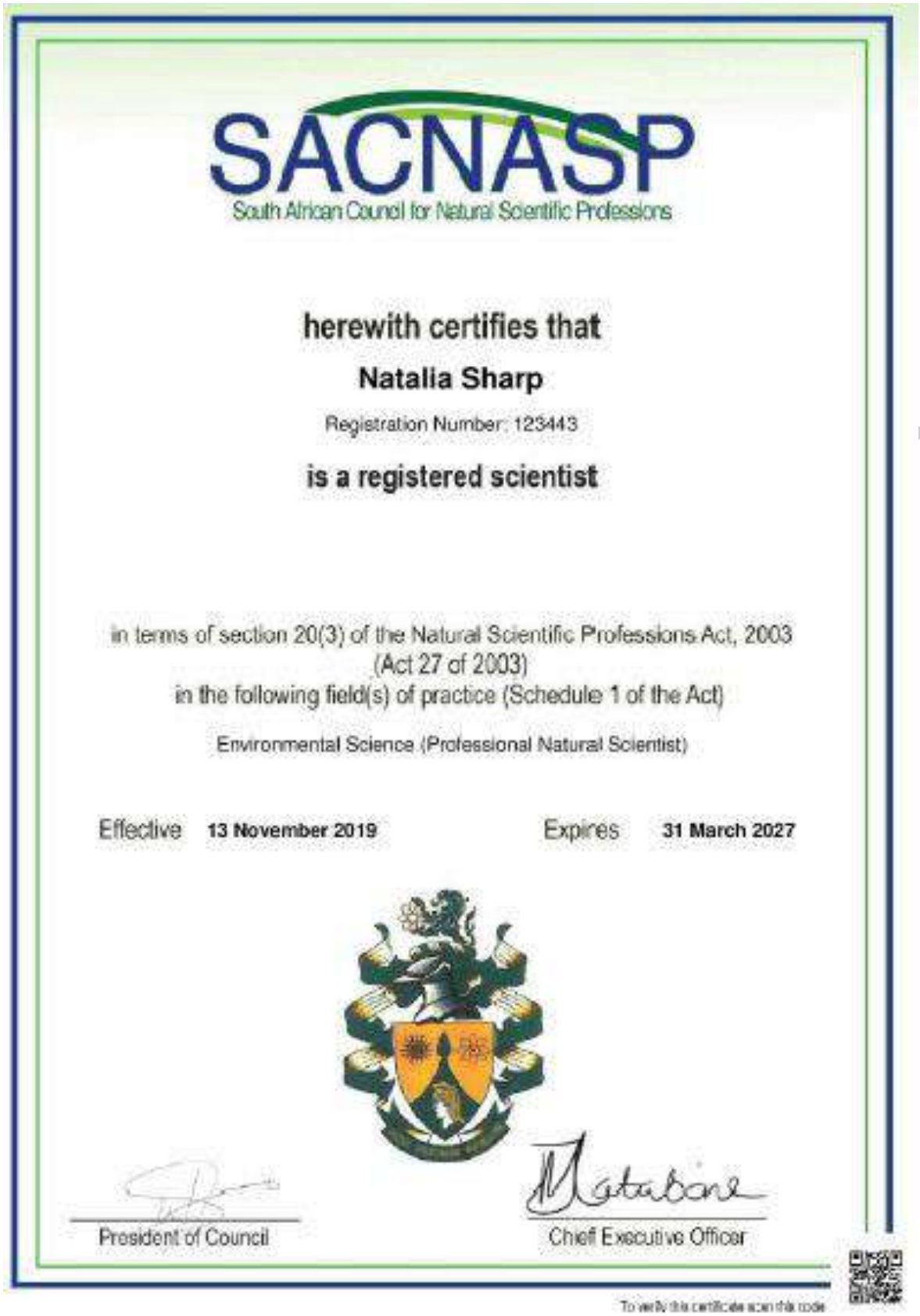
Chairperson

Registrar

SAQA

natalie@dsafrica.co.za

45 Church Street
Walmer
6070



SACNASP
South African Council for Natural Scientific Professions

herewith certifies that

Natalia Sharp

Registration Number: 123443

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule 1 of the Act)

Environmental Science (Professional Natural Scientist)

Effective **13 November 2019** Expires **31 March 2027**

President of Council

Chief Executive Officer

To verify this certificate scan this code

45 Church Street
Walmer
6070

DIE UNIVERSITEIT VAN DIE ORANJE-VRYSTAAT

THE UNIVERSITY OF THE ORANGE FREE STATE

HIERMEE WORD VERKLAAR DAT DIE GRAAD THIS IS TO CERTIFY THAT THE DEGREE

Baccalaureus Scientiae

Bachelor of Science

TOEGEKEN IS AAN
HAS BEEN CONFERRED UPON

NATALIA POTGIETER

NADAT AAN DIE STATUTE EN REGULASIES VAN DIE UNIVERSITEIT VOLDOEN IS. AS BEWYS DAARVAN PLAAS ONS ONS ONDERSKEIE HANDTEKENINGE EN DIE SEËL VAN DIE UNIVERSITEIT HIERONDER.

IN ACCORDANCE WITH THE STATUTES AND REGULATIONS OF THE UNIVERSITY. AS WITNESS OUR RESPECTIVE SIGNATURES AND THE SEAL OF THE UNIVERSITY BELOW.

45 Church Street
Walmer
6070

UNIVERSITEIT VAN DIE VRYSTAAT

UNIVERSITY OF THE FREE STATE

HIERMEE WORD VERKLAAR DAT DIE GRAAD THIS IS TO CERTIFY THAT THE DEGREE

Honneursbaccalaureus Scientiae

in LIMNOLOGIE
in LIMNOLOGY

TOEGEKEN IS AAN
HAS BEEN CONFERRED UPON

NATALIA POTGIETER

NADAT AAN DIE STATUTE EN REGULASIES VAN DIE UNIVERSITEIT VOLDOEN IS. AS BEWYS DAARVAN PLAAS ONS ONS ONDERSKEIE HANDTEKENINGE EN DIE SEEL VAN DIE UNIVERSITEIT HIERONDER.

IN ACCORDANCE WITH THE STATUTES AND REGULATIONS OF THE UNIVERSITY, AS WITNESS OUR RESPECTIVE SIGNATURES AND THE SEAL OF THE UNIVERSITY BELOW.

VISEKANSELIER/VICE-CHANCELLOR

DEKAAN/DEAN

REGISTRATEUR/REGISTRAR

10/4/2019

45 Church Street
Walmer
6070

UNIVERSITEIT VAN DIE VRYSTAAT

UNIVERSITY OF THE FREE STATE

HIERMEE WORD VERKLAAR DAT DIE THIS IS TO CERTIFY THAT THE

Magister in Omgewingsbestuur
Magister in Environmental Management

TOEGEKEN IS AAN
HAS BEEN CONFERRED UPON

NATALIA POTGIETER

NADAT AAN DIE STATUTE EN REGULASIES VAN DIE UNIVERSITEIT VOLDOEN IS, AS BEWYS DAARVAN PLAAS ONS ONS ONDERSKEIE HANDTEKENINGE EN DIE SEËL VAN DIE UNIVERSITEIT HIERONDER.

IN ACCORDANCE WITH THE STATUTES AND REGULATIONS OF THE UNIVERSITY, AS WITNESS OUR RESPECTIVE SIGNATURES AND THE SEAL OF THE UNIVERSITY BELOW.

VICE-CHANCELLOR

DEAN

100+ UV-UFS

1904 - 2004

REGISTRAR/REGISTRAR

BLOEMFONTEIN

12/4/2019

natalie@dsafrica.co.za

45 Church Street
Walmer
6070

APPENDIX B – SITE PLAN

Latitude (S)	Longitude (E)
Tweefontein:	
A: 29°24'36.52"S	23° 0'58.10"E
B: 29°24'33.35"S	23° 1'20.30"E
C: 29°24'33.61"S	23° 1'30.04"E
D: 29°24'39.64"S	23° 1'30.01"E
E: 29°24'44.76"S	23° 1'25.85"E
F: 29°24'49.48"S	23° 1'2.23"E
Kalkfontein:	
G: 29°24'30.96"S	23° 1'36.38"E
H: 29°24'34.43"S	23° 2'22.84"E
I: 29°24'32.80"S	23° 2'26.44"E
J: 29°24'22.44"S	23° 2'30.24"E
K: 29°24'23.36"S	23° 2'34.55"E
L: 29°25'2.99"S	23° 2'25.84"E
M: 29°24'47.00"S	23° 1'29.85"E

Draft

A Notice Board was erected not along the site boundary because there are no public roads and it would not be visible to any potential I&AP. Therefore the notice was placed at the turnoff to the farm, next to the public gravel road to notify potential I&AP's. Below is an aerial photo indicating the location of placing the board. The red polygon represents the study area under application, while the yellow drop pins represent the location of the board.

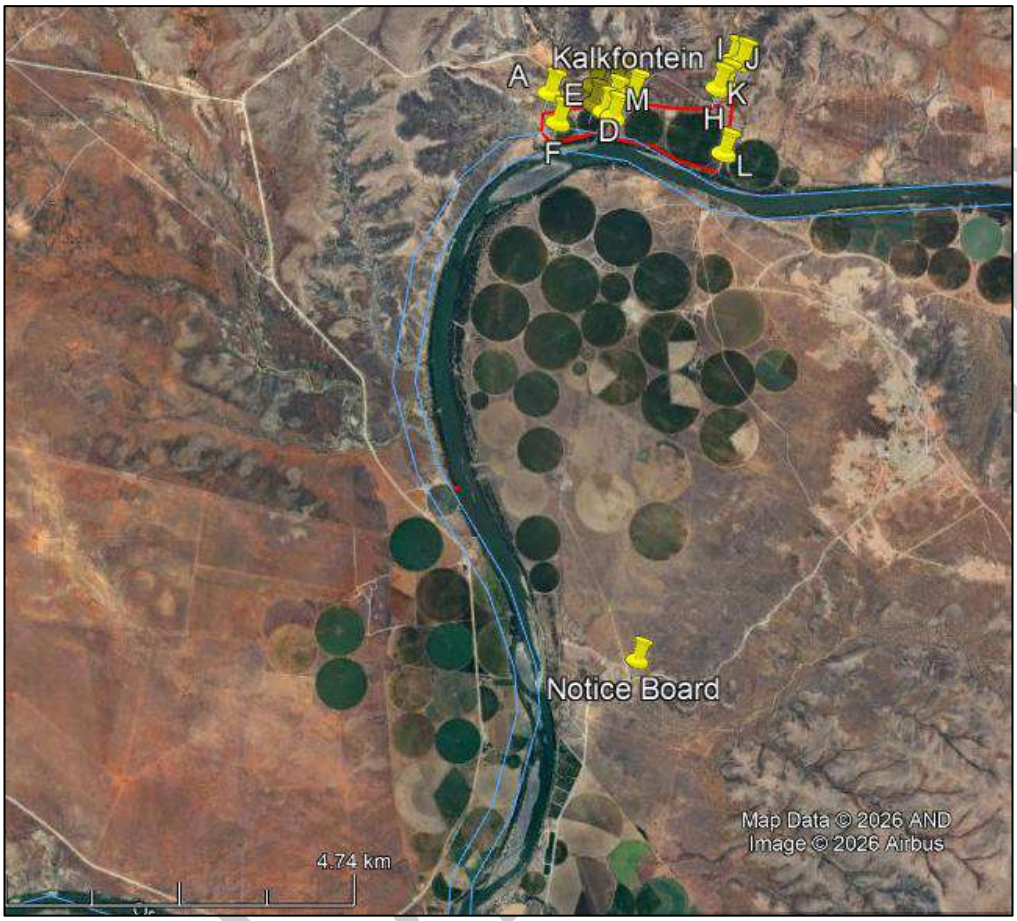


FIGURE 13: LOCATION OF THE NOTICE BOARD

Response for potential I&AP's was requested to be submitted within 30days from notification and those who registered / commented will be recorded in the I&AP registry.

45 Church Street
Walmer
6070

Notice Board

DRAFT

www.dsafrica.co.za natalie@dsafrica.co.za

45 Church Street
Walmer
6070

Noordwes-Karoo Nuusblad proof of advertisement placement

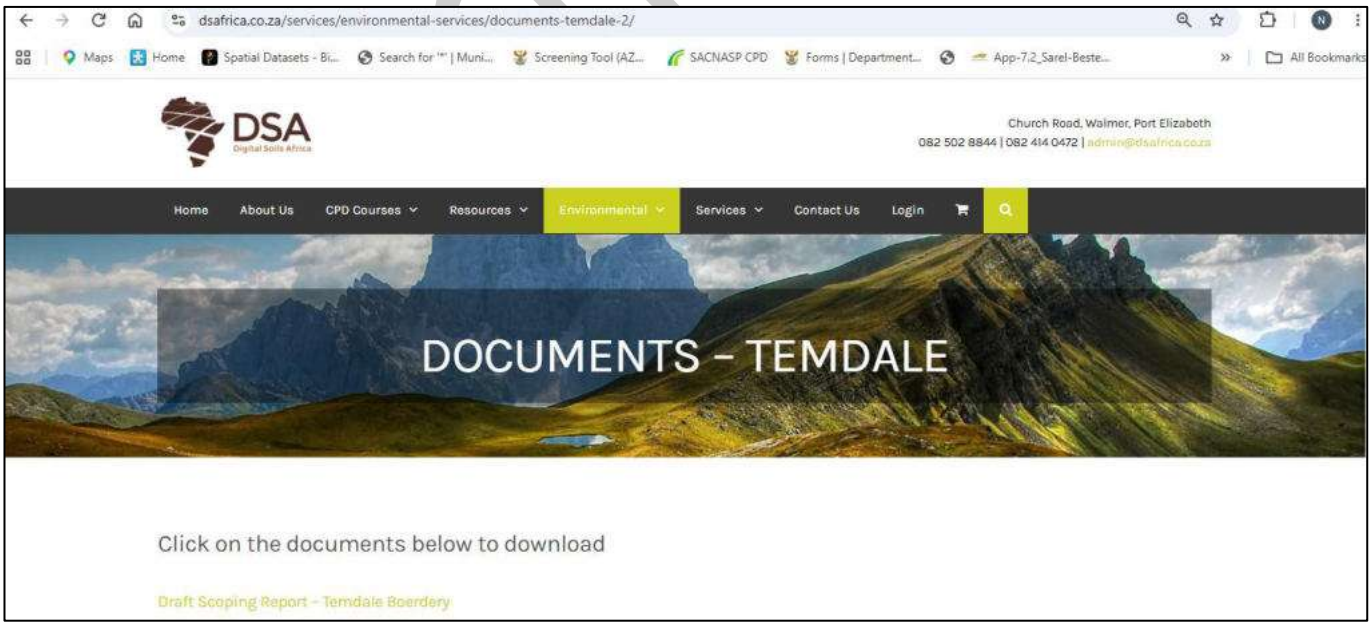
NOORDWES-KAROO NUUSBLAD

BEWYS VAN PLASING

BEWYS VAN PLASING: 12 JUNIE 2026

DATUM	GESKEDULEER	SKERMGREEP	SKAKEL
12 Junie 2026	10 Junie 2026		https://www.facebook.com/share/p/1HYRUHerj1/

Proof that the Draft Scoping Report document was placed on DSA website.



No response was received due to the placement of the advertisement and/or notice board.

Acknowledge of Draft and Final Scoping Report received for review and processing from the Department of Agriculture, Environmental Affairs, Rural Development, and Land Reform:

Draft EIA

agriculture, environmental affairs,
rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

IMPACT MANAGEMENT
90 Long Street, Kimberley, Northern Cape, South Africa, 8300, Tel: (053) 807 7300,
E-mail: gaildenc@gmail.com web: www.agrinc.gov.za

Enquiries :
Dipatlisiso : Ms M Madisa
Imibuzo :
Navrae :

Date :
Leshupelo :
Umhla : 01st July 2026
Datum :

Reference :
Tshupelo : NC/EIA/02/PIX/SIY/PRI1/2026
Isalathiso :
Verwysing :

DIGITAL SOILS AFRICA (PTY)LTD
Natalie Sharp
45 Church street
WALMER
6070

Email: nataie@dsarica.co.za

APPLICATION FOR ENVIRONMENTAL AUTHORISATION: PROJECT DESCRIPTION: EXPANSION OF EXISTING PIVOTS WITH 46HA ON THE REMAINDER OF THE FARM TWEEFONTEIN 373 AND PORTION 4 (PTN OF PTN 2) OF THE FARM KALKFONTEIN 374 TO ESTABLISH PECAN NUT ORCHARD. SIYATHEMBA LOCAL MUNICIPALITY, PIXLEY KA SEME DISTRICT MUNICIPALITY.

The Department confirms having received the **draft scoping report** for the abovementioned project on the 15th June 2026 as required in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

The reference number for this project is: NC/EIA/02/PIX/SIY/PRI1/2026 **Kindly quote this reference number in any future correspondence in respect of the application.**

Please draw the applicant's attention to the fact that the activity may not commence prior to an environmental authorization being granted by the Department.

Kindly note the responsible officer for this project is **Ms. M Madisa** and can be contacted at this number, **053 63100/076 833 2502**

Regards

G. Letimela
Senior Administration Clerk

agriculture, environmental affairs,
rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

IMPACT MANAGEMENT
90 Long Street, Kimberley, Northern Cape, South Africa, 8300, Tel: (053) 807 7300,
E-mail: gaildenc@gmail.com web: www.agrinc.gov.za

Enquiries :
Dipatlisiso : Ms M Madisa
Imibuzo :
Navrae :

Date :
Leshupelo :
Umhla : 28th July 2026
Datum :

Reference :
Tshupelo : NC/EIA/02/PIX/SIY/PRI1/2026
Isalathiso :
Verwysing :

DIGITAL SOILS AFRICA (PTY)LTD
Natalie Sharp
45 Church street
WALMER
6070

Email: nataie@dsarica.co.za

APPLICATION FOR ENVIRONMENTAL AUTHORISATION: PROJECT DESCRIPTION: EXPANSION OF EXISTING PIVOTS WITH 46HA ON THE REMAINDER OF THE FARM TWEEFONTEIN 373 AND PORTION 4 (PTN OF PTN 2) OF THE FARM KALKFONTEIN 374 TO ESTABLISH PECAN NUT ORCHARD. SIYATHEMBA LOCAL MUNICIPALITY, PIXLEY KA SEME DISTRICT MUNICIPALITY.

The Department confirms having received the **final scoping report** for the abovementioned project on the 20th July 2026 as required in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

The reference number for this project is: NC/EIA/02/PIX/SIY/PRI1/2026 **Kindly quote this reference number in any future correspondence in respect of the application.**

Please draw the applicant's attention to the fact that the activity may not commence prior to an environmental authorization being granted by the Department.

Kindly note the responsible officer for this project is **Ms. M Madisa** and can be contacted at this number, **053 63100/076 833 2502**

Regards

G. Letimela
Senior Administration Clerk

Consultation letter sent to I&AP's during the Scoping Phase

Draft EIA

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

12 June 2026

Dear Interested and Affected Party **Ref: NC/EIA/02/PIX/SIY/PRI1/2026**

ENVIRONMENTAL IMPACT APPLICATION IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998, FOR THE CLEARING OF VEGETATION ON THE REMAINDER OF FARM TWEEFONTEIN NO. 373 AND PORTION 4 (PTN OF PTN 2) OF FARM KALKFONTEIN NO. 374, PRIESKA. APPLICANT: TEMDALE BOERDERY (PTY) LTD. Scoping Public Participation Phase.

Temdale Boerdery (Pty) Ltd appointed Digital Soils Africa (Pty) Ltd (DSA) to conduct the necessary environmental impact assessment and public participation for the above-mentioned project.

In terms of Section 41 of NEMA Regulations, you have been identified as an Interested and Affected Party and are invited to participate in the public participation. All written comments will be responded to and forwarded to the relevant departments, in the form of a Public Participation Report.

The purpose of this letter and attached document is therefore to:

- Inform you of the locality of the proposed environmental authorization application.
- Allow you the opportunity to raise concerns or comments in respect of the proposed project detailed in the attached Background Information Document.

Public Participation Process

The purpose of the Background Information Document is to provide you with *basic information* regarding the proposed project and provide the opportunity to register as interested and affected parties and grant you the opportunity to raise any comments you might have on the proposed project.

If you would like to participate in the process, please register as an interested and affected party (I&AP), in writing. Comments/registration must be received **on or before 13 July 2026** no later than 5pm. If no comments are received from you, it will then be regarded that you do not have any comments.

Way Forward

- The outcome of this consultation process will be submitted to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform as part of the Final Scoping Report.
- Upon completion of the Scoping process, the EIA process will commence.
- The Draft EIA & EMP document and required specialist reports will be subjected to review by all registered I&AP's and relative governmental departments, following the time frames as stipulated in Section 3 (1) & (8) of the NEMA regulations (30 days).

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

- All information received will form part of the public record and may be made available to the public. By submitting comments, you consent to the inclusion of your personal information in public participation records, in accordance with POPIA. Correspondence throughout the remainder of the environmental process will be distributed to registered I&APs only.
- The outcome of that consultation process will be submitted to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform as part of the final EIA& EMP.
- The documents will be made available on the DSA website, www.dsafrica.co.za. Please follow the link to Services, Environmental Services, Documents and choose the Temdale link.
- All required documents will be submitted to the relevant department for decision-making.
- If the application is accepted, the relevant department will either issue or reject the Environmental Authorisation.
- As an I&AP's, you will be notified of the final decision of the relevant departments.

Yours sincerely

Natalie Sharp
Pri.Sci.Nat (Reg nr. 123443)
Reg. EAP (EAPASA)(2020/230)
Member of IAIAsa (7237)

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

12 June 2026

Department of Agriculture, Environmental Affairs, Rural Development and Land Reform
Directorate Environmental Quality/Assessment Management
Private Bag X6102
Kimberley
8300
Attention: Ms. M. Madisa **Ref: NC/EIA/02/PIX/SIY/PRI1/2026**

SUBMISSION OF DRAFT SCOPING REPORT IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998, FOR THE CLEARING OF VEGETATION ON THE REMAINDER OF FARM TWEEFONTEIN NO. 373 AND PORTION 4 (PTN OF PTN 2) OF FARM KALKFONTEIN NO. 374, PRIESKA. APPLICANT: TEMDALE BOERDERY (PTY) LTD. Scoping Public Participation Phase.

Temdale Boerdery (Pty) Ltd appointed Digital Soils Africa (Pty) Ltd (DSA) to conduct the necessary environmental impact assessment and public participation for the above-mentioned project.

In terms of Section 41 of NEMA Regulations, you have been identified as an Interested and Affected Party and are invited to participate in the public participation. All written comments will be responded to and forwarded to your Department, in the form of a Public Participation Report within the Final Scoping Report once the public participation has been completed for the Scoping Phase.

The purpose of this letter and attached draft Scoping Report is therefore to:

- Inform you of the locality of the proposed environmental authorization application.
- Allow you the opportunity to raise concerns or comments in respect of the proposed project detailed in the Draft Scoping Report.

Public Participation Process

If you would like to participate in the process, please submit comments in writing **on or before 13 July 2026** until 5pm. If no comments are received from you, it will then be regarded that you do not have any comments. This is done in accordance with GNR 326, chapter 2, Regulation 3, of the Environmental Impact Assessment Regulations (2014), as amended on 7 April 2017, of the National Environmental Management Act of 1998.

Where we are in the process

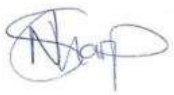
- Please note that in an attempt to follow a more 'green friendly' approach, a hard copy of the Draft Scoping Report will not be placed in a public place as a hard copy for the public, rather a digital copy will be made available on the DSA website.
- A Background Information Document and link to the digital copy of the Draft Scoping Report have been submitted for Public Participation to other Departments, the Municipality (Local and District), the ward councillor, and I&AP's (general public) for the comment period.

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

Way Forward

- The Draft Scoping Report and required specialist reports will be subjected to review by all registered I&AP's and relative governmental departments, following the time frames as stipulated in Section 3 (1) & (8) of the NEMA regulations (30 days).
- The documents will be made available on the DSA website, www.dsafrica.co.za. Please follow the link to Services, Environmental Services, Documents, and choose the Temdale link. In addition, a hard copy of the Draft Scoping Report was sent to the DAEARDLR via couriers.
- All comments received and responses written during the 30 days will be captured in the Public Participation Report and submitted to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform in the Final Scoping Report.
- The Department will make the final decision and will either accept or reject the Scoping Report and proceed with the EIA.

Yours sincerely



Natalie Sharp
Pri.Sci.Nat (Reg nr. 123443)
Reg. EAP (EAPASA)(2020/230)
Member of IAIAsa (7237)

Background Information document sent to all I&AP's as identified during the Scoping Phase.

Draft EIA

BACKGROUND INFORMATION REGARDING CLEARING OF VEGETATION ON THE REMAINDER OF THE FARM TWEEFONTEIN 373 AND PTN 4 (PTN OF PTN 2) OF THE FARM KALKFONTEIN 374, PRIESKA

TEMDALE BOERDERY (PTY) LTD

JUNE 2026

DSA
Digital Soils Africa

+27 82 414 0472
www.dsafrica.co.za
natalie@dsafrica.co.za
Walmer
Port Elizabeth

Directors:
Dr Darren Bouwer
Prof Johan Van Tol
Prof George Van Zijl

45 Church Street
Walmer
6070

PURPOSE OF THIS DOCUMENT

The purpose of this document is to provide all I&AP's with information about the intent of Temdale Boerdery (Pty) Ltd to apply for environmental authorisation to expan existing centre pivot irrigation areas by approximately 46 hectares on the Remainder of Farm Tweefontein No. 373 and Portion 4 (portion of Portion 2) of Farm Kalkfontein No. 374 for the establishment of a pecan nut orchard.

As an identified I&AP, you are invited to register and comment on any aspect related to the proposed development between the 12th of June 2026 and 13th of July 2026.

BRIEF PROJECT DESCRIPTION

The site is situated north-east of Prieska in the Northern Cape (29° 24' 42.00"S; 23° 01' 36.31"E) most centre point of the site) on the Remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, within the Siyathemba Municipal area. The site is located on the banks of the Orange River approximately 38km northeast of Prieska and 20 km southeast of Niekerkshoop.

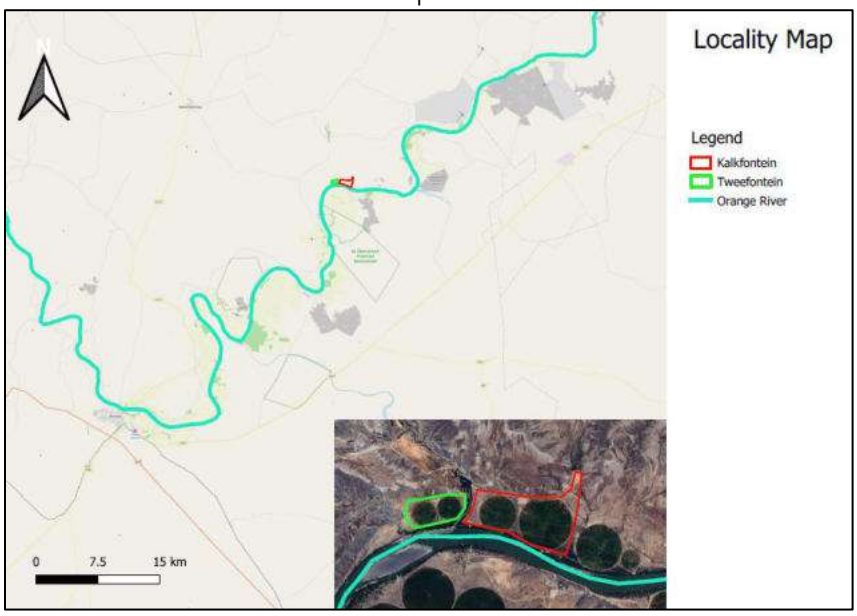


Figure 1: Site location

NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT NO. 107 OF 1998) AS AMENDED

Environmental Assessment

DSA was appointed by Temdale Boerdery (Pty) Ltd as the independent environmental assessment practitioner (EAP) to undertake the Environmental Application and apply for GNR 325 listed activities and the submission of a Scoping Report and Environmental Impact Assessment.

According to the latest Government Notice No. 324; 325 & 327, the following Listed Activities were triggered:

45 Church Street
Walmer
6070

GNR 325 (15): The clearance of an area of 20 hectares or more of indigenous vegetation.	*An area of 46 Ha of fall out areas between pivots, but host natural veldt will be cleared to establish pecan nut trees.*

POTENTIAL ENVIRONMENTAL ISSUES

The full impact on all environmental parameters will be concluded in the EIA and EMP phases. For background information, the most important potential environmental issues that will be addressed in the assessment include, but are not limited to:

- The loss of approximately 46 hectares of indigenous vegetation associated with the expansion of existing irrigated agricultural areas;
- Potential impacts on terrestrial biodiversity, including vegetation communities, plant species of conservation concern, and fauna habitat;
- Potential impacts on riparian vegetation and ecological processes associated with the Orange River and nearby drainage features;
- The suitability and sustainable use of agricultural soils for the proposed pecan nut orchards;
- Potential impacts on heritage and palaeontological resources;
- Potential cumulative impacts associated with the expansion of irrigated agriculture in the area;
- Socio-economic benefits associated with increased agricultural production and employment opportunities; and
- The identification of appropriate mitigation measures to avoid, minimise or manage potential environmental impacts.

PUBLIC PARTICIPATION

In terms of the NEMA, public participation forms an integral part of the environmental assessment process. The public participation process provides people who may be affected by the proposed development with an opportunity to provide comments and raise issues of concern about the project or make suggestions that may result in enhanced benefits for the project.

For this application, there will be two phases of public participation.

1. Scoping Phase
2. EIA Phase.

This is the first phase, and during the Scoping Phase, *potential* interested and affected parties (I&APs) are given notice via a notice board and local newspaper advertisement informing the public of the application. The *registered* I&APs are considered directly abutting neighbours and organs of state that have jurisdiction over the area, e.g. the Municipality, Ward counsellor, etc. and would be provided with a Background Information Document and given access to a digital copy of the Scoping Report on Digital Soils website for comment.

Comments and issues raised during the Scoping Phase of the public participation process will be captured, evaluated, and included in a Public Participation Report. These issues will be

addressed and included in the final Scoping Report, which will be submitted to the Department of Agriculture, Environmental Affairs, Rural Development, and Land Reform.

During the **EIA Phase** (which is the second phase) of public participation, only those I&AP's that are registered would be given notice and access to a digital copy of the Environmental Impact Assessment Report on Digital Soils website for comment.
Comments and issues raised during the EIA Phase of the public participation process will be captured, evaluated, and included in a Public Participation Report. These issues will be addressed and included in the final EIA Report, which will be submitted to the Department of Agriculture, Environmental Affairs, Rural Development, and Land Reform.

To register and/or submit a comment as an Interested and Affected Party, please respond in writing to the following email: natalie@dsafrica.co.za on or before **13 July 2026** no later than 5pm.
Alternatively, a copy of the Draft Scoping Report is also available on the DSA website at www.dsafrica.co.za. Please follow the link to Services, Environmental Services, Documents and choose the Temdale link.

If you have any other questions or inquiries, please do not hesitate the contact the office at 067 622 5687. If no comments are received from you, it will then be regarded that you do not have any comments.

Proof of correspondence with IA&P's

Public Participation_Scoping Phase_ for clearing of vegetation for Temdale Boerdery

Summarize

Natalie Sharp

To 'mmvstaden@siyathemba.gov.za'; 'willonpieterse@gmail.com'; 'mm@pksdm.gov.za'; 'idh@pksdm.gov.za'; 'hlengania@dws.gov.za'; 'ThembisileMA@daff.gov.za'; 'ThembisileMA@dalrrd.gov.za'; 'CRobertson@ncpg.gov.za'; 'Mangalane.DuToit@dlrrd.gov.za'

Bcc 'marinakotze26@gmail.com'; 'guneepsk@gmail.com'

Reply | Reply All | Forward

Fri 6/12/2026 8:16 AM

Cover letter for BID.pdf 297 KB

Background Information Document.pdf 315 KB

Good day,

Please note that an environmental authorisation application for the clearing of vegetation was lodged with the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform (**Ref: NC/EIA/02/PIX/SIY/PRI1/2026**). The applicant is Temdale Boerdery and the site is on the Remainder of Farm Tweefontein No. 373 and Portion 4 (Ptn of Ptn 2) of Farm Kalkfontein No. 374, Prieska.

Attached you will find information to the project should you wish to comment.

Kind regards

Natalie Sharp
Reg.EAP (EAPASA)
Pri.Sci.Nat (Reg No 123443)
Member of IAIAsa (7237)
natalie@dsafrica.co.za
+27 82 414 0472
www.dsafrica.co.za

Public Participation_Scoping Phase_ NC/EIA/02/PIX/SIY/PRI1/2026

Summarize

Natalie Sharp

To Miss Madisa

Cc 'gaildenc@gmail.com'; 'BFisher@ncpg.gov.za'; 'dkhakhane@ncpg.gov.za'; Ankia De Lange

Reply | Reply All | Forward

Fri 6/12/2026 8:32 AM

Cover letter for draft Scoping_DAEARDLR_Agriculture.pdf 292 KB

Good day Ms Madisa

Please find our cover letter for the submission of the Draft Scoping Report and the link (https://we.tl/t-srSF3Udpm2UVpyrT) to download the Draft Scoping Report for the above project, as part of the public participation.
Alternatively, the document can be downloaded directly from our website as well (https://dsafrica.co.za/services/environmental-services/documents-temdale-2/).

We will courier a hard copy to your office next week.

Please acknowledge receipt of the email.

Kind Regards

Natalie Sharp
Reg.EAP (EAPASA)
Pri.Sci.Nat (Reg No 123443)
Member of IAIAsa (7237)
natalie@dsafrica.co.za
+27 82 414 0472
www.dsafrica.co.za

PUBLIC PARTICIPATION FOR THE EIA PHASE

In terms of Regulation 40 of the Schedule published in GNR 326 under NEMA 107 of 1998, interested and affected parties must be consulted as part of the public participation process. Thus the following steps were taken, in accordance with current legislation:

- All abutting neighbours and government offices as listed in the above I&AP Register were consulted with a detailed letter and sent via email and an opportunity was given to object or raise concern about the proposed project. The letter was emailed on 9 October 2026 and the comment period will stop on 9 November 2026.

- An application to the South African Resource Agency was submitted online as per their SAHRIS application format. An opportunity was given to object or raise concerns about the proposed project. The application is currently in process.

The Draft EIA Report has been submitted to all organs of the state which have jurisdiction in respect of the activity or any part thereof during the mentioned 30 day period. At the cessation of the 30 day comment period, the Public Participation Report will be finalized and submitted with the Final EIA Report to the DAEARDLR.

If no comment or written request to be registered as an IAP is received from potential IAPs during this 30 day consultation period, then the public participation process will be concluded and only entities regarded as registered IAPs will be given notice of the outcome of the environmental authorisation for the 20 day appeal process.

Consultation letter sent to I&AP's during the EIA Phase

Draft EIA

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

6 October 2026

Dear Interested and Affected Party **Ref: NC/EIA/02/PIX/SIY/PRI1/2026**

ENVIRONMENTAL IMPACT APPLICATION IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998, FOR THE CLEARING OF VEGETATION ON THE REMAINDER OF FARM TWEEFONTEIN NO. 373 AND PORTION 4 (PTN OF PTN 2) OF FARM KALKFONTEIN NO. 374, PRIESKA. APPLICANT: TEMDALE BOERDERY (PTY) LTD. EIA Public Participation Phase.

Temdale Boerdery (Pty) Ltd appointed Digital Soils Africa (Pty) Ltd (DSA) to conduct the necessary environmental impact assessment and public participation for the above-mentioned project.

Previously you were consulted during the *Scoping Phase* of the application. The project has proceeded into the *Environmental Impact Assessment* (EIA) Phase.

In terms of Section 41 of NEMA Regulations, you have been identified as an Interested and Affected Party and are invited to participate in the public participation. All written comments will be responded to and forwarded to the relevant departments, in the form of a Public Participation Report.

The purpose of this letter and attached document is therefore to:

- Inform you of the locality of the proposed environmental authorization application.
- Allow you the opportunity to raise concerns or comments in respect of the proposed project detailed in the attached Background Information Document.

Public Participation Process

The purpose of the Background Information Document is to provide you with *basic information* regarding the proposed project and provide the opportunity as a registered interested and affected party to raise any comments you might have on the proposed project.

If you would like to participate in the process, please register as an interested and affected party (I&AP), in writing. Comments/registration must be received **on or before 5 November 2026** no later than 5pm. If no comments are received from you, it will then be regarded that you do not have any comments.

Way Forward

- The outcome of this consultation process will be submitted to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform as part of the Final EIA Report.
- The Draft EIA & EMP document and required specialist reports are subjected to review by all registered I&AP's and relative governmental departments, following the time frames as stipulated in Section 3 (1) & (8) of the NEMA regulations (30 days).

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

- All information received will form part of the public record and may be made available to the public. By submitting comments, you consent to the inclusion of your personal information in public participation records, in accordance with POPIA. Correspondence throughout the remainder of the environmental process will be distributed to registered I&APs only.
- The outcome of that consultation process will be submitted to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform as part of the final EIA& EMP.
- The documents will be made available on the DSA website, www.dsafrica.co.za. Please follow the link to Environmental, Documents and choose the Temdale link.
- All required documents will be submitted to the relevant department for decision-making.
- If the application is accepted, the relevant department will either issue or reject the Environmental Authorisation.
- As an I&AP's, you will be notified of the final decision of the relevant departments.

Yours sincerely

Natalie Sharp
Pri.Sci.Nat (Reg nr. 123443)
Reg. EAP (EAPASA)(2020/230)
Member of IAIAsa (7237)

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

6 October 2026

Department of Agriculture, Environmental Affairs, Rural Development and Land Reform
Directorate Environmental Quality/Assessment Management
Private Bag X6102
Kimberley
8300
Attention: Ms. M. Madisa **Ref: NC/EIA/02/PIX/SIY/PRI1/2026**

SUBMISSION OF DRAFT EIA REPORT IN TERMS OF THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998, FOR THE CLEARING OF VEGETATION ON THE REMAINDER OF FARM TWEEFONTEIN NO. 373 AND PORTION 4 (PTN OF PTN 2) OF FARM KALKFONTEIN NO. 374, PRIESKA. APPLICANT: TEMDALE BOERDERY (PTY) LTD. EIA Public Participation Phase.

Temdale Boerdery (Pty) Ltd appointed Digital Soils Africa (Pty) Ltd (DSA) to conduct the necessary environmental impact assessment and public participation for the above-mentioned project.

The Final Scoping Report was couriered to your department and acknowledged as received on 20 July 2026. To date, we have had no response on the Scoping Report and would presume there are no comments or responses and therefore we are proceeding with the EIA phase of this application.

In terms of Section 41 of NEMA Regulations, you have been identified as an Interested and Affected Party and are invited to participate in the public participation. All written comments will be responded to and forwarded to your Department, in the form of a Public Participation Report within the Final EIA Report once the public participation has been completed for the EIA Phase.

The purpose of this letter and attached draft EIA Report is therefore to:

- Inform you of the locality of the proposed environmental authorization application.
- Allow you the opportunity to raise concerns or comments in respect of the proposed project detailed in the Draft EIA Report.

Public Participation Process

If you would like to participate in the process, please submit comments in writing **on or before 5 November 2026** until 5pm. If no comments are received from you, it will then be regarded that you do not have any comments. This is done in accordance with GNR 326, chapter 2, Regulation 3, of the Environmental Impact Assessment Regulations (2014), as amended on 7 April 2017, of the National Environmental Management Act of 1998.

45 Church Street
Walmer
6070
0824140472
natalie@dsafrica.co.za
www.dsafrica.co.za

Where we are in the process

- A Draft Scoping Report was couriered to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform for comments, acknowledged by the Department on 15 June 2026 for a 30 day comment period. The Department did not comment during this time.
- The Final Scoping Report was couriered to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform acknowledged by the Department on 20 July 2026 for the 43 day processing period. The Department did not respond during this time.
- A Draft EIA Report is now submitted to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform for comments as part of the public participation process.

Way Forward

- The Draft EIA Report and required specialist reports are subjected to review by all registered I&AP's and relative governmental departments, following the time frames as stipulated in Section 3 (1) & (8) of the NEMA regulations (30 days).
- The documents will be made available on the DSA website, www.dsafrica.co.za. Please follow the link to Environmental, Documents, and choose the Temdale link. In addition, a hard copy of the Draft EIA Report was sent to the DAEARDLR via couriers.
- All comments received and responses written during the 30 days will be captured in the Public Participation Report and submitted to the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform in the Final EIA Report.

Yours sincerely

Natalie Sharp
Pri.Sci.Nat (Reg nr. 123443)
Reg. EAP (EAPASA)(2020/230)
Member of IAIAsa (7237)

Background Information document sent to all I&AP's as identified during the EIA Phase.

Draft EIA

BACKGROUND INFORMATION REGARDING CLEARING OF VEGETATION ON THE REMAINDER OF THE FARM TWEEFONTEIN 373 AND PTN 4 (PTN OF PTN 2) OF THE FARM KALKFONTEIN 374, PRIESKA

TEMDALE BOERDERY (PTY) LTD

6 OCTOBER 2026

DSA
Digital Soils Africa

+27 82 414 0472

www.dsafrica.co.za

natalie@dsafrica.co.za

Walmer

Port Elizabeth

Directors:
Dr Darren Bouwer
Prof Johan Van Tol
Prof George Van Zijl

45 Church Street
Walmer
6070

PURPOSE OF THIS DOCUMENT

The purpose of this document is to provide all I&AP's with information about the intent of Temdale Boerdery (Pty) Ltd to apply for environmental authorisation to expan existing centre pivot irrigation areas by approximately 46 hectares on the Remainder of Farm Tweefontein No. 373 and Portion 4 (portion of Portion 2) of Farm Kalkfontein No. 374 for the establishment of a pecan nut orchard.

You were previously consulted during the Scoping Phase and the project has now continued into the EIA phase.

As an identified I&AP, you are invited to comment on any aspect related to the proposed development between 6 October 2026 and 5 November 2026.

BRIEF PROJECT DESCRIPTION

The site is situated north-east of Prieska in the Northern Cape (29° 24' 42.00"S; 23° 01' 36.31"E) most centre point of the site) on the Remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, within the Siyathemba Municipal area. The site is located on the banks of the Orange River approximately 38km northeast of Prieska and 20 km southeast of Niekerkshoop.

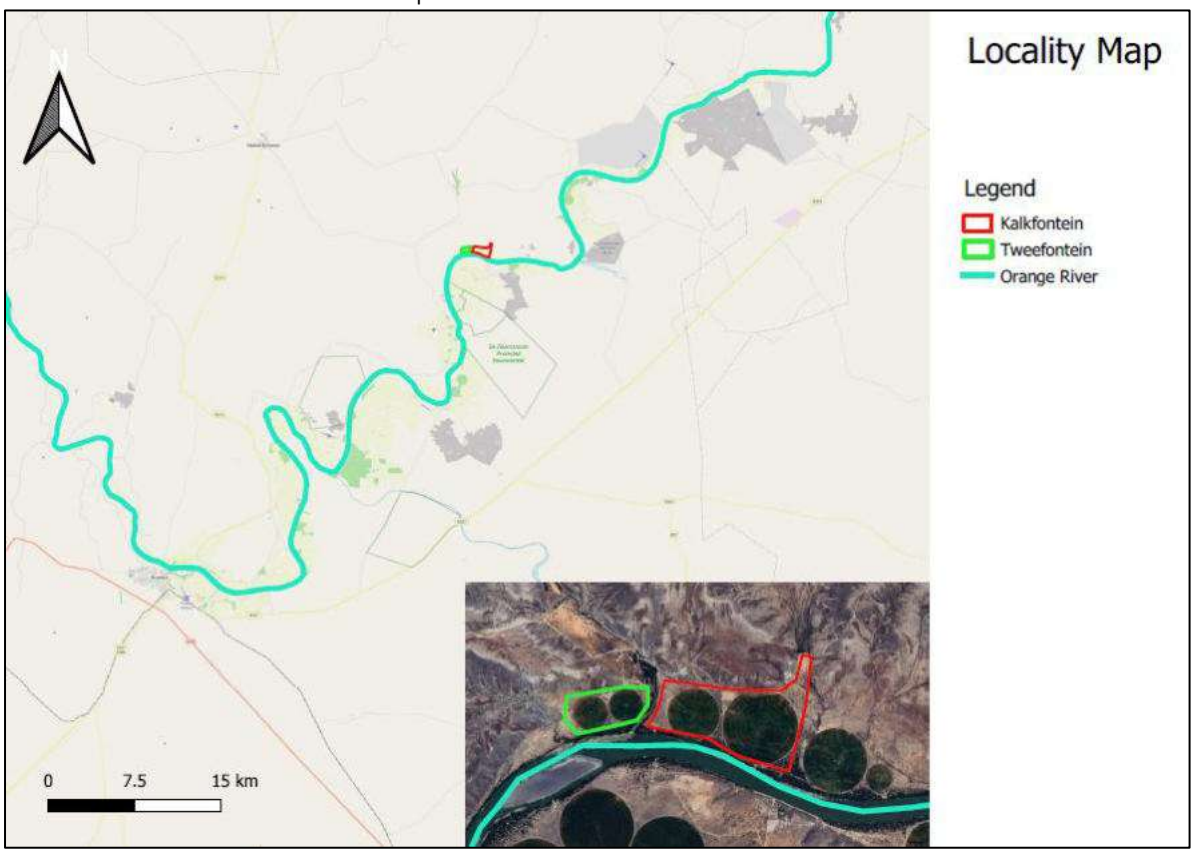


Figure 1: Site location

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NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT NO. 107 OF 1998) AS AMENDED

Environmental Assessment

DSA was appointed by Temdale Boerdery (Pty) Ltd as the independent environmental assessment practitioner (EAP) to undertake the Environmental Application and apply for GNR 325 listed activities and the submission of a Scoping Report and Environmental Impact Assessment.

According to the latest Government Notice No. 324; 325 & 327, the following Listed Activities were triggered:

GNR 325 (15): The clearance of an area of 20 hectares or more of indigenous vegetation.	*An area of 46 Ha of fall out areas between pivots, but host natural veldt will be cleared to establish pecan nut trees.*

POTENTIAL ENVIRONMENTAL ISSUES

The full impact on all environmental parameters will be concluded in the EIA and EMP phases. For background information, the most important potential environmental issues that will be addressed in the assessment include, but are not limited to:

- The loss of approximately 46 hectares of indigenous vegetation associated with the expansion of existing irrigated agricultural areas;
- Potential impacts on terrestrial biodiversity, including vegetation communities, plant species of conservation concern, and fauna habitat;
- Potential impacts on riparian vegetation and ecological processes associated with the Orange River and nearby drainage features;
- The suitability and sustainable use of agricultural soils for the proposed pecan nut orchards;
- Potential impacts on heritage and palaeontological resources;
- Potential cumulative impacts associated with the expansion of irrigated agriculture in the area;
- Socio-economic benefits associated with increased agricultural production and employment opportunities; and
- The identification of appropriate mitigation measures to avoid, minimise or manage potential environmental impacts.

PUBLIC PARTICIPATION

In terms of the NEMA, public participation forms an integral part of the environmental assessment process. The public participation process provides people who may be affected by the proposed development with an opportunity to provide comments and raise issues of concern about the project or make suggestions that may result in enhanced benefits for the project.

For this application, there will be two phases of public participation.

1. Scoping Phase – which has been completed.

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2. EIA Phase – in process.

This is the second phase of public participation and constitute the **EIA Phase**, *potential* interested and affected parties (I&APs) were given notice via a notice board and local newspaper advertisement informing the public of the application. The *registered* I&APs are considered directly abutting neighbours and organs of state that have jurisdiction over the area, e.g. the Municipality, Ward counsellor, etc. and would be provided with a Background Information Document and given access to a digital copy of the Draft EIA Report on Digital Soils website for comment.
Comments and issues raised during the EIA Phase of the public participation process will be captured, evaluated, and included in a Public Participation Report. These issues will be addressed and included in the final EIA Report, which will be submitted to the Department of Agriculture, Environmental Affairs, Rural Development, and Land Reform.

To submit comment as an Interested and Affected Party, please respond in writing to the following email: natalie@dsafrica.co.za on or before **5 November 2026** no later than 5pm.
Alternatively, a copy of the Draft EIA Report is also available on the DSA website at www.dsafrica.co.za. Please follow the link to Environmental, Documents and choose the Temdale link.

If you have any other questions or inquiries, please do not hesitate the contact the office at 082 414 0472. If no comments are received from you, it will then be regarded that you do not have any comments.

Register of I&AP's:

	Interested and Affected Party Name	Contact details (phone or email)	Address	Date received comments	Concerns raised	Response
1	Pixley Ka Seme District Municipality Att: Mr Izak Visser (Municipal Manager)	053 631 0891 / 082 802 2319 mm@pksdm.gov.za; idh@pksdm.gov.za	Private Bax X1012 De Aar 7000	No comment	None raised during the Scoping Phase	N/A
2	Siyathemba Municipality Att: Mr. Thomas van Staden (Municipal Manager)	053 492 3397 mmvstaden@siyathemba.gov.za	P O Box 16 Prieska 8940	No comment	None raised during the Scoping Phase	N/A
3	Ward Councillor Ward 3 Att: Mr. W. Pieterse	081 818 2602 / 065 680 0345 willonpieterse@gmail.com OR debbielottering28@gmail.com	P O Box 65 Niekerkshoop 8930	No comment	None raised during the Scoping Phase	N/A
4	Department of Water and Sanitation (Upington) Att: A. Hlengani	054 338 5800 HlenganiA@dws.gov.za	Private Bag X5912 Upington 8800	No comment	None raised during the Scoping Phase	N/A
5	Department of Agriculture: Directorate Land Use & Soil Management Att: Me. Thembisile Mabusa	053 807 2612 / 064 869 0976 ThembisileMA@dalrrd.gov.za	P O Box 2303, Kimberley 8300	25 February 2026	Plough Certificate was issued	N/A
6	Northern Cape Department of Roads and Public Works Att: Crystal Robertson	083 839 2183 CRobertson@ncpg.gov.za	P O Box 3132 Kimberley 8300	No comment	None raised during the Scoping Phase	N/A

Draft EIA

7	The Office of the Regional Land Claims Commissioner Land Restitution Support: Northern Cape Att: Dr. Mangalane du Toit	053 807 5700 mangalane.dutoit@dlrrd.gov.za	P O Box 2458 Kimberley 8300	No comment	None raised during the Scoping Phase	N/A
8	The Department of Agriculture, Environmental Affairs, Rural Development and Land Reform Att: Ms. Madisa Ms. Gail Letimela Mr Dineo Moleko Mr. Bryan Fisher Mr. David Khakhane	053 807 7300 / 076 833 2502 Madisa.agriculture@gmail.com gaildenc@gmail.com dmoleko@ncpg.gov.za bfisher@ncpg.gov.za dkhakane@ncpg.gov.za	90 Long Street Albertynshof Kimberley 8300	No comment	None raised during the Scoping Phase	N/A
9	SAHRA Online Application	sahrisnotices@sahra.org.za		Application was submitted on 15 June 2026	Application is in process	N/A
10	Marina Kotze (neighbour)	082 825 7000 Marinakotze26@gmail.com		No comment	None raised during the Scoping Phase	N/A
11	Goenie Williams (neighbour)	082 806 0770 Guneepsk@gmail.com		No comment	None raised during the Scoping Phase	N/A

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Draft EIA

APPENDIX D

ENVIRONMENTAL MANAGEMENT PLAN

For the

Application for Environmental Authorisation for the clearing of vegetation for expanding existing pivots on the Remainder of the Farm Tweefontein 373 and Ptn 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska

Prepared for

TEMDALE BOERDERY

OCTOBER 2026

Reference: **NC/EIA/02/PIX/SIY/PRI1/2026**

DSA
Digital Soils Africa

+27 82 414 0472
www.dsafrica.co.za
natalie@dsafrica.co.za
Walmer
Port Elizabeth

Directors:
Dr Darren Bouwer
Prof Johan Van Tol
Prof George Van Zijl

45 Church Street
Walmer
6070

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BACKGROUND

Digital Soils Africa (Pty) LTD (DSA) was tasked by Temdale Boerdery (Pty) Ltd to conduct environmental investigations and complete the Environmental Authorisation Application for the authorisation of clearing of about 46Ha of vegetation for the expansion of existing pivots on the Remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska in the Northern Cape, to establish pecan nut orchard.

In terms of the National Environmental Management Act 107 of 1998 ("NEMA"), environmental authorisation must be obtained before any person can conduct activities that cause damage to the environment.

DSA was appointed by Temdale Boerdery (Pty) Ltd (also referred to as the Applicant) as the independent environmental assessment practitioner (EAP) to undertake the Environmental Authorisation Application for the commencement of a listed activity in terms of the Environmental Impact Assessment Regulations 2014, as amended in 2017.

The proposed project entails the expansion of existing centre pivot irrigation areas by approximately 46 hectares on the Remainder of Farm Tweefontein No. 373 and Portion 4 (portion of Portion 2) of Farm Kalkfontein No. 374 for the establishment of a pecan nut orchard. The properties are currently utilised for irrigated agriculture, with four existing centre pivots already established on the site prior to 1998, comprising a 50 ha and 25 ha pivot on the Kalkfontein property and two 10 ha pivots on the Tweefontein property. The areas proposed for expansion are located predominantly within the undeveloped portions situated between and around the existing pivots, which currently still support indigenous vegetation and remnant outfall areas associated with the existing agricultural layout.

The vegetation assessment identified a combination of disturbed agricultural areas and near-natural Nama Karoo vegetation units on the Tweefontein and Kalkfontein properties. Soil samples were taken and analysed to investigate if the soil is suitable for establishing crops on Tweefontein as the areas between Kalkfontein pivots are old crop lands.The soil study found that the area is predominantly underlain by well-drained Oakleaf soil, which are considered highly favourable for both irrigation and cultivation.

An application to cultivate virgin soil (commonly known as a plough certificate) will also be applied for at the Department of Agriculture to ensure all legal requirements for such a development are met.

The Applicant has existing water use rights and therefore do not require additional applications for a Water Use Right. In the future, they might apply for an increase in usage, however, at this stage, it is not required.

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DETAILS OF THE ENVIRONMENTAL ASSESSMENT PRACTITIONER

Environmental Assessment Practitioner (EAP): Natalia Sharp
Postal address: 45 Church Street, Walmer, Gqeberha, 6070
Cell Phone: 082 414 0472
Email: natalie@dsafrica.co.za
EAP qualifications: B.Sc (Botany and Zoology) (UFS); B.Sc. (Hons) Limnology (UFS); Masters in Environmental Management: Evaluation of Phytoplankton as an indicator in a biomonitoring program, with special reference to the Modder River.
EAP Registrations/Associations: SACNASP (123443) & Reg. EAP (2020/230)

Natalie Sharp is the project manager and senior Environmental Assessment Practitioner leading this project and is registered as an Environmental Assessment Practitioner (EAP) with the Certification Board for Environmental Assessment Practitioners of South Africa (EAPSA) (Registration Number: 2020/230) and as a Professional Natural Scientist (Pri.Sci.Nat) with the South African Council for Natural Scientific Professions (SACNASP) (Registration Number: 123443) (see Appendix A for detailed CV and qualifications). Natalie Sharp has worked in the environmental industry for over seventeen years.

Digital Soils Africa Pty Ltd (DSA) is an independent environmental consulting firm that is also soil specialists, focussing on all soil solutions in the agricultural and environmental fields. The specialists are SACNASP registered and recognized leaders in their fields of study.

The soil specialist services provided include soil surveys, soil erosion mitigation, fertilization management, soil and land capability studies, and wetland delineation amongst others, while the fields of specialization are hydropedology and digital soil mapping. Together the directors have 58 years of experience.

Prof. Johan van Tol is a leading researcher on hydropedology. He is a NRF rated researcher, who boasts more than 100 peer reviewed scientific publications and has put his research to work in more than more than 130 consultancy reports. He is a SACNASP registered scientist and a full Professor in soil science at the University of the Free State.

Dr. George van Zijl is Africa's foremost Digital Soil Mapper. For his PhD he developed a DSM protocol for use in southern Africa, and has subsequently improved the methodology to include machine learning such as shown in the mapping of Ntabelanga catchment and City of Joburg Hydropedological mapping. He has served on the scientific committee for international DSM conferences. George has conducted more than 60 consultancy projects and is a SACNASP registered scientist.

Dr. Darren Bouwer boasts 12 years' experience as a soil scientist. His PhD incorporated chemical measurements into hydropedological assessments, which improves flow path determination. He has also completed a post doctorate at Ghent University, Belgium, where he specifically worked on

Draft EMP

hydropedological modelling. Darren is a SACNASP registered scientist, and has completed more than 45 consultancy reports.

PURPOSE OF THE DOCUMENT

This document serves as a programme to manage the environmental impacts during the pre-construction, construction, and operational phases of the proposed development. This document will provide mitigation measures to prevent, reduce, avoid, or rehabilitate and mitigation measures must be implemented during all the phases of the development. The objective will be to limit the negative impacts and increase positive impacts.

The Environmental Management Plan (EMP) will also:

- Provide applicable legislative framework;
- Provide management objectives, and actions to achieve such objectives;
- List roles and responsibilities;
- Provide record-keeping methods, auditing or review, and report writing;

SITE LOCALITY

The site is situated north-east of Prieska in the Northern Cape (29° 24' 42.00"S; 23° 01' 36.31"E) most centre point of the site) on the Remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, within the Siyathemba Municipal area. The site is located on the banks of the Orange River approximately 38km northeast of Prieska and 20 km southeast of Niekerkshoop (**Error! Reference source not found.**).

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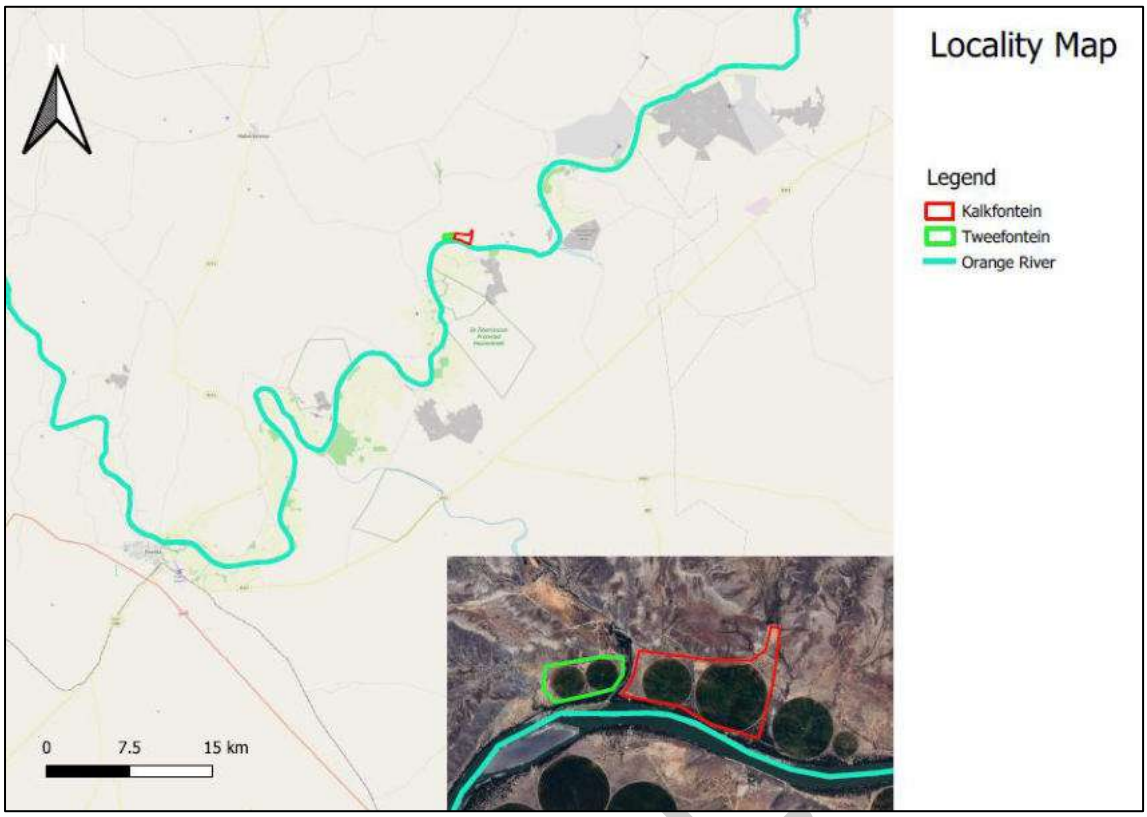

FIGURE 1: SITE LOCATION. THE ORANGE RIVER IS THE BLUE LINE. THE PROPOSED SITE IS REPRESENTED BY THE RED AND GREEN POLYGONS.

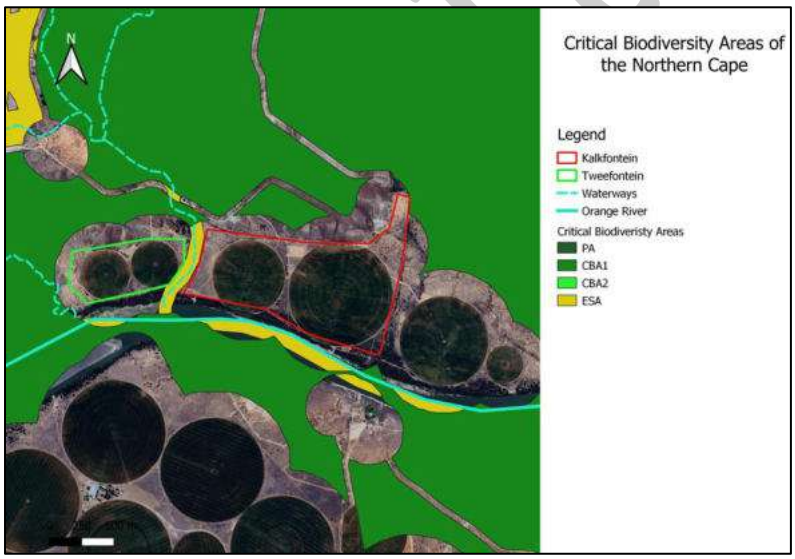

FIGURE 2: THE SITE DOES NOT FALL WITHIN CBA ACCORDING TO THE BGIS OF THE NORTHERN CAPE BIODIVERSITY CONSERVATION PLAN.

www.dsafrica.co.za natalie@dsafrica.co.za

DESCRIPTION OF THE PROPOSED LISTED ACTIVITIES

Act. No.	Listings	Describe the portion of the proposed project to which the applicable listed activity relates.	Coordinates of listed activities (centre point coordinates of the listed activity location)
Activity 15	The clearance of an area of 20 hectares or more of indigenous vegetation.	46Ha of infill clearing between pivots of 95Ha will be cleared from indigenous vegetation to bring the total area for development to 141Ha.	29° 24' 42.00"S 23° 01' 36.31"E

The proposed expansion represents a consolidation of an existing agricultural footprint rather than the establishment of a new, separate 141 ha cultivated area in previously undisturbed veld. Therefore, approximately 95 ha has already been transformed under existing centre-pivot irrigation, and the proposed additional 46 ha largely comprises infill areas between and around these established pivots. This approach makes more efficient use of land that is already fragmented by agricultural infrastructure, access tracks, irrigation systems and historic disturbance, and avoids the need to open up a separate, intact area elsewhere on the farms.

The clearance of vegetation will take place over the next 2 years.

Draft EMP

LEGISLATIVE REVIEW

ENVIRONMENTAL ASSESSMENTS UNDERTAKEN FOR THE DEVELOPMENT

In terms of the National Environmental Management Act 107 of 1998 ("NEMA"), environmental authorization must be obtained before any person can conduct activities that cause damage to the environment. Environmental legislation intends to regulate the interaction of human life with the natural environment. The purpose of environmental legislation is to protect and preserve the environment for current and future generations. The following Acts and Regulations apply to the proposed project:

LEGISLATION

The legislation was discussed in detail in the Final Scoping Report and would therefore not be repeated in this section. A summary of the applicable legislation include:

- Section 24 of the **Constitution of the Republic of South Africa Act (No 108 of 1996)**
- The **National Environmental Management Act (Act No 107 of 1998)**
- The **Environmental Impact Assessment Regulations**: 324, 325, 326 & 327 of 7 April 2017.

In terms of 2014 NEMA EIA Regulations, as amended, the activities listed in the below Table (Table 1) will be triggered by the clearing of vegetation, thereby requiring an EA from the Department of Agriculture, Environmental Affairs, Rural Development and Land Reform (DAEARDLR).

TABLE 1: EIA LISTED ACTIVITIES

Government Notice No. R325 Activity No(s):	Details of Activity(ies) requiring a Scoping Report and EIA
Activity 15	The clearance of an area of 20 hectares or more of indigenous vegetation.

- The **National Water Act (No. 36 of 1998) (NWA)**
- The **National Environmental Management: Biodiversity Act**
- The **National Environmental Management: Protected Areas Act**
- The **National Forests Act No. 84 of 1998 (NFA) & List of Protected Tree Species under the National Forest Act, 1998 (Act No. 84 of 1998)**
- **Conservation of Agricultural Resources Act (Act 43 of 1983)**
- **Bio-regional Plans:**

In terms of the provincial and local protected areas and considering all the maps available and data presented, it is concluded that the NPAES, the Northern Cape PAES, the Northern Cape Biodiversity Conservation Plan 2024 (NCBCP), and the Pixley Ka Seme SDF all indicate that the proposed site does not fall within any biodiversity-sensitive area.

- **Northern Cape Nature Conservation (Act 09 of 2009)**
- **The Provincial Spatial Development Framework for the Northern Cape (Office of the Premier of the Northern Cape, 2012)**
- The **National Heritage Resources Act (No 25 of 1999)**

Draft EMP

In terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA), an Environmental Authorisation (EA) must be obtained from the relevant competent authority before commencing with any listed activity that may impact the environment. The Applicant would like to clear more than 20Ha of vegetation between existing central pivots to establish pecan nut orchard for agricultural purposes.

The Applicant already has a Water Use License, for the abstraction of water for irrigation and has a ploughing certificate for cultivating virgin soil from the Directorate Land Use and Soil Management of the Department of Agriculture.

The vegetation assessment identified the site as ecologically important due to the presence of relatively intact Nama Karoo and Upper Gariep Alluvial Vegetation, including natural and near-natural vegetation units associated with the Orange River system. The riparian vegetation units were regarded as having a high conservation priority due to their ecological functioning, habitat diversity and the presence of protected plant species. Additional medium to medium-high sensitivity areas were identified within the natural and karroid shrubland vegetation units, which support indigenous shrubland, scattered trees and several protected succulent and bulb species. Although portions of the site have already been disturbed by existing agricultural activities, pivots and associated infrastructure, the assessment confirms that sections of the site still retain important ecological characteristics and contribute to the broader functioning of the surrounding Nama Karoo ecosystem.

Draft EMP

Ownership

The proposed site belongs to Temdale Eiendomme (Pty) Ltd who is also the applicant.

Zoning

The site is zoned Agriculture and the proposed development is not an application for a change of land used. The project will simply entail the change of grazing land to pecan nut production. Therefore, *no* application in terms of the Subdivision of Agricultural Land Act (SALA) Act 70 of 1970 for sub-division and rezoning, is necessary.

Water source

The Orange River – the applicant has a water use license (see Appendix G).

Irrigation

The proposed development will expand the existing irrigated agricultural footprint from approximately 95 ha to 141 ha, utilising the existing irrigation infrastructure and water supply. The applicant holds a Water Use Licence for irrigation abstraction. The soil specialist confirmed that the surveyed Tweefontein soils are predominantly suitable for irrigation and pecan nut production, subject to appropriate irrigation management. Irrigation scheduling must be adapted to soil conditions, and soil salinity and sodicity must be monitored and managed to prevent long-term soil degradation.

Drainage

The soil specialist confirmed that the Tweefontein site is predominantly underlain by well-drained Oakleaf soils, which are suitable for irrigation. Appropriate irrigation management is required to prevent waterlogging and the accumulation of salts in the soil, thereby maintaining long-term soil productivity.

Draft EMP

METHOD STATEMENT & ACTIVITY SPECIFIC MANAGEMENT PLAN

The Method Statements set out the materials, labour, and method that the contractor proposes using to carry out an activity, identified by the Environmental Officer and/or Project Manager/Farm Manager. The Method Statements contain sufficient detail such that the Environmental Officer and Project/Farm Manager can assess whether the Contractor's proposal is following the requirements of the Environmental Management Plan. The contractor must sign each Method Statement along with the Environmental Officer and Project/Farm Manager to formalize the approved Method Statement. Method Statements and/or Management Plans must be submitted by the Contractor to the Project/Farm Manager and Environmental Officer for approval before the commencement of the activity.

The Method Statements for this project, as a minimum, must include:

- Soil Management and Erosion;
- Stormwater control/drainage;
- Flora & Fauna Management;
- Water Quality & Aquatic Health;
- Fires
- Waste

Method Statements must address the following aspects:

- What – a brief description of the work to be undertaken;
- How – a detailed description of the process of work, methods, and materials;
- Where – a description of the location of the work (if applicable); and
- When – the sequencing of actions with commencement and completion date estimates.

Since this is a farm project it is unlikely that an Environmental Control Officer will be appointed. Therefore, such responsibilities and duties will be transferred to the Project/Farm Manager and/or Applicant, who must monitor the implementation of the Method Statements and activity-specific management plans during the operation phase of the project.

PLANNING AND DESIGN PHASE MANAGEMENT

The planning and design phase must ensure that the proposed expansion of the existing centre-pivot irrigation areas on Tweefontein 373 and Kalkfontein 374 is undertaken in accordance with the approved development footprint, Environmental Authorisation and relevant specialist recommendations.

The proposed development entails approximately 46 ha of additional cultivation within and around the existing centre-pivot irrigation areas, increasing the total agricultural footprint to approximately 141 ha. Planning must prioritise the protection of retained natural vegetation, the Orange River riparian corridor, drainage lines and identified species of conservation concern.

The following environmental management measures must be implemented before vegetation clearing, soil preparation or orchard establishment commences.

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Management aspect	Management and mitigation measures
Environmental authorisation and permits	Ensure that the Environmental Authorisation and all applicable permits and approvals are obtained before the commencement of activities to which they relate.
Development footprint	Finalise and demarcate the approved development footprint. Clearly identify all retained natural vegetation, watercourse buffers and no-go areas. No activities may take place outside the approved footprint.
Riparian vegetation and drainage lines	Retain and protect the main riparian vegetation corridor associated with the Orange River. Maintain the minimum 32m buffer along drainage lines identified in the EIA and exclude cultivation, chemical storage and waste disposal from designed watercourse buffers.
Protected plant species	Identify protected plant species within the development footprint before clearing. Obtain the necessary removal permits and arrange for the relocation of affected plants to suitable habitat under the supervision of a qualified plant ecologist. Retain larger *Boscia albitrunca* trees wherever practicable.
Fauna protections	Undertake pre-clearance fauna surveys of the proposed expansion areas. Complete an Aardvark burrow survey and identify any habitats or nesting sites requiring protection. Where species of conservation concern are confirmed, implement the fauna specialist's requirements before proceeding.

Draft EMP

Soil suitability and irrigation	Incorporate the soil specialist's findings into the orchard and irrigation planning. Irrigation scheduling must account for soil properties and crop requirements, with provision for monitoring soil salinity and sodicity. Consider the agronomic and economic implications of planting pecan trees in the identified marginal soil areas.
Water use	Confirm that the proposed irrigation activities comply with the existing Water Use Licence. Any water use not covered by the existing authorisation must be appropriately authorised before commencement.
Heritage and palaeontology	Ensure that the proposed ground-disturbing activities remain within the scope assessed by the heritage specialist. The specialist's finding that no additional archaeological or palaeontological mitigation is required is conditional on activities remaining within the scope of existing shallow disturbance.
Environmental awareness	Provide environmental awareness training to personnel before commencement. Training must include the identification and protection of species of conservation concern, no-go areas, Aardvark burrow avoidance and the fauna specialist's requirements.
Environmental management and compliance	Ensure that the approved EMP and applicable Environmental Authorisation conditions are communicated to the applicant, farm management and contractors before commencement. Establish responsibilities for implementing and monitoring the required environmental management measures.

Draft EMP

Implementation responsibility: Applicant / Farm Manager, with input from the relevant specialists and ECO where required.

Timeframe: Prior to vegetation clearing, soil preparation and the establishment of the proposed orchards.

OPERATION PHASE MANAGEMENT

The overall goal for the operational phase is to manage the activities associated with the operation and maintenance of the site in such a way that:

- The development maintains its positive socio-economic impact;
- Management of soil is kept in good condition through:
    - Monitoring the drainage,
    - Irrigation scheduling,
    - Monitor drainage so that accumulation does not impact abutting crops, and
    - Fertilization.
- Management of alien vegetation is sufficient to prevent spreading or causing fire hazards;
- Managing orchard health;
- The activity complies with all relevant legislation, permits, and authorizations.

The Applicant is responsible for ongoing management of the site until the farm is sold or an application for closure is submitted. All measures and conditions described in this EMP, the Environmental Authorisation, and any other relevant documents/legislation, should be strictly adhered to during the operational phase.

Draft EMP

ORGANIZATIONAL REQUIREMENTS

The Applicant should be familiar with the requirements of the EMP and should execute all maintenance activities in an environmentally responsible manner.

This overview offers a perspective of the proposed organization of the EMP and the recommended responsibilities of key members of the project team. The ultimate responsibility and public accountability for the EMP and general environmental management reside with the Applicant.

The workers will be responsible for implementing the instructions from the farm manager (or Applicant), and it is recommended that the farm manager appoints a responsible worker to report back on a daily/weekly/monthly basis, ensuring compliance with the conditions of the EMP. If needed, to provide a basic level of environmental training to the responsible worker/s.

If needed, an independent and external Environmental Control Officer (ECO) can be appointed by the Applicant to assist and advise on the implementation of the EMP and to conduct environmental audits no less than once every five (5) years unless otherwise instructed by the DAEARDLR.

45 Church Street
Walmer
6070

ROLES AND RESPONSIBILITIES

AUTHORITIES

The issuing of the necessary permits/licences/certificates and authorizations is the responsibility of the authorities, in this case, the Department of Agriculture (*for the approval of cultivating virgin land*), Environmental Affairs (*for environmental authorisation approval*), Rural Development and Land Reform (DAEARDLR). The authorities will also ensure that the Applicant complies with the conditions of the Environmental Authorisation and other permits/licenses/approvals.

Authorities are entitled to perform site inspections to ensure compliance with the conditions and of non-compliance, the authorities may provide instructions to ensure an action plan with corrective measures is carried out or to cease with the project, especially in the case of long-term non-compliance.

APPLICANT

The Applicant, in this case, Temdale Eiendomme (Pty) Ltd has the responsibility for environmental management during the pre-construction, construction and operational phase until the property is sold or an application for closure is made. Thereafter it will be the responsibility of the landowner or new tenants.

The EMP becomes legally binding to the Applicant and everyone acting on behalf of the Applicant during the construction and operation activities. The activities are regarded as permanent therefore there is no provision made for decommissioning activities.

In summary, the Applicant is responsible for:

- Reviewing the environmental monitoring programme in the EMP or as recommended by the Environmental Control Officer (ECO) if one is appointed;
- Ensuring that the required environmental audits are undertaken on a timely basis and that the results of the audits are communicated to all personnel that are responsible;
- Implementing an environmental monitoring programme approved by the authorities and providing such results to the authorities;
- Conducting regular site inspections and monitoring to ensure compliance with the EMP;
- Advising on actions to be taken in the event of incidents or public complaints;
- Keeping a complaint register on-site/on the farm.

Draft EMP

FARM MANAGER OR SENIOR PRODUCTION MANAGER

The Farm Manager's responsibility is to monitor staff, crops/orchard, purchasing supplies, and maintain a professional network of communication between the staff and the Applicant and other duties the Applicant would require.

The Applicant can appoint a Farm Manager / Senior Production Manager to also be responsible for the environmental management during the operational phase and must report to the Applicant regularly.

RESPONSIBLE CONTRACTORS

It is the responsibility of Contractors (clearing of the vegetation, construction of irrigation system, drainage systems, etc.) to ensure that there is compliance with the environmental specifications contained in the Environmental Impact Assessment (EIA), the Environmental Management Programme (EMP), and the Environmental Authorisation (EA). This implies that Contractors must familiarise themselves with the documentation and understand the restrictions and conditions. If any infringements are noted, the ECO (if one is appointed) or/and the Applicant must be notified before further action is taken.

Contractors will also be responsible for the workforce on-site and could appoint a suitable Farm Manager who must report to the Contractors.

SUB-CONTRACTORS

Sub-contractors must operate under the supervision of the Contractors and are liable for issues associated with their actions.

ENVIRONMENTAL CONTROL OFFICER

An Environmental Control Officer (ECO) can be appointed by the Applicant to advise and assist where necessary and to monitor the implementation of the EMP, as an external function. The ECO must have previous experience in environmental management and compliance monitoring.

The ECO should conduct an independent evaluation of compliance with the EMP, but is not responsible for enforcing the conditions of the EMP.

Draft EMP

Specific responsibilities include:

- Undertake environmental site audits as determined by the responsible authority;
- Recommend environmentally appropriate solutions to environmental problems;
- Recommend additional environmental management measures, if applicable;
- To assist in environmental training for the staff;
- Help raise awareness for environmental sensitive issues and help foster an appropriate environmental attitude towards the environment;
- Respond to non-compliance and provide corrective actions and procedures;
- Assist the Applicant if liaising with authorities is required.

SOIL SCIENTIST

The Soil Scientist must conduct a soil survey which must be included in the application for the cultivation of virgin soil. The Soil Scientist must assist with the irrigation scheduling by surveying the soil hydraulic properties, which is essential for variable rate irrigation, and the farm-scale water balance.

The Soil Scientist can also recommend fertilization for the crops, and assist with farm planning to help the Applicant optimize management to maximize profits.

The Soil Scientist should also allow for environmental protection works within the project budget, and determine the imposition of penalties for infringement of the Environmental Specifications and implement it.

MITIGATION MEASURES & MONITORING

The following maintenance and mitigation measures are recommended for implementation by the Applicant for the construction phase and the duration of the operational phase.

**Please note that this section will be amended and completed when all comment has been received from Commenting Authorities and interested and affected parties.*

Summary of significant impact with and without mitigation during the construction and operational phases.

Draft EMP

Environmental parameter	CONSTRUCTION (no mitigation)	CONSTRUCTION (with mitigation)	OPERATIONAL (no mitigation)	OPERATIONAL (with mitigation)
Topography	Low(-)	Very Low (-)	-	-
Geology	Low (-)	Very Low (-)	-	-
Soil Properties & Erosion	Low (-)	Very Low (-)	Low (-)	Very Low (-)
Soil Pollution	Low (-)	Very Low (-)	Low (-)	Very Low (-)
Flora	Medium-High (-)	Medium (-)	-	-
Fauna	High (-)	Medium-High (-)	High (-)	Medium-High (-)
Ecologically Sensitive Areas	High (-)	Medium (-)	-	-
Water	Medium (-)	Low (-)	Medium (-)	Low (-)
Air quality	Medium (-)	Low (-)	Medium-High (-) for uncontrolled pesticide application; Dust alone Low (-) to Medium (-) depending on wind.	Low–Medium (-) for pesticide-related air-quality risk, Low (-) for dust and negligible for exhaust.
Noise	Low (-)	Very Low (-)	Very Low (-)	Very Low (-)
Waste	Low-Medium (-)	Low (-)	Medium (-)	Low (-)
Visual & Aesthetics	Low (-)	Very Low (-)	Low (-)	Low (-)
Traffic	Very Low (-)	Very Low (-)	Low (-)	Low (-)
Socio-Economic	Low (+)	Low (+)	Low-Medium (+)	Medium (+)
Heritage / Archaeology	Low (-)	Low (-)	-	-

Draft EMP

PRE-CONSTRUCTION / PLANNING AND DESIGN

Item / objective	Actions / management measures	Responsible person & timeframe	Monitoring methods	Indicators / evidence
Statutory authorisations and environmental compliance	• Obtain and maintain all applicable statutory approvals, permits and licences required for the proposed development before undertaking the activities to which they relate. • Establish and maintain an environmental compliance register identifying the applicable Environmental Authorisation (EA), Water Use Licence (WUL), agricultural cultivation approval, protected-species permits and their relevant conditions. • Appoint the Farm Manager or another designated	Applicant - before commencement and throughout the project. Farm Manager / ECO – throughout construction and operations.	Review the compliance register, applicable approvals, inspection records and corrective-action records. Verify implementation of relevant conditions through site inspections and review of supporting documentation.	Applicable approvals and permits available on file; compliance register maintained; responsible person appointed; relevant conditions communicated to contractors and employees; non-compliances recorded and corrective actions completed.

Draft EMP

	person to oversee the implementation of the EMP and monitor compliance with applicable approval conditions. • Incorporate relevant approval conditions and specialist requirements into contractor instructions and operational management procedures. • Review compliance with the applicable conditions during the relevant project phases and record any non-compliance and corrective actions. • Maintain copies of applicable approvals, permits, compliance records and environmental audit reports, where required.			

Draft EMP

Approved footprint and no-go areas	• Set out the authorised ±46 ha infill footprint separately from the existing ±95 ha transformed pivot areas. • Demarcate retained natural vegetation, the Orange River riparian corridor and the minimum 32 m drainage-line buffer identified in the EIA. • Locate temporary works, stockpiles and access outside these areas.	Applicant / Farm Manager and ECO or appointed site representative; before clearing.	Compare pegged boundaries with approved plan; photograph no-go demarcation.	Footprint and buffers marked before work; no encroachment.
Flora and protected plants	• Undertake a pre-clearance plant search within the approved development footprint to identify protected plant species that may be affected by vegetation clearing. • Retain larger *Boscia albitrunca* individuals on Tweefontein as far as practically possible.	Applicant / Farm Manager: Before vegetation clearing. Qualified Plant Ecologist: During pre-clearance searches and plant relocation, with follow-up monitoring where required.	Review the plant search-and-rescue report, applicable permits, relocation records and written confirmation from the plant ecologist. Inspect retained protected plants and relocated individuals in accordance with the specialist's recommendations.	Protected plants identified and managed before clearing; applicable permits obtained; plant relocation records available; written specialist confirmation received; follow-up monitoring records maintained where required.

Draft EMP

	• Obtain the necessary permits before removing or disturbing protected plant species. • Where removal is unavoidable and authorised, relocate affected protected plants to suitable habitat outside the development footprint under the supervision of a qualified plant ecologist. • The plant ecologist must document the pre-clearance findings, identify plants requiring protection or relocation and provide written confirmation that the required plant management measures have been completed before clearing commences in the affected area.			

Draft EMP

	• Where protected plants are relocated, the plant ecologist must recommend appropriate follow-up monitoring and any necessary remedial measures.			
Faunal pre-clearance	• Complete specialist-led checks of all infill areas for species of conservation concern, active raptor and ground-bird nests, Aardvark burrows and tortoises before soil preparation. • If Black-footed Cat, African Striped Weasel or an active Tawny Eagle or Verreaux's Eagle nest is confirmed within the footprint, suspend work in that portion and consult the appropriate authority	Applicant and suitably qualified fauna specialist; before earthworks	Signed pre-clearance findings, mapped sensitive features, permits and hold-point sign-off.	No earthworks before required surveys; affected work suspended where triggered.

Draft EMP

	regarding required permits and measures.			
Wildlife buffers and chemical protocol	• Map known Aardvark burrows and establish explicit no-insecticide buffers around them, with the extent determined through specialist advice. • Design infrastructure to accommodate Aardvark movement. • Establish a rodenticide management protocol and habitat-buffer strategy addressing African Striped Weasel and Black-footed Cat exposure. • Prohibit gin traps.	Applicant, fauna specialist and Farm Manager; before orchard establishment.	Review mapped burrows, approved management protocol and farm operating procedures.	Burrows and habitat buffers documented; chemical restrictions communicated.
Soils, drainage and irrigation design	• Use the Tweefontein soil suitability mapping in orchard design; • Account for the less productive northern Prieska soils.	Applicant, irrigation designer / agronomist and Farm Manager; design stage	Review soil map, irrigation design, monitoring programme and WUL conditions.	Design reflects soil limitations; monitoring and runoff controls specified.

Draft EMP

	• Adapt irrigation scheduling to soil properties and crop requirements. • Plan monitoring and management of salinity and sodicity. • Design irrigation and runoff controls to avoid waterlogging, erosion and discharge into watercourse buffers.			
Heritage scope and chance finds	• Keep earthworks within the assessed inter-pivot footprint and shallow-disturbance scope. • The heritage specialist requires no additional mitigation or monitoring for that assessed scope. • As a precautionary EMPr measure, brief operators to stop work locally and seek heritage-authority advice if suspected fossils,	Applicant and Farm Manager; before earthworks	Approved footprint, induction records and incident procedure.	No unassessed deeper disturbance; chance-finds procedure available.

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	archaeological material or human remains are exposed.			
Induction and emergency planning	• Train workers before work and annually thereafter on species of conservation concern, legal protections, rodenticides and gin traps, Aardvark burrows, tortoise pre-clearance and dead-animal reporting. • Keep signed registers and display laminated species identification cards at the farm office, workshop and worker accommodation. • Establish spill, fire and incident-response procedures.	Applicant / Farm Manager; before work and annually.	Attendance registers, displayed cards and emergency procedures.	Documented induction and readily accessible response information.

Draft EMP

CONSTRUCTION PHASE / CLEARING AND SOIL PREPARATION

Item / objective	Actions / management measures	Responsible person & timeframe	Monitoring methods	Indicators / evidence
Site limits and access.	• Restrict clearing, machinery, vehicles, temporary works and stockpiles to the authorised footprint and existing or approved access. • Do not clear the retained riparian corridor, designated drainage-line buffer or other demarcated no-go areas.	Contractor and Farm Manager; throughout establishment.	Daily visual checks; ECO/site-representative inspections and photographic record.	No disturbance outside approved limits.
Phased vegetation clearing	• Restrict vegetation clearing to the approved development footprint and clearly demarcate the boundaries before clearing commences. • Undertake vegetation clearing and soil preparation progressively	Contractor and Farm Manager; during clearing.	Check clearing boundaries, waste handling and exposed areas.	Clearing limited to approved areas; no vegetation dumping.

Draft EMP

	to minimise the duration of exposed soil and reduce wind erosion. • Protect retained natural vegetation, particularly the near-natural vegetation units and the Orange River riparian corridor. • No clearing, stockpiling or machinery movement may occur within designated no-go areas. • Identify and protect the *Boscia albitrunca* individuals recorded within the development area. Where avoidance is not possible, obtain the necessary permits and implement the applicable specialist recommendations before disturbance.			

Draft EMP

	• Implement the flora specialist's recommendations (see Appendix E4) for the management of alien invasive plant species, including preventing their spread into retained natural vegetation. • Do not dispose of cleared vegetation within drainage lines, the riparian corridor or retained natural vegetation. • Reuse suitable, non-invasive cleared vegetation as mulch where practicable, provided that it does not contain material capable of spreading alien invasive species.			
Fauna protection during works	• Complete the fauna specialist's pre-clearance surveys of all proposed infill	Contractor, Farm Manager and fauna specialist where needed; during works.	Pre-start checks, wildlife incident register and specialist follow-up.	No avoidable injury; protected features remain intact.

Draft EMP

	expansion areas before earthworks or vegetation clearing commence, and implement the findings before entering each affected work area. • If a Black-footed Cat, African Striped Weasel, or active Tawny Eagle or Verreaux's Eagle nest is confirmed within the development footprint, suspend work in the affected portion. Consult the relevant authorities and obtain any required authorisation before proceeding. • Undertake an Aardvark burrow survey before soil preparation. Identify and protect known burrows and establish the specialist-recommended no-			

Draft EMP

	insecticide buffer around them. • Check for tortoises and other slow-moving animals before soil preparation. Any necessary handling or relocation must be undertaken under appropriate specialist direction and in accordance with applicable permit requirements. • Restrict machinery and personnel to the approved development footprint. • Protect designated no-go areas and retain the main Orange River riparian corridor. • Prohibit hunting, persecution, trapping and collection of wildlife. • Implement the specialist's rodenticide controls and			

Draft EMP

	prohibit gin traps (see Appendix E1). • Conduct and document fauna awareness training before construction commences. Training must cover the relevant species of conservation concern, Aardvark burrow avoidance, tortoise pre-clearance obligations, prohibited trapping methods and the reporting of dead or injured animals.			
Soil and erosion control	• Restrict soil disturbance and machinery movement to the authorised development footprint, designated access routes and working areas to minimise unnecessary soil compaction. • Undertake vegetation clearing and soil preparation progressively to minimise	Contractor and Farm Manager; throughout establishment.	Visual inspections after rain; erosion and corrective-action register.	No uncontrolled erosion or sediment delivery to watercourses.

Draft EMP

	the extent and duration of exposed soil. Avoid clearing during periods of strong winds, where reasonably practicable. • Retain or establish suitable ground cover between orchard rows as soon as practicable to reduce wind and water erosion. • Strip and retain topsoil separately where excavation or trenching is required, and replace it during rehabilitation. • Locate and stabilise soil stockpiles outside designated watercourse buffers and drainage paths, where they cannot be washed into drainage features. • Inspect disturbed areas and stockpiles after rainfall.			

Draft EMP

	Promptly repair erosion and implement appropriate runoff or sediment-control measures where concentrated flow, rills or sediment movement are identified.			
Surface water and buffers	• Clearly demarcate and maintain the proposed minimum 32 m vegetated buffer from the intervening drainage line and protect the retained Orange River riparian corridor. No vegetation clearing, soil preparation, machinery movement, stockpiling or waste disposal may occur within these areas. • Confine clearing and soil preparation to the authorised development footprint and undertake	Contractor and Farm Manager; throughout establishment.	Inspect buffer markers, runoff pathways and watercourse margins.	Buffers undisturbed; no visible sediment or contaminant discharge.

Draft EMP

	works progressively to minimise exposed soil. • Retain or establish ground cover as soon as practicable and stabilise disturbed areas and soil stockpiles. • Prevent concentrated runoff and sediment-laden water from entering drainage features through suitable erosion and sediment-control measures, where required. • Do not stockpile soil or excavated material where it could be washed into drainage lines. • Inspect disturbed areas and the drainage-line buffer after rainfall and promptly address erosion or sediment movement. • Do not store fuel on site. Use drip trays during			

Draft EMP

	emergency machinery servicing and promptly contain and clean up any spills. • Provide appropriate sanitation and waste receptacles to prevent sewage, litter, chemicals and other contaminants from entering runoff.			
Machinery, spills and waste	• Maintain vehicles and machinery in good working order and free from significant leaks. • Undertake routine servicing at the designated workshop, away from the development footprint and watercourses. • Do not store bulk fuel, oils, lubricants or other hazardous substances within the development footprint. Where	Contractor and Farm Manager; throughout establishment.	Equipment checks, spill log and waste-disposal records.	No unmanaged spills, litter or waste dumping.

Draft EMP

	emergency repairs are necessary, use suitable containment measures and keep spill-response materials available. • Contain and clean up spills promptly. Collect contaminated soil, absorbent material, used oil, filters and oily rags in suitable containers and dispose of them through appropriate waste channels. • Provide clearly labelled waste containers and separate general, recyclable and hazardous waste where practicable. • Remove non-reusable waste to an appropriately authorised waste facility and retain applicable disposal records.			

Draft EMP

	• Chip or mulch suitable cleared vegetation for reuse where practicable, provided that alien invasive plant material is managed to prevent regrowth or seed dispersal. • Do not burn waste or dispose of cleared vegetation, general waste or contaminated material in drainage lines, the Orange River riparian corridor or retained natural vegetation.			
Dust, fire and worker conduct	• Limit unnecessary vehicle movement and dust from exposed soil. • Use proportionate dust suppression without generating runoff. • Prohibit uncontrolled fires and burning of cleared vegetation.	Contractor and Farm Manager; throughout establishment.	Visual checks, complaints and incident registers.	No uncontrolled dust, fire or sanitation incidents.

Draft EMP

	• Provide appropriate sanitation, fire equipment and worker instruction.			
Heritage chance finds	• Confine excavation and soil preparation to the authorised development footprint and avoid unnecessary deep excavation. • Brief machine operators and other personnel involved in ground disturbance on the recognition and reporting of possible archaeological material, fossils and human remains. • If suspected archaeological material, fossils or human remains are discovered, immediately stop work in the affected area, protect the find from further disturbance and notify the	Contractor and Farm Manager; during ground disturbance.	Incident log and authority correspondence, if triggered.	Finds protected; work resumes only following appropriate direction.

Draft EMP

	ECO and relevant heritage authority. Do not remove, collect or disturb the material without the required direction or authorisation. • Record the location and circumstances of the discovery and allow sufficient time for any required specialist inspection, recording or recovery before work resumes. • Do not undertake deeper excavation beyond the disturbance assessed in the heritage specialist report without first reassessing the potential heritage and palaeontological implications.			

Draft EMP

Employment, skills development and local procurement.	• Prioritise suitably qualified local workers and service providers where practicable, subject to the skills and capacity required for the work. • Apply fair and transparent recruitment practices and comply with applicable employment requirements. • Provide workers with appropriate task-specific training, PPE and occupational health and safety instruction. • Procure suitable goods and services locally where feasible. • Maintain records of employment, training and local procurement associated with orchard establishment.	Applicant / Farm Manager and appointed contractors; during establishment.	Review employment, training and procurement records.	Recruitment and training records available; appropriate PPE provided; local employment and procurement opportunities recorded where realised.

Draft EMP

OPERATIONAL PHASE / ORCHARD MANAGEMENT

Item / objective	Actions / management measures	Responsible person & timeframe	Monitoring methods	Indicators / evidence
Water use and irrigation	• Operate within the applicable Water Use Licence conditions, ensuring that the authorised water use covers the proposed orchard expansion. • Schedule irrigation according to crop requirements and soil characteristics. • Inspect irrigation equipment for leaks, excessive application and runoff. • Prevent waterlogging and unnecessary irrigation return flow toward drainage lines and the Orange River.	Applicant / Farm Manager and irrigation operator; ongoing.	Water-use and irrigation records; inspections of leaks, ponding and runoff.	Licence compliance; no persistent waterlogging or avoidable runoff.

Draft EMP

Soil salinity and sodicity and soil management.	• Establish and implement a soil monitoring programme for the proposed orchards on Tweefontein and Kalkfontein, with sampling locations and results recorded separately for each farm. • Monitor soil salinity and sodicity during irrigation, including electrical conductivity (EC) and exchangeable sodium percentage (ESP), and compare results with the applicable baseline information and subsequent monitoring results. • Use the existing Tweefontein soil suitability assessment as baseline information for the areas surveyed on that farm. Do	Farm Manager / agronomist; ongoing.	Soil-test results and documented management responses.	Farm-specific baseline and monitoring results available; EC and ESP trends tracked; soil fertility measures implemented; corrective actions recorded where deterioration is identified.

Draft EMP

	not apply the Tweefontein laboratory results to Kalkfontein as though they represent conditions on that property. • Establish appropriate baseline soil chemistry information for the Kalkfontein orchard areas to enable subsequent monitoring of salinity and sodicity. • Determine the sampling locations, sampling depth, monitoring frequency and appropriate management responses in consultation with a suitably qualified soil specialist or agronomist. • Where monitoring indicates increasing salinity or sodicity, review irrigation scheduling, irrigation-water quality and fertility			

Draft EMP

	management, and implement appropriate corrective measures. • Implement a soil fertility programme appropriate to the soil conditions and crop requirements. Where pecan nut trees are planted in the marginal free-lime areas identified on Tweefontein, apply foliar micronutrient fertilisation in accordance with the soil specialist's recommendations (See Appendix E3). • Maintain soil test results and records of any changes made to irrigation or fertility management.			
Agricultural chemicals, runoff and surface water protection	• Apply fertilisers, herbicides and pesticides in accordance with the manufacturer's instructions	Farm Manager and trained chemical application operators; throughout the	Review chemical application records, equipment maintenance records and spill reports. Inspect	Chemical application records maintained; equipment appropriately maintained; no chemical application within

Draft EMP

	and applicable environmental requirements. • Restrict chemical application to the intended agricultural areas and prevent application within designated watercourse buffers, the retained Orange River riparian corridor and other chemical exclusion areas. • Do not undertake spraying during weather conditions that favour spray drift into watercourses, riparian vegetation or other sensitive areas. • Ensure that chemical application equipment is appropriately maintained and calibrated to prevent excessive application, leaks	operational phase and during each chemical application.	chemical storage areas, designated watercourse buffers and areas where runoff or contamination has been identified.	designated exclusion areas; no uncontrolled chemical discharge into watercourses; pollution incidents recorded and corrective actions completed.

Draft EMP

	and uncontrolled discharge. • Store agricultural chemicals securely outside riparian and drainage-line areas. Manage chemical residues, rinsate and empty containers in accordance with applicable label and disposal requirements. • Prevent fertiliser and pesticide runoff into drainage lines and the Orange River through appropriate irrigation and chemical application practices. • Where chemical spills, runoff or contamination are identified, immediately stop the activity responsible, contain the pollution where practicable			

Draft EMP

	and implement appropriate corrective measures. • Record chemical spills and pollution incidents, including the corrective measures implemented.			
Air Quality, noise and traffic	• Maintain farm roads and manage vehicle speeds to minimise dust generation during routine orchard operations and harvesting. • Maintain ground cover between orchard rows where practicable to limit wind erosion and dust from exposed soil. • Undertake pesticide and other agrochemical spraying in accordance with applicable product requirements and only under suitable weather conditions to minimise spray drift beyond the	Farm Manager, machinery operators and drivers; throughout orchard operation, including harvesting.	Routine visual inspections of farm roads and machinery; review of spraying records, equipment maintenance records and complaints.	Dust and spray drift controlled; machinery maintained; designated access routes used; complaints and corrective measures recorded.

Draft EMP

	orchard footprint and into sensitive areas. • Maintain tractors, vehicles, pumps and other machinery in good working order to minimise unnecessary noise and exhaust emissions. • Plan harvesting, deliveries and other vehicle movements to minimise unnecessary traffic and disturbance. Require drivers to use designated farm access routes and observe appropriate speeds. • Record and investigate complaints relating to dust, spray drift, noise or farm traffic and implement corrective measures where warranted.			

Draft EMP

Protection of fauna and species of conservation concern from agricultural chemicals	• Implement a documented rodenticide management protocol addressing the protection of African Striped Weasel and Black-footed Cat, including the prevention of secondary poisoning. • Prohibit or strictly control the use of anticoagulant and acute rodenticides within known or potential African Striped Weasel habitat, in accordance with the fauna specialist's recommendations. • Implement and maintain the habitat-buffer strategy for Black-footed Cat, including restrictions on rodenticide use within identified sensitive habitat.	Applicant / Farm Manager: Ensure the protocol is established before orchard operations commence and implemented throughout the operational phase. Fauna Specialist: Provide advice on the identification of sensitive habitat, buffer requirements and appropriate chemical restrictions. Trained Operators: Comply with the protocol during chemical application.	Review the rodenticide management protocol, farm operational maps, chemical application records and wildlife incident register. Inspect identified sensitive habitats and Aardvark burrow buffers for compliance with chemical restrictions.	Documented protocol available; sensitive habitat and chemical exclusion areas identified; application records maintained; no prohibited chemical application within designated buffers; wildlife incidents recorded and addressed.

Draft EMP

	• Maintain the specialist-recommended no-insecticide buffers around known Aardvark burrows. No insecticide application may occur within these buffers. • Clearly identify chemical exclusion areas and sensitive fauna habitat on the farm's operational maps and communicate the restrictions to personnel responsible for pest control. • Prohibit the use of gin traps. • Maintain records of rodenticide and insecticide applications, including the product used, application location and date. • Record suspected wildlife poisoning or chemical-			

Draft EMP

	related mortality and implement the fauna specialist's incident-reporting recommendations (See Appendix E1).			
Retained vegetation and alien plants	• Protect retained near-natural vegetation and riparian corridors against orchard expansion, dumping and vehicle encroachment. • Control invasive alien plants identified by the flora specialist, with follow-up treatment to prevent reinvasion. • Avoid damage to protected indigenous plants during control.	Farm Manager; ongoing	Vegetation and alien-plant inspections; control records.	No new encroachment; alien infestations actively managed.
Wildlife and incident reporting	• Conduct environmental awareness training before personnel commence work and repeat it annually,	Farm Manager and workers; ongoing.	Annual signed training register; wildlife incident and response log.	Training current; wildlife incidents documented and addressed.

Draft EMP

	maintaining signed attendance registers. • Record injured or dead wildlife and implement the specialists reporting procedure (Appendix E1), obtaining specialist or authority guidance where required. • Avoid persecution of Aardvarks, tortoises, birds of prey and other wildlife; maintain movement opportunities around farm infrastructure. • Keep SCC identification material available at the farm office, workshop and worker accommodation.			
Drainage and erosion	• Inspect drainage-line buffers, riparian margins and orchard areas for erosion, sediment	Farm Manager; ongoing and after significant rainfall.	Visual inspections, maintenance and waste records.	Buffers functioning; no unmanaged erosion or waste.

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	transport, waste and chemical contamination. • Repair erosion promptly; manage pruning material through suitable reuse or disposal without dumping in natural vegetation or watercourses.			
Waste and hazardous substances management.	• Provide suitable, clearly identified receptacles for general waste and separate hazardous waste from general farm waste. • Store agricultural chemicals, fuel, lubricants and other hazardous substances securely in designated areas away from drainage lines, the Orange River riparian corridor and other no-go areas.	Farm Manager, chemical storekeeper and machinery operators; throughout the operational phase.	Inspect chemical storage, maintenance and waste-storage areas; review spill records and available waste-disposal documentation.	Waste appropriately contained and removed; hazardous substances securely stored; no uncontrolled leaks, dumping or burning; spill and disposal records maintained.

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	• Keep chemical containers closed when not in use and manage chemical residues, rinsate and empty containers in accordance with the applicable product instructions and disposal requirements. Do not reuse empty chemical containers for water, food or other domestic purposes. • Undertake routine vehicle and machinery servicing in designated areas where leaks, used oil and other maintenance waste can be contained and collected. Avoid servicing or refuelling within designated watercourse buffers. • Keep suitable spill-control materials available at chemical storage, refuelling			

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	and maintenance areas. Contain and clean up spills promptly and manage contaminated materials appropriately. • Collect and dispose of general, recyclable and hazardous waste through appropriate waste-management services. Do not burn or dump waste within the orchard, retained natural vegetation or watercourse buffers. • Maintain records of significant spills, hazardous-waste disposal and corrective actions.			
Environmental compliance records	• Retain the applicable authorisations and permits, specialist survey and monitoring records, water-use and chemical-use	Applicant / Farm Manager and ECO or auditor where required; ongoing.	Periodic review of compliance file and EA audit schedule.	Traceable records and completed required audits.

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	records, environmental awareness attendance registers, wildlife incident reports, waste-disposal records and evidence of corrective action. • Undertake environmental audits at the intervals required by the EA and applicable legislation.			
Operational employment and local economic opportunities	• Prioritise suitably qualified local workers for additional permanent and seasonal employment opportunities where practicable. • Plan seasonal recruitment and transport requirements according to actual orchard operations and harvesting needs. • Provide appropriate training and skills development for orchard management, irrigation,	Applicant / Farm Manager; throughout the operational phase.	Review staffing, seasonal recruitment, training and procurement records.	Employment and training records maintained; local procurement recorded; employment and training measures implemented according to actual operational requirements.

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	chemical handling, machinery operation and harvesting, according to employees' duties. • Maintain lawful employment conditions and appropriate occupational health and safety measures. • Procure agricultural inputs and services locally where feasible and suitable capacity exists. • Maintain records of actual employment, training and local procurement associated with the proposed expansion.			
Environmental inspections, non-compliance and corrective action	• Appoint the Farm Manager or another designated representative to oversee day-to-day implementation of the EMP and maintain	Applicant: Overall compliance responsibility. Farm Manager / Designated Environmental Representative: Routine inspections, records and	Review inspection checklists, the compliance register, incident reports, corrective-action records and applicable audit reports. Verify closure of identified non-	Inspections documented; non-compliances assigned and addressed; corrective actions verified and closed; required audits completed and findings addressed.

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	the environmental compliance register. • Undertake and document routine inspections of the applicable EMP requirements, including the approved footprint and no-go areas, watercourse buffers, chemical storage and application, waste management, erosion controls and specialist-recommended fauna and flora measures. • Record identified non-compliances and environmental incidents, including the location, nature of the issue, corrective action required, responsible person and target completion date. • Implement corrective measures appropriate to	corrective-action follow-up throughout establishment and operation. ECO or independent auditor: Inspections or audits where required by the EA or EMP.	compliances through follow-up inspection or supporting evidence.	

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	the nature and severity of the non-compliance. Where an activity presents an immediate risk of environmental harm, suspend the affected activity until appropriate controls are in place. • Verify that corrective measures have been completed and are effective before closing the non-compliance record. • Retain inspection records, photographs where relevant, incident reports, corrective-action records and evidence of closure. • Undertake independent environmental audits where required by the EA or applicable legislation and implement any corrective			

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	measures arising from the audit findings.			

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Walmer
6070

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www.dsafrica.co.za natalie@dsafrica.co.za

DECOMMISSIONING PHASE

Should the activity be authorized, this is a permanent change from partial grazing and crop production to pecan nut tree orchard. Should the activity be authorized, it is highly unlikely that the proposed development will be decommissioned. However, should crop production cease, the site will be used for pasture.

Therefore a decommissioning Phase for the EMP is not included in this management plan, since an EMP is a living document and would need to be amended and adopted as the years' progress. This is normally the function of an Environmental Audit, which should take place once every 5 years, at least.

Also, it is most likely that environmental laws and local municipal laws would be amended and requirements might change over the years. Due to the uncertainty of the laws few years from now, it is proposed that if the result is the removal of the pecan nut trees and termination of the orchard, then a closure plan be submitted and approved by the relevant authority/ties before closure commence. Therefore at this stage, the decommissioning phase will not be discussed.

If for whatever reason the crops fails, the Applicant is responsible for the rehabilitation of the site back to a functional grazing unit and the necessary authorization must be obtained and the correct decommissioning protocol must be followed. The relevant State Departments (e.g. the DAEARDLR, (if applicable at the time of decommissioning) and an environmental consultant should be consulted before decommissioning.

Following the decommissioning of the site, the site should be rehabilitated back to a predetermined state, e.g. sufficient for grazing. A qualified botanical specialist should be contacted for more information on rehabilitation techniques.

MONITORING, REPORTING & AUDITING

A monitoring programme must be implemented to ensure compliance with the requirements of this EMPr, the Environmental Authorisation (EA), applicable permits and the relevant specialist recommendations. Monitoring must identify environmental impacts, non-compliances and management issues arising during the establishment and operation of the proposed agricultural development and ensure that appropriate corrective measures are implemented.

The Applicant remains responsible for ensuring compliance with the EMPr and EA. Environmental monitoring may be undertaken by the Farm Manager or an appointed Site Representative, with oversight by an Environmental Control Officer (ECO), where required by the EA.

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ESTABLISHMENT PHASE MONITORING

Environmental monitoring must be undertaken throughout vegetation clearing, soil preparation, irrigation infrastructure installation and orchard establishment. The frequency of formal ECO monitoring must comply with the requirements of the EA, while the Farm Manager must undertake routine inspections appropriate to the activities being carried out.

Monitoring must focus on the following:

- Compliance with the approved development footprint, including the protection of retained natural vegetation, the Orange River riparian corridor, drainage lines and designated no-go areas.
- Implementation of the flora specialist's recommendations, including protected plant identification, avoidance, permitting and relocation, where applicable.
- Implementation of the fauna specialist's recommendations, including pre-clearance surveys, protection of identified burrows and nesting sites, and measures to prevent injury or mortality of species of conservation concern.
- Compliance with the soil specialist's recommendations and the implementation of appropriate soil preparation, drainage and erosion-control measures.
- Prevention of pollution, uncontrolled runoff, sedimentation and disturbance of retained vegetation.
- Appropriate management of machinery, fuels, hazardous substances, waste and temporary work areas.
- Compliance with the heritage specialist's recommendations and implementation of the chance-finds procedure, where necessary.
- Identification, reporting and correction of environmental incidents and non-compliances.

The Farm Manager must ensure that identified non-compliances are addressed timeously. Where an activity poses an immediate risk of significant environmental damage, the affected activity must be suspended until appropriate corrective measures have been implemented.

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OPERATIONAL PHASE MONITORING

Following orchard establishment, environmental monitoring must continue as part of the farm's routine agricultural management. The Applicant or Farm Manager must ensure that the operational mitigation measures prescribed in the EMPr and applicable authorisations are implemented.

Operational monitoring must include:

- Monitoring irrigation practices, water use and compliance with the applicable Water Use Licence.

- Monitoring soil salinity and sodicity and identifying signs of waterlogging, soil degradation or irrigation-related erosion.
- Inspecting irrigation infrastructure for leaks, excessive water application and uncontrolled runoff.
- Monitoring the condition of retained natural vegetation, the Orange River riparian corridor and the designated drainage-line buffers.
- Monitoring alien invasive plant establishment and implementing appropriate follow-up control.
- Ensuring that agricultural chemicals, including fertilisers, herbicides, pesticides and rodenticides, are managed in accordance with the EMPr and relevant fauna specialist recommendations.
- Monitoring identified Aardvark burrows and implementing the prescribed insecticide restrictions and wildlife protection measures.
- Recording wildlife incidents and maintaining measures to prevent the injury, trapping or poisoning of species of conservation concern.
- Monitoring erosion, sediment accumulation, waste management and potential contamination of soil and water resources.

Where monitoring identifies environmental degradation or non-compliance, appropriate corrective measures must be implemented as soon as reasonably practicable.

Formal ECO monitoring during the operational phase must be undertaken where required by the EA or the Competent Authority. Routine operational monitoring remains the responsibility of the Applicant or Farm Manager.

RECORD KEEPING

The Applicant must maintain an environmental compliance file containing the applicable authorisations, permits, specialist reports, environmental monitoring records, training registers, incident reports, complaints, non-compliance reports and evidence of corrective actions.

Records of protected plant relocation, fauna pre-clearance surveys, wildlife incidents, agricultural chemical application, water use and relevant soil monitoring must also be retained, where applicable.

These records must be made available to the Competent Authority or other relevant authorities upon request.

NON-COMPLIANCE REPORTS

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All personnel involved in the establishment and operation of the development must report environmental non-compliances to the Farm Manager, Site Representative or ECO, as applicable.

A non-compliance report must be compiled for any contravention of the EMPr, EA or applicable permits. The report must identify the nature, location, cause and environmental consequences of the non-compliance, together with the corrective measures required and the person responsible for their implementation.

Non-compliances may include unauthorised vegetation clearing, disturbance of protected plants or fauna, encroachment into designated no-go areas, pollution incidents, failure to implement specialist mitigation measures or non-compliance with water-use requirements.

The Farm Manager must ensure that corrective measures are implemented within an appropriate timeframe, having regard to the nature and severity of the non-compliance. The ECO or appointed Site Representative must verify the effectiveness of the corrective measures, where applicable.

The non-compliance report must be updated to record the corrective actions undertaken and may only be closed once the non-compliance has been adequately addressed.

Where the EA or applicable legislation requires notification of the Competent Authority, the Applicant must ensure that the relevant reporting requirements and timeframes are complied with.

INCIDENT REPORTS

All environmental incidents occurring during the establishment and operational phases must be reported to the Farm Manager and, where appointed, the ECO or Site Representative.

Environmental incidents may include fuel or chemical spills, uncontrolled fires, pollution of water resources, unauthorised vegetation clearing, damage to protected plants, wildlife mortality or significant erosion and sedimentation.

Where an incident constitutes an emergency incident as contemplated in Section 30 of the National Environmental Management Act (NEMA), the responsible person must implement the applicable emergency response and statutory notification and reporting requirements.

The following information must be recorded for each incident:

- The date, time, location and nature of the incident.
- The cause of the incident, where known, and the environmental resources affected.

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- The substances involved and estimated quantities released, where applicable.
- The immediate measures implemented to contain the incident and minimise environmental damage.
- The corrective and rehabilitation measures undertaken.
- Measures implemented to prevent recurrence.
- Photographic evidence and correspondence with the relevant authorities, where applicable.

The Farm Manager must maintain an incident register and ensure that incidents are investigated and corrective measures implemented. Where required by applicable legislation or the EA, incidents must be reported to the relevant authorities within the prescribed timeframes.

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Example of Incident Register:

Date	Incident - *describe what incident and possible explanation and possible reasons, including photo record. Assign a reference no. for incident.*	Action Taken – *provide details and proof of action e.g. documents, photos, etc.*	Signature

Example of Accident Register:

Date	Names of persons involved	Accident - *describe what accident, injuries, and possible explanation and possible reasons, including photo record. Assign a reference no. for accident.*	Action Taken – *provide details and proof of action e.g. documents.*	Signature

Example of Complaint Register:

Date	Names of persons involved	Accident - *describe what complaint was received and reasons, including photo record if possible.*	Action Taken – *provide details and proof of action taken to resolve the complaint e.g. documents.*	Signature

MONITORING REPORTS

During the establishment phase, the ECO or appointed Site Representative must compile environmental monitoring reports at the frequency stipulated in the EA. The Farm Manager must maintain routine monitoring records and provide the ECO with relevant information regarding activities undertaken and environmental compliance.

Monitoring reports must record the following:

- Activities undertaken during the reporting period and compliance with the approved development footprint.
- Implementation of the applicable specialist recommendations, including protected plant management, fauna protection and soil conservation.
- The condition of retained natural vegetation, riparian areas, drainage-line buffers and designated no-go areas.
- Environmental incidents, complaints and non-compliances identified.
- Corrective measures required, the responsible persons and the status of implementation.
- Photographic evidence and relevant environmental monitoring records.

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The Contractor or Farm Manager must retain waste disposal records and manifests, where applicable, to demonstrate that waste has been appropriately managed and disposed of.

Following completion of the establishment phase, routine operational monitoring must become the responsibility of the Applicant or Farm Manager. Operational monitoring must focus particularly on irrigation management, soil salinity and sodicity, erosion, watercourse protection, retained vegetation, alien invasive plants and the implementation of the fauna specialist's recommendations.

Monitoring records must be retained and made available to the Competent Authority upon request. Formal monitoring reports must be submitted to the Department where required by the EA.

AUDIT REPORTS

The Applicant must ensure that environmental audits are undertaken in accordance with the requirements and timeframes stipulated in the EA and Regulation 34 of the NEMA EIA Regulations, 2014, as amended.

Where required, environmental audits must be undertaken by an independent person with the appropriate environmental auditing expertise. The audit must assess compliance with the EA and EMPr and evaluate the effectiveness of the environmental management measures implemented.

Auditing must specifically consider the following, where applicable:

- Compliance with the approved development footprint and protection of designated no-go areas.
- Implementation of the flora and fauna specialist recommendations, including protected species management, pre-clearance surveys and wildlife protection measures.
- Protection of the Orange River riparian corridor and drainage-line buffers.
- Soil conservation, erosion prevention and irrigation-related environmental management.
- Compliance with applicable water-use authorisations.
- Waste management, pollution prevention and management of agricultural chemicals.
- Implementation of environmental awareness training and maintenance of compliance records.
- Environmental incidents, non-compliances and the effectiveness of corrective measures.

The audit report must identify any non-compliances, assess the effectiveness of the EMPr and recommend corrective measures or amendments where necessary.

Audit reports must be submitted to the Competent Authority within the timeframes prescribed in the EA and applicable regulations.

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FINAL AUDIT REPORT

Following completion of the establishment phase, including vegetation clearing, soil preparation, irrigation infrastructure installation and initial orchard establishment, a final establishment-phase environmental audit must be undertaken where required by the EA.

The audit must assess compliance with the EA and EMPr, including implementation of the applicable specialist recommendations, protection of retained natural vegetation and watercourse buffers, management of protected species, soil conservation and rehabilitation of temporary disturbance areas.

The audit report must identify any outstanding non-compliances or rehabilitation requirements and specify the corrective measures necessary to achieve compliance.

The final establishment-phase audit does not relieve the Applicant of the obligation to implement the operational management and monitoring requirements of the EMPr.

The report must be submitted to the Competent Authority within the timeframe stipulated in the EA and applicable regulations.

ENVIRONMENTAL TRAINING

The goal of an environmental training or environmental awareness plan is to prescribe how the Applicant intends to inform all of his employees of all the possible environmental risks resulting from their particular line/function of work within the structures of the organization. This plan will also prescribe how the identified risks will be dealt with to avoid pollution and environmental degradation.

All personnel associated with the project must understand the purpose and benefits of the EMP.

The appropriate training must occur as part of an induction program and should include:

ENVIRONMENTAL MANAGEMENT INTRODUCTION TO ALL PERSONNEL:

General environmental information session/s to ensure that employees at each relevant function and level receive environmental information and are aware of the environmental management objectives.

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It is also the responsibility of the Applicant or the ECO (if one is appointed) or the Farm Manager to conduct basic training with less literate employees describing the listed environmental impacts and the mitigation measures to be followed more practically. The Applicant may choose to employ an independent consultant (ECO) to conduct such training. Such training is best done in the employee's home language, onsite as it is more useful and visual. As a minimum the Basic Environmental Awareness Plan must address the following:

- The need for training
- General discussion on what is the environment
- Why must the environment be protected
- Types of environmental impacts
- Mitigation measures and Basic Rules to comply with
- Fines and Penalties
- Questions and Answers

JOB-SPECIFIC TRAINING

Employees whose function of work can cause significant environmental impacts must be trained, educated, and afforded the experience to ensure that their tasks are performed to the best of their ability to minimize environmental degradation on the site, with specific reference to the receiving environment.

The spinoff of Environmental training will produce a group of people being equipped and enriched with the knowledge to implement the main principles that were taught to them, outside of the workplace as well. It will enable them to put into practice their knowledge at home or other workplaces, should they one day leave the site.

The Applicant/ECO is responsible to provide training annually (or more regularly if the need should arise) to employees on:

- The importance of compliance with the objectives of the EMP and procedures to achieve the objectives of the EMP.
- Identifying the significant environmental impacts: actual or potential impacts and how employees' activities might influence the impacts.
- Benefits for improved personal performance with regards to environmental awareness.
- Their roles and responsibilities in achieving compliance with the objectives of the EMP and procedures to achieve the objectives of the EMP, including emergency preparedness and response requirements.
- The potential consequences of departure from specified operating procedures.

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In terms of job-specific training, the Applicant, Farm Manager, or ECO, and Contractor must identify relevant personnel and training courses for employees performing tasks, which can cause significant environmental impacts. They must become competent based on appropriate education, training, and/or experience.

Comprehension training must include:

- Emergency preparedness and response, including an incident report.
- Soil stability and erosion control.
- Drainage management.
- Water conservation and water quality protection.
- Fire evacuations and risk control.
- Pesticide application.
- Poaching.
- Faunal incidences – prevention of disturbance to fauna, reporting any faunal mortalities.
- Alien vegetation identification and control.
- Waste management.
- Ability to recognize archaeological and palaeontological artefacts.
- Incentives and rewards for good environmental practice.

This list is not intended to be exclusive or exhaustive.

After training needs have been identified, it is the responsibility of the Applicant and ECO to ensure that employees attend the relevant identified training and attendance must be documented. The Applicant must decide on the appropriate time to conduct environmental training.

As an incentive to motivate employees, progress in compliance with the training programme can be recorded and evaluated to nominate and elect the best candidate who has improved personal performance with regard to environmental awareness. Such an employee may be rewarded at the discretion of the Applicant. This can be done through the following method:

- By Management through task observation;
- During internal and external audits, when the effectiveness of the EMP is evaluated;
- Own initiatives that are taken by employees to improve the environment.

The Environmental Awareness Plan must apply to the specific task and the level of understanding of the employee. Open communication between the employees and the Farm Manager, or ECO, the Contractor, and Applicant must be established and in the event of an environmental emergency, the Applicant, Farm Manager, and ECO must have process steps in place to ensure that the situation is contained and the correct procedure is followed to ensure that pollution and degradation do not occur.

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Mitigation measures listed in this document must be used as a guideline to conduct such training and to establish the rules for operation. After such training, each employee may receive a certificate for completing the training. The Applicant, Farm Manager, or ECO may also have a checklist available onsite to ensure that employees are constantly aware of the mitigation measures.

DESCRIPTIONS OF SOLUTIONS TO RISKS

The following risks have been identified:

- Soil management and stability and erosion after heavy rains.
- Unauthorized clearing of natural vegetation.
- Correct irrigation to protect the water resource.
- Alien vegetation infestation.
- Waste management.
- Dust control.
- Pesticide control.
- Safety and security management.

The following procedures must be brought to the attention of all staff and suitable material/equipment provided to deal with them.

SOIL STABILITY AND EROSION DURING HEAVY RAINS

- Assess the site and downstream area of drainage and inform the responsible person (s) accordingly.
- Assess the potential hazard and inform the responsible person(s) accordingly.
- Ensure that the soil structure is functional and does not result in being washed away after heavy rains; inform the responsible person (s) accordingly.
- Ensure that erosion rills are not left to deteriorate but removed/filled in and seeded as soon as possible.

UNAUTHORIZED CLEARING OF NATURAL VEGETATION

- Stop the operator of heavy equipment immediately carrying on with such activity and request him to vacate the site.
- Determine if any plants can be saved and place them in the soil and water.
- Assess the potential hazard and inform the responsible person(s) accordingly.

CORRECT IRRIGATION TO PROTECT THE WATER RESOURCE.

- Consult the Soil Scientist regularly regarding irrigation scheduling.

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- Assess the site after irrigation for signs of soil degradation.
- Assess the orchard after irrigation for signs of over or under irrigation.
- Log and register meter readings of water abstracted and used for irrigation.

ALIEN VEGETATION INFESTATION

- Assess the level/scope of degradation caused by infestation and inform the responsible person(s) accordingly.
- Identify the alien plants establishing and the best method to remove such plants.
- Ensure that procedures are handled as prescribed in the EMP.
- Ensure that the areas cleared from alien vegetation be re-established with plant species natural to this area.

WASTE MANAGEMENT

- Minimize environmental impacts associated with waste.
- Apply waste management principles of preventing, minimize, recycle, or re-use, with disposal as the last option.
- No littering on the site.
- Maintain a clean and tidy site.

DUST CONTROL

- Ensure that appropriate dust suppression measures or temporary stabilizing mechanisms are used when dust generation is unavoidable (e.g. dampening with water, chemical soil binders, etc.), particularly during prolonged periods of dry weather.
- Identify when dust suppression has to be undertaken.
- Ensure that speed limits are strictly adhered to.

PESTICIDE CONTROL

- Assess protective clothing and equipment before handling or applying pesticides to ensure there is no tears/lack/faulty clothing or equipment.
- Ensure exposure time is reduced to what is necessary, to reduce the risk of poisoning.
- Ensure correct pesticides are used and instructions according to the labels are followed.
- Ensure an emergency kit is available at the site and contact details of health professionals are known to workers.
- If animals are found dead at the site, try to establish if it is due to pesticide poisoning.
- Inform abutting neighbours of the time and date of pesticide application and monitor crops.

SAFETY & SECURITY MANAGEMENT

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- Ensure that construction workers and farmworkers are managed and informed of the consequences if trespassing occurs.
- Ensure suitable management of the labour force to prevent security-related issues.
- All requirements according to the OHS Act be followed and implemented.

ENVIRONMENTAL AWARENESS TRAINING

The following environmental training and training on dealing with emergencies and remediation measures for such emergencies:

ENVIRONMENTAL TRAINING

1. The Applicant, Farm Manager or ECO will have one-on-one information sessions with employees working in specific sections of the site.
2. Once a semester all employees should participate in a walkthrough of the specific site area and be requested to highlight unattended environmental impacts to increase their assessment ability and focus on potential impacts in the entire area.
3. Unattended impacts identified will be discussed and employees will be requested to provide solutions to such impacts. These solutions will be discussed and corrected if not in line with general environmental policies.
4. Employees should attend a 6 monthly or annual meeting to discuss any environmental aspect of concern and mechanisms to avoid such scenarios.
5. Employees will attend one course/seminar/presentation on environmental awareness.

TRAINING ON DEALING WITH EMERGENCIES AND REMEDIATION MEASURES FOR SUCH EMERGENCIES

- An emergency protocol will be established and documented and will deal specifically with the line of authority and responsibility and contact details of dedicated persons, including that of the landowner/abutting landowner.
- Potential emergencies will be determined and documented for each section of the site and will be discussed with individuals/groups. Emergencies identified at the site are erosion after heavy precipitation, unauthorized clearing of land, degradation of soil, pesticide poisoning, and alien vegetation infestation.
- Remediation measures, provisional and/or permanent, which are aligned with the conditions of the EMP will be documented for identified emergencies and will be discussed with employees. Each employee will be provided with a short manual on how to deal with identified emergencies.
- The Applicant or Farm Manager will provide an information session on dealing with emergencies and remediation of such emergencies once every two or five years by a recognized environmental practitioner (ECO).

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- Employees will be informed on suitable material/equipment available to deal with emergencies and the functions of this material/equipment.

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ANNEXURE 1: POSSIBLE DECLARATION OF CONTRACTOR

I, _____, declare that:

- I/we have read and understood the content of the Environmental Management Plan and the relevant associated documents from specialists for clearing of vegetation to establish an orchard on the Remainder of Farm Tweefontein 373 and Portion 4 of Farm Kalkfontein 374, near Prieska in the Northern Cape, of which Temdale Eiendomme (Pty) Ltd is the Applicant.
- I/we declare that I/we understand the responsibilities in terms of my/our role and responsibilities towards good environmental management practice.
- I/we declare that I/we understand the responsibilities in terms of my/our role and responsibilities towards good health and safety practice.
- I/we declare that I/we understand my/our role in terms of enforcing and implementing the requirements of the mitigation measures set out in the Environmental Management Plan.
- I/we declare that I/we understand my/our role in terms of honouring and enforcing the requirements set out in the Environmental Management Plan.
- I/we will comply with all applicable legislation.
- I/we have the expertise to perform the work as contracted.
- I/we will ensure that information containing my/our contract work is made available to the Applicant and ECO/SR for their information with a reasonable opportunity to act on the situation.
- I/we will provide the competent authority with access to all information at my/our disposal regarding the contract work, whether such information is favorable to the Applicant or not.

_____ _____

Signature of the contractor Name of company

_____ _____

Date Witness signature

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Draft EIA

BioBase Environmental Pty Ltd

Reg. No: K2024104397

ANIMAL SPECIES SPECIALIST ASSESSMENT REPORT:

Farm Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374) for Temdale Boerdery (Pty Ltd), Siyathemba Local Municipality, Pixley ka Seme District Municipality

Commissioned by Digital Soils Africa

Compiled by:

HJB Butler (PhD, Zoology)

E. Netherlands (PhD, Biology)

BioBase Environmental (Pty) Ltd

14 Eddie de Beer Street

Dan Pienaar

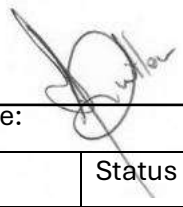
Bloemfontein

9301

DECLARATION OF SPECIALIST INDEPENDENCE

We, Dr Hennie JB Butler and Prof. Edward Netherlands hereby declare that:

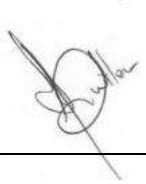
- we are acting as independent specialists regarding this application;
- we do not have any interest, hidden or otherwise, in the outcome of this application, apart from financial compensation for the work done to survey the proposed development area and compile this report;
- surveying the site for this faunal compliance statement was done objectively, and that this report and the facts therein contained (regardless of its impact on the application approval process) will not be affected by any outside factors;
- we have the required expertise to perform surveys and produce compliance statements as it pertains to the faunal aspect of this proposed development;
- we will comply with the relevant Acts, regulations and legislation;
- we have not, and will not, engage in conflicting interests while performing our duties for this activity, and have no influence over the decision-making authorities regarding their accepting or rejecting of this proposed development;
- we undertake to disclose to the applicant and competent authority all material and information within my possession that may influence the decision-making process regarding the proposed development;
- all particulars furnished by us in this form are true and correct, and that it is an offense to present a false declaration, and that such a false declaration is punishable in terms of Section 24F of the Act; and that
- this document is to be viewed as a whole and not misquoted out of context.



Date:

09 June 2026

Date:

Date	Status	Prepared by	Checked and approved by
09 June 2026	Approved for submission	Dr HJB Butler 	Prof. E Netherlands (SACNASP Registration Nr. 126419)

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DETAILS OF THE SPECIALISTS

Both specialists that compiled this document have experience in faunal species identification, and the identification of suitable habitats for terrestrial animals including birds, mammals, reptiles and frogs. Their details are in the table below.

Table 1. *The details and experience of the specialists involved with this report.*

Specialist and contact details	**Qualifications**	**SACNASP Registration**	**Experience**
Dr Hennie JB Butler **E mail:** hennie.butler@gmail.com **Mobile**: 0827718101	PhD (Zoology) UFS	Not registered	25 Years' experience in faunal ecology and behaviour in both the private and tertiary education sector. Current position: Lecturer in the Department Zoology & Entomology, University of the Free State
Prof. Edward C Netherlands **E mail:** ec.netherlands@gmail.com **Mobile**: 0791922833	PhD (Biology) KU Leuven & NWU	126419	More than 10 years' experience in reptiles and amphibians in both the private and tertiary education sector. Current position: Associate professor in the Department Zoology & Entomology, University of the Free State

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1. INTRODUCTION

BioBase Environmental was appointed by Digital Soils Africa to provide Terrestrial Animal Specialist inputs for the proposed establishment of pecan nut orchards under irrigation close to the town Prieska on the farms Tweefontein and Kalkfontein (Siyathemba Local Municipality) in the Pixley ka Seme District Municipality. These orchards will be planted on already existing centre-pivot irrigation systems (approximately 95 hectares) with the expansion of an additional 46 hectares of the infill areas between and around the existing pivot systems. Existing centre-pivot irrigation systems on the farm were installed before 2006 when environmental authorisation was not needed for the removal of vegetation in order to produce agricultural crops. Natural vegetation of large parts of the infill areas is altered and the most northern section of Kalkfontein covers old crop production fields.

1.1 Site location

The study sites are located on the farms Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374) are located the north-east of Prieska, in the corridor between the R386 road leading to Niekerkshoop and the R357 road leading to Douglas, along the riparian zone of the Orange River (Fig. 1). According to Mucina and Rutherford (2006), the majority the study area falls within the Upper Gariep Alluvial Vegetation (Aza 4) while a small portion of the most northern part of Kalkfontein falls in the Northern Upper Karoo Vegetation (Nku3) (Fig. 2).

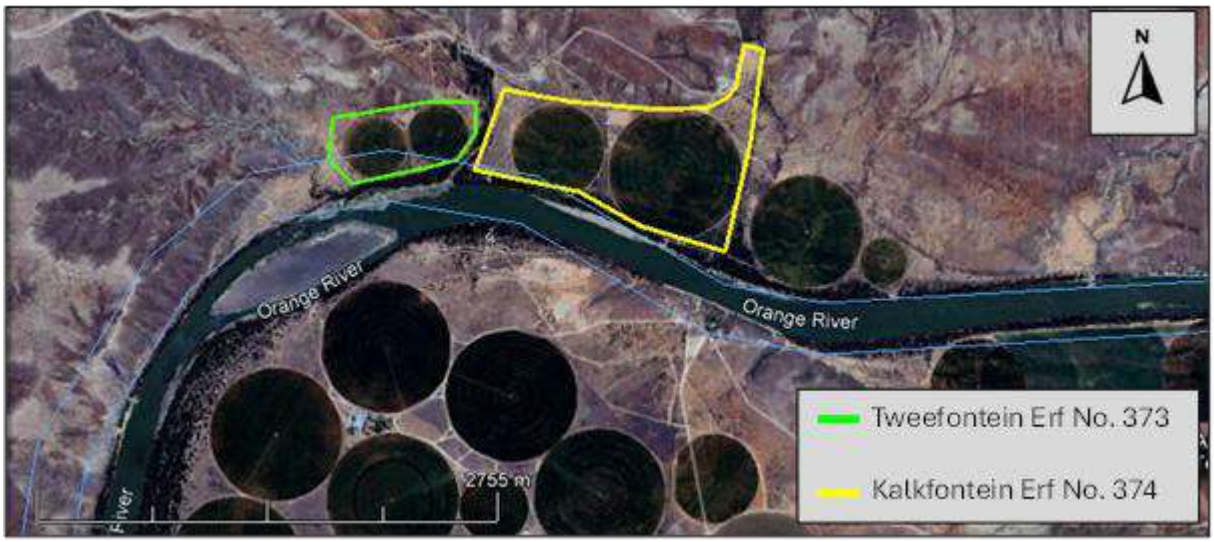

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***Figure 2**. Locality of the study area within the Upper Gariep Alluvial Vegetation and Northern Upper Karoo Vegetation according to Mucina & Rutherford (2006).*

1.2 Development Layout

According to the DFFE Screening Tool, the study area is located on the farms Tweefontein and Kalkfontein as listed in Table 2.

***Table 2**. Cadastral details of Tweefontein and Kalkfontein in the Prieska district (Northern Cape Province, South Africa) according to the DFFE screening tool.*

No	Farm Name	Farm/Erf No	Portion	Latitude	Longitude	Property Type
1	TWEEFONTEIN	373	0	29°25'17.23S	22°58'28.98E	Farm
2	KALKFONTEIN	374	0	29°23'15.68S	22°58'1.24E	Farm
3	TWEEFONTEIN	373	0	29°24'47.14S	23°0'5.98E	Farm Portion
4	TWEEFONTEIN	373	0	29°25'18.15S	22°58'28.04E	Farm Portion
5	KALKFONTEIN	374	4	29°24'28.3S	23°2'16.55E	Farm Portion

2 TERMS OF REFERENCE

The objective of this report is to provide ecological information regarding the terrestrial fauna that may be present in the study area on the farms near Prieska in the Northern Cape Province, South Africa (hereafter referred to as the study area). As per the "Protocols for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes" (hereafter called "the Protocols"), as promulgated in Government Gazette Notice 320 (Government Gazette 43110, 20 March 2020), and amended in Government Gazette Notice 3717 (Government Gazette 49028, 28 July 2023), the Protocols must be adhered to for all new applications for Environmental Authorisation.

As per the Protocols, the objectives of this study were to:

a) identify the SCC which were found, observed or are likely to occur within the study area;

b) provide evidence (photographs or sound recordings) of each SCC found or observed within the study area;

c) identify the distribution, location, viability and provide a detailed description of the population size of the SCC identified within the study area;

d) identify the nature and extent of the potential impact of the development on the population of the SCC located within the study area;

e) determine the importance of the conservation of the population of the SCC identified within the study area, based on the information available in national and international databases;

f) determine the potential impact of the proposed development on the habitat of the SCC located within the study area;

g) include a literature review of the SCC population sizes, the conservation interventions, and any national or provincial management plans for the SCC. This should also indicate whether the development is compliant with the applicable species management plans;

h) identify dynamic ecological processes (e.g. fire in fire-prone ecosystems) occurring within the broader landscape that might be disrupted by the development and result in negative impacts on the identified SCC;

i) identify any potential impact of ecological connectivity in relation to the broader landscape, resulting in impacts on the identified SCC and its long-term viability;

j) determine buffer distances as per the Species Environmental Assessment Guidelines used for the population of each SCC;

k) discuss the presence (or likely occurrence) of additional SCC not identified by the screening tool, as well as undescribed species, or roosting and breeding and foraging areas used by migratory species (where these species show significant congregations) occurring in the vicinity; and

l) identify any alternative development footprints within the preferred site that would be of “low” or “medium” sensitivity as identified by the screening tool and verified through site sensitivity verification.

m) A signed copy of the assessment must be appended to the Basic Assessment Report or Environmental Impact Assessment Report.

2.1 Screening Tool

Based on the screening tool (performed on 02 February 2026) of The Department of Forestry, Fisheries and the Environment (DFFE), the study sites were identified as having a **Medium sensitivity** for Tweefontein (Erf No. 373) and a **High sensitivity** for Kalkfontein (Erf No. 374) in terms of the animal species theme (Fig. 3). This is due to the possible occurrence of three species of conservation concern (SCC). These SCC (and their associated sensitivities) are listed in Table 3. It must be pointed out that the DFFE Screening tool listed the Ludwig’s Bustard as both **High** and **Medium** for Kalkfontein Erf No.374.

Table 3. *Species of Conservation Concern (SCC) as listed by the DFFE Screening Tool.*

Class	Common name	Genus & species	Sensitivity	
			Tweefontein	**Kalkfontein**
Aves	Tawny Eagle	*Aquila rapax*	Medium	Medium
	Ludwig’s Bustard	*Neotis ludwigii*	Medium	High / Medium
	Caspian Tern	*Hydroprogne caspia*	-	Medium

***Figure 3**. Sensitivity map for relative animal species theme on the farm of (A) Tweefontein (Erf No. 373) and (B) Kalkfontein (Erf No. 374) according to the DFFE screening tool.*

3 ASSESSMENT OF STUDY AREA

The findings of this report are based on:

1) a desktop study to determine the potential presence of the SCC identified by the DFFE screening tool report and any SCC not identified in the report at the study site; and

2) a site visit to the study area to determine the presence of, and habitat suitability for the SCC highlighted by the DFFE screening tool report, and any SCC not flagged by the screening tool report.

3.1 Methodology

3.1.1 Desktop assessment

A desktop study was undertaken to confirm and/or identify any species of conservation concern (SCC) near the study area. Information of such SCC was extracted from the Global Biodiversity Information Framework (GBIF) and iNaturalist. Bird species recorded in the pentad 2920_2300 as well as 2925_2300, where the study area is located, was obtained from the Southern African Bird Atlas Project 2 (SABAP2) and BirdLife International (The IUCN Red List of Threatened Species 2025). Possible mammal species and the conservation status thereof was obtained from the EWT Regional Mammal Red List (2025). The conservation status of Reptiles was obtained from the Conservation status of the reptiles of South Africa, Eswatini and Lesotho, Suricata 10 (Tolley et al. 2023). The conservation status of frog species was listed according to the assessment of SANBI as well as the South African Frog Re-Assessment Group (SA-FRoG).

3.1.2 Field assessment

A field assessment of both study sites was done on 3 February 2026. On the day, temperatures were hot without any clouds in the sky. The visibility for observations of terrestrial vertebrates was good on both study sites. During the site visits, a walk through the study sites was done. Any live vertebrate observed, sounds of animals, signs including tracks, burrows and even nests of birds were logged onto Fulcrum, a field all-in-one data collection platform to collect accurate, real-time data on mobile devices. Transects that were walked in both study sites as well as the localities of observed vertebrate species are shown in Figure 4. Data recorded on Fulcrum was downloaded and captured in an Excel spreadsheet. Farm animals were not included in the data sheet. In addition to the walk throughs, road kills of vertebrates that were encountered on the R357 road between Douglas and Prieska was also documented. Only road kills that were observed 30 km from the study area in both directions were considered.

Figure 4. *Transects walked (yellow line) on the farms Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374) during the site assessment.*

3.2 Assumptions and Limitations

Although public platforms like GBIF, iNaturalist and even SABAP2 can be regarded as reliable platforms of species distribution, these platforms include sightings of vagrant or passing animals upon which an assessment cannot reasonably be based. For example, Kalkfontein (Erf No. 374) falls between two adjacent pentads (2920_2300 and 2925_2300). However, the recorded bird species for these two pentads differ in composition with only 44 bird species that were recorded in pentad 2920_2300 while 79 bird species were recorded in pentad 2925_2300 by SABAP2. Expert interpretation is therefore applied to the full list of SCC identified by the various public platforms and some species are then excluded from further assessment due to the project area clearly lacking suitable habitat or the species clearly representing a vagrant or transient animal outside its normal range. Another limitation to the study is the outdated evaluation of some species. The SCC assessed in this report therefore represent those which may reasonably occur on site. However, some animal species are elusive and difficult to detect even with modern technology while other species have large Areas Of Occupancy (AOO), home ranges or are seasonal migrants and do not occupy such areas constantly. Although active field sampling was done on foot at both Tweefontein and Kalkfontein, and additional data from nine days of camera trapping at a site less than 12 km away from the study area, there is always the possibility that some SCC are overlooked in this process.

3.3 Results

3.3.1 Class Aves

A combined list of bird species that might occur as listed by GBIF, iNaturalist and SABAP2 for pentad 2920_2300 and 2925_2300, as well as the Regional Red Data Book Assessment of each species and species that were observed during the field survey is summarised in Appendix 1, Table A1. Of the 89 bird species that might occur in the study area, a total of only 39 species, 13 at Tweefontein (Erf No. 373) and 26 at Kalkfontein (Erf No. 374), were observed. Eleven bird species were observed at both study sites (Table A1).

None of the three SCC bird species that were listed by the DFFE screening tool, was observed during the assessment of the study area. However, the presence of two bird species of conservation concern was confirmed to be present in the study area. The Lanner Falcon and the Kori Bustard (both listed as **Near Threatened**) was observed during another field assessment in the same area. No photographic record of the Lanner Falcon could be obtained as the bird was viewed from a distance with the aid of binoculars. In addition, a Kori Bustard was observed during another field assessment in the same area and was also captured on one deployed camera trap in the area (Fig. 6) close to the study sites. The record of this species was reported on the iNaturalist website (https://www.inaturalist.org/observations/351691276). In addition, a neighbouring farmer (Mr David Muller) did confirm a recent siting of Verreaux's Eagle, listed as **Vulnerable**, in the area (pers.comm). The regional Red List status, habitat requirements as well as breeding and feeding behaviour of the six identified bird SCC (three from the screening tool plus four additional species) is summarised in Table 4. The Regional Red list status of SCC of the class Aves that occurred or might likely occur in the study area, suitability of habitat, likelihood of occurrence as well as reasons for occurrence are listed in Table 5. The habitat of the study area is suitable for all the identified species except for the Caspian Tern (Table 5). No Critically Endangered species were recorded in this pentad.

Figure 5. *A Kori Bustard (Ardeotis kori) captured on a camera trap in natural veld on the farm Muis Hoek close to the study sites. (https://www.inaturalist.org/observations/351691276)*

The status of the six SCC that were identified and as listed by SANBI, BirdLife South Africa (2025), IUCN, TOPS (Threatened or Protected Species under NEMBA Act 10 of 2004 (GN R151 of 2008, as amended 2023), CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) as well as their migratory status are listed in Table 6. Only three species, the Verreaux's Eagle, Lanner Falcon and Kori Bustard are listed under Appendix II (international trade regulated by permit) of CITES. All six species are resident to the area (Table 6).

***Table 4**. The regional Red List status, habitat requirements as well as breeding and feeding behaviour of SCC of the class Aves in the study area.*

***EN,** Endangered; **VU,** Vulnerable; **NT,** Near Threatened.*

Species	Regional Red list status	Habitat	Breeding	Feeding
Tawny Eagle (*Aquila rapax)*	**EN**	Occupies open and semi-open habitats including woodland savanna, grassland, bushveld, and arid shrubland. Avoids dense forest and heavily transformed agricultural land. In southern Africa favours the dry interior, including the Karoo and Kalahari biomes. Requires large, undisturbed tracts of natural veld with tall trees or rocky outcrops for nesting.	Monogamous and territorial; pairs maintain large home ranges year-round. Breeds from April to September in southern Africa. Constructs a large stick nest (eyrie) in the canopy of a tall tree, occasionally on a power-line pylon. Clutch size is typically 1–2 eggs; incubation lasts approximately 42–44 days. Usually only one chick survives (Cainism). The fledgling period lasts around 70–80 days.	An opportunistic, generalist predator and scavenger. Prey includes small to medium-sized mammals (hares, mongooses, ground squirrels), birds up to the size of francolins, reptiles, and carrion. Known to engage in kleptoparasitism, stealing food from other raptors and vultures. Hunts from a perch or by quartering low over open ground.
Ludwig's Bustard (*Neotis ludwigii)*	**EN**	Near-endemic to southern Africa; restricted to arid and semi-arid Karoo shrubland, Namib desert fringes, and Bushmanland. Strongly associated with flat, open gravel plains and sparse low shrubland. Avoids mountainous terrain, dense vegetation, and transformed habitats. Core distribution in the Northern Cape, Namibia, and marginally into the Western Cape and Free State.	Polygynous display system similar to other bustards. Females raise chicks alone. Nests are minimal or absent; eggs are laid directly in a shallow scrape on open ground, often in sparse vegetation. Lays 1–2 eggs. Incubation approximately 24 days. Chicks are precocial. Breeding season spans August to December. Highly sensitive to disturbance at nesting sites.	Omnivorous. Diet consists primarily of large invertebrates (beetles, locusts, termites, caterpillars) and plant material (seeds, berries, flowers). Also takes small lizards, rodents, and other vertebrates opportunistically. Forages by walking through open scrubland. Does not need free water if food moisture is adequate.

Verreaux's Eagle (*Aquila verreauxii)*	**VU**	Restricted to mountainous and rocky terrain, particularly kopjes, cliff faces, and rocky gorges with escarpments. Found from sea level to high-altitude ranges. Strongly associated with areas where Rock Hyrax (Procavia capensis) is abundant. Occurs in the Cape Fold Mountains, Drakensberg, and the arid rocky hills of the Karoo and Namaqualand.	Monogamous, with long-term pair bonds. Breeds from April to September. Nests are large stick structures (eyries) built on cliff ledges or in large trees on rocky hillsides; the same nest may be used for many years, growing very large over time. Lays 1–2 eggs (usually 2); incubation takes approximately 45 days. The second chick is almost always killed by the first (Cainism). Fledging occurs at approximately 95–99 days.	Highly specialised predator; Rock Hyrax typically comprises 90% or more of the diet. Will occasionally take other prey including small antelopes (e.g., young klipspringer), hares, dassies, birds, and monitor lizards. Hunts by fast, contour-hugging flight over rocky terrain, surprising hyrax in the open.
Caspian Tern (*Hydroprogne caspia)*	**VU**	Associated with large inland water bodies, estuaries, coastal lagoons, and large rivers. Favours open water with exposed sandbars, beaches, or rocky islets for roosting and nesting. In southern Africa found along the coast and at major inland dams and river systems. Largely non-breeding visitor to the interior, including the Northern Cape.	Colonial ground-nester on low-lying islands, sandbanks, and coastal beaches with minimal vegetation and no terrestrial predator access. Breeds in small to large colonies, sometimes mixed with other terns or skimmers. Lays 1–3 eggs in a shallow scrape. Incubation lasts approximately 26–28 days. Chicks are semi-precocial and fledge at approximately 35–45 days. Highly sensitive to disturbance at breeding colonies.	Exclusively piscivorous (fish-eating). Dives from height into open water to catch fish near the surface. Prey fish typically 10–25 cm in length. Will also steal fish from other terns and birds (kleptoparasitism). Forages over open water, often flying with bill angled downward scanning for fish.

Lanner Falcon (*Falco biarmicus*)	**NT**	Occupies open to semi-open habitats including arid and semi-arid shrubland, grassland, savanna, farmland, and rocky escarpments. Avoids dense forest. Common across the Karoo, Bushmanland, and Kalahari biomes. Often nests on cliff faces but also uses old stick nests of other large birds on pylons or tall trees. Highly adaptable to a range of arid environments.	Monogamous. Does not build its own nest; uses cliff ledges, old stick nests of other species (eagles, crows), or cavities in rock faces and buildings. Breeds from July to November. Lays 2–5 eggs; incubation lasts approximately 32–35 days. Both sexes incubate and provision chicks. Fledging occurs at approximately 35–40 days. May raise 1–2 broods per season under good conditions.	An agile aerial predator. Prey consists mainly of medium-sized birds (up to the size of doves and francolins), large insects (especially termite alates and beetles), and small mammals and lizards. Hunts by high-speed pursuit in open airspace, often cooperating in pairs to flush and catch prey. Also stoops at prey from height. Foraging activity peaks at dawn and dusk.
Kori Bustard (*Ardeotis kori)*	**NT**	Inhabits open arid and semi-arid grassland, Karoo shrubland, open savanna, and lightly wooded areas. Strongly avoids tall, dense vegetation and heavily cultivated land. Favours areas with short to medium grass cover interspersed with bare patches. Common in the Kalahari, Karoo, and dry open savanna of southern and East Africa. Requires large, unfragmented open landscapes.	Polygynous; males display at traditional lekking grounds during the breeding season (August–November). Females perform all parental duties alone. Nests are shallow scrapes in open ground, often with minimal cover. Lays 1–2 eggs; incubation approximately 23–24 days. Chicks are precocial and follow the female shortly after hatching. Juveniles remain with the female for several months.	Omnivorous and opportunistic. Diet includes insects (especially locusts, beetles, grasshoppers, and termite alates), small vertebrates (lizards, snakes, small rodents), plant matter (seeds, berries, flowers, and roots), and carrion. Takes advantage of invertebrate prey flushed by grass fires. Forages by walking slowly and deliberately through open habitat.

***Table 5**. Habitat suitability and likelihood of occurrence of Species of Conservation Concern of the class Aves that occurred or might likely occur in the study area. **EN,** Endangered; **VU,** Vulnerable; **NT,** Near Threatened.*

Species	Regional Red list status	Observed	Suitable habitat	Likelihood of occurrence	Reason
Tawny Eagle (*Aquila rapax)*	EN	No	Yes	Medium	In southern Africa, it is largely concentrated in protected areas in the north-east and central parts of the region, which is confirmed by more recent SABAP2 data. Although present in the arid areas, the species seems to have disappeared from large parts of the Northern Cape, Free State and Limpopo provinces. A small, sparsely distributed population persists in the grassy Karoo where they have capitalised on powerlines, using pylons as nest structures.
Ludwig's Bustard (*Neotis ludwigii)*	EN	No	Yes	High	Ludwig's Bustards are likely to be seen in transformed habitats with the preference of these birds to feed on pastures but they also utilise crops, stubbles or ploughed/fallow fields.
Verreaux's Eagle (*Aquila verreauxii)*	VU	Yes	Yes	Confirmed	This SCC is confirmed to be present by a neighbouring farmer.
Caspian Tern (*Hydroprogne caspia)*	VU	No	No	Low	This SCC has not been reported to be present in the area between 2007 and 2023.
Lanner Falcon (*Falco biarmicus*)	NT	Yes	Yes	Confirmed	This SCC is confirmed to be present on a neighbouring farm close to the study area.
Kori Bustard (*Ardeotis kori)*	NT	Yes	Yes	Confirmed	This SCC is confirmed to be present via camera trap data on a neighbouring farm.

Table 6. *Conservation status summary of bird SCC in pentad 2920_2300 and 2925_2300 (Prieska, Northern Cape Province, South Africa).* ***EN****, Endangered****; VU****, Vulnerable;* ***NT****, Near Threatened;* ***LC****, Least Concern;* ***—****, Not listed.*

Common Name / Scientific Name	SANBI Status	BirdLife SA Status (2025)	IUCN Status	TOPS (NEMBA)	CITES	Migratory Status
Tawny Eagle *Aquila rapax*	**EN**	**EN**	**VU**	EN	App. II	Resident (breeding)
Ludwig's Bustard *Neotis ludwigii*	**EN**	**EN**	**EN**	EN	—	Resident / nomadic
Verreaux's Eagle *Aquila verreauxii*	**VU**	**VU**	**LC**	VU	App. II	Resident (breeding)
Caspian Tern *Hydroprogne caspia*	**VU**	**VU**	**LC**	VU	—	Resident / migrant
Lanner Falcon *Falco biarmicus*	**VU**	**NT**	**LC**	VU	App. II	Resident (breeding)
Kori Bustard *Ardeotis kori*	**NT**	**NT**	**NT**	Protected	App. II	Resident (breeding)

Notes: SANBI status reflects the most recent regional Red List assessment from speciesstatus.sanbi.org. BirdLife SA status reflects the 2025 Red Data Book of Birds of South Africa, Lesotho and Eswatini (birdlife.org.za/red-list). IUCN status is the current global assessment (iucnredlist.org); where regional and global statuses differ, the more severe regional status is operative for this assessment. TOPS = Threatened or Protected Species under NEMBA Act 10 of 2004 (GN R151 of 2008, as amended 2023): EN = Endangered; VU = Vulnerable; Protected = Schedule 3 Protected Species. CITES App. II = international trade regulated by permit.

3.3.2 Class Mammalia

No mammal species was listed as a SCC by the DFFE screening tool. However, results from the desktop study revealed the possibility of 64 mammal species that might occur in or on the study area (Appendix 2, Table A2). This includes species from the Order Cetartiodactyla belonging to the families Bovidae and Giraffidae which are "game" species that are not regarded as part of the survey. The Common duiker and Steenbok were however included in the survey. Of 64 possible mammal species, only the Yellow Mongoose and Cape Porcupine were observed at the Tweefontein site while the Slender Mongoose, Suricate, Cape Ground Squirrel and Cape Porcupine were observed at the Kalkfontein site. However, during the same week as the assessment of these study sites, the presence of Black-backed Jackal, Steenbok, Common duiker, Aardvark (camera traps), Bat-eared Fox, Striped Polecat/Zorilla, Southern Small-spotted Genet (road kills), and Vervet Monkey (Road observations) were confirmed to be in the vicinity of the study area.

Of the listed mammal species that might occur in the study area, only six species are of conservational concern. This includes the Black-footed Cat (*Felis nigripes*), Brown Hyaena (*Parahyaena brunnea*), African Striped Weasel (*Poecilogale albinucha*), Damara Horseshoe Bat (*Rhinolophus damarensis*), Southern African Hedgehog (*Atelerix frontalis*), and Aardvark (*Orycteropus afer*). The regional Red list Status, habitat requirements, as well as the breeding and feeding behaviours of these species are listed in Table 7. The habitat suitability and likelihood of occurrence for the mammal SCC is listed in Table 8. Even though the majority of the study area is under centre-pivot irrigation, the areas between these pivots still provides suitable habitat for any of the SCC to be present. Although not in the study area itself, only the Aardvark was confirmed to be present in the area. The only other mammal species that has a high probability of occurrence to be present in the study area is the Southern African Hedgehog which was recorded between the year 2013 and 2024 (Smith & Da Silva, 2025).

***Table 7**. The regional Red List status, habitat requirements as well as breeding and feeding behaviour of SCC of the class Mammalia in the study area.*

***VU,** Vulnerable; **NT,** Near Threatened.*

Species	Regional Red list status	Habitat	Breeding	Feeding
Black-footed Cat (*Felis nigripes)*	**VU**	Restricted to arid and semi-arid open habitats in southern Africa, including Karoo shrubland, dry savanna, open grassland with sparse shrub cover, and dry riverbeds. Strongly avoids dense bush and transformed agricultural land. Closely associated with open, flat terrain with short vegetation cover. Found mainly in the Karoo, Kalahari, and adjacent areas of South Africa and Botswana.	Solitary and nocturnal. Females raise kittens alone. Does not construct its own den; uses burrows of aardvark, springhare, or porcupine, and termite mounds. Breeds year-round with peaks in summer. Litter size 1–3 kittens (typically 1–2). Gestation approximately 63–68 days. Kittens begin accompanying their mother on hunts at about 6 weeks; independent at approximately 5–6 months.	The most lethal hunter relative to body size of all wild cats. Diet comprises predominantly small mammals (gerbils, mice, shrews), small birds, reptiles (lizards, skinks), insects, and arachnids. Has been documented killing prey heavier than itself, including Cape Hare. Hunts almost exclusively at night using acute hearing to locate prey in darkness. Requires no free water — all moisture obtained from prey.
Damara Horseshoe Bat (*Rhinolophus damarensis)*	**VU**	Restricted to arid and semi-arid environments in northern Namibia and adjacent north-western South Africa (Northern Cape). Found in rocky terrain with caves, mine shafts, and rocky overhangs which serve as roost sites. Associated with sparse dry bushveld and desert-adjacent shrubland. A near-endemic of the arid western subregion.	Colonial rooster; maternity colonies form in caves or abandoned mining tunnels. Gives birth to a single pup once per year, typically in spring or early summer (October–December). Pups are born naked and altricial and cling to the mother until capable of independent flight.	Insectivorous; forages by low, slow flight close to vegetation and rock surfaces, using high-frequency echolocation to detect insects. Prey includes moths, beetles, flies, and other flying and resting invertebrates. Often hunts from a perch (perch-hunting), sallying out to

			Sexual maturity reached at approximately 1–2 years.	catch prey and returning to the same spot.
Brown Hyaena (*Parahyaena brunnea)*	**NT**	Occupies a wide range of arid and semi-arid habitats including open Karoo shrubland, desert fringes, dry savanna, grassland, and open woodland. Found throughout much of southern Africa, including the Karoo, Kalahari, and coastal zones. More tolerant of arid conditions than the Spotted Hyaena. Requires access to rocky areas or dense thickets for denning. Avoids densely forested areas.	Solitary or in small family groups (clan sizes much smaller than Spotted Hyaena). Dens typically located in rock crevices, aardvark holes, or dense thicket. Litters of 1–3 cubs born after a gestation of approximately 90–92 days. Cubs remain at or near the den for several months and are nursed for up to 12–16 months. Both parents (in pair-bonded groups) contribute to cub provisioning.	Primarily a scavenger; forages over very large home ranges (up to 1,000 km^2) in search of carcasses. Diet includes carrion of all sizes, supplemented by invertebrates (dung beetles, moths, locusts), wild fruits (especially tsamma melons for moisture), eggs, small vertebrates, and refuse near human habitation. Capable of crushing and digesting bones. Rarely kills large prey but will take small livestock, eggs, and injured animals.
African Striped Weasel (*Poecilogale albinucha)*	**NT**	Inhabits grassland, moist savanna, open woodland, and forest edges across eastern and southern Africa. Associated with areas of rank grass cover, reed beds, or dense ground vegetation near water. In South Africa found mainly in KwaZulu-Natal, Mpumalanga, Limpopo, and parts of the Northern Cape. Requires dense ground cover for foraging and shelter. Rarely encountered in open arid environments.	Solitary. Dens in grass clumps, dense vegetation, burrows, or beneath rocks and logs. Litter size 1–3 young, born after a gestation of approximately 32–33 days. Young are altricial (helpless at birth). Eyes open at approximately 6 weeks. Independence reached at about 10–12 weeks. Breeding may occur year-round but peaks in spring and summer.	Almost exclusively a predator of snakes, including venomous species (e.g., mambas, cobras) — one of the very few mammals specialised for this. Also takes lizards, small rodents, frogs, and invertebrates. Kills snakes by delivering a precise bite to the back of the skull. Has some immunity to snake venom. A relentless and ferocious hunter relative to its small body size.

Southern African Hedgehog (*Atelerix frontalis)*	**NT**	Occupies a range of habitats including open savanna, semi-arid shrubland, grassland with sparse bush, and mixed bushveld. Avoids dense forest and very arid desert. In South Africa found across the Northern Cape, Northwest, Gauteng, and Limpopo provinces. Requires areas with loose soil for foraging, and access to dense vegetation or rocky outcrops for shelter and hibernation sites.	Solitary; males and females associate only during the brief mating season. Breeds from August to March. Litter size typically 2–6 young after a gestation of approximately 35–40 days. Young are born blind and helpless; the first set of spines (soft, white) emerges within hours of birth beneath a membrane. Eyes open at approximately 18 days. Weaning occurs at 4–6 weeks. Enters torpor or hibernation during cold, dry months.	Omnivorous and opportunistic. Diet includes beetles, termites, crickets, millipedes, worms, caterpillars, small vertebrates (lizards, frogs, small rodents), bird eggs, fungi, and plant material such as seeds and berries. Has limited immunity to some toxins. Forages nocturnally by rooting through leaf litter and soil. Uses a highly developed sense of smell to detect prey.
Aardvark (*Orycteropus afer)*	**NT**	Occurs in a wide range of habitats including grassland, savanna, open woodland, bushveld, Karoo shrubland, and semi-arid environments. Avoids dense forest and very rocky terrain that prevents burrowing. Requires areas with suitable sandy or loamy soil for digging burrows and abundant termites and ants as food. Widespread across sub-Saharan Africa wherever suitable soil and ant/termite colonies exist.	Solitary and nocturnal. Breeds year-round, with a peak in spring and summer. Gives birth to a single young (rarely twins) after a gestation of approximately 7 months. The calf is born in the burrow and remains underground for the first few weeks. At approximately 2 weeks it begins to follow the mother on foraging trips. Weaning at 3–4 months; independent at 6 months. The young may share the burrow for up to 6 months after weaning.	Highly specialised ant and termite eater (myrmecophage). Diet consists almost exclusively of ants and termites, particularly harvester ants (*Messor* spp.) and termites (*Trinervitermes*, *Macrotermes*). Uses powerful foreclaws to excavate termite mounds and ant nests, and a long, sticky tongue (up to 30 cm) to extract insects. May consume up to 50,000 ants and termites in a single night. Also eats the wild Aardvark Cucumber (*Cucumis humifructus*) for water.

***Table 8**. Habitat suitability and likelihood of occurrence of Species of Conservation Concern of the class Mammalia that occurred or might likely occur in the study area.* ***VU,** Vulnerable; **NT,** Near Threatened.*

Species	Regional Red list status	Observed	Suitable habitat	Likelihood of occurrence	Reason
Black-footed Cat (*Felis nigripes)*	**VU**	No	Yes	Low	The Black-footed Cat is a semi-arid specialist inhabiting Nama Karoo, open savannah, and grassland habitats with sparse shrub and tree cover. The last recorded observation of this species in the study area was between 2000 and 2012.
Damara Horseshoe Bat (*Rhinolophus damarensis)*	**VU**	No	Yes	Low	The study area falls on the periphery of the Area Of Occupation (AOO) of this species. This species was last recorded in the area before 2000.
Brown Hyaena (*Parahyaena brunnea)*	**NT**	No	Yes	Low	Persecution of these animals by stock farmers as well as game farmers, almost exterminated the brown Hyaena from this area.
African Striped Weasel (*Poecilogale albinucha)*	**NT**	No	Yes	Low	Although the study area is located on the edge of the distribution of this species, no African Striped Weasel was recently recorded in this area. The Orange River riparian zone adjacent to the study area provides rank grass cover and dense ground vegetation near water, which constitutes suitable habitat for this species.
Southern African Hedgehog (*Atelerix frontalis)*	**NT**	No	Yes	High	Records of this species were documented in the area between 2013 and 2024.
Aardvark (*Orycteropus afer)*	**NT**	Yes	Yes	Confirmed	This SCC is confirmed to be present in adjacent areas.

A summary of the regional conservation status of mammal SCC in the study area is listed in Table 9. Only the Black-footed Cat, Brown Hyaena and Southern African Hedgehog is listed under the Threatened or Protected Species (TOPS) Regulations (Government Notice R. 151 of 2007, as revised in Government Gazette No. 47984 of 3 February 2023) promulgated under NEMBA (Act 10 of 2004). All three species are listed as **Protected** under **Schedule 3** (Indigenous species facing a high risk of extinction in the wild in the medium-term future). Of the six mammal SCC, only the Black-footed Cat (Appendix I) and Damara Horseshoe Bat (Appendix II) are listed by cites (Table 9). Appendix I prohibits the commercial trade of species while Appendix II permits the commercial trade of species only with valid permits.

***Table 9**. Summary of the regional conservation status of mammal SCC in the study area (Prieska, Northern Cape Province, South Africa). **VU**, Vulnerable; **NT**, Near Threatened; **LC**, Least Concern.*

Common Name / Scientific Name	EWT SA Status (2025)	SANBI Status (2016)	IUCN Status	TOPS (NEMBA)	CITES
Black-footed Cat (*Felis nigripes*)	**VU**	**VU**	**VU**	Protected (Sch 3)	App I
Damara Horseshoe Bat (*Rhinolophus damarensis*)	**VU**	**LC**	**LC**	—	App II
Brown Hyaena (*Parahyaena brunnea*)	**NT**	**NT**	**NT**	Protected (Sch 3)	—
African Striped Weasel (*Poecilogale albinucha*)	**NT**	**LC**	**LC**	—	—
Southern African Hedgehog (*Atelerix frontalis*)	**NT**	**NT**	**LC**	Protected (Sch 3)	—
Aardvark (*Orycteropus afer*)	**NT**	**LC**	**LC**	—	—

Notes: SANBI status reflects speciesstatus.sanbi.org (2016 Regional Red List of Mammals of South Africa — the most recent SANBI mammal assessment prior to the 2025 revision). EWT SA 2025 status reflects the 2025 Regional Mammal Red List coordinated by the Endangered Wildlife Trust and SANBI (ewt.org/2025-red-mammal-list/); '(uplisted)' denotes species whose status worsened in the 2025 revision. IUCN status is the current global assessment. TOPS = Threatened or Protected Species under NEMBA GN R151 of 2007 (as amended 2023); Schedule 3 = Protected Species. CITES listings: *Felis nigripes* = Appendix I (trade prohibited); *Rhinolophus damarensis* = Appendix II (trade regulated through a permit system); '—' = not listed under CITES or TOPS.

3.3.3 Class Reptilia

No reptile species was listed as a SCC by the DFFE screening tool. However, results from the desktop study revealed the possibility of 43 reptile species that might occur in or on the study area (Appendix 3, Table A3). Only two species, the Spotted Sandveld Lizard and Kalahari Tree Skink were observed at both the Tweefontein and Kalkfontein study sites. Two additional reptiles, a Puff Adder and a Cape cobra were however observed as road kills approximately 20 km before Prieska on the R357 road from the town Douglas.

Of the 43 reptile species as listed in Table A3, only the Tent Tortoise (*Psammobates tentorius*) is listed as a SCC. Restricted to South Africa and Namibia, three subspecies are recognised, though their distribution ranges overlap and there remains some uncertainty about their exact limits and therefore, the boundary zones should be treated with some caution in formal assessments. The sub species that is listed is probably *P. t. verroxii* (Northern Tent Tortoise) which has a wide distribution throughout the Nama Karoo in the Northern Cape and penetrates the Western Cape and possibly the Eastern Cape peripherally (Hofmeyr et al. 2023). Its range extends across the Orange River into Namibia, as far north as Mariental. The other two subspecies are unlikely to occur near Prieska: *P. t. tentorius* (Southern Tent Tortoise) occurs considerably further south, ranging through the Eastern Cape and southern Western Cape, well away from Prieska. *P. t. trimeni* (Western Tent Tortoise) is restricted to the Namaqualand Sandveld and Richtersveld to the west (Hofmeyr et al. 2023), a distinctly different habitat and bioregion to the Nama Karoo around Prieska. *P. t. verroxii* is currently assessed as **Least Concern** by both SANBI and the IUCN, making it the lowest-priority taxon in the table. However, it occurs within a population that is part of the broader *P. tentorius* **Near Threatened** species-level assessment, meaning ongoing habitat degradation, overgrazing, road mortality, livestock fence electrocution, and Pied Crow predation in the Prieska area are all relevant threat factors to consider. The species' naturally sparse occurrence and low population densities across the Nama Karoo mean that even localised habitat loss carries proportionate significance.

The habitat requirements as well as breeding and feeding behaviour of the Tent Tortoise is listed in Table 10 and the habitat suitability and likelihood of occurrence as well as a summary of the regional conservation status of the sub-species *Psammobates tentorius verroxii* that occur in the area is listed in Table 11 and Table 12 respectively.

***Table 10**. The regional Red List status, habitat requirements as well as breeding and feeding behaviour of reptile SCC in the study area.*

NT, Near Threatened

Species	Regional Red list status	Habitat	Breeding	Feeding
Tent Tortoise (*Psammobates tentorius)*	**NT (species)**	Restricted to the arid and semi-arid succulent Karoo and Nama Karoo of South Africa (Northern Cape, Western Cape, Eastern Cape) and marginally into southern Namibia. Inhabits low succulent shrubland, quartz gravel plains, and open Karoo flats. Requires areas with abundant low-growing succulents. Three subspecies recognised, each occupying slightly different habitat facies within the broader Karoo biome.	Oviparous. Mating occurs in late summer to autumn (February–April). Females lay small clutches of typically 1–3 eggs in shallow nests scraped in soft soil, concealed beneath shrubs. Incubation period approximately 150–200 days (dependent on temperature). Hatchlings emerge in late summer of the following year (December–February). Sexual maturity reached at approximately 5–8 years.	Strictly herbivorous. Diet consists almost entirely of succulent plant material including leaves and flowers of Karoo succulents (especially members of the families Aizoaceae, Crassulaceae, and Asteraceae). Also consumes dry plant material and occasionally fungi. Obtains water entirely from food. Forages during cooler parts of the day (morning and late afternoon) and becomes inactive during extreme heat.

Table 11. *Habitat suitability and likelihood of occurrence of Species of Conservation Concern of the class Reptilia that occurred or might likely occur in the study area.* ***LC****, Least Concern.*

Species	Regional Red list status	Observed	Suitable habitat	Likelihood of occurrence	Reason
Northern Tent Tortoise (*Psammobates tentorius verroxii*)	**LC**	No	Yes	**High**	The study area is situated on the Orange River in the central Northern Cape, within the Nama Karoo biome which is the core range of this species.

Table 12*. Summary of the regional conservation status of reptile SCC in the study area (Prieska, Northern Cape Province, South Africa).*

VU*, Vulnerable;* ***LC****, Least Concern.*

Common Name / Scientific Name	SANBI Status (2016)	IUCN Status	TOPS (NEMBA)	CITES
Northern Tent Tortoise (*Psammobates tentorius verroxii*)	**LC**	**VU (species)**	Protected under provincial nature conservation ordinances and biodiversity legislation in South Africa.	App II

3.3.4 Class Amphibia

No frog species was listed as a SCC by the DFFE screening tool. However, results from the desktop study revealed the possibility of 14 frog species that might occur in or on the study area (Appendix 4, Table A4). All identified frog species that might occur in the study area, are listed as Least Concern. No frogs were encountered in any of the two study sites.

4 SITE SENSITIVITY VERIFICATION

The DFFE screening tool identified the study area as having a **High sensitivity** (*vide* Fig. 4) for the animal species theme, due to the potential presence of three Species of Conservation Concern (SCC) as listed in Table 3. The site visit, and site sensitivity verification report confirmed that this property as a whole has a **High sensitivity**, due to:

- The likely presence of Verreaux's Eagle (VU) and Lanner Falcon (NT) in the study area as these species were confirmed to be present on a neighbouring farm close to the study area.
- The confirmed presence of other SCC which was not listed by the DFFE screening tool namely the Kori Bustard (*Ardeotis kori*) and Aardvark (*Orycteropus afer*).
- The likely presence of Tawny Eagle (*Aquila rapax*), Ludwig's Bustard (*Neotis ludwigii*), Caspian Tern (*Hydroprogne caspia*), Black-footed Cat (*Felis nigripes*), Brown Hyaena (*Parahyaena brunnea*), African Striped Weasel (*Poecilogale albinucha*), Damara Horseshoe Bat (*Rhinolophus damarensis*), Southern African Hedgehog (*Atelerix frontalis*) and the Tent Tortoise (*Psammobates tentorius verroxii)*.

5 IMPACT BY THE DEVELOPMENT

Although any development where natural vegetation is removed will have an impact on the environment, some animal species might take advantage of the establishment of agricultural crop production. For example, according to Shaw et al. (2016) Ludwig's Bustards are likely to be seen in transformed habitats with the preference of these birds to feed on pastures but they also utilise crops, stubbles or ploughed/fallow fields. The impact of the development of orchards on animal species include habitat loss by the removal of natural vegetation and fencing or fragmentation of habitats. This will lead to the diminishing of food sources or the prey basis for carnivorous or insectivorous feeders. Once the orchard is operational, the use of pesticides, rodenticides or herbicides will continue to have an effect on such food sources.

5.1 Class Aves

The impact of orchards relating to habitat loss or transformation of land, foraging or food sources and the use of pesticides or insecticides on bird Species of Conservation Concern is listed in Table 13. Bird species that are highly impacted in the study area are Tawny Eagles, Ludwig's Bustards and Kori Bustards. The impact on Verreaux's Eagle is considered to be moderately high based on their preference to feed on Rock Hyraxes which occurs in rocky terrains. The impact of orchards on both Lanner Falcons and Caspian Terns is considered to be moderate.

Table 13. *Impact of orchard development on bird Species of Conservation Concern. (Impact Rating Key:* ***HIGH*** *— Significant, mitigation and permit conditions required;* ***MODERATE–HIGH*** *— Notable, targeted mitigation essential;* ***MODERATE*** *— Manageable with good-practice mitigation).* ***EN****, Endangered;* ***VU****, Vulnerable;* ***NT****, Near Threatened.*

Species	Regional Status	Habitat Loss / Transformation	Food Source / Foraging	Pesticide / Insecticide	Overall Significance
Tawny Eagle *(Aquila rapax)*	**EN**	HIGH — open savanna and Karoo shrubland converted; requires large undisturbed tracts	HIGH — carrion, small mammals and prey diversity all reduced in intensively managed orchards; scavenging opportunities near farm infrastructure reduced	HIGH — secondary poisoning from rodenticide-killed carcasses and pesticide-affected prey; primary driver of raptor declines across Africa	**HIGH**
Ludwig's Bustard *(Neotis ludwigii)*	**EN**	HIGH — flat open Karoo gravel plains and sparse shrubland converted; near-endemic with no capacity to use cultivated land	MODERATE — omnivorous; some invertebrate foraging possible near unsprayed orchard margins on open ground	MODERATE — insecticides reduce large invertebrate prey (beetles, locusts, termites) in surrounding landscape	**HIGH**
Kori Bustard (*Ardeotis kori)*	**NT**	HIGH — requires large open dry savannahs and Karoo shrubland;	MODERATE — omnivorous; may exploit invertebrates	MODERATE — insecticides reduce large invertebrate prey	**HIGH**

Species	Regional Status	Habitat Loss / Transformation	Food Source / Foraging	Pesticide / Insecticide	Overall Significance
		cannot use orchard habitat; ground-nesting species sensitive to human disturbance	near unsprayed orchard margins; will forage in open areas adjacent to development	availability in the surrounding landscape	
Verreaux's Eagle *(Aquila verreauxii)*	**VU**	MODERATE — rocky terrain specialist; surrounding landscape conversion reduces hyrax prey base although cliff habitat not directly threatened	HIGH — extreme prey specialisation on Rock Hyrax; any hyrax population reduction through habitat change directly reduces eagle food availability	MODERATE — lower exposure than ground-foraging raptors; secondary poisoning risk present but reduced relative to diet	**MODERATE–HIGH**
Lanner Falcon (*Falco biarmicus)*	**NT**	LOW to MODERATE — highly adaptable; has colonised agricultural landscapes; corvid nests on irrigation pylons provide nesting opportunities	LOW to MODERATE — adaptable diet; small birds and insects associated with agricultural margins can be exploited	MODERATE — pesticide accumulation through prey documented; bioaccumulation in food chain a long-term risk	**MODERATE**
Caspian Tern *Hydroprogne caspia*	**VU**	LOW — associated with large water bodies; orchard	LOW to MODERATE — piscivorous; fish populations in the	MODERATE — pesticide and herbicide runoff into	**MODERATE**

Species	Regional Status	Habitat Loss / Transformation	Food Source / Foraging	Pesticide / Insecticide	Overall Significance
		footprint does not directly affect aquatic habitat along the Orange River	Orange River may be indirectly affected by agricultural chemical runoff and irrigation abstraction	water bodies accumulates in fish and passes to piscivorous birds through biomagnification	

5.2 Class Mammalia

The impact of orchards relating to habitat loss or transformation of land, food sources or prey and the use of pesticides or rodenticides on mammal Species of Conservation Concern is listed in Table 14. Mammal species that are highly impacted in the study area are the Black-footed Cat, African Striped Weasel and Aardvark as all three listed categories in Table 14 have a high significant impact on these species. The Southern African Hedge Hog will experience only a moderate-high impact. Based on the three listed categories, the Damara Horseshoe Bat will be affected moderately while the effect on the Brown Hyaena will be low-moderate.

***Table 14**. Impact of orchard development on mammal Species of Conservation Concern. (Impact Rating Key: **HIGH** — Significant, mitigation and permit conditions required; **MODERATE–HIGH** — Notable, targeted mitigation essential; **MODERATE** — Manageable with good-practice mitigation). **VU**, Vulnerable; **NT**, Near Threatened.*

Species	Regional Status	Habitat Loss / Transformation	Food Source / Prey	Pesticide / Rodenticide	Overall Significance
Black-footed Cat (*Felis nigripes*)	**VU**	HIGH — open Karoo short-grass habitat converted; strict short-grass specialist with no capacity to use orchard habitat; loss of open structure eliminates hunting ability	HIGH — rodenticides deployed in orchards eliminate the small mammal prey base entirely; no prey-switching capacity in this dietary specialist	HIGH — direct secondary poisoning from rodenticide-killed prey; bioaccumulation of organochlorines documented in small felids globally	**HIGH**
African Striped Weasel (*Poecilogale albinucha*)	**NT**	HIGH — grassland and rank grass habitat replaced; requires structurally complex ground cover that orchards completely remove; only 7 138 km^2 of natural habitat remains regionally	HIGH — rodenticides eliminate the rodent and snake prey base; obligate specialist predator with no alternative prey; high metabolic rate means prey depletion is rapidly fatal	HIGH — highest secondary poisoning risk of all species assessed; colonial burrowing rodents (primary prey) are direct targets of orchard rodenticide programmes	**HIGH**

Species	Regional Status	Habitat Loss / Transformation	Food Source / Prey	Pesticide / Rodenticide	Overall Significance
Aardvark (*Orycteropus afer*)	**NT**	HIGH — natural Karoo shrubland converted; soil preparation destroys burrow systems; compaction by heavy machinery renders soil unburrrowable	HIGH — insecticides applied to orchard soils eliminate ant and termite colonies that are the sole food source; cannot survive without sufficient colony availability	HIGH — insecticide application directly destroys the entire food base; no alternative diet exists; Karoo densities of ~8 animals per 10 km^2 make local losses significant	**HIGH**
Southern African Hedgehog (*Atelerix frontalis*)	**NT**	MODERATE — some tolerance of garden-like environments; orchard margins with leaf litter and mulch may provide partial substitute habitat adjacent to natural veld	MODERATE — insecticides reduce invertebrate prey (beetles, worms, crickets); reduction in prey abundance rather than total elimination given broader diet	HIGH — direct poisoning from insect-control schemes well-documented; orchard and vegetable farmers in the Free State specifically report severe hedgehog declines linked to insecticide use	**MODERATE–HIGH**

Species	Regional Status	Habitat Loss / Transformation	Food Source / Prey	Pesticide / Rodenticide	Overall Significance
Damara Horseshoe Bat (*Rhinolophus damarensis*)	**NT**	LOW — roosts in rocky caves and mine shafts well away from orchard footprint; direct land transformation does not affect roost sites	MODERATE — insecticides reduce aerial insect biomass over irrigated areas, reducing foraging productivity in the surrounding landscape	MODERATE — organochlorine and systemic insecticides reduce flying insect prey; bioaccumulation documented globally; horseshoe bats are among the most insecticide-sensitive bat families	**MODERATE**
Brown Hyaena (*Parahyaena brunnea*)	**NT**	LOW — wide habitat tolerance; very large home range (up to 1 000 km^2) means orchard footprint represents a small fraction of total territory	LOW — primary scavenger with extremely broad diet; carrion, wild fruits, insects and small vertebrates remain available well beyond the orchard footprint	LOW to MODERATE — not a primary target of rodenticide programmes; risk of secondary poisoning through scavenging poisoned carcasses exists but is low relative to body mass	**LOW–MODERATE**

5.3 Class Reptilia

The impact of orchards relating to habitat loss or transformation of land, food sources or foraging and the use of pesticides or herbicides on reptile Species of Conservation Concern is listed in Table 15. The transformation of land and ultimately loss of habitat will ultimately have an effect on food source and foraging. Although the Northern Tent Tortoise (*Psammobates tentorius verroxii*) is listed as Least Concern, the impact of orchards on the collective group of the Tent Tortoise (*Psammobates tentorius*) sub-species is **High**.

***Table 15**. Impact of orchard development on reptile Species of Conservation Concern. (Impact Rating Key: **HIGH** — Significant, mitigation and permit conditions required). **NT**, Near Threatened.*

Species	Regional Status	Habitat Loss / Transformation	Food Source / Foraging	Pesticide / Herbicide	Overall Significance
Tent Tortoise (*Psammobates tentorius)*	**NT**	HIGH — strictly confined to arid Nama Karoo succulent shrubland on specific soil types; soil preparation, ripping and irrigation destroy both substrate and food plants simultaneously; no capacity to use cultivated land	HIGH — entirely dependent on Karoo succulent plants (Aizoaceae, Crassulaceae, Asteraceae) for food and moisture; conversion of shrubland eliminates the food source completely; all water obtained from succulent food items	MODERATE — not a direct target of rodenticide programmes; herbicide use to control orchard understory eliminates the succulent plant food base; systemic pesticide uptake through plant consumption possible	**HIGH**

6 RECOMMENDATIONS AND CONCLUSION

The proposed development of pecan nut orchards under irrigation across approximately 141 hectares on the farms Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374) will take place within a landscape that supports a high diversity of Species of Conservation Concern (SCC). The assessment confirmed the presence of the Kori Bustard, Lanner Falcon and Aardvark in or adjacent to the study area, and identified a further eleven SCC as likely or possibly occurring on site. The overall site sensitivity is High.

6.1 Overall Assessment

The existing pivot areas (approximately 95 ha) that were established before 2006 represent already-transformed habitat and their conversion to orchard does not require additional mitigation beyond the general operational measures. The proposed 46 ha infill expansion is the primary ecological concern and must be subject to all pre-clearance surveys before any earthworks commence.

Should any of the pre-clearance surveys described in this section confirm the presence of Black-footed Cat, African Striped Weasel, or an active Tawny Eagle or Verreaux's Eagle nest within the development footprint, the affected portion of the infill expansion must be suspended and the developer must consult with the proper authorities before proceeding. In such a scenario, a TOPS Section 57 permit will be required before any development that would negatively affect these species' individuals or habitat may lawfully proceed.

The developers are encouraged to approach this development not only as a compliance exercise but as an opportunity to establish the farm as a model of biodiversity-compatible agriculture in the Karoo, a region where farming practices and wildlife conservation are increasingly being shown to be mutually reinforcing when managed with ecological intelligence.

Of all the species in this ecological report, the African Striped Weasel is arguably the most sensitive to orchard development because of its absolute dependence on prey-rich, structurally complex grassland habitat and its extreme vulnerability to rodenticide secondary poisoning. Any orchard development on the farm should include an explicit rodenticide management protocol that prohibits or strictly controls anticoagulant and acute rodenticide use in the vicinity of known or potential weasel habitat.

The Black-footed Cat's possible presence in the study area is highly significant. The Northern Cape Karoo is the global stronghold of this species. The IUCN Red List categorises the Black-footed Cat as Vulnerable to extinction with fewer than 10,000 individuals remaining. Any development that converts open Karoo shrubland to intensively managed orchard habitat should explicitly assess the potential impact on this species, and a rodenticide management protocol and habitat buffer strategy should be mandatory components of any environmental authorisation conditions.

It is recommended that an Aardvark burrow survey must be done prior to soil preparation. A study in the Karoo estimated the density of Aardvark to be approximately eight animals per 10 km^2 — meaning the farm likely supports several individuals within its boundaries. Any orchard expansion should include an explicit no-insecticide buffer zone around known burrow sites, and farm infrastructure design should account for Aardvark movement to minimise the conflict that typically drives persecution.

6.2 Environmental Awareness Training

Environmental awareness training is a regulatory requirement under the Protocols (GG 43110, 20 March 2020) and is the single most cost-effective conservation measure available to the developer. The following minimum standard is required:

- Training must be conducted before construction begins, repeated annually, and documented with a signed attendance register.
- Training content must cover: identification of all SCC listed in this report; legal protection status and penalties under NEMBA; the prohibition of rodenticides and gin traps;

Aardvark burrow avoidance; tortoise pre-clearance obligations; and the dead-animal reporting protocol.

- Laminated SCC identification cards with photographs must be produced and posted at the farm office, workshop, and worker accommodation.

6.3 Conclusion

The proposed pecan nut orchard development on Tweefontein and Kalkfontein is considered **permissible from a faunal conservation perspective**, subject to the full and documented implementation of the recommendations set out below.

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APPENDIX 1

Table A1. *Bird species (Class Aves) as listed by SABAP2 for pentad 2920_2300 and 2925_2300 combined at Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374), the Global and Regional Red Data Book Assessment of each species, as well as species observed during the field survey. (Source; GBIF, iNaturalist, SABAP2, SANBI).* ***EN,*** *Endangered;* ***VU,*** *Vulnerable;* ***NT,*** *Near Threatened;* ***LC****, Least Concern.*

Order / Family	**Genus & Species**	**Common Name**	**Red Data Book Assessment**		**Observed**	
			Global	**Regional**	**Tweefontein**	**Kalkfontein**
Accipitriformes						
	Aquila rapax	Tawny Eagle	VU	EN		
Accipitridae	*Aquila verreauxii*	Verreaux's Eagle	LC	VU		
	Haliaeetus vocifer	African Fish Eagle	LC	LC		
Anseriformes						
Anatidae	*Alopochen aegyptiaca*	Egyptian Goose	LC	LC		
	Tadorna cana	South African Shelduck	LC	LC		
Bucerotiformes						
Upupidae	*Upupa africana*	African Hoopoe	LC	LC		**1**
Caprimulgiformes						
Apodidae	*Apus affinis*	Little Swift	LC	LC		
	Cypsiurus parvus	African Palm Swift	LC	LC		
Charadriiformes						
Charadriidae	*Vanellus armatus*	Blacksmith Lapwing	LC	LC		**1**
	Vanellus coronatus	Crowned Lapwing	LC	LC		
Laridae	*Hydroprogne caspia*	Caspian Tern	LC	VU		

Pteroclidae	*Pterocles namaqua*	Namaqua Sandgrouse	LC	LC		
Ciconiiformes						
Threskiornithidae	*Bostrychia hagedash*	Hadada Ibis	LC	LC		**1**
Coliiformes						
Coliidae	*Colius colius*	White-backed Mousebird	LC	LC	**1**	**1**
	Urocolius indicus	Red-faced Mousebird	LC	LC		
Columbiformes						
Columbidae	*Columba guinea*	Speckled Pigeon	LC	LC		**1**
	Columba livia	Rock Dove	LC	LC		
	Oena capensis	Namaqua Dove	LC	LC		**1**
	Spilopelia senegalensis	Laughing Dove	LC	LC		
	Streptopelia capicola	Ring-necked Dove	LC	LC		**1**
	Streptopelia semitorquata	Red-eyed Dove	LC	LC		
Coraciiformes						
Dacelonidae	*Halcyon albiventris*	Brown-hooded Kingfisher	LC	LC		
	Megaceryle maxima	Giant Kingfisher	LC	LC		**1**
Meropidae	*Merops apiaster*	European Bee-eater	LC	LC		
	Merops bullockoides	White-fronted Bee-eater	LC	LC		
Galliformes						
Numididae	*Numida meleagris*	Helmeted Guineafowl	LC	LC		**1**
Otidiformes						
Otididae	*Afrotis afraoides*	Northern Black Korhaan	LC	LC		**1**
	Ardeotis kori	Kori Bustard	NT	NT	**Camera trap**	**Camera trap**
	Lophotis ruficrista	Red-crested Korhaan	LC	LC		
	Neotis ludwigii	Ludwig's Bustard	EN	EN		
Passeriformes						
Acrocephalidae	*Acrocephalus baeticatus*	African Reed-warbler	LC	LC		
Alaudidae	*Calendulauda africanoides*	Fawn-colored Lark	LC	LC		

	Calendulauda sabota	Sabota Lark	LC	LC	
	Certhilauda subcoronata	Karoo Long-billed Lark	LC	LC	
	Chersomanes albofasciata	Spike-heeled Lark	LC	LC	
Cisticolidae	*Cisticola aridulus*	Desert Cisticola	LC	LC	
	Cisticola juncidis	Zitting Cisticola	LC	LC	
	Cisticola tinniens	Levaillant's Cisticola	LC	LC	
	Malcorus pectoralis	Rufous-eared Warbler	LC	LC	
	Phragmacia substriata	Namaqua Warbler	LC	LC	
	Prinia flavicans	Black-chested Prinia	LC	LC	
Corvidae	*Corvus albus*	Pied Crow	LC	LC	
Fringillidae	*Crithagra atrogularis*	Black-throated Canary	LC	LC	
	Crithagra flaviventris	Yellow Canary	LC	LC	**1**
Hirundinidae	*Hirundo dimidiata*	Pearl-breasted Swallow	LC	LC	
	Ptyonoprogne fuligula	Large rock martin	LC	LC	**1**
	Riparia paludicola	Brown-throated Martin	LC	LC	
Macrosphenidae	*Sylvietta rufescens*	Long-billed Crombec	LC	LC	
Malaconotidae	*Batis pririt*	Pririt Batis	LC	LC	
	Nilaus afer	Brubru	LC	LC	
	Tchagra australis	Brown-crowned Tchagra	LC	LC	
	Telophorus zeylonus	Bokmakierie	LC	LC	
Motacillidae	*Anthus cinnamomeus*	African Pipit	LC	LC	
	Motacilla capensis	Cape Wagtail	LC	LC	
Muscicapidae	*Cercotrichas coryphoeus*	Karoo Scrub Robin	LC	LC	**1**
	Cercotrichas paena	Kalahari Scrub Robin	LC	LC	
	Cossypha caffra	Cape Robin-Chat	LC	LC	**1**
	Melaenornis silens	Fiscal Flycatcher	LC	LC	
	Monticola brevipes	Short-toed Pied Thrush	LC	LC	
	Myrmecocichla formicivora	Ant-eating Chat	LC	LC	**1**

	Oenanthe familiaris	Familiar Chat	LC	LC		
	Saxicola torquatus	African Stonechat	LC	LC		
	Turdus smithi	Karoo Thrush	LC	LC	**1**	**1**
Nectariniidae	*Cinnyris fuscus*	Dusky Sunbird	LC	LC		
Paridae	*Melaniparus cinerascens*	Ashy Tit	LC	LC		
Passeridae	*Passer diffusus*	Southern Grey-headed Sparrow	LC	LC		
	Passer domesticus	House Sparrow	LC	LC		
	Passer melanurus	Cape Sparrow	LC	LC	**1**	**1**
Ploceidae	*Euplectes orix*	Southern Red Bishop	LC	LC		
	Philetairus socius	Sociable Weaver	LC	LC	**1**	**1**
	Plocepasser mahali	White-browed Sparrow-Weaver	LC	LC		
	Ploceus velatus	Southern Masked Weaver	LC	LC	**1**	**1**
	Quelea quelea	Red-billed Quelea	LC	LC		**1**
	Sporopipes squamifrons	Scaly-feathered Weaver	LC	LC		
Pycnonotidae	*Pycnonotus nigricans*	African Red-eyed Bulbul	LC	LC	**1**	**1**
Sturnidae	*Creatophora cinerea*	Wattled Starling	LC	LC		
	Lamprotornis nitens	Cape Glossy Starling	LC	LC	**1**	**1**
Sylviidae	*Acrocephalus gracilirostris*	African Reed Warbler	LC	LC		
	Curruca subcoerulea	Chestnut-vented Warbler	LC	LC		
	Eremomela icteropygialis	Yellow-bellied Eremomela	LC	LC		
Zosteropidae	*Zosterops pallidus*	Orange River White-eye	LC	LC	**1**	**1**
Pelecaniformes						
Ardeidae	*Ardea cinerea*	Grey Heron	LC	LC	**1**	
	Ardea melanocephala	Black-headed Heron	LC	LC		
Piciformes						
Lybiidae	*Trachyphonus vaillantii*	Crested Barbet	LC	LC		
	Tricholaema leucomelas	Acacia Pied Barbet	LC	LC		

Strigiformes					
Strigidae	*Glaucidium perlatum*	Pearl-spotted Owlet	LC	LC	
Tytonidae	*Tyto alba*	Western (Common) Barn Owl	LC	LC	
Suliformes					
Anhingidae	*Anhinga rufa*	African Darter	LC	LC	**1**
Phalacrocoracidae	*Phalacrocorax lucidus*	White-breasted Cormorant	LC	LC	
Upupiformes					
Rhinopomastidae	*Rhinopomastus cyanomelas*	Common Scimitarbill	LC	LC	

APPENDIX 2

Table A 2. *Mammal species (Class Mammalia) as listed by iNaturalist, GBIF, the Global and Regional Red Data Book Assessment of each species, as well as species observed during the field survey at Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374).* ***EN,*** *Endangered;* ***VU,*** *Vulnerable;* ***NT,*** *Near Threatened;* ***LC****, Least Concern.*

Order/Family	Genus & Species	Common Name	Red Data Book Assessment		Observed	
			Global	Regional	Tweefontein	Kalkfontein
Carnivora						
Canidae	*Lupulella mesomelas*	Black-backed Jackal	LC	LC	**Camera trap**	**Camera trap**
	Otocyon megalotis	Bat-eared Fox	LC	LC	**Road kill**	**Road kill**
	Vulpes chama	Cape Fox	LC	LC		
Felidae	*Caracal caracal*	Caracal	LC	LC		
	Felis lybica cafra	Southern African Wildcat	LC	LC		
	Felis nigripes	Black-footed Cat	VU	VU		
Herpestidae	*Atilax paludinosus*	Water/Marsh Mongoose	LC	LC		
	Cynictis penicillata	Yellow mongoose	LC	LC	**1**	
	Herpestes pulverulentus	Cape Grey Mongoose	LC	LC		
	Herpestes sanguineus	Slender Mongoose	LC	LC		**1**
	Suricata suricatta	Suricate/Meerkat	LC	LC		**1**
Hyaenidae	*Parahyaena brunnea*	Brown Hyaena	NT	NT		
	Proteles cristatus	Aardwolf	LC	LC		
Mustelidae	*Ictonyx striatus*	Striped polecat/Zorilla	LC	LC	**Road kill**	**Road kill**
	Mellivora capensis	Honey Badger	LC	LC		
	Poecilogale albinucha	African Striped Weasel	LC	NT		
Viverridae	*Genetta genetta*	Southern Small-spotted Genet	LC	LC	**Road kill**	**Road kill**

Cetartiodactyla						
Bovidae	*Alcelaphus buselaphus caama*	Red Hartebeest	LC	LC		
	Antidorcas marsupialis	Springbok	LC	LC		
	Connochaetes taurinus	Blue Wildebeest	LC	LC		
	Connochaetes gnou	Black Wildebeest	LC	LC		
	Kobus ellipsiprymnus	Common Waterbuck	LC	LC		
	Oreotragus oreotragus	Klipspringer	LC	LC		
	Oryx gazella	Gemsbok	LC	LC		
	Raphicerus campestris	Steenbok	LC	LC	**Camera trap**	**Camera trap**
	Sylvicapra grimmia	Common duiker	LC	LC	**Camera trap**	**Camera trap**
	Tragelaphus oryx	Eland	LC	LC		
	Tragelaphus strepsiceros	Greater Kudu	LC	LC		
Giraffidae	*Giraffa camelopardalis*	Southern Giraffe	VU	LC		
Chiroptera						
Molossidae	*Tadarida aegyptiaca*	Egyptian Free-tailed Bat	LC	LC		
Nycteridae	*Nycteris thebaica*	Egyptian Slit-faced Bat	LC	LC		
Rhinolophidae	*Rhinolophus clivosus*	Geoffroy's Horseshoe Bat	LC	LC		
	Rhinolophus damarensis	Damara Horseshoe Bat	LC	VU		
Vespertilionidae	*Cnephaeus hottentotus*	Long-tailed Serotine Bat	LC	LC		
	Laephotis capensis	Cape Roof Bat	LC	LC		
Eulipotyphla						
Erinaceidae	*Atelerix frontalis*	Southern African Hedgehog	LC	NT		
Soricidae	*Suncus varilla*	Lesser Dwarf Shrew	LC	LC		
Hyracoidea						
Procaviidae	*Procavia capensis*	Rock Hyrax	LC	LC		
Lagomorpha						
Leporidae	*Lepus capensis*	Cape Hare	LC	LC		

	Pronolagus rupestris	Smith's Red Rock Rabbit	LC	LC		
Macroscelidea						
Macroscelididae	*Macroscelides proboscideus*	Karoo Round-eared Sengi	LC	LC		
	Macroscelides rupestris	Western Rock Sengi	LC	LC		
Primates						
Cercopithecidae	*Chlorocebus pygerythrus*	Vervet Monkey	LC	LC	**Road obs.**	**Road obs.**
	Papio ursinus	Chacma Baboon	LC	LC		
Rodentia						
Sciuridae	*Xerus inauris*	Cape ground squirrel	LC	LC		**1**
Bathyergidae	*Cryptomys hottentostus*	Common Mole-rat	LC	LC		
Hystricidae	*Hystrix africaeaustralis*	Cape Porcupine	LC	LC	**1**	**1**
Muridae	*Aethomys chrysophilus*	Red Veld Rat	LC	LC		
	Desmodillus auricularis	Cape Short-eared Gerbil	LC	LC		
	Gerbilliscus brantsii	Brants's Gerbil	LC	LC		
	Gerbilliscus leucogaster	Bushveld Gerbil	LC	LC		
	Mastomys coucha	Southern Multimammate Mouse	LC	LC		
	Micaelamys namaquensis	Namaqua Rock Rat	LC	LC		
	Mus minutoides	Pygmy Mouse	LC	LC		
	Otomys unisulcatus	Karoo Bush Rat	LC	LC		
	Parotomys brantsii	Brants' Whistling Rat	LC	LC		
	Rhabdomys bechuanae	West-Central Four-striped Grass Rat	LC	LC		
Nesomyidae	*Malacothrix typica*	Large-eared Mouse	LC	LC		
Pedetidae	*Pedetes capensis*	Springhare	LC	LC		
Tubulidentata						
Orycteropodidae	*Orycteropus afer*	Aardvark	LC	NT	**Camera trap**	**Camera trap**

APPENDIX 3

Table A 3. *Reptile species (Class Reptilia) as listed by iNaturalist, GBIF, the Global and Regional Red Data Book Assessment of each species, as well as species observed during the field survey at Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374).* ***EN,*** *Endangered;* ***VU,*** *Vulnerable;* ***NT,*** *Near Threatened;* ***LC****, Least Concern.*

Order/Family	**Genus & Species**	**Common Name**	**Red Data Book Assessment**		**Observed**	
			Global	**Regional**	**Tweefontein**	**Kalkfontein**
Order Squamata						
Agamidae	*Agama aculeata*	Ground Agama	LC	LC		
	Agama atra	Southern Rock Agama	LC	LC		
Amphisbaenidae	*Monopeltis infuscata*	Dusky Worm Lizard	LC	LC		
	Zygaspis quadrifrons	Kalahari Dwarf Worm Lizard	LC	LC		
Colubridae	*Dasypeltis scabra*	Common Egg Eater	LC	LC		
	Telescopus beetzii	Karoo Tiger Snake	LC	LC		
Cordylidae	*Karusasaurus polyzonus*	Karoo Girdled Lizard	LC	LC		
Elapidae	*Naja nivea*	Cape cobra	LC	LC	**Road kill**	**Road kill**
	Elapsoidea sundevallii	Sundevall's Garter Snake	LC	LC		
	Naja nigricincta	Western Barred Spitting Cobra	LC	LC		
Gekkonidae	*Chondrodactylus bibronii*	Bibron's Thick-toed Gecko	LC	LC		
	Lygodactylus capensis	Common Dwarf Gecko	LC	LC		
	Ptenopus garrulus	Common Barking Gecko	LC	LC		
Lacertidae	*Meroles suborbitalis*	Spotted Desert Lizard	LC	LC		
	Heliobolus lugubris	Bushveld Lizard	LC	LC		
	Nucras intertexta	Spotted Sandveld Lizard	LC	LC	**1**	**1**
	Nucras tessellata	Western Sandveld Lizard	LC	LC		

	Pedioplanis lineoocellata	Spotted Sand Lizard	LC	LC		
	Pedioplanis namaquensis	Namaqua Sand Lizard	LC	LC		
Lamprophiidae	*Boaedon capensis*	Cape House Snake	LC	LC		
	Pseudaspis cana	Mole Snake	LC	LC		
Leptotyphlopidae	*Leptotyphlops scutifrons*	Peter's Thread Snake	LC	LC		
Prosymnidae	*Prosymna sundevallii*	Sundevall's Shovel-snout	LC	LC		
Psammophiidae	*Psammophis leightoni*	Cape Whip Snake	LC	LC		
	Psammophis notostictus	Karoo Sand Snake	LC	LC		
	Psammophis trinasalis	Fork-marked Sand Snake	LC	LC		
Scincidae	*Acontias lineatus*	Striped Legless Skink	LC	LC		
	Acontias occidentalis	Western Legless Skink	LC	LC		
	Trachylepis capensis	Cape skink	LC	LC		
	Trachylepis spilogaster	Kalahari Tree Skink	LC	LC	**1**	**1**
	Trachylepis sulcata	Western Rock Skink	LC	LC		
	Trachylepis variegata	Variegated Skink	LC	LC		
Typhlopidae	*Rhinotyphlops lalandei*	Delalande's Beaked Blind Snake	LC	LC		
Varanidae	*Varanus albigularis*	Rock Monitor	LC	LC		
	Varanus niloticus	Water Monitor	LC	LC		
Viperidae	*Bitis arietans*	Puff adder	LC	LC	**Road kill**	**Road kill**
	Bitis caudalis	Horned Adder	LC	LC		
Order Testudines						
Testudinidae	*Stigmochelys pardalis*	Leopard Tortoise	LC	LC		
	Psammobates tentorius	Tent Tortoise	NT	NT		
Pelomedusidae	*Pelomedusa galeata*	South African Helmeted Terrapin	LC	LC		

APPENDIX 4

Table A 4*. Frog species (Class Amphibia, Order Anura) as listed by iNaturalist, GBIF, the Global and Regional Red Data Book Assessment of each species, as well as species observed during the field survey at Tweefontein (Erf No. 373) and Kalkfontein (Erf No. 374).* ***EN,*** *Endangered;* ***VU,*** *Vulnerable;* ***NT,*** *Near Threatened;* ***LC****, Least Concern.*

Family	Genus & Species	Common Name	Red Data Book Assessment		Observed	
			Global	Regional	Tweefontein	Kalkfontein
Brevicipitidae	*Breviceps a. adspersus*	Common Rain Frog	LC	LC		
Bufonidae	*Poyntonophrynus vertebralis*	Southern Pygmy Toad	LC	LC		
	Sclerophrys capensis	Raucous/Ranger's Toad	LC	LC		
	Sclerophrys gutturalis	Guttural Toad	LC	LC		
	Sclerophrys poweri	Western Olive Toad	LC	LC		
	Vandijkophrynus gariepensis	Karoo Toad	LC	LC		
Hyperoliidae	*Kassina senegalensis*	Bubbling Kassina	LC	LC		
Pipidae	*Xenopus leavis*	Common Platanna	LC	LC		
Pyxicephalidae	*Amietia delalandii*	Common River Frog	LC	LC		
	Amietia poyntoni	Poynton's River Frog	LC	LC		
	Cacosternum boettgeri	Boettger's Caco	LC	LC		
	Pyxicephalus adspersus	Giant Bullfrog	LC	LC		
	Tomopterna adiastola	Tremolo Sand Frog	LC	LC		
	Tomopterna tandyi	Tandy's Sand frog	LC	LC		

agriculture, environmental affairs, rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Application for authorization in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 as amended.

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

1. Project title:

Development of the remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, Siyathemba Local Municipality, Northern Cape province.

2. Details of the specialist:

Project Specialist:	Dr HJB Butler		
Trading name (if any):	BioBase Environmental Pty LTD		
Business reg. no./ID. no.:	2024/104397/07		
Contact person:	H Butler		
Physical address:	14 Eddie de Beer, Dan Pienaar, Bloemfontein		
Postal address:	14 Eddie de Beer, Dan Pienaar, Bloemfontein		
Postal code:	9301	**Cell:**	0827718101
Telephone:		**Fax:**	
E-mail:	Hennie.butler@gmail.com		
Qualifications:	PhD (Zoology)		
Professional affiliation (s) (if any)	Southern African Wildlife Management Association (SAWMA)		

3. Details of the consultant

Project consultant/firm:	Digital Soils Africa (Pty) Ltd		
Business reg. no./ID. no.:	2012/111217/07		
Contact person:	Natalie Sharp		
Postal address:	45 Church Street, Walmer		
Postal code:	6070	**Cell:**	082 414 0472
Telephone:	082 414 0472	**Fax:**	
E-mail:	natalie@dsafrica.co.za		

4. Declaration by the specialist appointed in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

I, HJB Butler, declare that --

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

BioBase Environmental Pty LTD

Name of company (if applicable):

26 /05/2026

Date:

Signature of the Commissioner of Oaths:

2026-05-27

Date:

SERGEANT

Designation:

Official stamp (below):

SUID-AFRIKAANSE POLISIEDIENS
COMMUNITY SERVICE CENTRE
27-05-2026
BAYSWATER
SOUTH AFRICAN POLICE SERVICE

Abridged Curriculum Vitae
Hendrikus Johannes Beukes Butler, PhD

Department of Zoology & Entomology, University of the Free State, Bloemfontein, South Africa

Date of birth: 19 March 1966; Nationality: South African; Marital status: Married, three children

E-mail: butlerhj@ufs.ac.za Tel: 027 51 4012489

EMPLOYMENT: Lecturer

TERTIARY EDUCATION:
PhD Zoology University of the Free State
MSc Zoology University of the Free State
BSc Hons Zoology University of the Free State
BSc Zoology University of the Free State

ACADEMIC CONTRIBUTIONS AND COLLABORATIONS

Teaching Experience:

Teaching experience in **Animal biodiversity** (second year level)
Teaching experience in **Animal anatomy** (First- and second-year level)
Teaching experience in **Animal physiology** (First- and second-year level)
Teaching experience in **Animal behaviour** (Second-, third and Hons level)

Undergraduate students

First Year:

Biology Practical. First Year **(BLG 114)**	1995 - 2000
Zoology practical. First Year **(DRK 124)**	1995 - 1999
Biology practical. First Year **(BLG 124)**	2000 - 2002
Biology. First Year **(BLG 124)**	2000 – 2002
Biology practical. First Year **(BLG 144)**	2003, 2004
Biology. First Year **(BLG 144)**	2010 - 2017
Biology Lectures and Practical for schoolteachers from Randse Afrikaanse University. First and second year level.	2000, 2001
Biology. First Year **(ZLGY 1663)** 5 lectures	2025

Second Year:

Animal Behaviour. Second Year **(DRK 226)**	1997
Vertebrate Research Techniques. Second Year **(DRK 262)**	2000
Animal Behaviour. Second Year **(DRK 222)**	2000
Evolution and Distribution of Vertebrates **(DRK 242)**	2003, 2004
African Vertebrates. Second Year **(DRK 224)**	2006 – 2008
Exploring Life Sciences: From Passion to Profession (**ENZO 2605**)	2026
Introduction to Animal Physiology (**ENZO 2665**)	2026

Third Year:

Supervise Zoology Year Projects. Third Year	1999, 2000
African Vertebrates. Third Year **(DRK 352)**	2000 - 2004
Animal Behaviour. Third Year **(ZLGY 3744)**	2007 – 2025
Behavioural Ecology (**ZLGY 3744**)	2026

Honors:

Africa Ornithology. **(DRK 602)**	1999 – 2004
Animal Behaviour. **(ZLGY 6864)**	2007 – currently
Supervision of Research Projects (Hons).	27 students

Master's Degree Students

P.D.S. le Roux. Aspects of the Biology of Feral Pigeons *(Columbia livia)* in the Bloemfontein urban area. 2005 – 2007

L. Heyns. Using activity patterns and STR markers to distinguish between Blesbok *(Damaliscus pygargus phillipsi)* and Bontebok *(D. p. pygargus)* in the Free State. 2006 – 2010

D. du Plessis. Relative brain size in non-mammalian cynodonts and its implications for the evolution of endothermy. 2008 – 2010

A. Grobbelaar. Parasite induced behavioural changes in Fish. 2009 – 2011

M. van As. Livestock, Leopards and Brown Hyena: Conflicts of cohabitation in the Roodewalshoek Conservancy, Mpumalanga. 2008 – 2012

N. Jacobs. Functionality of colour differences in behavioural activities of Sable Antelope *(Hippotragus niger)*. 2010 – 2015

P. Olivier. Colour variation and population dynamics of Bovidae in the Free State: Management implications in the game farm industry. 2010 – 2015

R. Wiid. Population control of Rock Hyrax *(Procavia capensis)* in Bloemfontein residential areas. 2011 – 2017

E. Coetzee. Geophagia among cattle. 2011 – 2017

K. Darker. Geophagia among African elephants *(Loxodonta africana)* 2019 – 2023

K. Sutherland. Taste responses of South African game species to chemical stimuli. 2018 – 2023

J. Viljoen. The contribution of inselbergs to diversity in the Free State

grasslands. 2023 – current

Mini Dissertation Master of Environmental Management Supervisor

P.A. Hoffman. Area selection of game species around pans on a game ranch in the Western Free State. 2014 – 2016

PUBLIC CONTRIBUTIONS

13 public Lectures and/or talks

Invited guest speaker; "Extreme Life: Exploring Life in the Extremes and the Extremes of Life."
Production Ecology and Resource Conservation Graduate School, Wageningen, Netherlands.
November 2012.

COMMITTEES

Occupational Health & Safety Committee
(Faculty of Natural and Agricultural Sciences) 1990 – 2017
Buildings Committee
(Faculty of Natural and Agricultural Sciences) 2004 – 2018
Inter-faculty Animal Ethics committee 2010 – 2025

MEMBERSHIPS

Animal Behaviour Society 2009 – 2016
South African Wildlife Society Management
Association (SAWMA) 2010 – currently

PUBLICATIONS

16 articles in peer reviewed journals

14 national conference contributions

8 international conference contributions

4 Book contributions

14 Unpublished technical reports

INTERNATIONAL VISITS

Deosai National Park (Himalayas, Pakistan) September 1998
Deosai National Park (Himalayas, Pakistan) June 1999
Dijon France July 2008
Botswana 1996 – 2022

Wageningen Netherlands	November 2012
Madagascar VAHATRA	April 2015

OTHER ACADEMIC CONTRIBUTIONS

Organising committee of conferences

SAWMA Conference (Golden Gate)	2023
ZSSA Conference	2023

Karoo Ecology Research Unit (KERU)

- Established a research camp and laboratory on a private farm next to the Van der Kloof Dam.
- Giraffe research project.

TECHNICAL REPORTS

Amphibian and Reptile Survey; Anglo America, Kumba Iron Ore, Kolomela Mine.	2012 – currently
Beeshoek Mine, Postmasburg. Biodiversity Biomonitoring for EMX.	2025 – currently
Faunal biodiversity for Assmang (Pty) ltd Black Rock Mine Operations, Hotazel, Northern Cape: ASSMANG Manganese	2024 – currently
Rock Hyrax Capture and Relocation on Black Rock Mine Operations (BRMO), Hotazel, Northern Cape.	2024
Bat acoustic survey; Anglo America, Kumba Iron Ore, Kolomela Mine (Postmasburg).	2026

Southern African Wildlife Management Association

P.O. Box 217, Bloubergstrand, South Africa 7436 E-mail Address: ***office@sawma.co.za*** *Tel: 0+27 713523226*

Membership Certificate

This is to certify that

Dr. Hennie Butler

currently is a subscribed member of the Southern African Wildlife Management Association until 28 April 2027.

E M Marais

E. M Marais
SAWMA Secretariat

Date: 2026-03-25

agriculture, environmental affairs,
rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Application for authorization in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 as amended.

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

1. Project title:

Development of the remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, Siyathemba Local Municipality, Northern Cape province.

2. Details of the specialist:

Project Specialist:	Prof Edward C. Netherlands		
Trading name (if any):	BioBase Environmental Pty LTD		
Business reg. no./ID. no.:	2024/104397/07		
Contact person:	E.C. Netherlands		
Physical address:	10 Ebenezer complex, 11 Deurmekaarbos Avenue, Bloemfontein, South Africa		
Postal address:	10 Ebenezer complex, 11 Deurmekaarbos Avenue, Bloemfontein, South Africa		
Postal code:	9301	**Cell:**	0791922833
Telephone:		**Fax:**	
E-mail:	ecnetherlands@gmail.com		
Qualifications:	PhD (Biology), MSc Environmental Sciences; Hons. Environmental Sciences; BSc Zoology & Botany		
Professional affiliation (s) (if any)	SACNASP; Herpetological Association of Africa (HAA) Executive Committee; Parasitological Society Of Southern Africa (PARSA)		

3. Details of the consultant

Project consultant/firm:	Digital Soils Africa (Pty) Ltd		
Business reg. no./ID. no.:	2012/111217/07		
Contact person:	Natalie Sharp		
Postal address:	45 Church Street, Walmer		
Postal code:	6070	**Cell:**	082 414 0472
Telephone:	082 414 0472	**Fax:**	
E-mail:	natalie@dsafrica.co.za		

4. Declaration by the specialist appointed in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

I, Edward Charles Netherlands, declare that --

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

BioBase Environmental Pty LTD
Name of company (if applicable):

26 /05/2026
Date:

Signature of the Commissioner of Oaths:

2026-05-27
Date:

SERGEANT
Designation:

Official stamp (below):

SUID-AFRIKAANSE POLISIEDIENS
COMMUNITY SERVICE CENTRE
27 -05- 2026
BAYSWATER
SOUTH AFRICAN POLICE SERVICE

ABRIDGED CURRICULUM VITAE – Edward Charles Netherlands, PhD

Department of Zoology and Entomology, PO Box 339, University of the Free State, 9300, South Africa

PROFILE

Tel. (w) +27 (0) 51 401 7585
Email: NetherlandsEC@ufs.ac.za
Date of birth: 1989-05-15
Nationality: South African
Languages: English (Native), Afrikaans (Fluent), Sesotho (Limited)

WEB LINKS:

Research Gate: https://www.researchgate.net/profile/Edward-Netherlands
Orcid ID: https://orcid.org/0000-0003-1856-0586

EMPLOYMENT & EDUCATION

CURRENT:
Associate Professor: Department of Zoology and Entomology, University of the Free State (UFS), RSA

TERTIARY EDUCATION:

PhD - Biology: KU Leuven & NWU (2015-2019)
MSc - Environmental Sciences (2013-2014)
BSc Honours - Environmental Sciences (2012)
BSc - Zoology, Botany & Tourism (2009 -2011)

SECONDARY EDUCATION:

Ficksburg High School: Matriculated – 2007

SPECIAL AWARDS:

2023: Finalist of the National Science and Technology Forum (NSTF) - TW Kambule-NSTF Awards: Emerging Researchers
2019: Parasitological Society of Southern Africa: Winner of the Senior WO Neitz Medal (Best PhD)
2018: Nation Research Foundation: Research Excellence for Next Generation Researchers Award (Best PhD)
2015: North-West University – Faculty Natural Sciences (2015): Winner of the S2A3 Medal (Best NWU MSc)
2015: Parasitological Society of Southern Africa (2015): Winner of the Junior WO Neitz Medal (Best MSc)

EDITORIAL ACTIVITIES:

Editorial board - **African Journal of Herpetology** - Print ISSN: 2156-4574 (2019 – current)

GUEST EDITOR:

African Journal of Wildlife Research - Print ISSN: 2410-7220; Online ISSN: 2410-8200 (2023)
African Zoology - Print ISSN: 1562-7020; Online ISSN: 2224-073X (2023-2025)
International Journal for Parasitology: Parasites and Wildlife - ISSN: 2213-2244 (2025)

LECTURING:

UFS: BLGY1663 Biology: Introduction to Zoology & Entomology – 1st year (2024)
UFS: ZLGY6862: Biodiversity – Excursion – Honours (2024 – current)
UFS: ZLGY3724: Life history strategies in arid environments - Third year (2022 – 2025)
UFS: ZLGY6844: Capita selecta – Herpetology – Honours (2022 – current)
NWU: Ectothermic vertebrates handling and ethics – Postgraduate (2019 – 2017)
NWU: OMSB 627: Herpetology in practice – Honours (2017 – 2021)

SUPERVISION:
Doctoral: 4 Current, 1 completed
Masters: 1 current, 8 completed
Honours: 9 competed

RESEARCH OUTPUTS

JOURNAL ARTICLES (Last 10/53)**:**

1. Dutton, H.R., Jacobs, F.J., Beytell, P.C., **Netherlands, E.C.**, Du Preez, L.H., Bullard, S.A. (2026). New genus and species of Liolopidae Odhner, 1912 (Platyhelminthes: Digenea) infecting Nile crocodile, Crocodylus niloticus (Laurenti, 1768)(Crocodilia: Crocodylidae) in the Kavango River, Namibia. *Journal of Parasitology*. *112(1) 21–27*. https://doi.org/10.1645/25-36
2. Barnard, M., Codron, D., Dutton, H.R., Bullard, S.A., H. du Preez, L.H., **Netherlands, E.C.** (2025). Life In Cold Blood: Exploring the cryptic diversity of species of Haemogregarina in Southern Africa's terrapins. *International Journal for Parasitology: Parasites and Wildlife*, 29, 101179. https://doi.org/10.1016/j.ijppaw.2025.101179
3. Jordaan, B.J., Alvaro, A., Cattaneo, G., Barnard, M., Epis, S., **Netherlands, E.C.** (2025). Unveiling Sauroleishmania in southern Africa: An investigation and supplementary description of Leishmania (Sauroleishmania) zuckermani from the gecko host Chondrodactylus bibronii. *International Journal for Parasitology: Parasites and Wildlife*, 28, 101154. https://doi.org/10.1016/j.ijppaw.2025.101154
4. Griesbaum, F., **Netherlands, E.C.,** Schäfer, M. (2025). First record of kin-cannibalism in Fornasini's Spiny Reed Frog, Afrixalus fornasini (Anura: Hyperolidae), tadpoles. *Reptiles & Amphibians*, 32, e23418. https://doi.org/10.17161/randa.v32i1.23418
5. Du Preez, L.H., **Netherlands, E.C.,** Minter, L.R. (2025). A new Rain Frog (Anura: Brevicipitidae; Breviceps) from the KwaZulu-Natal Midlands, South Africa. *African Journal of Herpetology*, 74:2, 188-209. https://doi.org/10.1080/21564574.2025.2478896
6. Le Roux, C., Cook, C.A., **Netherlands, E.C.,** Truter, M., Smit, N.J. (2025). Molecular and morphological characterization of 1 known and 3 new species of fish parasitic Trypanosoma Gruby, 1972 from the south coast of South Africa. *Parasitology*, 152, 531–550. https://doi.org/10.1017/S0031182025000496
7. Van As, M., **Netherlands, E.C.,** Van As, J., Cook, C.A., Smit, N.J. (2025). Life cycle stages of *Hepatozoon ingwe* (Apicomplexa: Adeleorina: Hepatozoidae) in an *Ixodes* sp. tick vector (Arthropoda: Ixodida: Ixodidae) and an African leopard *Panthera pardus pardus*. *International Journal for Parasitology: Parasites and Wildlife,* 26, 101049. https://doi.org/10.1016/j.ijppaw.2025.101049
8. Cajiao-Mora, K., Dutton, H.R., Jacobs, F.J., Beytell, P.C., **Netherlands, E.C.**, Du Preez, L.H., Bullard, S.A. (2025). Supplemental description of *Stephanoprora ornata* Odhner, 1902 (Digenea: Echinochasmidae) infecting the Nile crocodile, *Crocodylus niloticus* (Crocodylidae) from Namibia with emendation of Mesorchis Dietz, 1909 and a phylogenetic analysis. *Journal of Helminthology*. 99, e20, 1–14. https://doi.org/10.1017/S0022149X25000100
9. Megía-Palma, R., Sánchez-Montes, G., **Netherlands, E.C**., Palomar, G., Martínez-Solano, I. (2024). High prevalence of *Trypanosoma* infection in Iberian green frogs (*Pelophylax perezi*) and evidence of a negative relationship between blood parasites and two indices of frog body condition. *Basic and Applied Herpetology.* 00 (2024) 000-000. http://dx.doi.org/10.11160/bah.294
10. Jordaan, B.J., du Preez, L.H., **Netherlands, E.C.** (2024). Revisiting the diversity and phylogenetic relationships of trypanosomes (*Trypanosoma*) infecting pelomedusid (Pelomedusidae) freshwater turtles in Southern Africa. *Zoological Journal of the Linnean Society.* 202, zlae107. https://doi.org/10.1093/zoolinnean/zlae107

BOOKS & BOOK CHAPTERS:

1. Phaka FM, **Netherlands EC**, Kruger DJ, du Preez, LH (2017): A Bilingual Field Guide to the Frogs of Zululand. South African National Biodiversity Institute, Pretoria. 978-1-928224-19-8
2. Acosta AA, **Netherlands EC**, Retief F, de Necker L, du Preez L, Truter M, Alberts R, Gerber R, Wepener V, Malherbe W. Smit NJ. (2020). Conserving Freshwater Biodiversity in an African Subtropical Wetland: South Africa's Lower Phongolo River and Floodplain. In Managing Wildlife in a Changing World. IntechOpen. https://doi.org/10.5772/intechopen.93752
3. Vanhove MPM, Kmentová N, Luus-Powell WJ, **Netherlands EC**, de Buron I, Barger MA (2022): A snapshot of parasites in tropical and subtropical freshwater wetlands: modest attention for major players. In: Dalu T, & Wasserman RJ, (eds). Fundamentals of Tropical Freshwater Wetlands: From Ecology to Conservation Management. Academic Press, London. Chennai: Elsevier, 417–485. https://doi.org/10.1016/B978-0-12- 822362-8.00020-7

CONFERENCES; SYMPOSIA; & WORKSHOPS (Last 10)**:**

1. **Netherlands, E.C.*** Life Cycles and Vector Dynamics of Amphibian and Reptile Parasites. *2nd WIldlife MAlaria NETwork (WIMANET) COST Action Workshop, 25*–28 August 2025, Vilnius, Lithuania. (**Invited speaker**).
2. **Netherlands, E.C.*** Blood parasites of amphibians and reptiles. *2nd WIldlife MAlaria NETwork (WIMANET) COST Action Summer School,* 18–22 August 2025, Vilnius, Lithuania. (**Invited speaker**).
3. **Netherlands, E.C.*** The Biology and Interactions of Amphibian and Reptile Blood Parasites. *Faculty of Biological Sciences, Complutense University of Madrid,* 13 June 2025, Madrid, Spain. (**Invited speaker**).
4. **Netherlands, E.C.*** The Biology of Blood Parasites in Amphibians and Reptiles: Uncovering Host-Parasite Dynamics and Ecological Insights. *Department of Biosciences and Pediatric Clinical Research Center, University of Milan,* 23 May 2025, Milan, Italy. (**Invited speaker**).
5. **Netherlands, E.C.*** Life in Cold Blood: The Biology and Interactions of Amphibian and Reptile Blood Parasites. *Department of Biology and Biotechnology, University of Pavia,* 14 May 2025, Pavia, Italy. (**Invited speaker**).
6. **Netherlands EC.** The biology of blood parasites in amphibians and reptiles: Insights into host-parasite interactions and ecology. *VI International Conference on Malaria and Other Blood Parasites of Wildlife & III International Symposium of the Wildlife Diseases Research Network* 26–29 November 2024, Medellín, Colombia. (**Keynote speaker**).
7. **Netherlands EC***, Jordaan BJ, Du Preez LH & Van As J. Exploring the diversity of haemoparasites in *Smaug depressus* (flat dragon lizard), an endemic from the Soutpansberg mountain range in South Africa. *10th World Congress of Herpetology* 5–9 August 2024, Kuching, Sarawak, Malaysia.
8. **Netherlands EC**, Jordaan BJ, Du Buisson J, Haarhof T & Du Preez LH. Under the Dragon's Veil: investigating the diversity of blood parasites in the Flat dragon lizard (*Smaug depressus*) from the Soutpansberg mountain range. *51st Annual Congress of PARSA*, 17–20 September 2023, Muldersdrift.
9. **Netherlands EC**, Jordaan BJ, Du Buisson J, Haarhof T & Du Preez LH. Small dragons, big surprises: exploring the diversity of blood parasites in *Smaug depressus* (flat dragon lizard) from the Soutpansberg mountain range. Zoological Society of Southern Africa (ZSSA), 25–29 September 2023, Central Drakensberg.
10. **Netherlands EC***, du Preez LH. Haemoparasites found parasitizing species of *Leptopelis* (Arthroleptidae) from southern Africa. *19th meeting of the African Amphibian Working Group (AAWG).* Windhoek, Namibia, 22–23 November 2022.

GRANTS OBTAINED:

NRF: Knowledge, Interchange and Collaboration (KIC) (2025) – Grant No: KIC250326306724**:** 2nd WIldlife MAlaria NETwork (WIMANET) COST Action Summer School and Workshop, 18–28 August 2025, Vilnius, Lithuania (R39,240.00).

NRF: Foundational Biodiversity Information Programme (FBIP) (2025/2027) – Grant No: FBIS250408309449: Dragon Blood: Exploring the Diversity of Blood Parasites in South Africa's Dragon Lizards (R249,700.00).

NRF: National Equipment Programme (NEP) (2024/2025) - Laser Microdissection microscope system (R2,988, 970.00 + R1,494,485.00 = R4,483,455.00)

Herpetological Association of Africa Professional Research Grant (2023): Research on *Breviceps* (R15 000.00).

Interdisciplinary Research Grant (2023/2024) – UFS: Greater Kruger Herptile and Human Health (R100,000.00).

Foundational Biodiversity Information Programme (2021/2022) – National Research Foundation (NRF), Grant No: 129114: DNA Barcoding of Ectotherm Blood Parasites from Southern Africa (R185,000.00): Outputs to date: 2× Peer reviewed paper

Foundational Biodiversity Information Programme (2020/2021) – National Research Foundation (NRF), Grant No: 120782: Anuran Diversity and Habitat Utilisation in the Vhembe Biosphere (R199,500.00): Outputs to date: 3× Peer reviewed papers

Parasitological Society of Southern Africa (2019) – Early-career Conference Support grant.

Foundation for the Promotion of Biodiversity Research in Africa (2019) - Botanic Garden Meise, Belgium Grant.

Foundational Biodiversity Information Programme (2017/2018) – National Research Foundation (NRF), Grant UID 98114: Amphibian biodiversity and eco-tourism (R155,000.00): Outputs: 1× Field guide; 4× Peer reviewed papers; 3× MSc degrees; 4× Conference proceedings

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Edward Netherlands

Registration Number: 126419

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule 1 of the Act)

Environmental Science (Professional Natural Scientist)

Effective **7 May 2025** Expires **31 March 2027**

President of Council

Chief Executive Officer

To verify this certificate scan this code

Draft EIA

PALAEONTOLOGICAL AND HERITAGE IMPACT ASSESSMENT FOR INTER-PIVOT AREAS ON FARMS TWEEFONTEIN 373 & KALKFONTEIN 374, PRIESKA, SIYATHEMBA LM, NORTHERN CAPE PROVINCE.

Report prepared for
Digital Soils Africa
www.dsafrica.co.za

Report prepared by
L Rossouw BA Hons (US) MSc (Wits) PhD (UFS)
Paleo Field Services
CC Registration Number: 2011/097199/23
12 Piet du Plooy Street
Langenhovenpark, Bloemfontein, 9301
Cell: 0842505992
Email: lloyd@paleofs.co.za
ASAPA Registration No. 122
#rossouwlloyd
www.linkedin.com/in/lloyd-rossouw-33507b69

Specialist Info

Lloyd Rossouw previously led the Archaeology and Florisbad Quaternary Research Departments at the National Museum in Bloemfontein and has more than 30 years of fieldwork experience in South African archaeology and Quaternary palaeontology. He earned a BA degree in Archaeology, completed an Honours programme in Stone Age Archaeology at the University of Stellenbosch, and received training in osteology and Quaternary palaeontology for his MSc at the Bernard Price Institute of Palaeontology (Wits). He also undertook instruction in human anatomy at Duke University in Durham, North Carolina, USA. For his PhD at the University of the Free State, he developed a palaeobotanical method that uses plant silica remains to reconstruct past environmental conditions. His fieldwork includes participation in various excavations and surveys, such as historical built environments and farmsteads (including Keerweder, Zomerlust, Boekenhoutskloof, Bien Donne, Sterhuis, Fredericksberg, Aurora), rock art surveys (Ceres, Vanrhynsdorp, Clanwilliam, Piketberg), industrial projects (coastal section for Mossgas Pipeline Project, Molenaars River crossing for Du Toitskloof Pass Tunnel Project), Stone Age sites (Hoedjiespunt, Klasies River Mouth, Erfkroon, Damvlei, Thyspunt, Sunnyside, Baden Baden, Florisbad, Cornelia), and palaeontological localities (Langebaanweg, Zwartklip, Besaansklip, Boesmansfontein, Spitskop, Cango Valley, Braamhoek, Gladysvale, Taung). He has surveyed and mapped multiple open sites in the central interior region, including the northern Karoo, lower Orange, Vaal, Modder, Vet and Sand River basins as well as the central Makgadikgadi basin.

Declaration of Independence

Paleo Field Services remains financially independent, with no vested interest in project activities or outcomes except for professional fees. Its sole remuneration comes from agreed-upon services for each project. Paleo Field Services accepts client-provided information as accurate.

Yours truly,

April 2026

SUMMARY

A Phase 1 Palaeontological and Heritage Impact Assessment (PIA/HIA) was undertaken for the inter-pivot areas on the farms Tweefontein 373 and Kalkfontein 374, approximately 38 km north-east of Prieska on the right bank of the Orange River. The assessment focused on the areas between and around existing irrigated crop cultivation under adjoining mechanised centre-pivot systems. Results indicate that the residual palaeontological and archaeological risk associated with the intervening land parcels associated with the existing centre-pivot cultivation is low. The study area is situated on a floodplain-margin landform underlain by Holocene alluvium and locally reworked aeolian sand, forming a near-level sandy plain. Such deposits are widely regarded as having low palaeontological sensitivity, as they are geologically young and subject to frequent reworking, conditions that are generally unfavourable for the accumulation or preservation of fossil material. This interpretation is supported by field observations, which recorded no fossil material in inspected exposures or cuttings across the affected areas. The field survey also recorded no *in situ* Stone Age artefacts or artefact scatters, no visible graves or burial grounds, and no historical structures or infrastructure older than 60 years within the demarcated development footprints. It is noted that the affected areas have already been subjected to substantial prior surface disturbance associated with the establishment and ongoing operation of the existing centre-pivot infrastructure. Any archaeological impacts have therefore largely already occurred and are confined to reworked surface contexts. On this basis, the continuation of the existing agricultural activity is unlikely to result in any additional loss of unique, significant, or scientifically irreplaceable palaeontological or archaeological resources. The centre-pivot areas on both farms are accordingly assigned a Generally Protected C (low significance) rating, on condition that future activities do not involve deeper ground disturbance beyond the already impacted footprint.

CONTENTS

INTRODUCTION 4
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REFERENCES 17

INTRODUCTION

A Phase 1 Palaeontological and Heritage Impact Assessment (PIA/HIA) was undertaken for the inter-pivot areas on the farms Tweefontein 373 and Kalkfontein 374, approximately 38 km north-east of Prieska on the right bank of the Orange River. The assessment focused on the areas between and around existing irrigated crop cultivation under adjoining mechanised centre-pivot systems (**Fig. 1 & 2**).

Map Reference: 1:50 000 scale topographic map 2923AC Niewejaarskraal and 1:250 000 scale geological map 2922 Prieska.

Farm Reference: Remainder of the Farm Tweefontein 373 & Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374.

Centroid Coordinates

Tweefontein Pivots: 29°24'40.09"S 23° 1'14.41"E (~31 hectares)

Kalkfontein Pivots: 29°24'44.11"S 23° 2'2.84"E (~104 hectares)

Figure 2. General view of the study area.

LEGAL FRAMEWORK

The assessment is required as a prerequisite for new development in terms of the National Heritage Resources Act (NHRA) 25 of 1999. The NHRA identifies what is defined as a heritage resource, the criteria for establishing its significance and lists specific activities for which a heritage specialist study may be required. The NHRA prescribes a system of grading of places/objects via Section 7 and makes provision for the general protection of heritage resources via Sections 34, 35, 36, and 37 (in respect of the built environment, archaeology/ palaeontology, burial grounds/graves and monuments/memorials, respectively), while

Section 38 sets out guidelines under which heritage impact assessments are required when new developments may impact upon heritage resources.

Section 38(1) applies when a development triggers heritage assessment requirements but does not require an environmental authorisation from another regulatory authority, including:

1. Construction of a road, powerline or pipeline, canal or other similar form of linear development or barrier longer than 300m.
2. Construction of a bridge or similar structure exceeding 50 m.
3. Development exceeding 5,000 m².
4. Rezoning of land exceeding 10,000 m², or
5. Any development that may impact recognized heritage resources (e.g., archaeological sites, graves, buildings older than 60 years).

Section 38(3) of the NHRA sets the minimum information requirements for a Heritage Impact Assessment report: the responsible heritage resources authority must ensure that any report submitted includes, at least, the core elements listed in Section 38(3)(a)–(g), namely identification and mapping of heritage resources, significance assessment, impact assessment, evaluation against socio-economic benefits, consultation outcomes, consideration of alternatives (where impacts occur), and mitigation planning.

DISCLAIMER, ASSUMPTIONS AND LIMITATIONS

Information provided by the Client and/or Environmental Assessment Practitioner (EAP) was assumed to be accurate and complete for the purposes of this assessment. Observations presented in this report are based solely on aboveground visibility of features and outcrops as encountered during field survey. The reliability and completeness of these observations are subject to several inherent limitations:

- Fossiliferous outcrops are often limited to exposed lithologies and may be obscured by colluvium, vegetation, or soil mantling; the degree of weathering affects the preservation and visibility of fossil material, with heavily weathered surfaces potentially masking fossil content or fragmenting specimens; stratigraphic context is inferred from visible lithologies only; subsurface fossil-bearing horizons may remain undetected without trenching or coring; access limitations may restrict inspection of

key geological exposures, particularly in rugged terrain or areas with restricted land access.

- The surface visibility of archaeological remains is variable and may be significantly reduced by vegetation cover, soil accumulation, or recent land disturbance (e.g., ploughing, erosion, construction); subsurface archaeological remains (e.g., buried structures, features, or artefact scatters) may not be detectable without excavation or remote sensing; weathering and exposure can obscure diagnostic features such as stone alignments, midden deposits, or low-relief structures, especially in areas with high sedimentation or seasonal vegetation growth; accessibility constraints (e.g., fenced properties, steep terrain, or dense bush) may prevent systematic coverage, resulting in partial or biased spatial data.

METHODOLOGY

The site assessment was carried out in line with the National Heritage Resources Act (Act No. 25 of 1999) and the 2007 SAHRA Minimum Standards for Archaeological and Palaeontological Impact Assessments. Initial site ratings were based on existing field data, relevant databases, and published literature. Topographic, aerial and geological maps were used for illustrative purposes and to identify potential fossil-bearing formations. Fieldwork involved direct observation through foot surveys, with vehicle access where possible. A Garmin Etrex Vista handheld GPS (set to the WGS 84 datum) and a digital camera were used to record spatial and visual data throughout the survey. GPS coordinates are presented in *Degrees, Minutes, Seconds* format in the report.

TERMS OF REFERENCE

The Terms of Reference outlines the scope and objectives for assessing potential impacts on heritage resources—both tangible and intangible—arising from the proposed development, in accordance with relevant legislative standards.

1. Conduct site investigation for a Heritage *Impact Assessment (HIA)* to identify and map heritage sites and occurrences in the affected area(s) and provide an assessment of

their significance. This must be done regardless of the sensitivity indicated on the *DESTEA National Web Based Environmental Screening Tool,* as the Department of Environmental Affairs and its entities make no warranty—express or implied—regarding the accuracy, reliability, usefulness, or completeness of the *archaeological and cultural heritage theme layer.*

Figure 3. Study area marked by yellow polygons on portion of SAHRIS palaeosensitivity map.

2. Conduct a site investigation for a Palaeontological Impact Assessment (PIA) using the SAHRIS PalaeoSensitivity Map (**Fig. 3**), regardless of the sensitivity indicated on the *DESTEA National Web Based Environmental Screening Tool*. Identify and map fossils or exposures in the area and assess their significance. This is required as the Department of Environmental Affairs does not guarantee the accuracy or completeness of the *palaeontology theme layer*.
3. Assess impacts of the proposed development on heritage resources relative to the sustainable social and economic benefits to be derived from the development *if planned impacts will result in the loss of any resources*.
4. Provide a system of grading of places and objects which form part of the national estate, and which distinguishes between at least the categories as prescribed under Section 7 of the NHRA (**Table 1**).

Table 1. Description of Field Rating categories as prescribed in Section 7(1) of the NHRA where SAHRA must by regulation establish a system of grading of places and objects which form part of the national estate, and which distinguishes between at least the categories— (a) Grade 1: Heritage resources with qualities so exceptional that they are of special national significance; (b) Grade 2: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; (c) Grade 3: Heritage resources which can be considered to have special qualities which make them locally significant; and Generally Protected: Other heritage resources which may require mitigation before destruction.

Field Rating	**Grade (NHRA No. 25 of 1999, Section 7)**	**Significance**	**Mitigation**
National Significance (NS)	Grade 1	-	Conservation: national site nomination
Provincial Significance (PS)	Grade 2	-	Conservation: provincial site nomination
Local Significance (LS)	Grade 3A	High significance	Conservation: mitigation not advised
Local Significance (LS)	Grade 3B	High significance	Mitigation (part of site should be retained)
Generally Protected A	-	High/medium significance	Mitigation before destruction
Generally Protected B	-	Medium significance	Recording before destruction
Generally Protected C	-	Low significance	Destruction

PALAEONTOLOGICAL BACKGROUND

From oldest to youngest, the study area and immediate surrounds are underlain by localised Early Permian Dwyka sediments (C-Pd), widespread Late Tertiary to Quaternary calcretes (T-Qc), aeolian sand (Qs) and other superficial deposits (**Fig. 4**).

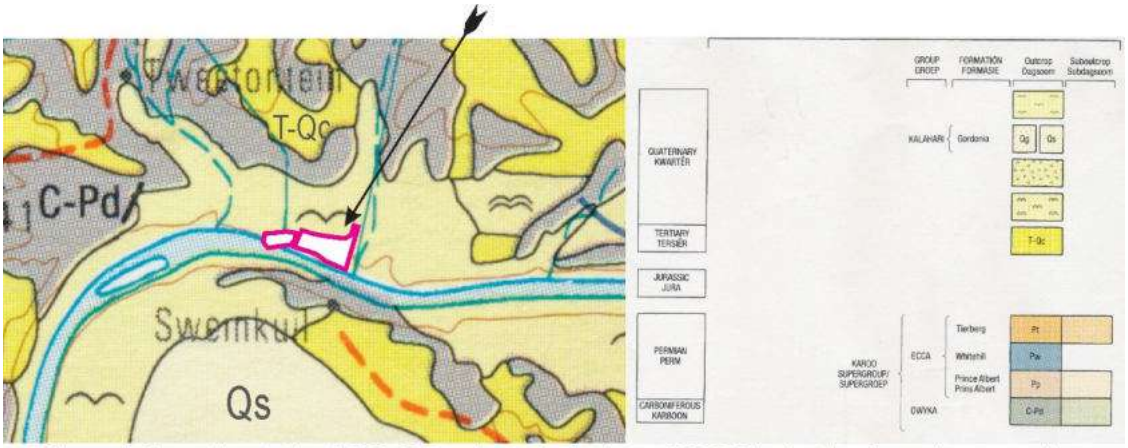

Figure 4. According to the 1:250 000 scale geological map 2922 Prieska the site and surrounding areas are underlain by Early Permian Dwyka sediments (C-Pd) and widespread Late Tertiary to Quaternary calcretes (T-Qc), aeolian sands (Qs) and alluvium.

Localised Dwyka-aged palaeovalleys preserve evidence of glaciation, including glaciated pavements with polished, striated basement surfaces, tillites and Dwyka mudrocks are noted as having yielded trace fossils (including fish and invertebrate trackways), microfossil remains (foraminifera, bryozoans, sponge spicules and radiolaria), and fossil plant material including lycopods, Glossopterids, fossilised wood and plant micro-remains (spores and pollen). In younger deposits, Late Cenozoic duricrusts and eluvium include calcretes (T–Qc), surface gravels and reworked calcretes, aeolian sand. Rare Florisian-type vertebrate fossil remains are known from old calcrete quarries in the area.

FIELD ASSESSMENT – PALAEONTOLOGY

The study area is situated on a floodplain margin along the right bank of the Orange River and is underlain by unconsolidated alluvium and locally reworked aeolian sand characterised by a near-level sandy plain (**Fig. 5**). Exposed riverbank sections show discontinuous gravel lags where finer sediments have been deflated or washed out. The areas indicate substantial deposits of fine- to medium-grained, structureless sand, which contain scattered small

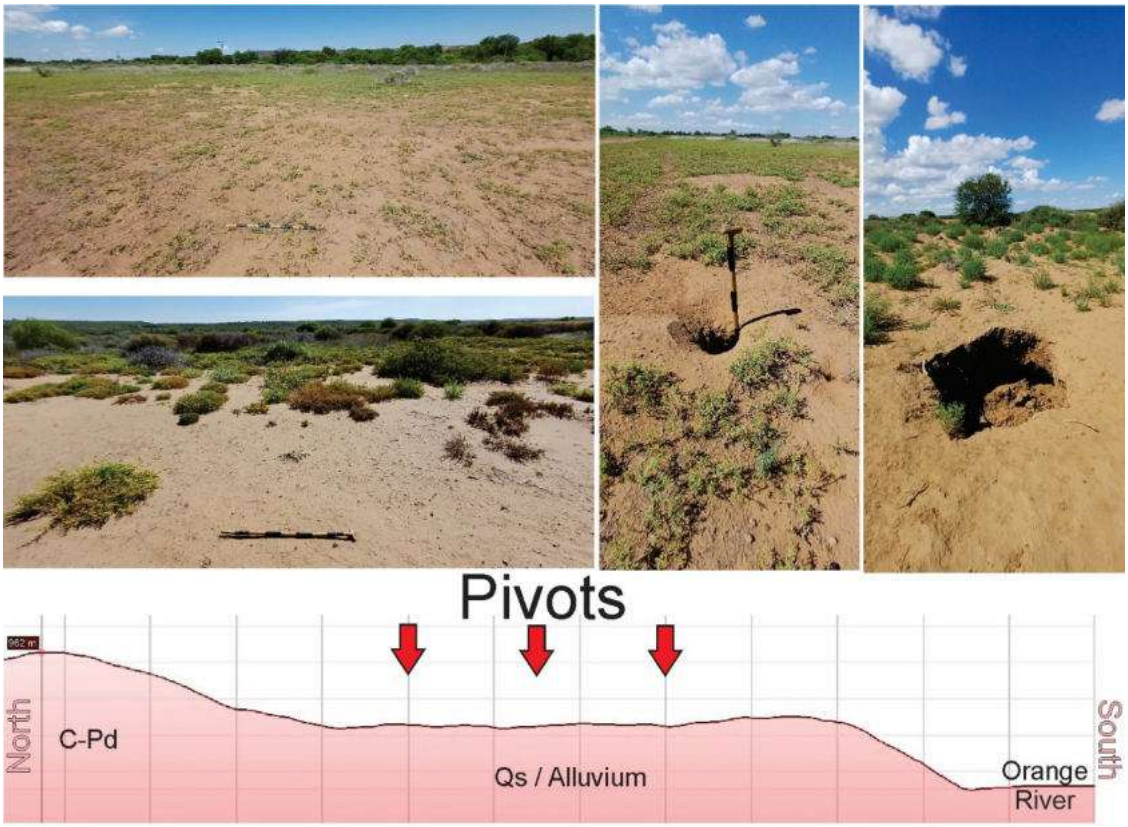

Figure 5. The study area is situated on a floodplain margin along the right bank of the Orange River and is underlain by unconsolidated alluvium and locally reworked aeolian sand characterised by a near-level sandy plain where the pivots are situated (elevation profile, below)

pebbles and cobbles, including subrounded lithic clasts characteristic of river-derived bedload, as well as occasional calcrete nodules (**Fig. 6**). Overall, the terrain reflects an episodically active depositional setting which is most plausibly Holocene in age where it forms part of the active floodplain. Holocene alluvial deposits, which are generally too young and too frequently reworked to accumulate and preserve fossil material are widely regarded as having low palaeontological sensitivity, and this expectation is corroborated by the absence of fossils in inspected exposures and cuttings at the site. Consequently, both the Kalkfontein and Tweefontein sites are assigned a Generally Protected C (low) palaeontological field rating (**Table 1**).

PALAEONTOLOGICAL IMPACT AND RECOMMENDATIONS (NHRA SECTION 38(3))

The results of the site investigation are presented under the minimum information requirements set out in Section 38(3)(a)–(g) of the National Heritage Resources Act (NHRA):

Figure 6. Exposed riverbank sections show discontinuous gravel lags where finer sediments have been deflated or washed out. The areas indicate substantial deposits of fine- to medium-grained, structureless sand, which contain scattered small pebbles and cobbles, including subrounded lithic clasts characteristic of river-derived bedloads, as well as occasional calcrete nodules. Scale 1 = 10 cm.

a) Identification and mapping of all heritage resources

A desktop and field-based palaeontological assessment was undertaken using geological mapping (1:250 000 scale), regional palaeontological literature, the SAHRIS PalaeoSensitivity Map, aerial imagery, and on-site inspection. The study area was confirmed to be positioned on a floodplain margin that is underlain by unconsolidated alluvium (Qs / alluvium) with locally reworked aeolian sand. Exposures comprise fine- to medium-grained, structureless sandy overbank deposits with discontinuous gravel lags and occasional calcrete nodules. No fossil material or fossil-bearing horizons were observed at surface or within inspected cuttings/exposures.

b) Assessment of the significance of identified heritage resources

No fossils/fossil localities were identified. The affected sediments are interpreted as a geologically young active floodplain and are assigned Generally Protected C (low) palaeontological field rating for both the Kalkfontein and Tweefontein sites.

c) Assessment of the nature and extent of potential impacts

Potential impacts are limited to the disturbance/removal of near-surface sandy alluvium during typical agricultural activities (e.g., ploughing, harvesting). Given that the deposits are loose, structureless, and actively reworked overbank/alluvial sands, the likelihood of impacting scientifically significant fossil material is very low, and no fossils were observed in exposed sections.

d) Evaluation of impacts in relation to the anticipated social and economic benefits of the proposed development

Given the absence of palaeontological resources and the negligible level of impact, the continuation of agricultural activities presents no conflict with palaeontological conservation objectives.

e) Consultation with interested and affected parties regarding potential impacts on heritage resources

No objections or concerns relating to palaeontological heritage were raised during EAP consultation processes.

f) Consideration of feasible alternatives where heritage resources may be adversely affected, including alternative layouts or development options.

Due to the lack of palaeontological resources and the low sensitivity of Holocene overbank and alluvial sands, there are no palaeontological constraints that necessitate alternative layouts or cessation of operations.

g) Mitigation measures to avoid, minimise, or manage adverse impacts on heritage resources during construction, operation, and post-completion phases of the development.

No mitigation or monitoring is required. The study area is assigned a **Generally Protected C** rating for palaeontology under Section 35 of the NHRA, conditional on future activities remaining within the scope of existing shallow disturbance.

ARCHAEOLOGICAL BACKGROUND

The wider Prieska region preserves a well-defined Stone Age footprint together with historical period remains, with Early, Middle and Later Stone Age sites recorded particularly in association with pan and mountain plateau environments, while open plains are generally characterised by low-density surface scatters. Isolated ESA and MSA artefact scatters are also recorded within Orange River overbank sediments between Douglas and Prieska, with named occurrences including Marksdrift, Kliphuis, Elswater, Brakfontein, Holsloot and Nuwejaarskraal, and stone tool surface scatters have been recorded in the Prieska Townlands to the southwest. Rock art occurs along the steep slopes of the Asbes and Doringberge to the north and south of Prieska, with noted examples including Wonderdraai, Omdraaisvlei and Sandfontein, and rock engravings have been recorded in younger valley fills along steeper slopes at Sandfontein north of Prieska. Archaeological and historical accounts describe precolonial occupation by Bushman hunter-gatherers and Khoi pastoralists, with early travellers encountering Koranna, Griqua and Bushman groups in the region, and the place-

name “Prieska” is derived from a Koranna term meaning “place of the lost she-goat”; the Middle Orange River context is further described in terms of Khoikhoi group distributions and later movements of Xhosa-speaking groups into the Pramberg and Karreeberg regions south of Prieska.

Historical-period heritage includes remnants dating to the Anglo-Boer War and its aftermath, including a stone fort on top of the Prieska Koppie overlooking the town, and other listed historical buildings and burial places in Prieska (including the Dutch Reformed Church in Church Street and an old graveyard near the Prieska Golf Club). The regional historical landscape also includes ruins and graveyards linked to the early 20th-century asbestos mining industry at multiple localities north and south of Prieska, including occurrences associated with Karabee and Keikams Poort, as well as Kliphuis on the Orange River northwest of Prieska, and wider distributions of stone-walled ruins on farms in the surrounding district.

FIELD ASSESSMENT - ARCHAEOLOGY

Both the Kalkfontein and Tweefontein sites are situated on a floodplain margin separated by a right bank tributary (drainage line) of the Orange River and is underlain by unconsolidated sandy sediments (alluvium and reworked aeolian sand). No heritage resources were identified within the project footprint during the Phase 1 field survey. The field survey reports no *in situ* Stone Age artefacts or scatters, no aboveground signs of graves/burial grounds, and no historical structures or infrastructure older than 60 years within the demarcated development footprints. It is noted that the affected areas are already subject to existing agricultural pivot infrastructure and associated surface disturbance. Impacts to archaeological resources have therefore largely already occurred and are confined to reworked surface contexts. As such, the *continuation* of the existing agricultural activity is unlikely to result in additional loss of unique or scientifically irreplaceable archaeological resources. The overall archaeological impact associated with the existing pivots is accordingly assessed as low, and the pivots are assigned a site rating of Generally Protected C (**Table 1**), provided that future activities do not involve deeper ground disturbance beyond the currently impacted areas.

ARCHAEOLOGICAL IMPACT & RECOMMENDATIONS (NHRA S38(3))

The results of the site investigation are presented under the minimum information requirements set out in Section 38(3)(a)–(g) of the National Heritage Resources Act (NHRA):

a) Identification and mapping of all heritage resources

A desktop and field-based palaeontological assessment was undertaken using geological mapping (1:250 000 scale), regional archaeological literature, aerial imagery, and on-site inspection. The affected area comprises a near-level **sandy floodplain-margin surface** on Orange River alluvium with local gravel lags and minor calcrete nodules. Within the areas inspected, **no archaeological material or features** (e.g., stone artefact scatters, structures, kraals, midden material, graves) were identified on the surface or in visible cuttings.

b) Assessment of the significance of identified heritage resources

As **no archaeological resources** were identified, the archaeological significance of the affected footprint is assessed as **low**, subject to the limitation that **buried or obscured materials** can occur unpredictably in alluvial settings

c) Assessment of the nature and extent of potential impacts

In this floodplain-margin context the probability of encountering intact archaeological horizons in the loose, structureless sand is assessed as **low**, and no surface indicators were observed. Any likely impacts to archaeological resources have already occurred and are confined to reworked surface contexts.

d) Evaluation of impacts in relation to the anticipated social and economic benefits of the proposed development

The residual archaeological impact is expected to be **low** when weighed against the anticipated economic benefits of the proposed development.

e) Consultation with interested and affected parties regarding potential impacts on heritage resources

No objections or concerns relating to archaeological heritage were raised during EAP consultation processes

f) Consideration of feasible alternatives where heritage resources may be adversely affected, including alternative layouts or development options.

Due to the lack of archaeological resources, there are no archaeological constraints that necessitate alternative layouts or cessation of operations.

g) Mitigation measures to avoid, minimise, or manage adverse impacts on heritage resources during construction, operation, and post-completion phases of the development.

No mitigation or monitoring is required. The study area is assigned a **Generally Protected C** rating for archaeology under Section 35 of the NHRA, conditional on future activities remaining within the scope of existing shallow disturbance.

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agriculture, environmental affairs, rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Application for authorization in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 as amended.

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

1. Project title:

Development of the remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, Siyathemba Local Municipality, Northern Cape province.

2. Details of the specialist:

Project Specialist:	Dr. L. Rossouw		
Trading name (if any):	Paleo Field Services		
Business reg. no./ID. no.:	6711225124086		
Contact person:	L. Rossouw		
Physical address:	Piet du Plooy Str. 12, Langenhovenpark, Bloemfontein, 9301		
Postal address:	" " "		
Postal code:	9330	**Cell:**	0842505992
Telephone:	0842505992	**Fax:**	
E-mail:	lloyd@paleofs.co.za		
Qualifications:	Phd		
Professional affiliation (s) (if any)	ASAPA & PSSA		

3. Details of the consultant

Project consultant/firm:	Digital Soils Africa (Pty) Ltd		
Business reg. no./ID. no.:	2012/111217/07		
Contact person:	Natalie Sharp		
Postal address:	45 Church Street, Walmer		
Postal code:	6070	**Cell:**	082 414 0472
Telephone:	082 414 0472	**Fax:**	
E-mail:	natalie@dsafrica.co.za		

Gesertifiseer 'n ware afskrif van die oorspronklike / Certified a true copy of the original
Datum 28/07/2026 Date

Ex Officio KOMMISSARIS VAN EDE
Ex Officio COMMISSIONER OF OATHS
BRAAM VAN WYK
PRINSIPAAL / PRINCIPAL

Grey Kollege Sekondêr
Jock Meiringstraat
Parkwes
Bloemfontein

Grey College Secondary
Jock Meiring Street
Parkwest
Bloemfontein

4. Declaration by the specialist appointed in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

I, Lloyd Rossouw, declare that --

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Paleo Field Services

Name of company (if applicable):

28/07/2026

Date:

Signature of the Commissioner of Oaths:

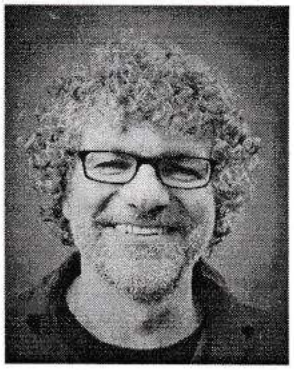
Date:

Designation:

Official stamp (below):

Gesertifiseer 'n ware afskrif van die oorspronklike / Certified a true copy of the original
Datum 28/07/2026 Date
Ex Officio KOMMISSARIS VAN EDE
Ex Officio COMMISSIONER OF OATHS
BRAAM VAN WYK
PRINSIPAAL / PRINCIPAL
Grey Kollege Sekondêr
Jack Meiringstraat
Parkwes
Bloemfontein
Grey College Secondary
Jack Meiring Street
Parkwest
Bloemfontein

L ROSSOUW - BIOSKETCH



Name: Lloyd Rossouw
Nationality: South African
ID # 6711225124086
Home Address: 12 Piet du Plooy Street, Langenhovenpark, Bloemfontein, 9330, South Africa.

Academic Education & Qualifications

Degrees

Ph.D Palaeoenvironmental Science, Dept. of Plant Science, 2009. University of the Free State.
M.Sc. Quaternary Vertebrate Palaeontology (cum laude), 2001. Bernard Price Institute for Palaeontology, University of the Witwatersrand.
B.A. (Hons.) Archaeology, 1991. University of Stellenbosch.

Formal Courses

Theory and Practice of Stable Light Isotope Spectrometry, Stable Light Isotope Facility, University of Cape Town, RSA (2003)
Gross Human Anatomy, Duke University Medical School, Durham, North Carolina, United States of America (1999).

Employment History

Director, Paleo Field Services (2024 -).
HOD & Curator of Collections, Florisbad Quaternary Research Station, National Museum, Bloemfontein (2019 – 2024).
HOD, Department of Archaeology, National Museum, Bloemfontein (2010 – 2019).
Museum Scientist, Florisbad Quaternary Research Station, National Museum, Bloemfontein (1999 – 2009).
Field Investigator, Palaeo-Anthropological Research Group, Department of Anatomical Sciences, University of the Witwatersrand (1998).
Collections Manager, Florisbad Quaternary Research Station, National Museum, Bloemfontein (1994-1997).

Professional Affiliation

Member and registered heritage practitioner, Association of Southern African Professional Archaeologists (ASAPA Reg. no. 122), 2002 – Present.
Member, Palaeontological Society of Southern Africa (PSSA), 2002 - Present
Research Fellow, Dept. of Plant Sciences, University of the Free State, Bloemfontein (2018 – Present).

Fieldwork Experience

Lloyd Rossouw previously led the Archaeology and Florisbad Quaternary Research Departments at the National Museum in Bloemfontein and has more than 30 years of fieldwork experience in South African archaeology and Quaternary palaeontology (**Appendix 1**). He earned a BA degree in Archaeology, completed an Honours programme in Stone Age Archaeology at the University of Stellenbosch, and received training in osteology and Quaternary palaeontology for his MSc at the Bernard Price Institute of Palaeontology (Wits). He also undertook instruction in human anatomy at Duke University in Durham, North Carolina, USA. For his PhD at the University of the Free State, he developed a palaeobotanical method that uses plant silica remains to reconstruct past environmental conditions. His fieldwork includes participation in various excavations and surveys, such as historical built environments and farmsteads (including Keerweder, Zomerlust, Boekenhoutskloof, Bien Donne, Sterhuis, Fredericksberg, Aurora), rock art surveys (Ceres, Vanrhynsdorp, Clanwilliam, Piketberg), industrial projects (coastal section for Mossgas Pipeline Project, Molenaars River crossing for Du Toitskloof Pass Tunnel Project), Stone Age sites (Hoedjiespunt, Klasies River Mouth, Erfkroon, Damvlei, Thyspunt, Sunnyside, Baden Baden, Florisbad, Cornelia), and palaeontological localities (Langebaanweg, Zwartklip, Besaansklip, Boesmansfontein, Spitskop, Cango Valley, Braamhoek, Gladysvale, Taung). He has surveyed and mapped multiple open sites in the central interior region, including the northern Karoo, lower Orange, Vaal, Modder, Vet and Sand River basins as well as the central Makgadikgadi basin.

Ten most recent Heritage Impact Assessments 2026

1. 2926AA Bloemfontein_Palaeontological and Heritage Impact assessment for the proposed Mangaung Metropolitan Municipality Northern Bulk Distribution Pipeline, Bloemfontein, Free State Province.
2. 2827AA Ventersburg_ Heritage Impact Statement & Site Management Plan: Mashiane family graveyard — Virginia Solar Park, Lejweleputswa DM, Free State Province.
3. 2824DA Barkley West_Palaeontological and Heritage Impact assessment for a proposed new cemetery and crematorium development on Portion 350 of farm Vooruitzicht 81, near Kimberley, Sol Plaatje LM, Northern Cape Province.
4. 2728AD Frankfort_Palaeontological and Heritage Impact assessment for a proposed new cattle feedlot development and compost facility on adjoining farms Van Oordt 664 and Van Oordt A 935 near Frankfort, Mafube LM, Free State Province.
5. 2824BB Warrenton_PIA & HIA Warrenton WWTW & Bulk Water Reticulation NC.
6. 2726DD Riebeeckstad_Desktop PIA - 7ha Residential Development, Constantia Str Thabong, FS.
7. 2926 AA Bloemfontein_Palaeontological and Heritage Impact assessment for the proposed 17 km section N8 Ring Road (Phase 1) near Bloemfontein, FS Province.
8. 2922DB Prieska Oos_PIA & AIA Bloukrans Goue Akker & Montery Agricultural Development.
9. 3026CB Goedemoed_HIA Brandfontein 36 Feedlot Expansion.
10. 2819CD Oupvlakte_ PIA & AIA Sending WWTW & Irrigation Area.

Peer-reviewed Publications

1. Monteagudo, F.C., Richard, M. **Rossouw, L.** and Toffolo M. B. 2025. Archaeological survey of the Modder River dongas, Free State, South Africa. Southern African Field Archaeology. DOI: https://doi.org/10.36615/safa.20.3540.2025

2. Toffolo, M.B., Tribolo, C., Horwitz, L.K., **Rossouw, L.**, Bousman, C.B., Richard, M., Boaretto, E. and Miller, C.E. 2023. Palaeoenvironments and chronology of the Damvlei Later Stone Age site, Free State, South Africa. *South African Archaeological Bulletin* 78 (219).
3. Richard, M., Kaplan-Ashiri, I., Alonso, M., Pons-Branchu, E., Dapoigny, A., **Rossouw, L.** and Toffolo, M.B. 2023. New ESR dates from Lovedale, Free State, South Africa: implications for the study of tooth diagenesis. *South African Archaeological Bulletin* 78 (219).
4. Will Archer, Darya Presnyakova, Vera Aldeias, Debra Colarossi, Louisa Hutten, Tobias Lauer, Guillaume Porraz, **Lloyd Rossouw**, Matthew Shaw. **2023**. Late Acheulean occupations at Montagu Cave and the pattern of Middle Pleistocene behavioral change in Western Cape, southern Africa, Journal of Human Evolution 184, https://doi.org/10.1016/j.jhevol.2023.103435.
5. Bousman, B., Codron, D., Gowlett, J., Herries, A.I.R., **Rossouw, L.**, Toffolo, M. **2023**. *Cornelia-Uitzoek, Free State, South Africa*. **In** Beyin, A. Wright, D., Wilkins, J., Bouzouggar, A. Olszewski, D. (EDs.) Handbook of Pleistocene Archaeology of Africa: Hominin Behavior, Geography, and Chronology. Springer.
6. Bousman, B., Brink, J.S., **Rossouw, L.**, Bateman, M., Morris, S., Meier, H., Cohen, B., Trower, G., Herries, A.I.R., Palmison, M., Ringstaff, C., Thornton-Barnett, S. **2023**. *Erfkroon, Western Free State, South Africa*. **In** Beyin, A. Wright, D., Wilkins, J., Bouzouggar, A. Olszewski, D. (EDs.) Handbook of Pleistocene Archaeology of Africa: Hominin Behavior, Geography, and Chronology. Springer.
7. James S. Brink+, John A.J. Gowlett, Andy I.R. Herries, John Hancox, Jacopo Moggi-Cecchi, Daryl Codron, **Lloyd Rossouw**, Gary Trower, Olivia M.L. Stone, C. Britt Bousman, Rainer Grün, and Antoine Souron **2022**. Cornelia-Uitzoek: Paleoecology, Archeology, and Geochronology In: S.C. Reynolds and R. Bobe (eds). *African Paleoecology and Human Evolution*. Cambridge University Press.
8. Liora Kolska Horwitz, Margaret D. Avery, Marion K. Bamford, Francesco Berna, James S. Brink+, Michaela Ecker, Yolanda Fernandez-Jalvo, Paul Goldberg, Sharon Holt, Julia Lee-Thorp, Ari Matmon, Robyn Pickering, Naomi Porat, **Lloyd Rossouw**, Louis Scott, and Michael Chazan **2022**. Wonderwerk Cave, Northern Cape Province: An Early–Middle Pleistocene Paleoenvironmental Sequence for the Interior of South Africa. In: S.C. Reynolds and R. Bobe (eds). *African Paleoecology and Human Evolution*. Cambridge University Press.
9. Kristen Wroth, Chantal Tribolo, C. Britt Bousman, Liora Kolska Horwitz, **Lloyd Rossouw**, Christopher E. Miller, Michael B. Toffolo **2022**. Human occupation of the semi-arid grasslands in the interior of South Africa during Marine Isotope Stage 4: New archaeological and paleoecological evidence from Lovedale, Free State. *Quaternary Science Reviews*, 283 https://doi.org/10.1016/j.quascirev.2022.107455
10. **Rossouw, L. 2022**. Morphological variation in the distal phalanges of the springbok, Antidorcas marsupialis (Zimmermann 1780) (Mammalia: Bovidae). *South African Journal of Science*, 118(3/4) https://doi.org/10.17159/sajs.2022/10452Grine, F., Gonzalvo, E., Rossouw, **L**, Holt, S, Black, W. && Braga J. 2021.Variation in Middle Stone Age mandibular molar enamel-dentine junction topography at Klasies River Main Site assessed by diffeomorphic surface matching. *Journal of Human Evolution* 161.

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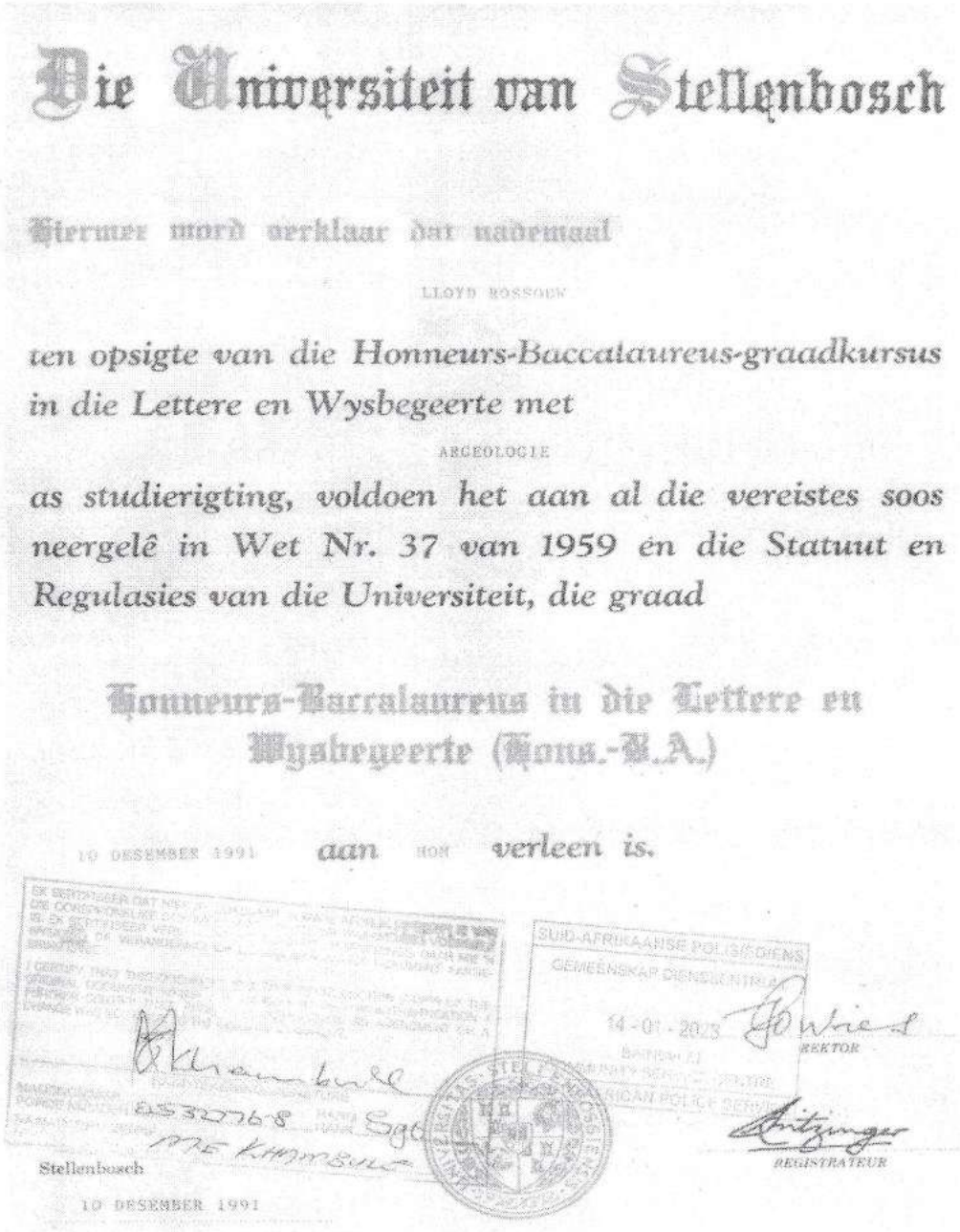

Die Universiteit van Stellenbosch

Hiermee word verklaar dat nademaal

LLOYD ROSSOUW

ten opsigte van die Honneurs-Baccalaureus-graadkursus in die Lettere en Wysbegeerte met

ARGEOLOGIE

as studierigting, voldoen het aan al die vereistes soos neergelê in Wet Nr. 37 van 1959 en die Statuut en Regulasies van die Universiteit, die graad

Honneurs-Baccalaureus in die Lettere en Wysbegeerte (Hons.-B.A.)

10 DESEMBER 1991 aan HOM verleen is.

Stellenbosch

10 DESEMBER 1991

REKTOR

REGISTRATEUR

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

At a congregation of the University

held on 24 April 2001

Lloyd Rossouw

was admitted to the Degree of

Master of Science

(with distinction)

Dean, Faculty of Science

Acting Vice-Chancellor and Principal

Registrar

SUID-AFRIKAANSE POLISIEDIENS
GEMEENSKAP DIENSSENTRUM
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SOUTH AFRICAN POLICE SERVICE

UNIVERSITEIT VAN DIE VRYSTAAT

UNIVERSITY OF THE FREE STATE

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IT IS HEREBY CERTIFIED THAT, IN ACCORDANCE WITH THE STATUTES AND REGULATIONS OF THE UNIVERSITY, AND PURSUANT TO THE SUBMISSION OF A THESIS ENTITLED

THE APPLICATION OF FOSSIL GRASS-PHYTOLITH ANALYSIS IN THE RECONSTRUCTION OF LATE CAINOZOIC ENVIRONMENTS IN THE SOUTH AFRICAN CENTRAL INTERIOR

DIE GRAAD THE DEGREE

Philosophiae Doctor

in Plantwetenskappe
in Plant Sciences

TOEGEKEN IS AAN
HAS BEEN CONFERRED UPON

LLOYD ROSSOUW

AS BEWYS DAARVAN PLAAS ONS ONS ONDERSKEIE HANDTEKENINGE EN DIE SEËL VAN DIE UNIVERSITEIT HIERONDER.

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THE ASSOCIATION OF SOUTHERN AFRICAN PROFESSIONAL ARCHAEOLOGISTS

CERTIFICATE OF MEMBERSHIP

HEREBY CONFIRMS THAT

LLOYD ROSSOUW

Is a Professional Member (No 0122) of
the Association of Southern African Professional
Archaeologists and is in good standing
with the organisation

Valid April 2025
March 2026

WOUTER FOURIE
CHAIRPERSON

SHAHZAADEE KHAN
TREASURER

APPENDIX 1: Synopsis of fieldwork experience

1989

Eastern Cape (Tsitsikamma Coast, Kouga LM), research excavations into the Middle Stone Age cave deposits at Klasies River Main Site, on the Indian Ocean cliff line ~25 km east of Humansdorp — a globally significant MSA sequence preserving some of the earliest anatomically modern human (*Homo sapiens*) remains, MSA I–II / Howiesons Poort assemblages, and rich shellfish, marine mammal and terrestrial faunal records spanning MIS 5–3 (Rossouw, 1989a).

Northern Cape (Kenhardt district, Khâi-Ma / Kai !Garib LM margin), research survey of Later Stone Age open-air occupation sites at Bitterputs, on the southern Bushmanland plain — characteristic Wilton-related microlithic assemblages, ostrich eggshell scatters and ephemeral hearth features associated with Holocene pan margins and ephemeral water sources (Rossouw, 1989b).

Southern / Western Cape (Mossel Bay – Cape Winelands corridor), Phase 1 archaeological impact study of coastal shell middens along the ~30 km Vlees Bay Mossgas Pipeline footprint, on Holocene aeolianite and beach-rock substrates — middens typical of the southern Cape "Strandloper" Late Holocene LSA tradition, with mixed *Choromytilus/Patella* shellfish, lithic scatters and occasional ceramics (Rossouw, 1989c); and historical archaeology contracts at Sterhuis Veepos, Grabouw (Theewaterskloof LM), First National Bank, Stellenbosch, and 17 Van Ryneveld Street, Stellenbosch — VOC-period (late 17th – 18th century) Cape Dutch built-environment investigations (Rossouw, 1989d–f).

1990

Western Cape (Garden Route, Cederberg / Olifants River basin, Cape Winelands), coastal palaeoenvironmental research (vibra-coring of Holocene wetland sediments around Knysna lagoon and adjacent estuarine pans) targeting pollen, diatom and phytolith proxies of post-LGM sea-level and vegetation change; and rock art recording and rehabilitation expeditions at Kagga Kamma in the Ceres Karoo (~30 km NE of Ceres) and at Gifberg / Wiedouw west of Vanrhynsdorp, on Table Mountain Group sandstone shelters preserving fine-line San hunter-gatherer paintings (eland, therianthropes, geometric motifs) of likely mid- to Late Holocene age (Rossouw, 1990a–c); continuation of the First National Bank, Stellenbosch, historical archaeology contract; historical archaeology contract at Bien Donné Farmstead (est. 1762), Franschhoek (Cape Dutch werf complex on a French Huguenot land grant); and historical archaeology contract at Simondium (Rossouw, 1990d–f).

1991

Western Cape (Cederberg, Cape Winelands, Swartland), rock art recording and rehabilitation expeditions at Traveller's Rest, Clanwilliam (Olifants River valley, Table Mountain Group sandstone shelters with San fine-line paintings and finger-dot motifs) and at Banghoek, Piketberg (Rossouw, 1991a–b); historical archaeology contracts at Fredericksberg Farmstead (est. 1690 — among the earliest Huguenot-period werf complexes in the Drakenstein), Franschhoek; Boekenhoutskloof Farmstead (est. 1776), Franschhoek; and Bien Donné [Phase 2], Simondium (Rossouw, 1991c–e).

1992

Western Cape (Cape Winelands), historical archaeology contracts at Keerweder, Franschhoek; Zomerlust, Paarl (early Cape Dutch townhouse / outbuilding complex); Bien Donné [Phase 3], Simondium; and the Markötter Sports Ground Grave, Stellenbosch — historical burial investigation and exhumation under HWC / NHRA Section 36 protocols (Rossouw, 1992a–d).

1994

Free State (Mangaung Metro), research excavation of the Middle Stone Age living floor at Florisbad spring site (~45 km NW of Bloemfontein) on the Florisbad Pan margin — type locality of the Florisian Land Mammal Age and source of the ~260 ka archaic *Homo helmei* / early modern human cranium, with *in situ* preparation of fossil remains and the recording, plotting and cataloguing of associated MSA stone tools (points, scrapers, blades) and Florisian fossil mammals (Rossouw, 1994).

1995

Free State (Mangaung Metro, Xhariep DM), research excavations and recording at Boesmansfontein, Philippolis (Late Pleistocene carnivore lairs eroding from calcretised pan margins, with brown hyena / spotted hyena bone accumulations of taphonomic significance for MSA fauna interpretation) and continuation of the Florisbad MSA living-floor programme (Rossouw, 1995a, c).

Free State / Eastern margin (Phumelela LM), recording of vertebrate fossils eroding from Middle Pleistocene fossil-bearing strata at the Cornelia-Uitzoek type locality — a Cornelian Land Mammal Age type site on the upper Wilge River system associated with Acheulean (Earlier Stone Age) artefacts and an extinct large mammal fauna including *Megalotragus*, *Antidorcas bondi*, *Equus capensis* and *Pelorovis* (Rossouw, 1995b).

North West / Northern Cape margin (Lekwa-Teemane LM), excavation of early Holocene hyena lairs from diamond-bearing Vaal River gravels at Kareepan, Bloemhof, with associated Wilton-type LSA microlithics and a brown-hyena-accumulated faunal assemblage (Rossouw, 1995d).

Western Cape (Eden DM, Saldanha Bay LM), research survey and excavation of Late Pleistocene fossil localities in the Cango Valley foothills of the Swartberg Mountains, Oudtshoorn — karstic cave systems with MSA-associated faunas comparable to Boomplaas (Rossouw, 1995e); and Council for Geoscience–contract excavation, plotting, *in situ* preparation, analysis and cataloguing of vertebrate fossil remains from a species-rich terminal Pleistocene carnivore lair at Besaansklip, on the rocky promontory south of Saldanha Bay (Rossouw, 1995g).

Eastern Cape (Kouga LM), research survey of early Last Glacial archaeological localities and fossil vertebrate remains from eroded carnivore lairs at Oyster Bay, Cape St Francis, on Holocene Schelm Hoek Formation coastal dune barriers, with MSA / early LSA surface scatters and palaeo-shoreline shell middens (Rossouw, 1995f).

1996

Free State (Lejweleputswa, Mangaung Metro – Modder / Sand River system), PURE-affiliated research expeditions surveying and recording vertebrate fossil exposures and Stone Age archaeological surface sites exposed by extensive erosional gully systems on the Sand River and Doring River in the Virginia district — Florisian fossil mammals together with MSA / LSA lithic scatters eroding from Quaternary alluvial terraces (Rossouw, 1996a–b); and mapping, plotting and recovery of terminal Pleistocene fossil vertebrate remains and lithic artefacts from Modder River overbank sediments at Mitasrust, Sannaspos and Damvlei east of Bloemfontein, on the same Florisian / post-Florisian alluvial sequences that frame the Florisbad regional palaeoenvironmental record (Rossouw, 1996c–e).

1997

North West Province (Greater Taung LM), palaeontological and archaeological research survey at Taung and Equus Cave, on the Ghaap Plateau dolomite escarpment ~60 km north of Vryburg — Taung is the discovery site of the *Australopithecus africanus* "Taung Child" (Plio-Pleistocene tufa / breccia infill), while Equus Cave preserves a Late Pleistocene – Holocene faunal and LSA archaeological sequence (Rossouw, 1997a).

Free State (Lejweleputswa – Modder / Sand River system), continued PURE-affiliated survey and recording of vertebrate fossil exposures and Stone Age surface sites along the Sand River and Doring River erosional gully systems, Virginia district; and mapping and excavation of discrete localities at Erfkroon on the Modder River (~60 km SW of Florisbad) yielding MSA and LSA artefacts together with Florisian fossil vertebrates — a key open-air locality complementing the Florisbad type sequence (Rossouw, 1997b–d).

1998

Free State (Lejweleputswa, Phumelela LM), archaeological excavations into the fossil-bearing deposits of the Cornelia-Uitzoek type locality — Acheulean ESA artefacts in primary association with the Cornelian large-mammal fauna; and continued PURE-affiliated survey along the Sand River and Doring River erosional gully systems, Virginia district (Rossouw, 1998a–c).

Botswana (Central, North-East, Kgalagadi and Bobirwa Districts), regional reconnaissance expeditions mapping and recording Late Pleistocene fossil vertebrate remains and Stone Age archaeological localities along the Boteti River (~250 km between Maun and Tsoe, north-eastern Makgadikgadi) — palaeo-lake Makgadikgadi shorelines with associated MSA / LSA scatters; the northern Makgadikgadi pans at Makgwe Pan; the central Makgadikgadi at Ntwetwe Pan and Sowa Pan / Orapa (kimberlite-hosted palaeo-drainage and lacustrine sequences); the Tuli Block sandstone belt along the Motloutsi River (between Mmadinare and Pontdrif) and the Shashe River, with rock-art shelters and Iron Age occurrences; the southern Kalahari along the Molopo River (Metlojane to Tshabong); and a ~1,200 km eastern Kalahari traverse from Tshabong through Mabuasehube to Maun, on Kalahari Group aeolian sands mantling Karoo and basement substrates — recording surface MSA points and LSA microlithic scatters on pan margins and linear dune crests (Rossouw, 1998d–k).

1999

Free State (Thabo Mofutsanyana, Lejweleputswa, Xhariep DM), mapping and recording of Late Pleistocene fossil vertebrate remains and Stone Age archaeological localities along the Brakspruit and Venterspruit tributaries of the north-eastern Free State; mapping and recording of Late Pleistocene / Holocene fossil vertebrates and Stone Age surface sites along the Riet River in the Koffiefontein district — a region with well-documented Wilton LSA, Type R Iron Age stone-walled settlements and historic Griqua / Korana presence; and a high-resolution theodolite stratigraphic survey of the fossil-bearing Plio/Pleistocene river gravels exposed by the Virginia Railway Cutting on the northern bank of the Sand River, providing a reference section for ESA / MSA gravel-terrace archaeology of the central interior (Rossouw, 1999a, b, f).

Gauteng / North West margin (Sterkfontein Valley UNESCO World Heritage Site / Cradle of Humankind), research excavation, plotting and analysis of Late Pleistocene fossil vertebrate remains from the decalcified deposits outside Gladysvale Cave (Member 1–3 fossil-bearing sediments yielding *Australopithecus africanus*, *Paranthropus robustus* dental remains and a rich Plio-Pleistocene mammal fauna); and sorting and analysis of Australopith-bearing breccia at Kromdraai (type locality of *Paranthropus robustus*) for fossil vertebrate identification (Rossouw, 1999c–d).

Mpumalanga / Free State margin (Dipaleseng / Lekwa LM), palaeontological survey of extensive erosional gullies along the Klip River near Platrand, Standerton — Karoo Supergroup (Beaufort Group) substrates with potential for *Lystrosaurus*-zone vertebrate exposures (Rossouw, 1999e).
Northern Cape (Frances Baard, Pixley ka Seme DM – Vaal–Orange confluence), archaeological and palaeontological survey of Stone Age localities and material along ~50 km of river banks and terraces between Warrenton and Douglas — classic Vaal River gravel terrace sequences with Earlier Stone Age (Victoria West / handaxe assemblages), MSA and LSA components, and diamond-bearing palaeo-drainage exposures (Rossouw, 1999g).

2000

Free State (Phumelela LM), extended archaeological and palaeontological research excavations into the fossil-bearing deposits of the Cornelia-Uitzoek type locality, refining the Acheulean ESA / Cornelian fauna stratigraphic association at the type site (Rossouw, 2000).

2001

Northern Cape (Siyancuma LM), Phase 1 archaeological survey for impact assessment at Margaux, Griekwastad — region with Griqua / 19th-century mission history overlying earlier LSA and Korana / Tswana presence (Rossouw, 2001).

2002

Free State (Mangaung Metro – Modder River basin), research monitoring of Quaternary overbank sediments for vertebrate fossil exposures and Stone Age archaeological surface sites along ~80 km of the Modder River between Sannaspos and Waterval east of Bloemfontein — extension of the regional Florisian / post-Florisian alluvial archive (Rossouw, 2002).

2003

Free State (Thabo Mofutsanyana DM), research survey and phytolith sampling of the grassy terraces on the north-western Korannaberg plateau at Merimetsi — sampling for C3/C4 grass discrimination and Holocene palaeoenvironmental reconstruction (Rossouw, 2003a).
Northern Cape (Pixley ka Seme DM), Phase 1 archaeological impact assessment at the Skietbaan Railway Siding, Douglas, on Vaal River gravel terraces with potential ESA / MSA components (Rossouw, 2003b).

2004

Tanzania (Ngorongoro Conservation Area), participation in palaeoanthropological research fieldwork at Laetoli, on the Eyasi Plateau of the southern Serengeti — type locality of the ~3.66 Ma *Australopithecus afarensis* hominin trackways and Pliocene Laetolil Beds tuffs (Rossouw, 2004a).
Free State (Thabo Mofutsanyana DM), dating, palaeoenvironmental sampling and archaeological excavation at the Sunnyside 1 MSA/LSA locality, Clarens (Clarens Formation cave shelter on the sandstone escarpment of the Maluti foothills, with a stratified MSA → LSA sequence and OSL chronology; subsequently published as Henderson, Scott, Rossouw & Jacobs, 2005); phytolith sampling at the Heelbo Holocene fossil vertebrate locality near Senekal; and Phase 1 archaeological impact assessment at Eensgevonden Driekuil (Rossouw, 2004b–d).

2005

Free State (Lejweleputswa, Mangaung Metro, Xhariep, Phumelela LM), palaeontological and archaeological research survey of pans in the Wesselsbron district — Quaternary pan-margin fossil and lithic exposures; phytolith sampling at the Erfkroon fossil exposures and archaeological horizons on the Modder River (MSA / LSA sequence in alluvial fines); archaeological excavation of vertebrate fossils and Early Stone Age (Acheulean) artefacts at the Middle Pleistocene Cornelia-Uitzoek type locality; Phase 1 archaeological impact assessment of a 10 km section of road P42/2 at Bethulie; Phase 1 archaeological impact assessment of an informal graveyard at Bergendal, Bloemfontein; and Phase 1 archaeological impact assessment of a section of road R702/R26 at Wepener (Rossouw, 2005a, c, d, e, f, h).
Northern Cape (John Taolo Gaetsewe DM), phytolith research sampling at Excavations 1 and 6, Wonderwerk Cave, on the eastern Kuruman Hills dolomite escarpment — one of southern Africa's longest stratified cave sequences (Oldowan / Acheulean ESA through MSA, LSA and Iron Age, with associated palaeoenvironmental proxies) (Rossouw, 2005b).
North West Province (Maquassi Hills LM), Phase 1 archaeological impact assessment at Kareeboom, Wolmaransstad, on Highveld interior with potential LSA, Late Iron Age stone-walled settlement and historic farmstead components (Rossouw, 2005g).

2006

Free State (Phumelela, Lejweleputswa, Moqhaka LM), continued research investigation of the fossil-bearing deposits of the Cornelia-Uitzoek type locality (ESA / Cornelian fauna) and the Erfkroon fossil and archaeological locality on the Modder River (~60 km SW of Florisbad), refining the open-air MSA / Florisian alluvial archive; and Phase 1 archaeological impact assessment of the Lace Diamond Mine, Kroonstad (Rossouw, 2006a, b, f).
North West Province (Ramotshere Moiloa, JB Marks LM), Phase 1 archaeological impact assessments at Broekmansfontein, Groot Marico and Droogpan, Ventersdorp, in regions with characteristic Late Iron Age Tswana stone-walled settlement landscapes and Anglo–Boer War features (Rossouw, 2006c–d).
Free State / KwaZulu-Natal border (Maluti-a-Phofung – uThukela DM), archaeological survey along the inter-provincial route between Metsimatsho Dam and Rugged Glen Nature Reserve, across the Drakensberg foothills — terrain rich in San rock-art shelters in Clarens Formation sandstone overhangs and Late Iron Age / historic Basotho settlement features (Rossouw, 2006e).

2007

Limpopo (Waterberg DM), research excavation and phytolith sampling at the Late Pleistocene Wonderkrater spring locality, Naboomspruit, for palaeoenvironmental reconstruction — a reference sequence for MIS 3 – Holocene vegetation and climate, with associated MSA / LSA archaeology (Rossouw, 2007a).
Free State (Lejweleputswa), continued mapping of the fossil-bearing Plio/Pleistocene river gravels exposed by the Virginia Railway Cutting on the northern bank of the Sand River — reference exposure for ESA / MSA gravel-terrace stratigraphy of the central interior (Rossouw, 2007b).
Free State (Mangaung Metro, Thaba Patshwa), Phase 1 archaeological impact assessments of the Somerton Graveyard, Bloemfontein, and at Thaba Patshwa (Rossouw, 2007e, i).
Northern Cape (Siyancuma, Renosterberg, Karoo Hoogland LMs; Frances Baard DM margin), Phase 1 archaeological impact assessments of a section along the Orange River in the Hay District (riverine LSA, colonial trekboer features); of the Petrusville town lands; an archaeological survey of the ~135 km road between Williston and Sutherland (Karoo dolerite landscapes with ESA / MSA quarry sites and Bushmanland LSA occurrences); and an archaeological and palaeontological survey of Farm Kromellenboog near Christiana (Rossouw, 2007c, d, g, h).
Eastern Cape (Chris Hani DM), Phase 1 archaeological impact assessment of the Steynsburg town lands, on the western Karoo margin — region with Karoo Supergroup palaeontology, LSA / colonial frontier archaeology (Rossouw, 2007f).
North West Province (JB Marks LM), Phase 1 archaeological impact assessment at Zwartplaats, Ventersdorp (Rossouw, 2007j).

2008

Western Cape (West Coast DM, Saldanha Bay LM), palaeontological research excavations into the Mio-Pliocene Varswater Formation phosphate sands at Langebaanweg West Coast Fossil Park — Africa's premier ~5 Ma terminal Miocene / early Pliocene vertebrate locality, with sabre-toothed cats, short-necked giraffes, three-toed horses and one of the richest fossil bird assemblages globally (Rossouw, 2008a).
Free State (Lejweleputswa – Modder River basin), continued mapping of Stone Age artefacts (MSA points, LSA microliths) and Florisian fossil vertebrates at Erfkroon, refining the open-air alluvial reference sequence (Rossouw, 2008b).

2009

Northern Cape / North West margin (John Taolo Gaetsewe DM), research survey and sampling of modern hyena dens at Tswalu Game Reserve in the Korannaberg foothills, for taphonomic comparative reference — providing actualistic baselines for interpreting Late Pleistocene carnivore-accumulated bone assemblages (Rossouw, 2009a).
Northern Cape (Namakwa DM), archaeological research survey of Pleistocene coastal dunes at Cliff Point, in collaboration with the University of Cape Town Department of Archaeology — targeting MSA / LSA coastal adaptations along the cool Benguela-influenced west coast (Rossouw, 2009b).

2010

Gauteng / North West border (Cradle of Humankind UNESCO World Heritage Site), phytolith research sampling of the Pliocene fossil-bearing deposits at the Malapa hominid site for palaeoenvironmental reconstruction — type locality (~1.98 Ma) of *Australopithecus sediba*, with phytolith data informing the local Plio-Pleistocene vegetation context (Rossouw, 2010a).
Free State (Thabo Mofutsanyana, Xhariep, Mangaung Metro), archaeological research survey of a portion of the Sterkfontein Dam Nature Reserve near Harrismith (Clarens Formation sandstone shelters with potential San rock art and LSA occupation); monitoring of Quaternary overbank sediments for vertebrate fossil exposures and Stone Age archaeological surface sites along the Riet River between Koffiefontein and Kalkfontein Dam (~70 km river reach on the Free State / Northern Cape border, with documented LSA, Type R settlements and Griqua / Korana presence); and survey of historical British military sites of the Anglo–Boer War (1899–1902) and its aftermath in Bloemfontein North — blockhouses, redoubts, concentration camp peripherals and Imperial cemetery features (Rossouw, 2010b–d).

Northern Cape (Umsobomvu LM), research mapping of Stone Age quarry / knapping sites in the Noupoort district, located along Karoo dolerite – sedimentary bedrock contact zones on the Stormberg / Karoo Supergroup margin — primary lithic raw-material extraction loci typical of central interior ESA / MSA quarry behaviour (Rossouw, 2010e).
Western Cape (Central Karoo DM), Phase 1 palaeontological survey of a proposed new subsurface water pipeline route at Beaufort West, on Permian Adelaide Subgroup substrates — strata noted for *Pristerognathus–Tropidostoma* Assemblage Zone therapsid fossils (Rossouw, 2010f).

2011

Free State (Lejweleputswa, Phumelela LM), continuation of the Florisbad Quaternary Research Department fieldwork programme — Erfkroon / Modder River mapping and excavation (MSA / LSA + Florisian fauna), ongoing field monitoring of the Cornelia-Uitzoek type locality (ESA Acheulean + Cornelian fauna), and modern reference sampling of central-interior game reserves and hyena den environments for taphonomic and phytolith comparative work (NM Bfn *Kwartversloe*, 2011); and Phase 1 HIA at Aqua Boerdery, Boshof, on Quaternary alluvium of the upper Modder catchment with potential for surface LSA scatters.
Eastern Cape (Tsitsikamma Coast – Kouga LM; Chris Hani & Amathole DM; OR Tambo DM), Phase 1 PIA / HIA surveys for the St Francis 66 kV Transmission Line (RedCap), traversing coastal MSA / LSA shell midden landscapes; BESC Borrow Pits across the Chris Hani and Amathole Districts, in Karoo Supergroup and Beaufort Group terrain with frontier-war historical features; isi-Xwiba Tsomo Pipeline and Qumanco Borrow Pit, crossing Late Iron Age / historic Xhosa settlement landscapes; AIA of the Xashimba Abattoir, Queenstown; and the BESC Oliver Tambo Borrow Pits ×54 PIA on Msikaba / Natal Group sandstone and Karoo dolerite substrates.
North West Province (Ditsobotla LM), Phase 1 HIA for the Elizabeth 357 Township, Lichtenburg — region with Late Iron Age Tswana stone-walling and Anglo–Boer War heritage.
Northern Cape (Pixley ka Seme DM), Phase 1 AIA for the Mooifontein Uranium prospecting footprint, on Karoo Supergroup substrates of the Bushmanland plain (Rossouw, 2011a–j).

2012

Free State (Lejweleputswa, Mangaung Metro, Thabo Mofutsanyana DM – Modder, Vet and Sand River basins), continued Erfkroon and Cornelia-Uitzoek research field seasons (MSA / ESA + Quaternary fauna), with phytolith and palaeoenvironmental sampling expeditions across the three river basins (NM Bfn *Kwartversloe*, 2012); Phase 1 HIAs for the TERRA Thabong Stormwater (Welkom), TERRA Botshabelo Solar, EKO Grootspruit Solar, EKO Portion 4 Bronkhorstfontein Solar, and the TERRA N5 Section 1 Kestell–Harrismith road corridor — the last skirting Clarens Formation sandstone country with documented San rock-art shelters.
Northern Cape (John Taolo Gaetsewe, Frances Baard, Pixley ka Seme DM), Phase 1 AIAs / HIAs for the TERRA Hotazel R31 Borrow Pits ×3 (Kalahari plain, surface LSA scatters); TERRA Heuningvlei Pipeline; TERRA Borrow Pits ×6 Hotazel; TERRA Riverton Pipeline; MDA Strydenburg Pipeline (Quaternary calcrete and aeolian sand on Ghaap Plateau dolomite, with potential ESA / MSA on calcrete pavements); and CSS Cluster 6 Borrow Pit.
Eastern Cape (Sarah Baartman, Buffalo City, Amathole DM), Phase 1 PIAs for the TERRA Little Mooi River Weir; CES KOS to Alexandria Bulk Water; CES Port Alfred Bulk Water Abstraction (coastal Holocene middens and Khoekhoe / Strandloper traces); CSS Harbour View, East London; isiXwiba Ripplemead; and isiXwiba Killarney Dam.
Free State / Mining Belt (Matjhabeng LM), EKO Vogelsrand Quarry & Crusher HIA, in Witwatersrand Supergroup gold-mining landscape with associated 20th-century industrial heritage (Rossouw, 2012a–r).

2013

Free State (Mangaung Metro, Xhariep, Lejweleputswa, Thabo Mofutsanyana DM), continued Florisbad / Erfkroon / Cornelia research field seasons with phytolith sampling at selected Holocene fossil exposures (NM Bfn *Kwartversloe*, 2013); Phase 1 HIAs / PIAs for the SRK Trompsburg N1 Section 14 (Karoo Supergroup substrates with potential therapsid fauna); EKO Sydenham 445 Borrow Pit; TERRA N5 Tom Schutte Bridge; SS Winburg Cemetery; SS Theunissen Cemetery (two parcels); NSVT Roodewal; NSVT Rouxville Bulk Water Pipeline; EKO Tafelkop Quarry; PHETHOGO Homestead Township (two parcels); MDA Verkykerskop AIA, Phumelela LM (Anglo–Boer War battlefield landscape); EKO Rouxville–Aliwal Borrow Pit; and the CSIR Dealesville Mainstream Solar ×12 PV palaeontological assessment.
Eastern Cape (Amathole, Sarah Baartman, OR Tambo DM), EKO Koonap Quarry HIA; CCS Willowvale–Dwesa Borrow Pits PIA (Wild Coast, Late Iron Age / historic Xhosa landscape); MDA Phase 1 HIA Farm Bosduifkloof 522; CCS Phase 1 PIA Farm 559, East London; ZITHATHILE Phase 1 HIA Zithathele Quarry; SAVANNAH Blackwood and Boundary Solar desktop PIAs; and the PPC Disco Chicks PIA, Kirkwood (Sundays River Formation Cretaceous fossil substrates).
Northern Cape (John Taolo Gaetsewe, Pixley ka Seme DM), TERRA Bankhara Borrow Pit, Kuruman HIA (Ghaap Plateau dolomite, with documented LSA and Korana / Tswana heritage); TERRA Hotazel–Tsineng Graves Letter of Recommendation (NHRA Section 36 graves protocol); TERRA Dithakong Road HIA — passing close to the historically significant Battle of Dithakong (1823) landscape; SS Morago Pipeline PIA; MDA Blaauwskop HIA; and the DIACOR Prieska HIA across the Remainder & Portions 1–4 of Farm 23, Kliphuis 29 and Engelde Wildeboom 22 (commenced September 2013) on Orange River terrace and Kalahari plain.
National coastal logistics corridor, CSIR Transnet Marine Infrastructure DEIAR — Chapter 12 Heritage Assessment, covering port and rail-linked facilities along the South African coastline with associated shipwreck, harbour, lighthouse and coastal midden heritage (Rossouw, 2013a–z).

2014

Free State (Mafube, Phumelela, Tswelopele, Setsoto, Mantsopa, Mafube LMs, Mangaung Metro), continued Florisbad / Erfkroon / Cornelia research field seasons and central-interior reference sampling (NM Bfn *Kwartversloe*, 2014); the NSVT Free State Township Development series at Frankfort, Tweeling, Cornelia and Villiers — central interior with Late Iron Age Tswana stone-walled settlements and Anglo–Boer War landscape; PHETHOGO Township Development HIAs at Vrede, Memel, Bultfontein Phahameng, Warden and Paul Roux; MDA Wesselsheim, Bethlehem HIA; MDA Lennertsville Cemetery AIA (NHRA Section 36); TERRA Harrismith N5–R712 AIA; NSVT Koffiefontein SWS PIA; TRAKONE Petrus Hennenman AIA; and the ENVIRO Nalisview Cemetery combined HIA on Farm Nalisview 2835 near Bloemfontein — the last recording three historical structures (dated ~1913–1940), a series of large circular stone mounds (likely Late Iron Age / early historic Sotho-Tswana kraal features), and one modern building.
Northern Cape (Pixley ka Seme, Frances Baard DM), MDA Hopetown Extraction Point HIA (Vaal River gravel terraces, ESA / MSA); TERRA Prieska Fairview Residential AIA; and RALPH MABILO AIA on a portion of Barkly West Commonage 687 — within the historic Griqua / Korana diamond-fields landscape.
North West Province (Matlosana LM), EKO Van Niekerks Rust Sand Mine; EKO Spytfontein Quarry; DERA Goedvooruitzicht AIA; DERA Rhenosterspruit 326 AIA; and the ENVIRO Mahikeng Curro School HIA — region with Late Iron Age Tswana stone-walled towns (e.g. Kaditshwene complex) and Anglo–Boer War heritage.
Eastern Cape (Amathole, Joe Gqabi, Chris Hani DM), CSS Masimini–Madonisi Borrow Pits ×4 PIA; ARCHEOMAPS Phase 1 PIA Calypso Heights, East London; EKO Indwe Quarry AIA; EKO Cambden Shooting Range AIA; CCS KeiGate East London Phase 1 PIA; and EKO Sterkspruit WWTW & Lines HIA — frontier-war and 19th-century mission-station heritage.
Renewable-energy / hydroelectric series and Lesotho cross-border work, ENVIRO Rooikat Hydroelectric PIA and three iterations of the ENVIRO Meerkat Hydroelectric PIA; and the ENVIRO Maseru Truckstop combined PIA & HIA (Lesotho lowlands, Karoo Supergroup substrates with regional Sotho heritage) (Rossouw, 2014a–af).

2015

Free State (Mangaung Metro, Lejweleputswa DM), continued Florisbad and Erfkroon research field seasons (MSA / LSA + Florisian fauna) with ongoing phytolith reference sampling (NM Bfn *Kwartversloe*, 2015); the Rusfontein Dam WTW combined HIA; and the Q435 MvW Phase 1 PIA on Plaas Onderverdeling 5, Avenham Nr. 2187.
Northern Cape (John Taolo Gaetsewe, Namakwa DM), EKO Hotazel Witloop & Vlermuislaagte Power Lines HIA — two new power-line sections south of Hotazel between Hotazel and Kathu on aeolian sand and calcrete substrates of the Kalahari plain, with potential for surface LSA Wilton microlithic scatters; and the 2918BB Aggeneys ENDEMIC Black Mountain – Aggeneys 56 Big Syncline HIA, a 25 ha pristine exploration drilling footprint ~3 km NW of Aggeneys on Bushmanland Group gneisses of the Namaqua–Natal Metamorphic Complex, Khâi-Ma LM — area associated with Bushmanland LSA hunter-gatherer occupation and Nama / ǁKhomani heritage (Rossouw, 2015a–d).

2016

Free State, Northern Cape & Eastern Cape interior, final NM Bfn Florisbad / Erfkroon / Cornelia field seasons during the transitional year prior to full-time consultancy (NM Bfn *Kwartversloe*, 2016); and a Phase 1 HIA / PIA portfolio on infrastructure, agricultural and mining footprints — including continuing assignments for EKO, TERRA, NSVT, MDA, ENVIRO and Greenbox client portfolios across the three provinces, sampling a representative range of Karoo Supergroup, Witwatersrand Supergroup, Vaal River gravel and Kalahari Group substrates and their associated ESA / MSA / LSA, Iron Age and historic heritage signatures (Rossouw, 2016a–n).

2017

Free State (Xhariep DM), closing field season of the NM Bfn quarterly research programme (final entries in *Evaluering Kwartversloe Personeel*, 2017); and the Q527 PGS Tetra4 Cluster 1 PIA, Gariep, on Karoo Supergroup substrates of the Adelaide Subgroup — relevant to the *Tropidostoma – Cistecephalus* Assemblage Zone therapsid record.
Northern Cape (John Taolo Gaetsewe DM), EKO Hotazel Witloop & Vlermuislaagte Powerlines (re-issue), Kalahari plain.
Free State and Northern Cape interior, continuing portfolio of HIAs and PIAs across the central interior, sampling Karoo and Kalahari heritage substrates (Rossouw, 2017a–n).

2018

Free State, Northern Cape and Eastern Cape interior, Phase 1 HIA / PIA portfolio across the central and eastern Karoo — on Adelaide and Tarkastad Subgroup substrates with associated Karoo therapsid palaeontology, ESA / MSA quarry sites near dolerite contacts, and surface LSA Wilton scatters — with project register and invoicing schedule consolidated in the running quotation workbook (Rossouw, 2018a–n).

2019

Northern Cape (John Taolo Gaetsewe, Frances Baard, ZF Mgcawu DM), field-based PIAs for the PGS Kolomela A1a & Kalkfontein Powerlines (Kumba Iron Ore's Kolomela operations, on Ghaap Plateau dolomite and Banded Iron Formation substrates — bedrock of the Transvaal Supergroup with associated ESA quarry potential); the Q868 GBOX Dithakong Borrow Pits ×5 (BP 8–12) HIA — near the documented Battle of Dithakong (1823) historical landscape; the Q872 ECOCON Olifantshoek Township Development HIA; and the Q883 EMG Reivilo HIA.

Gauteng / West Rand (Mogale City LM), Q870 GBOX 500 ha Development Area HIA, Krugersdorp, on Witwatersrand Supergroup substrates within the broader Cradle of Humankind / Sterkfontein Valley sensitivity envelope.

Mpumalanga (Emakhazeni LM, Nkangala DM), Q871 GBOX Farm Vlakfontein HIA, Dullstroom, on Karoo Supergroup substrates of the eastern Highveld escarpment — region with documented Late Iron Age Bokoni stone-walled agricultural terrace landscapes (Rossouw, 2019a–f).

2020

Free State, Northern Cape and Mpumalanga, Phase 1 HIA / PIA surveys for infrastructure, solar and township developments during the COVID-19-constrained field season — including assessment of Karoo Supergroup palaeontological sensitivity, surface LSA and Late Iron Age stone-walled features and historic farm-complex heritage, with desktop and site-visit components carried out under prevailing pandemic protocols (Rossouw, 2020a–n).

2021

Free State (Xhariep, Lejweleputswa, Thabo Mofutsanyana DM), GBOX Bethulie Solar PIA; the 2825 DB Dealesville EMG Good Hope Solar PV HIA; the 2829 AC Harrismith EMATRIX Intabazwe Pipeline HIA; the 2829 AC Harrismith & 2828 BD Korfskop EMATRIX Tshiame Pipeline HIA; and the 2829 AC Harrismith EMATRIX Bergsig Residential Development HIA — last three in Clarens / Elliot Formation sandstone country with potential San rock-art shelters and Anglo–Boer War heritage.

Northern Cape (Pixley ka Seme DM), 2923 DB Rooidam DSA Phase 1 HIA for the Naauwtes Fontein Pivots, Hopetown, on Quaternary calcretes mantling Karoo Supergroup substrates of the Orange River basin, near the Vaal–Orange ESA / MSA gravel-terrace archive.

Western Cape (Central Karoo DM, Beaufort West LM), Palaeontological Impact Statement for the Ishwati Emoyeni WEP Amendment — addition of 33 turbines to the previously authorised 80-turbine Ishwati Emoyeni Wind Energy Facility near Murraysburg, on Permian Adelaide Subgroup substrates with documented *Pristerognathus – Tropidostoma* Assemblage Zone therapsid fossils (SAHRA Case No. 130611TS10) (Rossouw, 2021a–g).

2022

Northern Cape (Pixley ka Seme, Frances Baard DM), GBOX Phase 1 HIA Bottomland Solar Facility & associated electricity, water and road network for the Prieska Energy Hub (BIF / haematite / crocidolite / chert bedrock of the Asbestos Hills Subgroup, capped by Tertiary calcretes and Quaternary aeolian and alluvial cover — substrates with elevated ESA / MSA raw-material potential); GBOX Phase 1 HIA 170 MW Townlands Solar 1 Development, Prieska (400 ha solar footprint + substation + 760 m access road + 6.6 km × ~50 m 132 kV powerline corridor, on aeolian sand, polymict gravels and localised BIF-capping limestones); ENVIRONAMICS Phase 1 PIA Droogfontein PV Footprints D4 + Alt (615 ha) and D5 + Alt (1,000 ha) near Kimberley (Vaal River gravel terrace catchment, ESA / MSA potential); and the EXM Phase 1 PIA Macarthy-Zama Mining Right Application on Macarthy Farm (~775 ha).

Mpumalanga (Nkomazi LM, Ehlanzeni DM), ENVIRONAMICS Phase 1 PIA Gas-to-Power Project, Komatipoort — comprising the Marathon Substation expansion, Komatipoort Substation B, a 100 km × 400 kV Gumeni–Marathon line, three 115 km × 400 kV Marathon–Komatipoort B lines, and a 5 km × 275 kV Komatipoort B–Komatipoort line on Lebombo / Karoo basalt substrates — within the regional Late Iron Age and historic Tsonga / Swazi settlement landscape.

Western Cape (Saldanha Bay LM, Central Karoo DM), GBERG Phase 1 PIA for the residential development on Erf 325 & 1475, Jakobsbaai, on Cape Supergroup substrates of the West Coast — area with documented coastal MSA and Holocene shell midden heritage; and the 3223BC Kunna EMG Phase 1 HIA for an agricultural development (two orchards + two irrigation pivots), Farm Harmonie 140/RE, Murraysburg, on Adelaide Subgroup substrates.

Free State (Matjhabeng LM, Lejweleputswa DM), ERM Phase 1 PIA Grootspruit II 300 MW PV Solar Facility on parts of Welverdruk 67, Langverwacht 281 and Schotland Noord 178, Odendaalsrus — Witwatersrand Supergroup mining belt landscape.

Northern Cape / Western Cape (Kai !Garib – Matzikama LMs), AECOM Phase 1 PIA for the 2 × 765 kV Powerlines between Juno and Aries Substations (~350 km, Kenhardt to Vredendal), traversing Bushmanland and Knersvlakte plains — long linear corridor crossing diverse LSA / Bushmanland hunter-gatherer and Khoekhoe pastoralist heritage.

North West Province (Moses Kotane LM, Bojanala Platinum DM), AG Phase 1 HIA for the Mogwase 7.5 km Outflow — within the broader Pilanesberg / BaKgatla-ba-Kgafela cultural landscape.

Eastern Cape (Kouga LM, Sarah Baartman DM), Exigent Phase 1 HIA Oyster Village Project, Farm Goed Geloof 745, St Francis Bay (re-issue), on Holocene Schelm Hoek Formation coastal dune barriers with potential MSA / LSA shell midden heritage (Rossouw, 2022a–k).

2023

Free State (Mangaung, Lejweleputswa, Fezile Dabi, Thabo Mofutsanyana DM), Phase 1 PIA, HIA & Heritage Compliance Statement field surveys for residential, agro-industrial, infrastructure and waste developments — sampling Karoo Supergroup, Vaal / Modder / Wilge alluvial and Clarens Formation substrates with their associated palaeontological, LSA / Iron Age and Anglo–Boer War heritage — comprising the PIA & HIA New 38 ha Residential & Commercial Development, R64 Bainsvlei, Bloemfontein; HIA Bulk Sewer Line Connection to the Municipal Network, Thaba Nchu Cluster Schools (within the historic BaRolong / Methodist mission landscape); HIA Martindale Incinerator, Bloemfontein; HIA Kestell WWTW; HCS Wolwehoek Compost, Sasolburg; HCS Blokhuis Composting, Harrismith; HCS Reitz Milling Plant; HIA Qibing Filling Station, Wepener; HCS Usherwood Chicken Houses, Bloemfontein; HIA Township Establishment on Plot 5 Midway Small Holdings, Bloemfontein; HIA Phambili Estoire-type residential subdivisions; and two assessments at HIA Resort Development, Farm Beginsel, Fouriesburg (~15 ha) (initial and expanded scopes) — in Clarens Formation sandstone country with documented San rock-art shelters.

Northern Cape (Frances Baard, ZF Mgcawu, John Taolo Gaetsewe DM), combined PIA / HIA & HCS field investigations for the HCS Phase 1 HIA Owendale Township Development (manganese fields landscape); HCS 4.5 ha Hotel Development, Hotazel; and the HIA Jannic Boerdery Landbou Ontwikkeling (~52 ha), Kimberley (Vaal River gravel terrace context).

North West Province (Dr Ruth Segomotsi Mompati, Bojanala Platinum DM), Phase 1 HIA & PIA field surveys for the HIA Bloemhof Shopping Center (~7 ha); HIA Schweizer Reneke Reservoir; and the HIA Mogwase 7.5 km Outflow (the latter spanning the December 2022 – February 2023 field season, within the BaKgatla cultural landscape).

Limpopo (Mopani DM), Phase 1 HIA field investigation for the Residential & Cemetery Development (~25 ha residential + 100-grave cemetery), Tzaneen — within the broader Tsonga / Northern Sotho settlement landscape.

KwaZulu-Natal (Newcastle LM, Amajuba DM), Heritage Compliance Statement for the HIA New Fair International Poultry Abattoir, Newcastle — within Anglo–Boer War, Anglo-Zulu War and colliery industrial heritage.

Eastern Cape (Buffalo City Metro, Sarah Baartman & Dr Beyers Naudé DM), Phase 1 HIA field investigations comprising the HIA Rem 813 East London Mixed-Use Development (~35 ha); HIA 66 kV Overhead Power Line Options ×2, Queenstown; HIA Filling Station N2 Papiesfontein, near Gqeberha; HIA New Filling Station, Graaff-Reinet (within 18th–19th-century frontier town heritage); and the AIA Oyster Village Project, Portion 247 Erf 745, Farm Goed Geloof 745, St Francis Bay (~28 ha) on Holocene Schelm Hoek Formation coastal dune barriers with potential MSA / LSA shell midden heritage.

Western Cape (Central Karoo DM), Phase 1 HIA fieldwork on Permian Adelaide Subgroup (Teekloof and Balfour Formation) substrates — *Cistecephalus / Dicynodon* Assemblage Zone therapsid sensitivity — comprising the HIA Mordant Solar PV Facility (~3,500 ha) near Three Sisters; the HIA Murraysburg Wind Turbine Tower Manufacturing Facility (~13 ha); and the HIA Wilge WWTW & Associated Sewer Pump Stations – Letter of Exemption.

2024

Free State (Mangaung, Lejweleputswa, Fezile Dabi, Thabo Mofutsanyana DM), Phase 1 PIA / HIA and Heritage Compliance Statement field surveys for township, agro-industrial, infrastructure and renewable-energy developments — sampling Karoo Supergroup palaeontological substrates, Vals / Modder / Wilge alluvial archives and Clarens Formation sandstone country — comprising the HIA & PIA Mabele Emoyeni Wind Energy Project (~30,900 ha between Ventersburg, Kroonstad, Steynrus and Senekal); HIA Bellevue 51 Truckstop, Winburg (Anglo–Boer War battlefield context); HIA Morago Borrow Pit; HIA Welgegund Borrow Pit, Excelsior; HIA Ficksburg WWTW; the two large Enviromatrix borrow-pit / quarry packages — HIA 9× Quarries Central and Eastern Free State (Package 1: A1, A2, A3, A5, A7, A8, A9, A10, A13) and HIA 9× Quarries Central and Southern Free State (Package 2: B1, B2, B3, B4, B5, B8, B9, B10, B13); PIA Frankfort Township Establishment, Mafube LM; HIA Frankfort Township Development, Farm Aberdeen 530; HIA Selosesha 3/900 Township Development (~290 ha) within the BaRolong cultural landscape; HIA Reddersburg Township Establishment; HIA Truckstop Development, Klein Smaldeel, Parys; HIA Memel Township Establishment; HCS Qwa Qwa Petrol Station; HIA Villiers Township Establishment; HIA Trompsburg Township Development Expansion (~43 ha); HCS Lefika Crusher Expansion, Bethlehem; HIA Kroonstad Holiday Resort (~18 ha); PIA Grootvlei Hatchery Expansion, Kroonstad (left bank Vals River alluvium, with potential surface LSA scatters and reworked Quaternary fauna); PIA & HIA Old Mill Drift Agri-Estate, Portion 1 Beginsel 346, Fouriesburg (Clarens Formation sandstone shelters); and the PIA Fuel Depot Expansion, Kroonstad – Letter of Exemption.

Northern Cape (Frances Baard, ZF Mgcawu & John Taolo Gaetsewe DM), Phase 1 PIA & HIA field surveys for the HIA Platfontein Real Estate Development (~50 ha), Kimberley — area with documented !Xun and Khwe community heritage; HIA New Truckstop Development, RE Erf 1 & 10 Postmasburg (manganese mining and historic Griqua context); and the HIA Phambili Township Development, Letsemeng LM, Jacobsdal.

Western Cape (Hessequa LM), Phase 1 HIA & Heritage Compliance Statement for the HIA Eco-Estate, Portion 22 Farm Zwarte Jongers Fontein 489, Jongensfontein — coastal landscape with MSA / LSA shell midden potential.

North West Province (Greater Taung & Dr Ruth Segomotsi Mompati DM), Palaeontological Impact Statement for the Prospecting Application on Farm Kareefontein 340, Bloemhof (Vaal River gravel terrace setting); and combined HIA field survey for the pipeline through the Harts River, Schweizer Reneke — within the BaTlhaping cultural and 19th-century colonial frontier landscape.

Limpopo (Sekhukhune DM), Phase 1 HIA field investigation for the HIA Burgersfort Township Development — within BaPedi heritage landscape.
Eastern Cape (Inxuba Yethemba LM, Chris Hani DM), Phase 1 PIA & HIA field assessments on the western Karoo margin for the PIA & HIA Kwanonzame Township Development (~188 ha), Middelburg (palaeontologically insignificant igneous rock intruding Adelaide Subgroup sandstone and mudstone) and the PIA & HIA Midros Township Development, Middelburg — within 19th-century frontier-war and colonial settlement heritage.

2025

Free State (Mangaung, Lejweleputswa, Fezile Dabi, Thabo Mofutsanyana DM), combined Phase 1 palaeontological and archaeological field surveys and impact assessments for residential, agro-industrial, infrastructure and renewable-energy developments — across Karoo Supergroup palaeontological sensitivity, alluvial and Clarens Formation substrates — including the HIA Proposed Industrial Development, Farm Ribblesdale 1506 near Bloemfontein; PIA & HIA Plots 9 & 12 Lilyvale, Bloemfontein (MDA); HIA Expansion of existing Cattle Feedlot, Farm Witfontein 398 near Parys; HIA Proposed Feed Mill, Farm Goedehoop 1188 near Vredefort (within the Vredefort Dome UNESCO World Heritage Site environs); HIA Proposed cemetery, Farm Kameeldoorn 35, Hoopstad; HIA Proposed cemetery, Farm Wesselsrust 451, Bultfontein; PIA & HIA Diesel Depot & Truck Stop, Bothaville; PIA & HIA Bluegum Bush Filling Station, Phuthaditjhaba; PIA & EIA Ladybrand WWTW (Clarens Formation sandstone country with documented San rock-art shelters); Desktop HIA & PIA Manyatseng Bulk Outfall Sewer Upgrade, Ladybrand (Mantsopa LM); PIA & HIA Welbedacht WWTW (Welbedachtdam); PIA & HIA New Cemetery Development, Philippolis; PIA & HIA 2× Cemetery Expansions, Fouriesburg; PIA & HIA TS Development, Portion 5 Helena 213, Slabberts; PIA & HIA TS Development Atbara 1752, Bethlehem; PIA & HIA Bethlehem WWTW; PIA & HIA Farm 3/1880 Randfontein Solar PV, Harrismith; and the PIA & HIA Inversion Flight Academy, Portion 12 Poortje 389, Heidelberg.
Northern Cape (Frances Baard, Sol Plaatje, Pixley ka Seme, Kareeberg, John Taolo Gaetsewe, ZF Mgcawu & Namakwa DM), extensive Phase 1 PIA / HIA field investigations along the Vaal–Orange River corridor and Karoo interior — sampling Ghaap Plateau dolomite, Vaal / Orange gravel terraces and Kalahari plain heritage substrates — comprising the HIA Bulk Water Supply Pipeline between Riverton and Kimberley (Sol Plaatje LM); HIA MBSC1 Section 1 Bulk Water Pipeline Riverton–Midstation; HIA New Truckstop Facility at Modder River; HIA Proposed Sewer Pipeline & WWTW, Postmasburg; HIA Koelkop Reservoir Water Pipeline, Carnarvon (Kareeberg LM); the 2723AD Kuruman HIA Batlharos RDP Internal Roads (~4.5 km gravel road & 250 m Kuruman River culvert-bridge), Batlharos Ba Ga Motlhware — including a small cemetery north of the river and four graves east of Section E–F (NHRA Section 36 graves protocol); PIA & HIA Prieska Mall Development (14.5 ha); 2821DD Groblershoop Heritage Impact Statement, Orange River Solar PV Facility internal roads, batching plant & crusher sites (ZF Mgcawu DM, on Orange River terrace ESA / MSA substrates); PIA & HIA Kathu Waste Handling Facility (~95 ha, John Taolo Gaetsewe — close to the Kathu Pan ESA / MSA archaeological landscape); PIA & HIA Screening, BVI DKM Solar Facility, Klip Kraal 451, Upington (~1,250 ha); Groblershoop ORSF Substation PIA & HIA; HIA Four new borrow-pit sites along the N14 Section 3 between Kakamas and the Orange River Bridge; and the PIA & HIA Pella, Melkbosrand & Sending WWTW (Khâi-Ma LM — Bushmanland LSA and Nama heritage).
Western Cape (Prince Albert LM, Central Karoo DM), Phase 1 PIA field investigation for the Bulk Water Storage Facility (~3 ha, ~50,000 m³ / ~15 m deep excavation), Prince Albert, on Karoo Supergroup substrates (Beaufort Group therapsid sensitivity).
North West Province (JB Marks LM, Dr Kenneth Kaunda DM), combined PIA & HIA fieldwork for the Jouberton and Alabama Phase 2 Outfall Sewer Upgrade, Klerksdorp; and the PIA & HIA Makwasi Road Upgrade (D1954 / D158 / D565 / D156, ~40 km linear footprint) — across Witwatersrand Supergroup gold-mining and Late Iron Age Tswana stone-walled settlement landscape.
Limpopo (Capricorn DM), Phase 1 HIA field survey for the Proposed Moringa Tree cultivation area at Ga-Raditshaba — within Northern Sotho heritage landscape.
Gauteng / West Rand (Rand West City LM), Phase 1 HIA & PIA field survey of the Cooke 4 Ezulwini mine footprint (~1,600 ha), Westonaria, on Witwatersrand Supergroup substrates within the Cradle of Humankind / West Rand mining heritage envelope.
Mpumalanga (Gert Sibande DM), Phase 1 HIA & PIA fieldwork for the Lekwa Solar PV Facility (~258 ha, three sections on one land portion), Standerton; and combined PIA & HIA assessments for the Tutuka Solar PV Powerline (~1,500 ha) and Majuba Solar PV Powerline (~2,000 ha) grid-connection corridors — across Karoo Supergroup substrates with Anglo–Boer War battlefield heritage and historic farmstead complexes.

2026

Free State (Lejweleputswa, Mangaung, Fezile Dabi, Thabo Mofutsanyana DM), combined Phase 1 palaeontological and archaeological field surveys for residential, infrastructure and agro-industrial developments — across Karoo Supergroup, Vals / Modder / Wilge alluvial and Vredefort Dome environs — including the 2726DD Riebeeckstad Desktop PIA – 7 ha Residential Development, Constantia Str Thabong; 2926AA Bloemfontein PIA Chicken Broiler De Hoop 230, Bloemfontein; 2926DD Welbedachtdam PIA Pre-treatment Sedimentation Tanks, Welbedacht WTW; 2727CA Kroonstad PIA Maokeng 880 m Smaldeel Road Upgrade; 2926AA Bloemfontein HIA Mangaung Metropolitan Northern Bulk Distribution Pipeline; 2926AB Maselspoort HIA Bloemspruit Plots; 2926AA Bloemfontein HIA Ribblesdale Industrial Development; 2728AB Vanrheenenskop HIA Wilgedraai 1159 Cattle Feedlot, Frankfort (Mafube LM); 2828CB Clarens HIA Old Mill Agri-Estate, Farm Beginsel 346, Fouriesburg (Clarens Formation sandstone country, San rock-art sensitivity); 2628CC Deneysville PIA & HIA Brakpan 700 & Vaaldam Settlement 1777 Feedlot s24G Rectification (Vaal Dam catchment, with potential reworked Vaal River gravel ESA / MSA archaeology); MDA PIA & HIA Residential Development, Farm Zuurfontein 2022, Bloemfontein; MDA PIA & HIA Philippolis WWTW (within the historic Griqua capital landscape); LEFATSE PIA & HIA Expansion of Chicken Houses, Farm Hamelfontein 169RE, Trompsburg; EMATRIX 21.2 km N8 Ring Road around Bloemfontein; NSVT Heritage Compliance Statement – Farm Georgina 2150 Cemetery Subdivision; NSVT PIA & HIA Filling Station, Farm Isaaks Hoop A 590, Petrusburg; PIA & HIA Constantia St Electrification, Welkom; and the 3026CB Goedemoed PIA Brandfontein 36 Feedlot Expansion on the southern Free State / Eastern Cape margin.
Mantsopa & Setsoto LM, eastern Free State, palaeontological / archaeological survey, recording and impact assessment for the 2927AB Ladybrand PIA Manyatseng Bulk Outfall Sewer — Karoo Supergroup substrates within Clarens Formation sandstone country with documented San rock-art shelters and Late Iron Age / Sotho heritage.
Lejweleputswa DM (Mashiane Family Graveyard, Virginia Solar Park development footprint), NHRA-aligned heritage impact assessment and heritage management plan for an *in situ* family burial ground within the development footprint (graveyard heritage under NHRA Section 36 and the Removal of Graves and Dead Bodies Ordinance), with associated buffer recommendations and chance-find protocols.
Northern Cape (Kareeberg, Pixley ka Seme, Frances Baard, Siyathemba, Dawid Kruiper, Khâi-Ma & Tsantsabane LMs), extensive Phase 1 PIA / HIA field investigations along the lower Orange River corridor and Karoo interior — sampling Ghaap Plateau dolomite, Vaal–Orange gravel terraces, Kalahari plain and Bushmanland heritage substrates — comprising the 2824BB Warrenton PIA Warrenton WWTW & Bulk Water Reticulation; 2824BA Majeng PIA & HIA Majeng Village Electrification (Kalahari Group aeolian sands mantling pedogenic calcretes, with surface LSA scatter potential); 2824DD Beaconsfield HIA Bulk Water Pipeline MBSC6 Section 3A Midstation–Galeshewe, Kimberley (within the historic Kimberley diamond-fields landscape); 2823AC Postmasburg HIA Proposed Sewer Pipeline & WWTW Facility; 2723AD Kuruman HIA Batlharos RDP Internal Road Upgrade – Revised Alignment (including a structured Public Participation Process and site visit on 17 March 2026 following a SAHRA cease-works order related to unmarked graves; an ESA unifacial flake was recorded ~90 m west of the impact corridor, consistent with the wider Kathu Pan ESA landscape); Archaeological Monitoring Report – one-week construction monitoring near grave sites, Batlharos Road (Project 391); 3022CC Carnarvon HIA New Sewer Pipeline WWTW to Carnarvon (Kareeberg LM); 2922DB Prieska Oos PIA Tweefontein 373 & Kalkfontein 374 Pivots; 2922DB Prieska Oos PIA & AIA Uitdraai Nursery & Pistachio Processing Plant; 2922DB Prieska Oos PIA & AIA Erf 1 & Erf 971 Pecan Orchard & Pivot Development; 2922DB Prieska Oos HIA Bloukrans, Goue Akker & Montery (Muis Hoek 34) s24G Rectification of centre-pivot cultivation on the left bank of the Orange River (with potential reworked Orange River terrace ESA / MSA archaeology); 2922DD Redlands HIA Doringberg PV, Prieska; 2821CA Kanoneiland PIA Olyvenhouts Drift Raisins s24G Rectification; 2620DD Askham HIA Cemetery Expansion (Dawid Kruiper LM — ǁKhomani San heritage); 2821AD Upington East HIA Cemetery Expansion near Louisvale Road, Upington (Dawid Kruiper LM); NSVT PIA & HIA Cemetery 316 ha Footprint, Farm Vooruitzicht 81 KBY; ENDEMIC HIA & PIA Epang Uranium Projects PRA_1, PRA_2 & PRA_3, Springbok (Namaqua–Natal Metamorphic Complex; Nama heritage landscape); EMG Airfield Development (RPAS Airline) between Copperton & Vanwyksvlei; and the EMG Prince Albert Raw Water Supply Project (Adelaide Subgroup therapsid sensitivity).
Khâi-Ma & !Kheis LMs, lower Orange River frontier (NC), combined PIA / HIA fieldwork on Namaqua–Natal Metamorphic Complex substrates (Bushmanland Group gneisses and granites) mantled by Quaternary aeolian sands and bedrock-derived gravelly topsoils — with potential for surface Bushmanland LSA / Wilton microlithic scatters and Khoekhoen / Nama pastoralist heritage — for the 2919AA Pella PIA & AIA Pella WWTW & Irrigation Area (within the historic Roman Catholic mission landscape of Pella); 2819CD Oupvlakte PIA & AIA Sending WWTW & Irrigation Area (near Onseepkans); and 2819CD Oupvlakte PIA & AIA Melkbosrand WWTW & Irrigation Area, with systematic pedestrian survey along low-lying sandy plains and incised drainage lines.
North West Province (Bojanala Platinum & Dr Kenneth Kaunda DM), Phase 1 PIA & HIA fieldwork for poultry, mining and infrastructure developments — within the broader BaKgatla / BaTswana Late Iron Age stone-walled settlement landscape and Witwatersrand Supergroup mining heritage — comprising the EMG HIA & PIA Tisella Poultry Farm Development, Rhenosterfontein 86; LT PIA & HIA Brits Chicken Houses; and the 2626DC Klerksdorp HIA Jouberton and Alabama Phase 2 Outfall Sewer Upgrade, Klerksdorp.
Limpopo / Gauteng border (Bela-Bela & Lesedi LMs), Phase 1 PIA & HIA field investigations — within Bushveld Igneous Complex / Karoo Supergroup substrates with associated Late Iron Age Tswana and Anglo–Boer War heritage — comprising the 2528AB Pienaarsrivier PIA Coldmix Plant, Farm Springbokvlakte 41 JR.

LLOYD ROSSOUW

Director — Paleo Field Services

Senior Heritage, Archaeological & Palaeontological Impact Specialist

South Africa • ASAPA Reg. No. 122 (since 2002) • Ph.D. (UFS) • *M.Sc. cum laude (Wits)*

Field-based heritage specialist with **35+ years of on-site fieldwork** and **300+ specialist reports** delivered nationwide across every province of South Africa.

35+	300+	9 / 9
Years of fieldwork	Specialist reports	Provinces surveyed

Field Experience by Sector

Sector	Field Experience & Typical Footprints
Renewable Energy	Solar PV, wind, battery storage & grid across Free State, Northern Cape, North West & Western Cape — field surveys on large footprints. (primary growth sector)
Linear Infrastructure	On-foot corridor walkdowns for powerlines, bulk water & sewer pipelines, road upgrades across multi-jurisdictional routes.
Mining & Industrial	Prospecting/mining right areas, waste facilities & industrial expansions in geologically & archaeologically complex terrain.
Agro-Industrial	Feedlots, irrigation pivots, orchards & agri-processing sites in mixed-sensitivity rural landscapes.
Township & Residential	Township establishment, mixed-use & urban infill footprints integrated with planning approvals.
Graves & Community	Field identification of family graveyards & cemeteries; exhumation/relocation planning.

Core Services

- Heritage Impact Assessments (HIA) — NHRA s.38(3)
- Palaeontological Impact Assessments (PIA) — desktop & field
- Archaeological Impact Assessments (AIA) — Phase 1 & mitigation
- Chance Find Protocols — construction-phase compliance
- Cultural Landscape & Heritage Management Plans
- Section 24G rectification & SAHRA / PHRA liaison

Career Highlights

Years	Role	Institution
2024 – Present	Director	Paleo Field Services
2019 – 2024	HOD & Curator of Collections	Florisbad Quaternary Research Station, National Museum
2010 – 2019	Head of Department: Archaeology	National Museum, Bloemfontein
1999 – 2009	Museum Scientist	Florisbad Quaternary Research Station

Qualifications & Professional Standing

Qualifications

- **Ph.D.** Palaeoenvironmental Science — Univ. of the Free State
- **M.Sc.** Quaternary Vertebrate Palaeontology *(cum laude)* — Univ. of the Witwatersrand
- **B.A. (Hons.)** Archaeology — Univ. of Stellenbosch

Professional Standing

- **ASAPA Registered Heritage Practitioner** (No. 122) — continuous since 2002

Member, **PSSA**, continuous since 2002

- **Research Fellow**, University of the Free State
- **Peer-reviewed author** — Nature Ecology & Evolution, Quaternary Science Reviews, J. Human Evolution, S. Afr. J. Science

Die Universiteit van Stellenbosch

Hiermee word verklaar dat nademaal

LLOYD ROSSOUW

ten opsigte van die Honneurs-Baccalaureus-graadkursus in die Lettere en Wysbegeerte met

ARGEOLOGIE

as studierigting, voldoen het aan al die vereistes soos neergelê in Wet Nr. 37 van 1959 en die Statuut en Regulasies van die Universiteit, die graad

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14-01-2022
COMMUNITY SERVICE
SOUTH AFRICAN POLICE SERVICE

At a congregation of the University

held on 24 April 2001

Lloyd Rossouw

was admitted to the Degree of

Master of Science

(with distinction)

Dean, Faculty of Science

Acting Vice-Chancellor and Principal

Registrar

SUID-AFRIKAANSE POLISIEDIENS
GEMEENSKAP DIENSSENTRUM
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THE APPLICATION OF FOSSIL GRASS-PHYTOLITH ANALYSIS IN THE RECONSTRUCTION OF LATE CAINOZOIC ENVIRONMENTS IN THE SOUTH AFRICAN CENTRAL INTERIOR

DIE GRAAD THE DEGREE

Philosophiae Doctor

in Plantwetenskappe
in Plant Sciences

TOEGEKEN IS AAN
HAS BEEN CONFERRED UPON

LLOYD ROSSOUW

AS BEWYS DAARVAN PLAAS ONS ONS ONDERSKEIE HANDTEKENINGE EN DIE SEËL VAN DIE UNIVERSITEIT HIERONDER.

AS WITNESS OUR RESPECTIVE SIGNATURES AND THE SEAL OF THE UNIVERSITY BELOW.

VISEKANSELIER/VICE-CHANCELLOR

DEKAAN/DEAN

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THE ASSOCIATION OF SOUTHERN AFRICAN PROFESSIONAL ARCHAEOLOGISTS

CERTIFICATE OF MEMBERSHIP

HEREBY CONFIRMS THAT

LLOYD ROSSOUW

Is a Professional Member (No 0122) of
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Archaeologists and is in good standing
with the organisation

Valid April 2025
March 2026

2025

WOUTER FOURIE
CHAIRPERSON

SHAHZAADEE KHAN
TREASURER

Draft EIA

Cultivation and Irrigation suitability of the Farm Tweefontein, near Prieska, Northern Cape

Prepared for

Jaco Gous (Temdale)

October 2025

DSA
Digital Soils Africa

+27 83 387 6243
www.dsafrica.co.za
johan@dsafrica.co.za
Rorich Crescent
Bloemfontein

Directors:
Prof Johan Van Tol
Prof George Van Zijl
Dr Darren Bouwer

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EXECUTIVE SUMMARY

A soil assessment was carried out on the Tweefontein farm, located near Prieska in the Northern Cape, on behalf of Jaco Gous (Temdale). The investigation covered an area of approximately 34 ha. The objective was to evaluate the suitability of the land for establishing a pecan nut orchard.

Findings from the survey indicate that the area is predominantly underlain by well-drained Oakleaf soils, which are considered highly favourable for both irrigation and cultivation. These soils offer adequate depth, efficient drainage, and favourable chemical characteristics. A small section to the north of the site is covered by Prieska soils. Although cultivation of these soils is unlikely to result in soil degradation, it will probably not be very productive for pecan nut production. The suitability is depicted in Figure A.

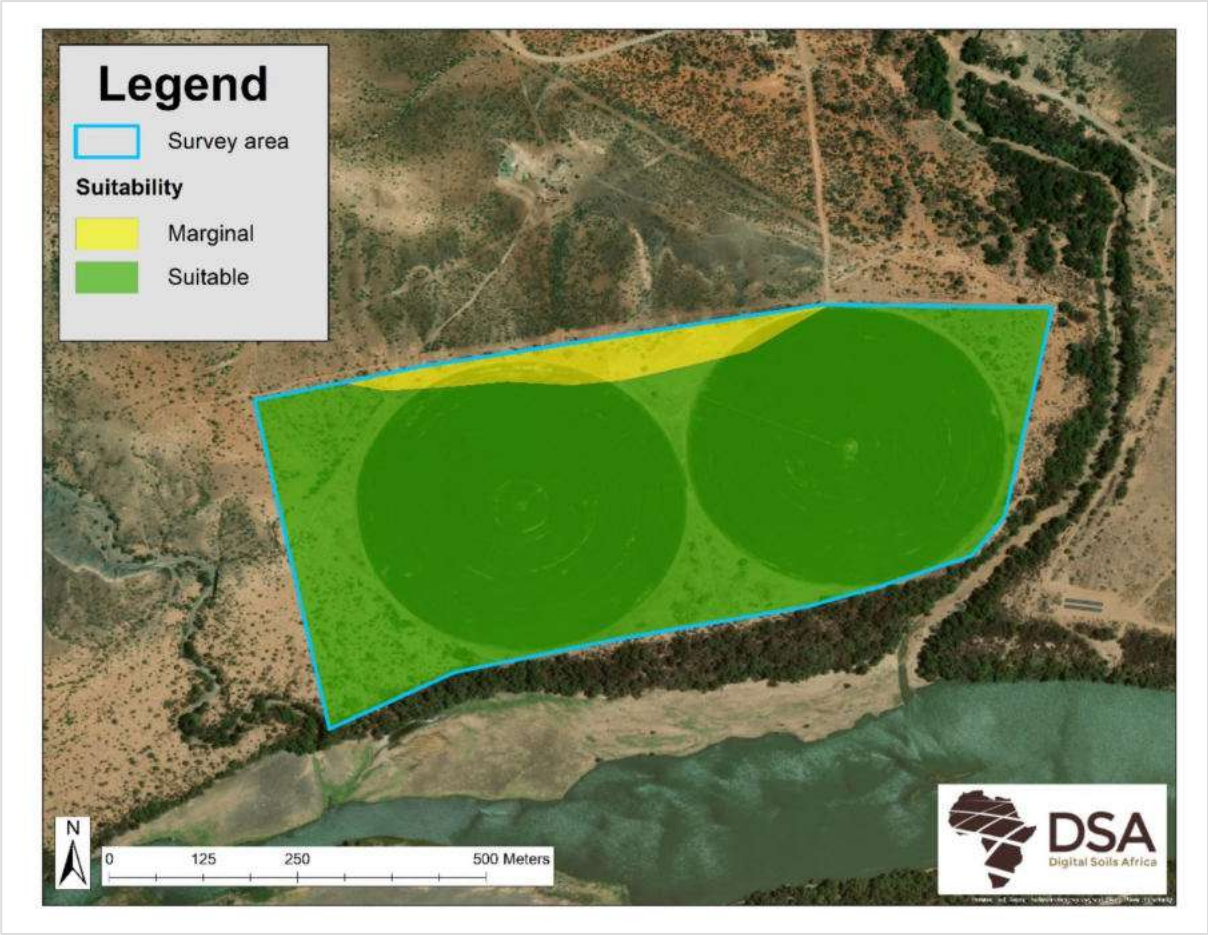

Figure A: Suitability classes for irrigation on portions of the farm Tweefontein near Prieska.

1. INTRODUCTION

Digital Soils Africa (Pty) Ltd (DSA) was commissioned by Jaco Gous of Temdale to conduct a soil survey on approximately 34 ha of land near Prieska in the Northern Cape. The land, situated on the farm Tweefontein (hereafter referred to as the site or study area), requires a ploughing certificate. The survey was therefore undertaken in accordance with the Northern Cape Department of Agriculture's guidelines for the cultivation of virgin soils.

The objective of the survey was to assess the suitability of the soils for cultivation and irrigation. Sustainable irrigation depends on identifying risks of waterlogging and salinization. When irrigation water is applied, dissolved salts accompany it, but plants primarily remove only the water through transpiration. Over time, this can lead to salt accumulation in the soil, reducing yields and, in severe cases, rendering the soil unproductive. Proper management can mitigate these effects, provided that the soil has suitable physical and chemical characteristics.

Accordingly, the Department of Agriculture specifies minimum standards for soil properties before a ploughing licence can be issued. These include aspects influencing water infiltration, as well as salt and sodium accumulation. The current survey therefore aimed to characterise the soil properties and their spatial distribution across the site to identify areas where irrigation can be managed sustainably.

2. LOCATION

The location of the centre pivot on the farm Tweefontein are shown in Figure 1 with the coordinates of the perimeter in Table 1. The site is located on the banks of the Orange River approximately 38 km northeast of Prieska and 20 southeast of Niekerkshoop (Figure 1). The coordinates of the focus areas are presented in.

Table 1: Coordinates of selected points on the perimeter of the studied area

Number	X	Y	Number	X	Y
1	23.01561	-29.41045	10	23.02428	-29.41218
2	23.01585	-29.41150	11	23.02457	-29.41184
3	23.01617	-29.41292	12	23.02486	-29.41056
4	23.01650	-29.41437	13	23.02514	-29.40934
5	23.01800	-29.41369	14	23.02350	-29.40932
6	23.01932	-29.41342	15	23.02248	-29.40930
7	23.02034	-29.41323	16	23.02110	-29.40950
8	23.02176	-29.41299	17	23.01916	-29.40980
9	23.02310	-29.41266	18	23.01720	-29.41012

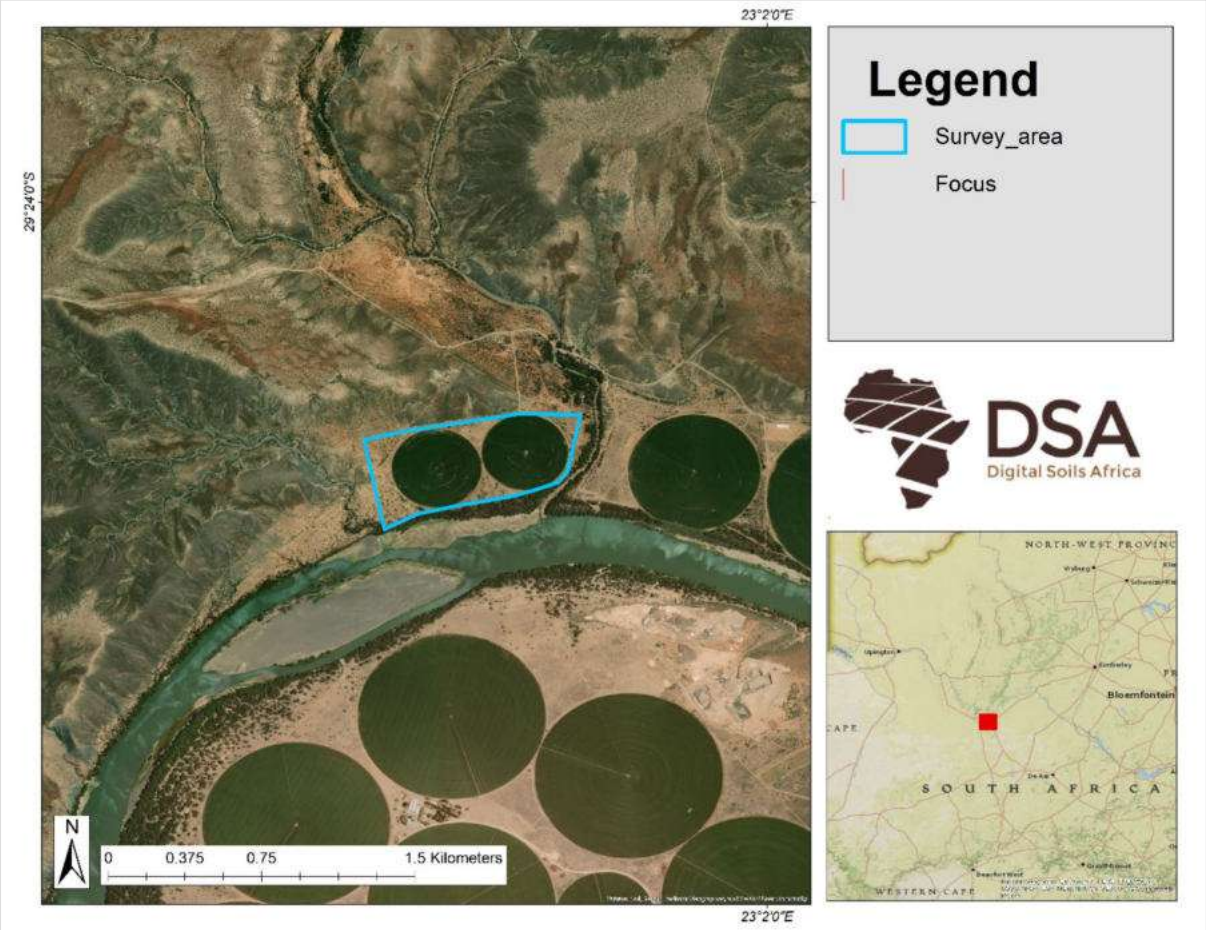

Figure 1: The location of the focus area of this study on the banks of the Orange River.

3. METHODOLOGY

A field visit was conducted on the 17th of September 2025. Thirteen soil observations were made using opened profile pits. The location of these observations is presented in Figure 2 with their coordinates in Table 2. The profiles were opened to approximately 2.5 m. Soils were classified according to Soil Classification: A Natural and Anthropogenic System for South Africa (2018) which is now the officially recognised classification system for South African soils. Soil depth, freely drainable depth and limiting material were noted and mapped. Samples of two representative profiles were taken for chemical and physical analysis. A total of six samples were analysed which included three topsoil samples (0 – 0.3 m) and three subsoil samples (0.3 – 0.6 m). Texture was measured with the pipette method, basic cations from a 1:10 NH_4OAc extract (White 2006) and soil pH in a 1:2.5 KCl extract. Phosphorus was measured with Bray I method and selected micro-nutrients with the DTPA method.

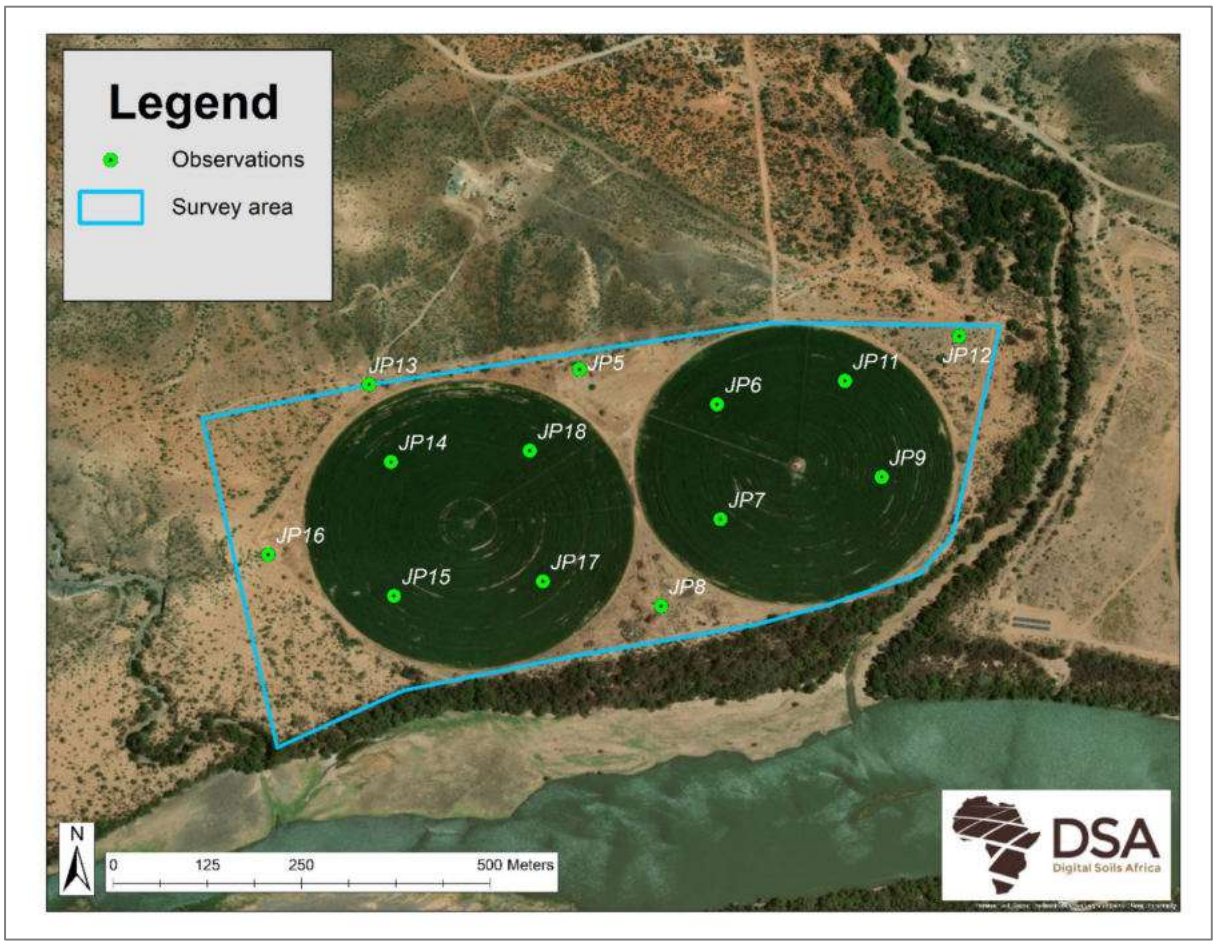

Figure 2: Surveyed area and soil observation locations for the site.

Table 2: Observation locations in study area

Name	X	Y	Name	X	Y
JP5	23.02011	-29.4099	**JP13**	23.01760	-29.4100
JP6	23.02176	-29.4103	**JP14**	23.01786	-29.4110
JP7*	23.02180	-29.4116	**JP15***	23.01790	-29.4126
JP8	23.02109	-29.4127	**JP16**	23.01639	-29.4121
JP9	23.02372	-29.4111	**JP17**	23.01967	-29.4124
JP11*	23.02328	-29.4100	**JP18**	23.01952	-29.4108
JP12	23.02465	-29.4095			

(observation numbers followed by * were sampled)

4. RESULTS

4.1 SOILS FORM

The site is dominated by very deep soils of the Oakleaf and Ermelo form. To the north of the site a small section of carbonate rich Augrabies and Prieska soils were observed.

AUGRABIES/PRIESKA

The Augrabies and Prieska soils both have an orthic topsoil horizon overlying a neocarbonate subsoil horizon. In the Augrabies soil, no third horizon was observed, whereas in the Prieska soil a hard carbonate horizon occurs at approximately 2.1 m (Figure 3). Given the depth at which this horizon occurs, no drainage problems are expected, although the soils are naturally alkaline. For orchard establishment, these soils are considered marginal, although such development is unlikely to cause soil degradation.

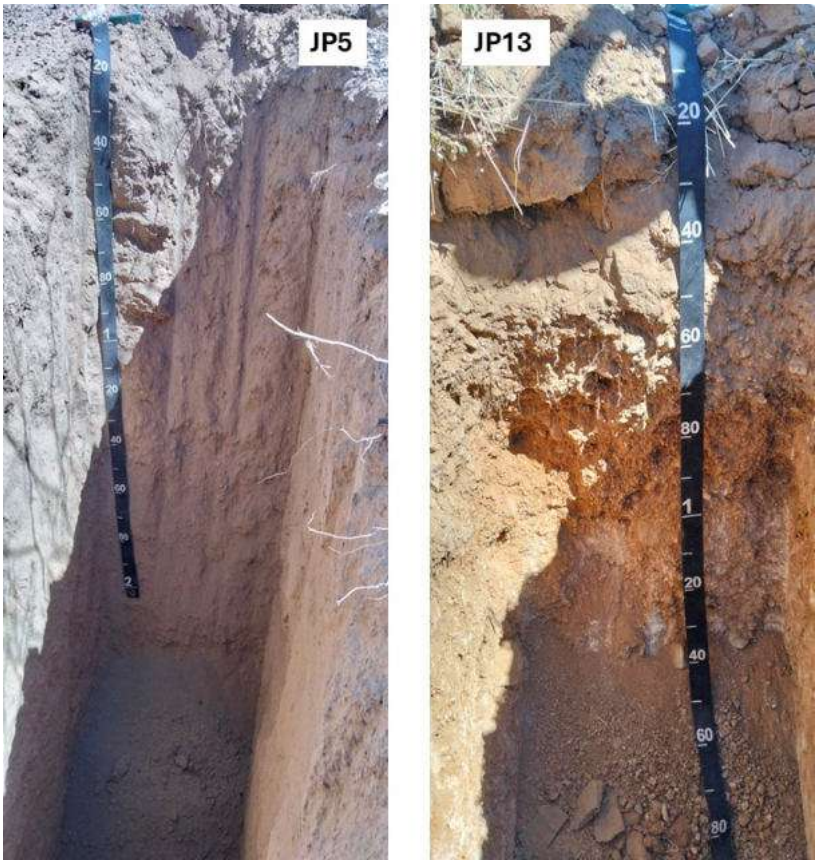

Figure 3: Augrabies (JP5) and Prieska soils (JP13) observed at Tweefontein.

OAKLEAF/ERMELO

The Oakleaf soil form consists of an orthic horizon overlying a deep neocutanic horizon (Figure 4). These soils are very deep—exceeding 2.5 m—and have developed from alluvial deposits. Their morphology indicates that they are freely drained and highly suitable for irrigation. One observation (JP8) was uniformly coloured and very sandy, and was classified as an Ermelo form, which comprises an orthic horizon over a very deep (>2.5 m) yellow-brown apedal horizon. Both the Oakleaf and Ermelo soils are therefore considered highly suitable for irrigation.

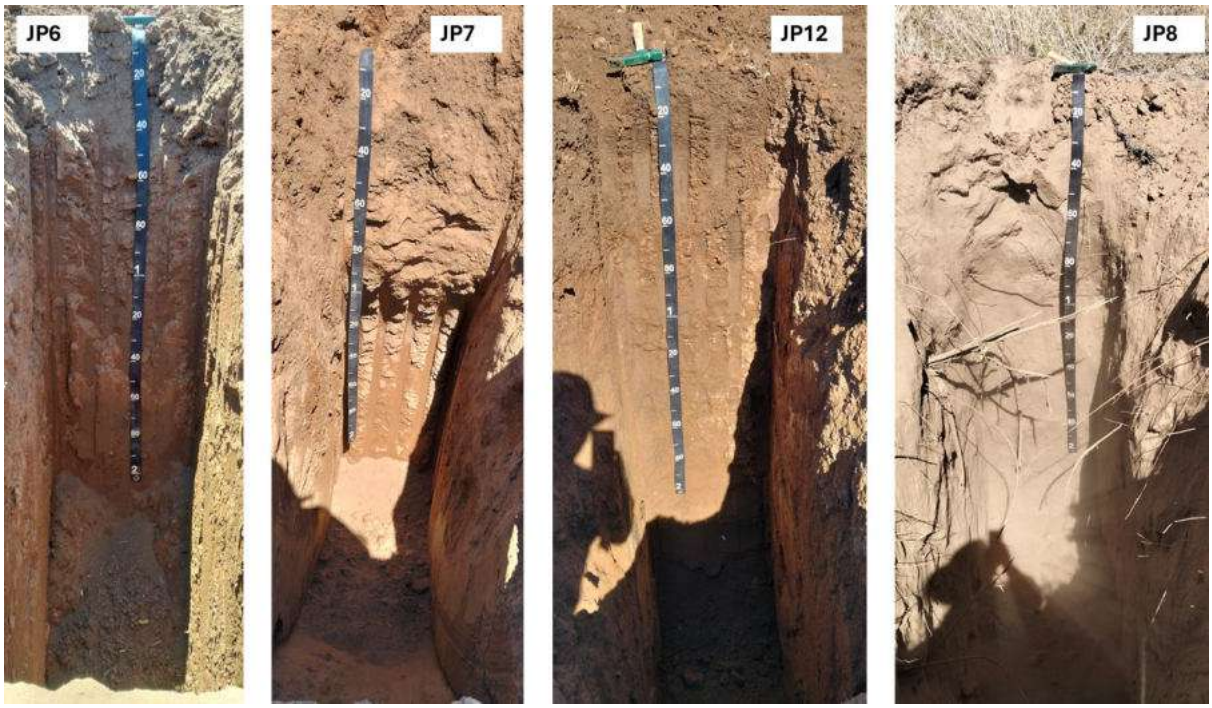

Figure 4: Oakleaf soils represented by JP6, JP7 & JP12. A sandy Ermelo soil was observed at JP8.

4.2SOIL AND SOIL DEPTH MAPS

The majority of the site is covered by Oakleaf/Ermelo soils and small section in the northern part with Augrabies/Prieska soils (Figure 5). The lower boundary of the soils was not reached in the Oakleaf soils but were around 2.1 m in the Prieska soils. Based on this, the soil depth was classified in the 2.51–3.00 m for the Oakleaf and 2.01-2.50 m category for the Prieska soils, respectively, in accordance with the Departmental Guidelines (Figure 6).

The freely drained depth was assumed to be equal to the total soil depth (Figure 7). In all cases, the underlying material could be broken relatively easily; therefore, the drainable depth was also considered equal to the total soil depth, although in practice it may be even deeper (Figure 8). No depth-limiting layers were encountered in the Oakleaf soils whereas the hard carbonate horizon could potentially restrict deep drainage in the Prieska soils (Figure 9).

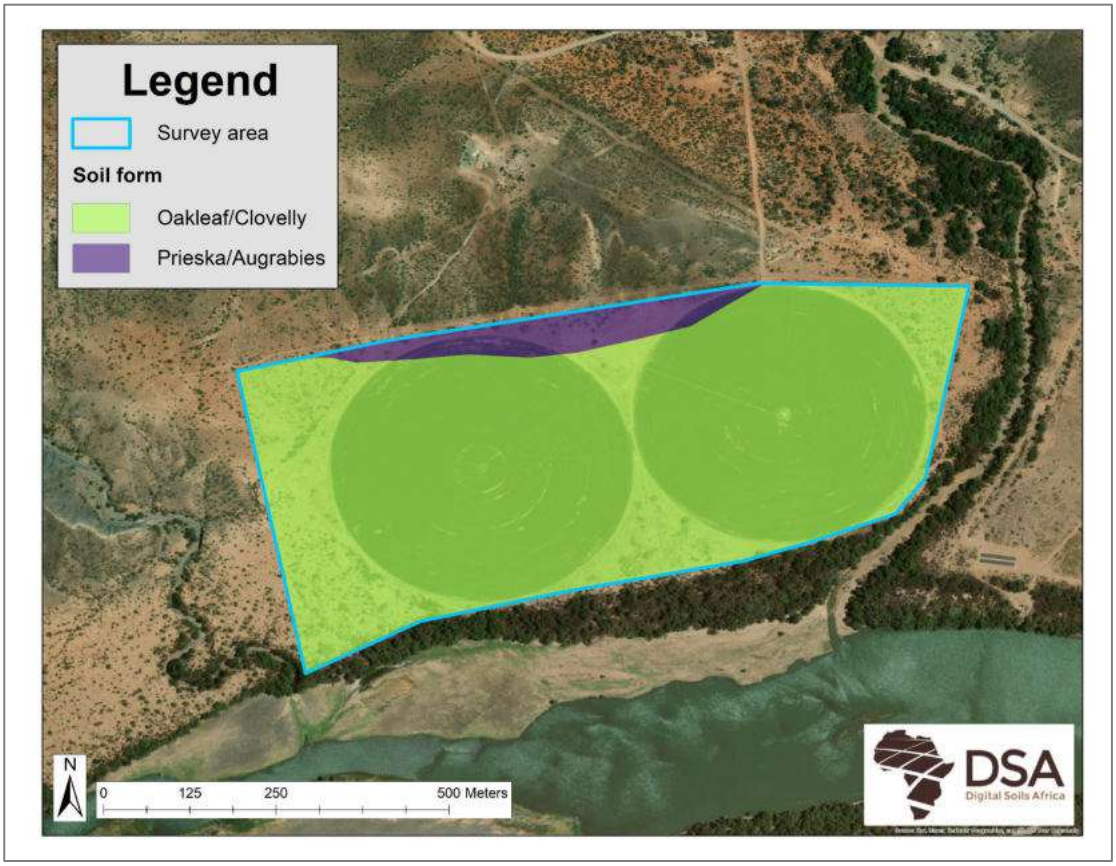

Figure 5: Soil map of the surveyed area.

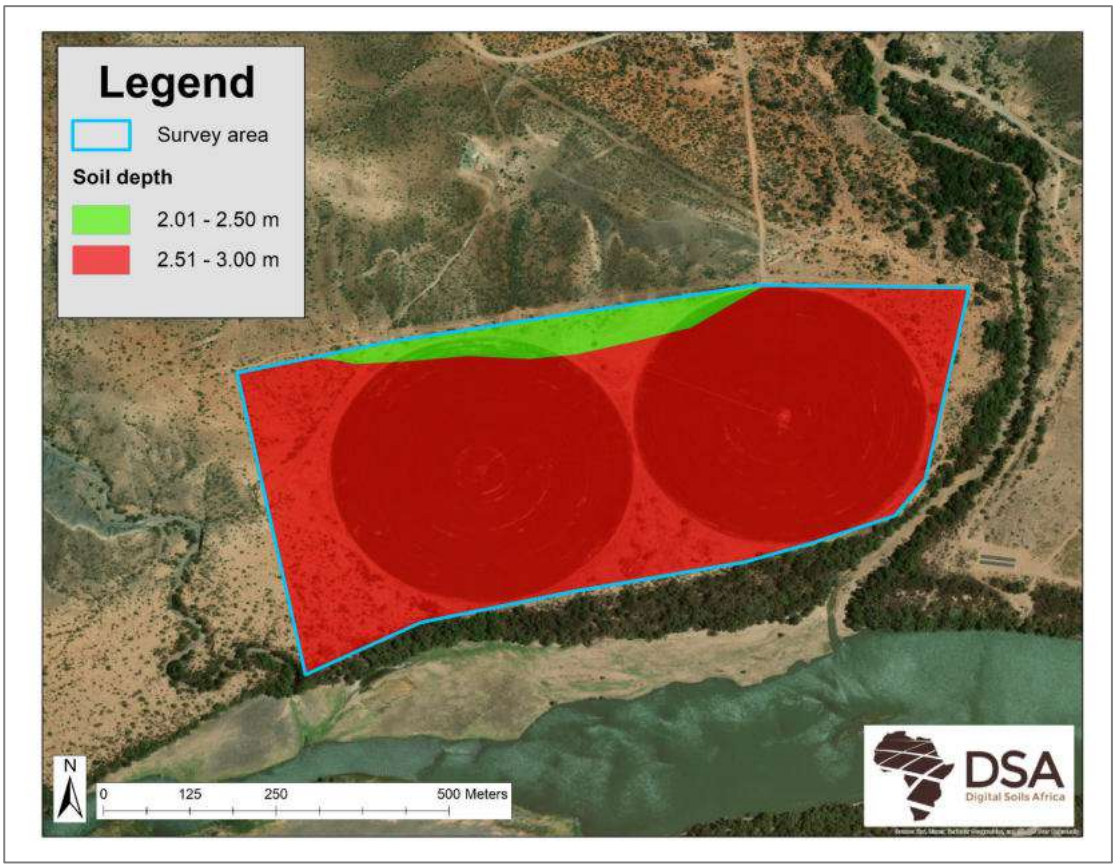

Figure 6: Total soil depth of the surveyed area.

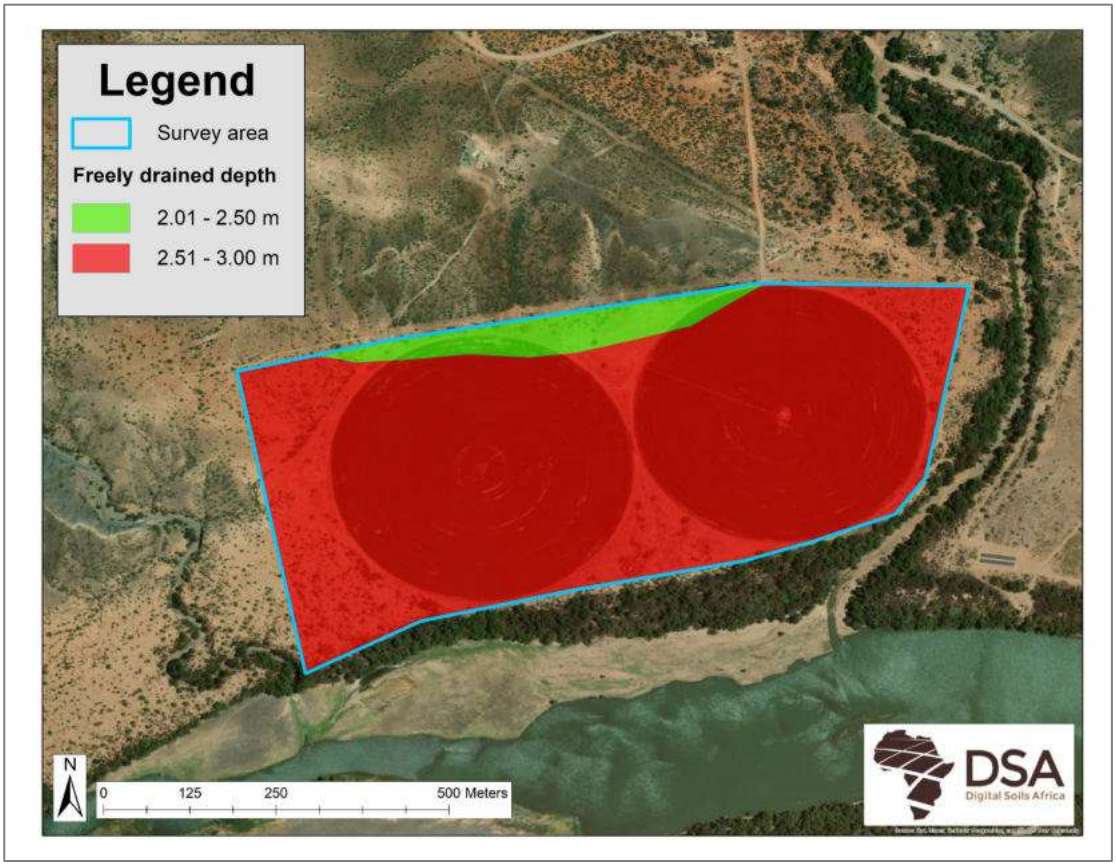

Figure 7: Freely drained depth of the surveyed area.

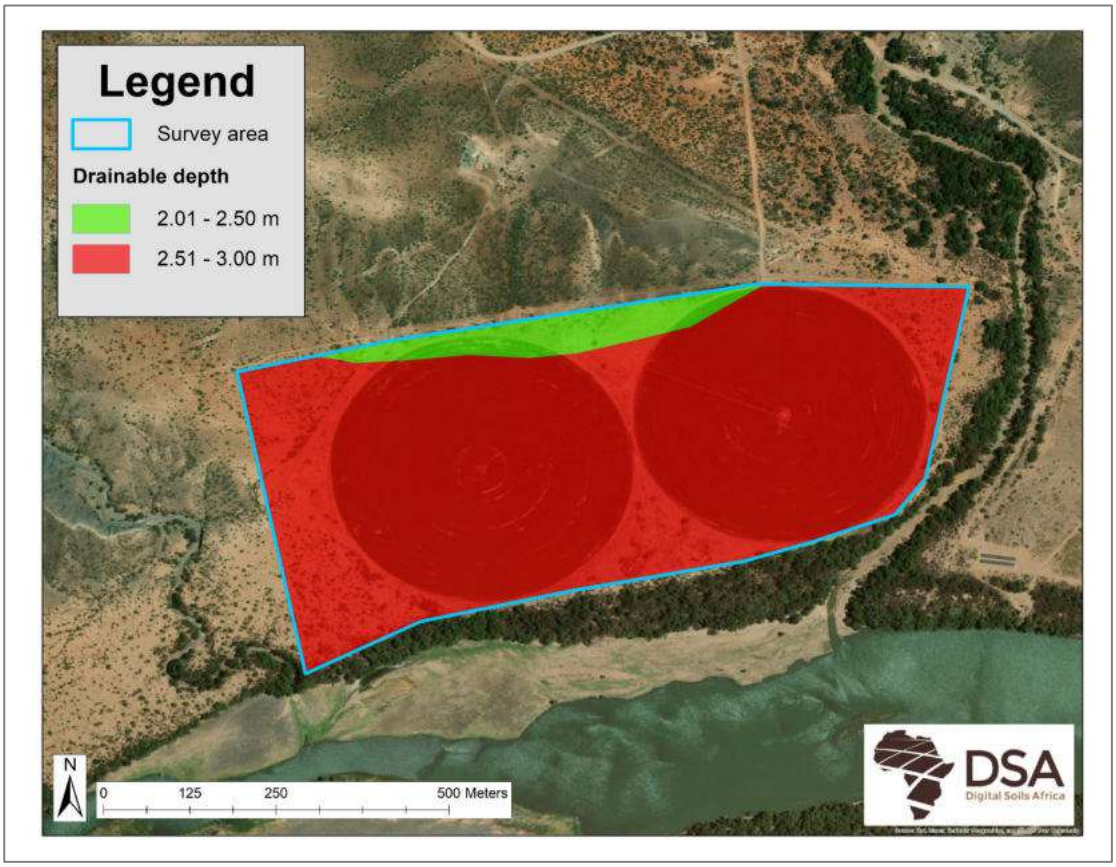

Figure 8: Drainable depth of the surveyed area.

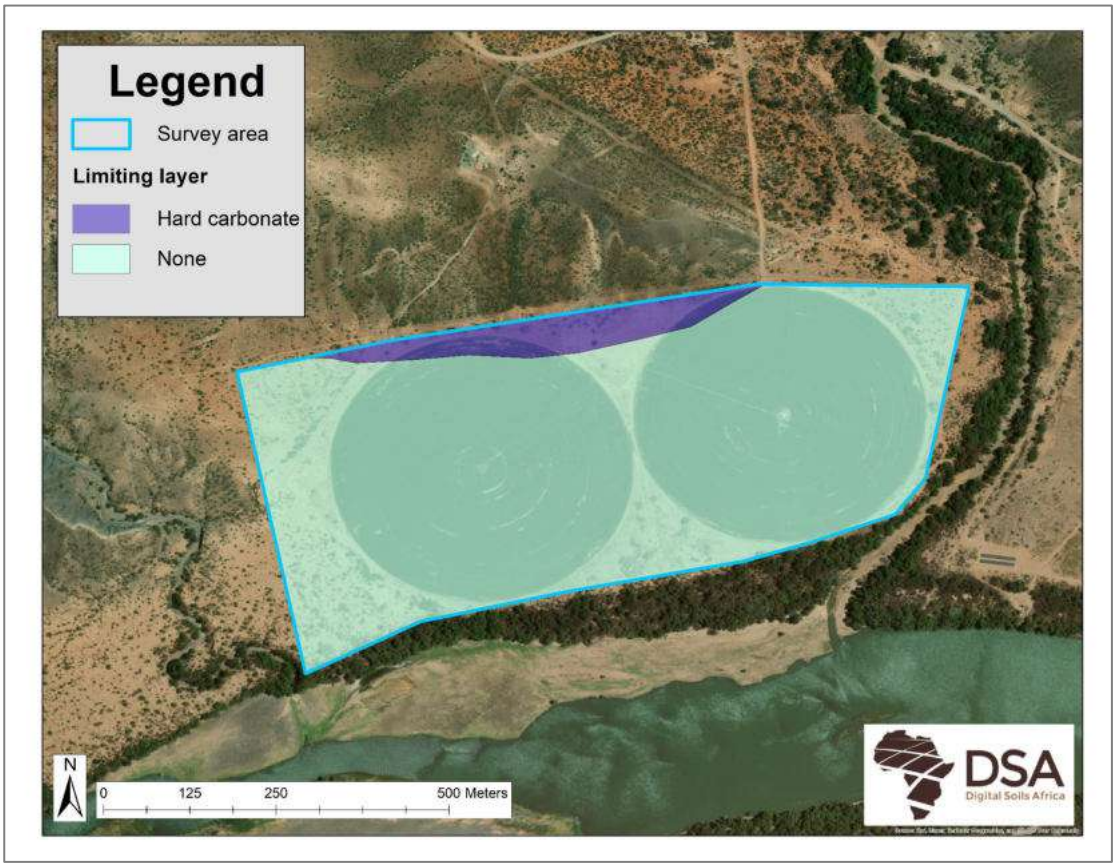

Figure 9: Depth limiting layer of the surveyed area.

4.3 CHEMICAL AND SOIL TEXTURE ANALYSIS

Table 3 (chemical) and Table 4 (texture) present selected soil properties of samples taken from modal profiles.

Based on the chemical analysis, none of the soils exceed the norms in terms of any of the chemical norms for irrigatable soil. Since the soils are freely drained and excessive Na is not a problem leaching with excessive water will maintain EC levels within acceptable norms. Exchangeable Sodium Percentage (ESP) and the Sodium Adsorption Ratio (SAR) are all within the norms for soils to be irrigated. The P content is low but will be elevated when fertiliser is applied.

The clay percentages of all the top and subsoils are all within the recommended ranges of the Department.

Table 3: Selected chemical properties for soil profile observations

Observation	Soil form	Horizon	pH (KCl)	EC	Ca	Mg	Na	K	CEC	ESP	SAR*	S	P
				mS/m	cmol(+)/kg					%		mg/kg	
JP-7A	Oakleaf	Orthic	6.03	48.30	14.25	5.65	0.23	0.32	20.46	1.11	0.07	28.27	17.22
JP-7B		Neocutanic	6.67	54.80	16.36	4.81	0.51	0.16	21.84	2.34	0.16	37.15	2.09
JP-11A	Oakleaf	Orthic	6.66	126.00	11.90	4.96	0.20	1.10	18.16	1.12	0.07	27.87	26.90
JP-11B		Neocutanic	6.75	53.70	21.07	6.81	0.27	0.39	28.54	0.96	0.07	49.46	5.03
JP-15A	Oakleaf	Orthic	6.69	95.30	18.34	3.88	0.22	0.79	23.24	0.93	0.06	42.27	12.93
JP-15B		Neocutanic	6.79	99.50	17.22	4.92	0.75	0.16	23.05	3.27	0.23	41.75	1.98

* SAR – approximated from 1:10 NH_4OA_c extract

Table 4: Particle size distribution of soil observations

Observation	Soil form	Horizon	Sand	Silt	Clay
			%		
JP-7A	Oakleaf	orthic	45.8	22.3	32.6
JP-7B		neocutanic	49.2	23.4	27.4
JP-11A	Oakleaf	orthic	51.7	21.2	27.2
JP-11B		neocutanic	43.3	24.4	32.4
JP-15A	Oakleaf	orthic	61.2	17.2	22.4
JP-15B		neocutanic	42.2	24.2	34.0

4.4SUITABILITY MAPS

Based on soil morphology and laboratory analysis, the entire surveyed areas are suitable for cultivation and irrigation in accordance with the guidelines of the Northern Cape Department of Agriculture (Figure 10). The Oakleaf soils all very deep (>2.5 m) and show no signs of saturation. The Prieska soils are also deep and the limiting layer only at >2 m. The perimeter coordinates of the final suitability classes for both areas are the same as the surveyed area presented in Table 1. We did highlight in Figure 10 that the Prieska soils might not be ideal for pecan nut production but do not foresee any degradation of the soils when pecans are produced.

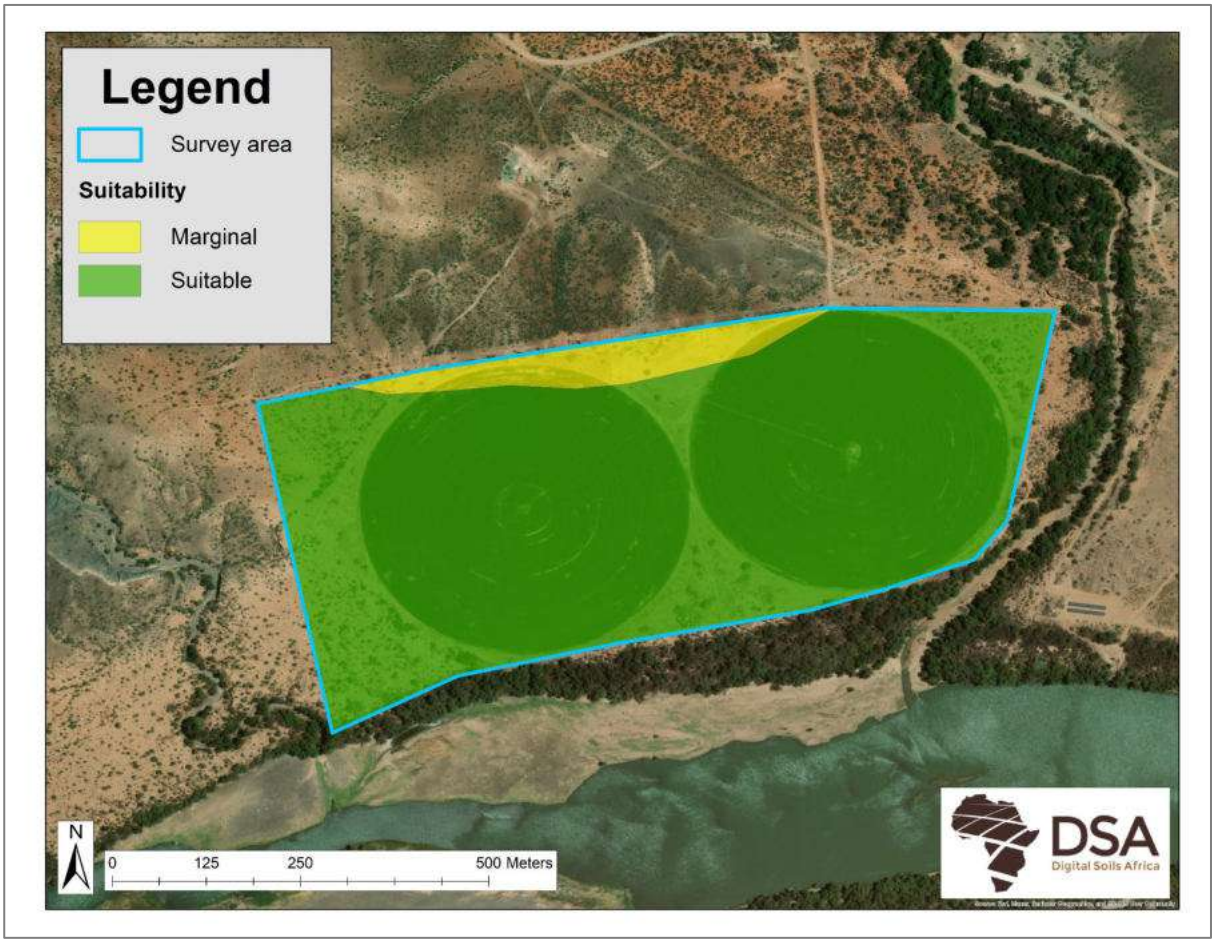

Figure 10: Suitability for cultivation and irrigation of focus area.

5. CONCLUSION

The soil survey conducted on portions of the Tweefontein farm confirms that the area is mostly covered by freely drained Oakleaf soils well-suited for irrigation and cultivation. The area in the north covered by Prieska soils is also suitable, although not as suitable as the Oakleaf soils. All four surveyed portions have soils exhibiting sufficient depth, good drainage characteristics, and

favourable chemical properties. Overall, the land is suitable for irrigation, provided that appropriate management practices are implemented to mitigate potential salinity risks.

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7. DISCLAIMER

Digital Soils Africa cannot be held responsible for any advice given based on incorrect laboratory analysis given by our providers. Although all care is taken to ensure that the results reported are correct, we are dependent on services from other companies.

8. APPENDICES

APPENDIX 1: MODAL SOIL PROFILE DESCRIPTION

General Information					
Site:	Tweefontein JP7			Soil form:	Oakleaf
Map/Photo example:	Figure 4			Soil family:	2110
GPS Position:	23,0218; -29,4416			Colour	Chromic
Surface stones:	0%			Occurrence of flooding:	None
Altitude:	978 masl			Wind erosion potential:	Moderate
Terrain unit:	Footslope			Water erosion potential:	Low
Slope:	1%			Vegetation/Land use:	Cultivated Land
Slope shape:	Planform	Straight	Profile Straight	Water table:	None
Aspect:	None				
Micro-relief:	None			Described by:	JJ van Tol
Parent material solum:	Alluvial deposits			Date described:	2025-09-17
Geological group:	Dwyka Formation			Weathering of underlying material:	

Profile Information						
Horizon Depth (mm)	*Diagnostic Horizon*	*Colour*	*Structure*	*Redoximorphic features*	*Lime*	*Transition*
A 300	Orthic A	Brown	Weak- Moderate, medium, SANBL	None	Absent	Gradual
B1 2500+	Neocutanic	Brown	Weak-moderate, medium, SANBL	None	Absent	Not reached

General Information					
Site:	Tweefontein JP15			Soil form:	Oakleaf
Map/Photo example:	Figure 4			Soil family:	2120
GPS Position:	23,01639; -29,4121			Colour	Chromic
Surface stones:	0%			Occurrence of flooding:	None
Altitude:	965 masl			Wind erosion potential:	Moderate
Terrain unit:	Footslope			Water erosion potential:	Low
Slope:	1%			Vegetation/Land use:	Cultivated Land
Slope shape:	Planform	Straight	Profile Straight	Water table:	None
Aspect:	None				
Micro-relief:	None			Described by:	JJ van Tol
Parent material solum:	Alluvial deposits			Date described:	2025-09-17
Geological group:	Dwyka Formation			Weathering of underlying material:	

Profile Information

Horizon Depth (mm)	*Diagnostic Horizon*	*Colour*	*Structure*	*Redoximorphic features*	*Lime*	*Transition*
A 300	Orthic A	Brown	Weak- Moderate, medium, SANBL	None	Absent	Gradual
B1 2500+	Neocutanic	Brown	Weak-moderate, medium, SANBL	None	Absent	Not reached

APPENDIX 2: AGRONOMICAL REPORT

Compiled by Prof. G.M. van Zijl

Pr.Sci.Nat – Agricultural Science 400065/15

Pr.Sci.Nat – Soil Science

PhD (Soil Science – UFS)

M.Sc. Agric (Soil Science – SU)

B.Sc. Agric (Agronomy – SU)

Contact: +27 72 386 8632; george@dsafrica.co.za

Agronomical report for the production of pecan nuts on the farm Tweefontein, Prieska, Northern Cape

1. General soil requirements for pecan nut production

Pecan nuts grows optimally in fertile, well drained soils with a moderate to loose structure. In ideal situations the roots can grow as deep as 3 metres, but feeding roots occur only in the top 40-60 cm. No lime should occur in the area where the feeder roots grow (40-60 cm), as a high pH renders micro-nutrients unavailable for uptake by pecan nut roots. Thus neocarbonate, soft carbonate and hard carbonate horizons should not occur within 60 cm of the soil surface. Hard, root impenetrable horizons (indurated or heavy clay soils) should not occur within 60 cm of the soil surface, as pecan nuts require a well-drained soil medium to ensure adequate aeration. Therefore, soils with a clay percentage of 10-40% is preferred for pecan nut production, provided the drainage and aeration is acceptable for pecan nuts. Pecan nuts can grow in soils with a coarse fraction of up to 80%, as long as the medium is loose enough to allow root growth. Irrigation scheduling should be adapted according to the soil properties. A good water holding capacity is desirable, with a clay percentage of above 5%. Soils with a high fertility are preferred, but as fertility can be rectified with a fertilization plan, the other soil prerequisites take precedence over the fertility requirements. The exchangeable sodium percentage (ESP) should not exceed 3%, but can be rectified with chemical and irrigation management.

2. Specific Tweefontein situation.

2.1. Soil Depth

The soil depth for the entire area is freely drained to at least 2 m. Therefore the soil is suitable for pecan nut production.

2.2. Soil texture

The soil texture referred to has a clay percentage of between 22 and 34%, which is within the acceptable limits. The soil is well drained, with sufficient water holding capacity.

2.3. pH

For the suitable marked area, no lime containing horizons were found within the top 60 cm of the soil, and the pH for the samples are between 6.0 and 6.8, which is sufficient for pecan nut production. However, the area marked as marginal does contain free lime within the top 60 cm, and pecan nut trees planted here will struggle with micro nutrient uptake. A leaf spray should be administered for micro nutrient fertilization within this area.

2.4. Fertility

The CEC value is between 18 and 23 cmol(+)/kg, which indicates that the soil is sufficiently fertile for pecan nut production. Fertility management does however stay important for optimal production.

2.5. Salinity and sodicity

The electrical conductivity of 48-126 mS/m is below the treshold for pecan nut production (200 mS/m), showing that salts have not accumulated in the soil. The ESP is also below 3, showing that sodicity levels are also in line. With irrigation, salts and sodium will be deposited in the soil, and should be monitored and managed as necessary. However, as the soils are very deep on the largest part of Tweefontein, salinity and sodicity is a small threat, which should easily be managed through irrigation and fertility management.

3. Conclusions

Based on morphological, physical and chemical observations and measurements, the area indicated as suitable is suitable for pecan nut production. The marginal area is indeed marginal, as free lime in the upper 60 cm will hinder micro nutrient uptake which needs to be applied through foliar sprays. However, the issue is economical (cost of foliar sprays vs yield), and panting of pecan nut trees will not lead to soil degradation.

APPENDIX 3 – SPECIALIST CV - JOHAN VAN TOL

Jacobus Johannes van Tol

EDUCATION

Certificate in Environmental Law	University of Pretoria	2017
PhD Soil Science	University of the Free State	2011
M.Sc. Agric Soil Science	University of the Free State	2008
B.Sc. Agric (Hon)	University of the Free State	2007
B.Sc. Agric	University of the Free State	2006

PROFESSIONAL AFFILIATIONS

- SACNASP- Pri Nat Sci 400274/13
- Past-President of the Soil Science Society of South Africa
- Member of the Soil Classification Work Group
- Member of South African Soil Surveyors Organisation

WORK EXPERIENCE

- University of the Free State / Professor (full): current
- Digital Soils Africa / Soil Scientist: 2015 – Present
- University of Fort Hare / Senior Lecturer: 2011 - 2016
- University of the Free State / Researcher: 2007 - 2011

RECENT PUBLICATIONS

Total peer reviewed publications: 97 full list

Total consultancy and research projects: > 120

- Van Zijl, G.M. & van Tol, J.J., 2024. Digital soil mapping enables informed decision-making to conserve soils within protected areas. *South African Journal of Plant and Soil*. https://doi.org/10.1080/02571862.2023.2255158
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- Van Tol, J.J., Bieger, K. & Arnold, G., 2021. A Hydropedological approach to simulate streamflow and soil water contents with SWAT+. *Hydrological Processes.* DOI:10.1002/hyp.14242.
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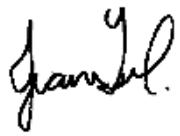
SPECIALIST DECLARATION

I, Johan van Tol, declare that –

- I act as the independent specialist in this application;
- I regard the information contained in this report to be true and correct;
- I do not have a conflict of interest in this project;
- I will conduct the work relating to the project in an objective manner.



Prof. Johan van Tol
PhD Soil Science
Pri Nat Sci 400274/13

agriculture, environmental affairs,
rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform ,
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Application for authorization in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 as amended.

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

1. Project title:

Development of the remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, Siyathemba Local Municipality, Northern Cape province.

2. Details of the specialist:

Project Specialist:	Prof Johan van Tol		
Trading name (if any):	DIGITAL SOILS AFRICA (PTY) LTD		
Business reg. no./ID. no.:	8497195080089		
Contact person:			
Physical address:	18 Rorich Crescent, Bloemfontein		
Postal address:			
Postal code:	9322	**Cell:**	0833876243
Telephone:		**Fax:**	
E-mail:	johan@dsafrica.co.za		
Qualifications:	PhD (Soil Science)		
Professional affiliation (s) (if any)	Soil Science Society of South Africa SACNASP 400274/13		

3. Details of the consultant

Project consultant/firm:	Digital Soils Africa (Pty) Ltd		
Business reg. no./ID. no.:	2012/111217/07		
Contact person:	Natalie Sharp		
Postal address:	45 Church Street, Walmer		
Postal code:	6070	**Cell:**	082 414 0472
Telephone:	082 414 0472	**Fax:**	
E-mail:	natalie@dsafrica.co.za		

4. Declaration by the specialist appointed in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

I, Johan van Tol, declare that –

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Digital Soils Africa

Name of company (if applicable):

20/07/2026

Date:

Signature of the Commissioner of Oaths: 20/07/2026

HANRI HONIBALL
1 KEMSLEY STREET
PORT ELIZABETH 6001
EX OFFICIO COMMISSIONER OF OATHS
ADMITTED ATTORNEY (RSA)

Date:

Designation:

Official stamp (below):

CURRICULUM VITAE

J.J. VAN TOL

2026

Curriculum Vitae: JJ van Tol
18 Rorich Crescent, Bloemfontein, 9301
E-mail: vantoljj@ufs.ac.za
Tel: +2783 387 6243

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Curriculum Vitae: JJ van Tol
18 Rorich Crescent, Bloemfontein, 9301
E-mail: vantoljj@ufs.ac.za
Tel: +2783 387 6243

SUMMARY

Professor (full) in Soil Science; President of the Soil Science Society of South Africa; Chair of IUSS Working Group on Hydropedology; NRF C2 rated researcher; 95 peer reviewed publications; 9 peer reviewed book chapters and 1 book; 28 international and 65 national congress presentations; lead/involved in 19 externally funded research projects; produced 100+ scientific consultancy reports; received numerous awards/accolades for research and/or academic outputs.
Research focus: hydropedology, environmental soil science; soil physics; pedology

PERSONAL INFORMATION

Name: Jacobus Johannes (Johan)
Surname: van Tol
Identity Number: 8407195080089
Date of Birth: 19 July 1984
Drivers Licence: Code B
Nationality: South African
Home Language: Afrikaans
Other Languages: English
Home Address: 18 Rorich Crescent, Bloemfontein, South Africa, 9301
Work Address: Department of Soil, Crop and Climate Sciences, University of the Free State, Bloemfontein, South Africa.

QUALIFICATIONS

PhD. in Soil Science (UFS): Characterizing Sub-Surface Lateral flow in selected hillslope soils to facilitate hydrological predictions (2011).
M.Sc. Agric in Soil Science (UFS): Soil indicators of Hillslope Hydrology in the Bedford and Weatherley catchments (2008) – *cum laude.*
B.Sc. Agric (Hons) in Soil Science (UFS) in 2007 – *cum laude*.
B.Sc. Agric in Soil Science and Agronomy (UFS) in 2006.
Matriculate (Transvalia High School) in 2002 – average > 80%.

CAREER

Professor (full) (2024 -): University of the Free State
Responsibilities: Lecturing undergraduate and postgraduate modules, research, post graduate supervision and general institutional administration.

Director (2015 -): Digital Soils Africa (Pty) LTD
Responsibilities: Planning and execution of soil science consultancy projects.

Associate Professor & Senior Lecturer (2016 - 2023): University of the Free State
Responsibilities: Lecturing undergraduate and postgraduate modules, research, post graduate supervision and general institutional administration.

Lecturer & Senior Lecturer (2011 – 2016): University of Fort Hare

Responsibilities: Lecturing undergraduate and postgraduate modules, research, post graduate supervision and general institutional administration.

Researcher (2007 – 2011): University of the Free State

Responsibilities: Innovative research (field work, compiling research reports and training of assistant researchers), time-on-task lecturing (2009 – 2011).

TEACHING

Undergraduate modules at UFS (2016 -):

- SOIL3774: Soil classification and land-use planning (re-developed module)
- SOIL4834: Advanced classification and geomorphology
- SOIL3714: Soil fertility management
- SOIL3724: Soil pollution and management (considerable contribution to content)

Undergraduate modules at UFH (2011 - 2016):

- AGS211: Introduction to soil science (pedology, soil chemistry and soil fertility sections)
- AGS221: Pedology
- AGS322: Soil Taxonomy
- ALP313: Land Use Planning (soil science section)
- AGS413: Seminar in Soil Science
- AGS422: Soil Physics
- AGS401: Project in Soil Science

Undergraduate modules at UFS (2009 – 2011: time-on-task):

- GKD314: Soil Evaluation and Land-Use Planning
- GKD444: Soil Geography

Post graduate modules:

- SOIL7904: Land Evaluation
- AGS612: Soil Physics (Hons) - UFH
- AGS621: Pedology (Hons) – UFH
- AGS601&602: Seminar and project in soil science
- MOB708: Magister in Environmental Management (UFS) – The Soil Resource and Impact on the Environment (Guest lecturer since 2011)
- MOB741: Magister in Environmental Management (UFS) – Soil and Pollution (Guest lecturer since 2011)

EVALUATIONS

- External moderator for final year soil science modules for Stellenbosch University (2017-18) and hons modules at University of Pretoria (2026 -)
- External examiner of 4 PhD thesis' and 14 M.Sc dissertations from various Universities
- Internal examiner of 4 PhD thesis' and 4 M.Sc dissertations.

POST GRADUATE SUPERVISION

PhD:

1. Nebo, G. (PhD). Short term impacts of conservation agriculture practices on soil physical properties, moisture and temperature regimes, and draught resilience in a semi-arid South Africa (2025 – co-promotor; University of Fort Hare).
2. Nkosi, M. (PhD). Evaluating the impacts of urbanisation on water resources using a hydropedological approach: a case study of quaternary catchment X22 (2025 – co-promotor; University of Limpopo).
3. Kotze, J.J. (PhD). Towards a Landslide Early Warning System for South Africa (2025 - UFS)
4. Mc Lean, C.C. (PhD). Assessing the impact of degradation on soil quality within selected National Parks (2025 - UFS).
5. Strydom, T. (PhD). Short- and long-term impacts of experimental fires on selected soil properties in the Kruger National Park (2024 - UFS).
6. Smit, I.E. (PhD). Soil information in hydrological modelling: Mapping, modelling and applications in the macro-scale Sabie-Sand catchment (2024 - UFS).
7. Malongweni, S.O. (PhD). Fire-Herbivore interactions in savanna ecosystems of the Kruger National Park, South Africa: Impact on Soil Quality (2023 – UFS).
8. Harrison, R. (PhD). Interactions between dissolved organic carbon and hydropedology in Afromontane catchments (2023 – UFS).
9. Mamera, M. (PhD). Effect of biochar amendment on reducing migration of faecal pollutants from simulated pit latrines in soils with different textures (2022 – UFS).
10. Chichongue, O.J. (PhD). Comparison of crop management systems for smallholder farmers in Mozambique (2020 – UFS).
11. Bouwer, D. (PhD). Integration of soil morphology, chemistry and hydrometry for optimizing hydrological response models (2018 – UFS).
12. Cosmas, P. (PhD). Litter quality effects on the architecture of soil particles and erosion in the soils of the Ntabelanga area, Eastern Cape, South Africa (2016 – UFH).

In progress

13. Job, N. (PhD – SU). Integrating hydropedological assessments in wetland delineation and management (submission – end 2026).
14. Muller, M. (PhD). Impacts of conservation on soil-plant interactions in the Golden Gate National Park (submission – mid 2025).
15. Novela, M. (PhD). Factors impacting avocado yield and quality in the Limpopo region of South Africa (submission – end 2025).
16. Buys, J.A., (PhD)…
17. Daniel Isadory (PhD)
18. Mariné Blaauw (PhD).
19. Colby Weiss (PhD)
20. Siboniso Thela (PhD)
21. Bhavna Ramdhani (PhD)

M.Sc:

1. Buys, J.A. (M.Sc). Characterization of spatial and temporal variability in soil microbial biomass at Benfontein Nature Reserve (2024 – UFS). *Co-supervisor.*
2. Nienaber, K (M.Sc). Determining wetland health using plant and soil indicators in the Golden Gate Highlands National Park, Free State Province, South Africa (2023 - UFS). *Co-supervisor.*

3. Kotze, J.J. (M.Sc). Quantifying soil carbon stocks in Alpine areas of the Maloti-Drakensberg mountains using digital soil mapping approaches (2023 – UFS). ***Cum laude***
4. Muller, M. (M.Sc). Quantification of soil- and vegetation degradation in the Golden Gate Highlands National Park, Free State, South Africa (2022 – UFS). *Co-supervisor*
5. Baasi, L. (M.Sc). Characterisation of soil and vegetation of wetlands in Sehlabatebe, Lesotho (2022 – UFS)
6. Smit, I.E. (M.Sc). Impacts of soil information of process based hydrological modelling in the upper Goukou catchment, South Africa (2021 – UFS). ***Cum laude***
7. Seboko, R. (M.Sc). Charaterisation of soil carbon stocks in an urban environment. *Co-supervisor* (2021 – UFS).
8. Marx, J.D. (M.Sc). Long term effects of rangeland conditions on soil properties in semi-arid South Africa. (2021 – UFS).
9. Moorcroft, M-A (M.Sc). Identifying critical areas of overgrazing using the SWAT model. *Co-supervisor* (2020 - TU-Dresden).
10. Dinga, P. (M.Sc). An examination of *Pendimethalin* accumulation in agricultural soils of the Mpongwe district, Zambia (2020- UFS).
11. Baker, I. (M.Sc). Characterisation of vadose zone processes in a tailings facility. (2019 – NWU). *Co-supervisor*
12. Setsipane, T. (M.Sc). Characterisation of hydropedological processes on sandstone and tillite hillslopes in Kwa-Zulu Natal (2019 - UFS).
13. Du Plessis, C. (M.Sc). Large scale mapping of factors influencing erosion in the T35D-E catchments of the Eastern Cape, South Africa (2019 – UFH).
14. Ngesi, S. (M.Sc). Characterising and predicting the soil carbon balances associated with the Mzimvubu Water Project, Eastern Cape, South Africa (2019 - UFH).
15. Mamera. M. (M.Sc). Pollution potential of on-site dry sanitation systems associated with the Mzimvubu Water Project (2018 – UFH).
16. Magomani, I. (M.Sc). The effect of fire on hydraulic properties of rangeland soils. (2017 – UFH).
17. Tinnefeld, M. (M.Sc.). Conceptualise hydrological response models for selected arid soilscapes in the Douglas area, South Africa (2015 – UFS). *Co-supervisor.*
18. Chungag, A. (M. Phil). Impact of cattle unguided cattle husbandry on some urban peripheral and landscape elements: Case study in Alice (2015 – UFH). *Co-supervisor.*
19. Omar, M.Y (M.Sc.). Impacts of channel incision on soil water levels, soil morphology and vegetation in a degraded wetland in the Hogsback region, South Africa (2015 – UFH).
20. Bouwer, D. (M.Sc.). Hydrological response models for selected soilscapes in the Weatherley catchment (2013 – UFS). *Co-supervisor.* ***Cum laude.***

In progress:

21. David Shipangana
22. Omphile Mogapi
23. Tawanda Nyamandi
24. Ntokozo Maseka

Curriculum Vitae: JJ van Tol
18 Rorich Crescent, Bloemfontein, 9301
E-mail: vantoljj@ufs.ac.za
Tel: +2783 387 6243

PUBLICATIONS

Peer reviewed Journal Publications

1. van Tol, J.J., Clark, V.R., Kotzé, E. et al., 2026. Southern African mountain carbon: Lies, Lessons and Lighthouses. *Transactions of the Royal Society of South Africa*. https://doi.org/10.1080/0035919X.2026.2679016.
2. Van Tol, J.J., & Kotze, J.J., 2026. Towards a landslide early warning system for South Africa: Model coupling and evaluation. *South African Journal of Science.* https://doi.org/10.17159/sajs.2026/22201.
3. Anticho, L.A., Shomre, M.W., Alemu, M.D., van Tol, J.J., 2026. Integrated modelling of soil erosion under land-use and climate change in the Kulfo River Catchment, Ethiopia: implications for climate-resilient management. *Modelling Earth Systems and Environment.* 12:154. https://doi.org/10.1007/s40808-026-02800-0.
4. Alemu, M.D., Laekemariam, F., Belay, S., van Tol, J. & Mengistu, A.G., 2026. Landscape Transformation in Ethiopia's Abaya–Chamo Sub-Basin: Patterns and Dynamics of LULC Change (2016–2021). *Applied and Environmental Soil Science*, 2026; 2026:3757527. https://doi.org/10.1155/aess/3757527.
5. Alemu, M.D., Aweke, A., van Tol, J. & Mengistu, A.G., 2026. Spatio-temporal modeling of soil erosion dynamics under land use and land cover changes in the bilate river catchment, Ethiopia. *Environmental Earth Science*, 10.1007/s12665-025-12709-z
6. Melo, V.F., de Matos, C.H.L., Schaefer, E.C.G.R, Uchôa, S.C.P., Montenegro, R.A, Iuit, C.E.C., do Nascimento, C.R., Barni, P.E., Van Tol, J.J., Augusti, M.L., 2026. Indigenous lands of Roraima and ecosystem services: pedology and land use, vegetation cover, total carbon stock, and water resources. *Journal of Nature Conservation.* 90, 127175. https://doi.org/10.1016/j.jnc.2025.127175.
7. Marx, J.D.J., Kotzé, E., van Tol, J.J. & Loke, P.F., 2025. Simulated rangeland conditions and seasonal variations influence soil quality in semi-arid central South Africa, African Journal of Range & Forage Science, 42, 264-275, https://doi:10.2989/10220119.2025.2538057.
8. Kotze, J.J., Le Roux, J.J. & van Tol, J.J., 2025. Investigating Soil Properties at Landslide Locations in the Eastern Cape Province, South Africa. *GeoHazards*, 6, 68. https://doi.org/10.3390/geohazards6040068.
9. Honold, M.A., Hilmers, T., Geldenhuys, C.J., Makhubele, L., van Tol, J.J., Ahmed, S., Buys, A., Kotze, E., Tshidzumba, R.P., Chirwa, P.W., Tshaduli, N., Araia, M.G., Uhl, E., Pretzsch, H., 2025. Drivers of forest structure and biomass along a climatic gradient in the Soutpansberg, South Africa. *Trees, Forests and People.* https://doi.org/10.1016/j.tfp.2025.100945
10. Kotze, J.J., Le Roux, J.J., & van Tol, J.J., 2025. Creating a landslide inventory in the Eastern Cape Province, South Africa: a pixel-based change detection method using fuzzy membership functions. *Natural Hazards*, https://doi.org/10.1007/s11069-025-07515-6.
11. Praeg, N., Steinwandter, M., Urbach, D., Snethlage, M.A…..van Tol, J.J…(25 authors)., 2025. Biodiversity in mountain soils above the treeline. *Biological Reviews*, https://doi.org/10.1111/brv.70028.
12. Le Roux, J.J., Mararakanye, N., van der Laan, M., Mudaly, L., Weepener, H.L. & van Tol, J.J. 2025. South African soil, land cover and weather generator file databases for SWAT applications. *Journal of Hydrology: Regional Studies.* 59. *https://doi.org/10.1016/j.ejrh.2025.102387*.
13. Alemu, M.D., Laekemariam, F., Belay, S., van Tol, J. & Mengistu, A.G., 2025. Modeling soil erosion for sustainable landscape management using RUSLE in the landscapes

of Abaya-Chamo Sub-Basin, Ethiopia. *Modelling Earth Systems and Environment*. https://doi.org/10.1007/s40808-025-02337-8

14. Harrison, R.E., van Tol, J.J., Suchet, P.A., Thevenot, M & Mathieu, O., 2025. Environmental Factors Influencing Dissolved Organic Carbon Concentrations in Afromontane Catchments. *International Journal of Environmental Research.* 19 (78). https://doi.org/10.1007/s41742-025-00745-3.
15. Malongweni, S.O., Mrubata, K., van Tol, J.J., Elbasit, M., & Harebottle, D.M., 2025. Consequences of Invasive Prosopis (Mesquite) on Vegetation, Soil Health, Biodiversity, and Compliance of Management Practices in South African Rangelands: A Review. *Grasses* 4, 2. https://doi.org/10.3390/grasses4010002.
16. Van Tol, J.J., 2024. Mapping and understanding degradation of alpine wetlands in the northern Maloti-Drakensberg, southern Africa. *Journal of Mountain Science,* 21, 2956 – 2966. https://doi.org/10.1007/s11629-024-8671-3.
17. Smit, I.E., van Zijl, G.M., Riddell, E.S. & van Tol, J.J., 2024. Model calibration using hydropedological insights to improve the simulation of internal hydrological processes using SWAT+. *Hydrological Processes*. https://doi.org/10.1002/hyp.15158
18. Van Aardt, A.C., de Jager, J.C.L. & van Tol, J.J., 2024. Firebreaks and Their Effect on Vegetation Composition and Diversity in Grasslands of Golden Gate Highlands National Park, South Africa. *Diversity.* 16, 373. https://doi.org/10.3390/d16070373.
19. Strydom, T., Smit, I.P.J., & van Tol, J.J., 2024. The effect of time since last fire occurrence on selected soil hydrological properties in a South African savanna. *Plant & Soil*, https://doi.org/10.1007/s11104-024-06763-y
20. Van Tol, J.J. & Bouwer, D., 2024. Hydropedology of South African soil forms and families. *WaterSA*, 50(2), 236 – 245. https://doi.org/10.17159/wsa/2024.v50.i2.4094.
21. Strydom, T., Smit, I.P.J., & van Tol, J.J., 2024. Short and long-term fire effects on soil C and N in an African savanna. *Geoderma Regional*. https://doi.org/10.1016/j.geodrs.2024.e00802.
22. Malongweni, S.O. & van Tol, J.J., 2024. Effects of herbivory, fire, and vegetation type on soil compaction and aggregate stability in a semi-arid savanna. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-024-04489-6
23. Van Zijl, G.M. & van Tol, J.J., 2024. Digital soil mapping enables informed decision-making to conserve soils within protected areas. *South African Journal of Plant and Soil*. 40, 216 – 226. https://doi.org/10.1080/02571862.2023.2255158.
24. Kotze, J.J., Mc Lean, C, van Tol, J.J., 2024. Digitally mapping soil carbon of the uThukela headwater catchment in the Maloti-Drakensberg, a remote Afromontane mountain region. *South African Geographical Journal.* https://doi.org/10.1080/03736245.2023.2272896.
25. Malongweni, S.O. & van Tol, J.J., 2023. Medium-term interactive effects of herbivores and plant life form on the biochemistry of shallow sandy soils in a protected semi-arid savanna. *Environmental Systems Research*. 12:38 https://doi.org/10.1186/s40068-023-00320-9
26. Kotze, J.J., van Tol, J.J. & Clark, V.R., 2023. Africa's First Alpine and Transboundary Long-Term Socioecological Research Platform. 43(3). *Mountain Research and Development.* https://doi.org/10.1659/mrd.2023.00035.
27. Smit, I.E., van Zijl, G.M., Riddell, E.S. & van Tol, J.J., 2023. Examining the value of hydrological soil data on hydrological modelling at different scales in the Sabie catchment, South Africa. *Vadose Zone Journal.* https://doi.org/10.1002/vzj2.20280
28. Malongweni, S.O. & van Tol, J.J., 2023. Influence of herbivores and trees on soil biochemical properties of a semi-arid savanna. *Koedoe*. 10.4102/koedoe.v65i1.1742

29. Smit, I.E., van Zijl, G.M., Riddell, E.S. & van Tol, J.J., 2023. Downscaling legacy soil information for hydrological soil mapping using multinomial logistic regression. *Geoderma*, https://doi.org/10.1016/j.geoderma.2023.116568
30. Seboko, K.R., van Tol, J.J. & Kotze, E., 2023. Predicting soil carbon in granitic soils using Fourier-transform mid-infrared (FT-MIR) spectroscopy: the value of database disaggregation. *South African Journal of Plant and Soil,* 40, 1 – 11. *https://doi.org/10.1080/02571862.2023.2180098*
31. Elumalai, V., Rajmohan. N, Sithole, B, Li, P, Uthandi, S. & van Tol J., 2023. Geochemical evolution and the processes controlling groundwater chemistry using ionic ratios, geochemical modelling and chemometric analysis in a semi-arid region of South Africa. *Chemosphere.* https://doi.org/10.1016/j.chemosphere.2022.137179
32. Kotze, J.J. & van Tol, J.J., 2023. Extrapolation of Digital Soil Mapping approaches for soil organic carbon stock predictions in an Afromontane Environment. *Land,* 12, 520. https://doi.org/10.3390/land12030520
33. Van Tol, J.J. & van Zijl, G.M., 2022. South Africa needs a hydrological soil map: a case study from the upper uMgeni catchments. *Water SA,* 48(4) 335 – 347. https://doi.org/10.17159/wsa/2022.v48.i4.3977.
34. Harrison, R.L., van Tol, J.J. & Amiotte-Suchet, P., 2022. Hydropedological characteristics of the Cathedral Peak Research Catchments. *Hydrology*, 9, 189. https://doi.org/10.3390/hydrology9110189.
35. Julich, S., Moorcroft, M.A., Feiger, K.H. & van Tol, J.J., 2022. The impact of overgrazing on water fluxes in a semi-arid watershed – The suitability of watershed scale modeling in a data scarce area. *Journal of Hydrology: Regional Studies.* https://doi.org/10.1016/j.ejrh.2022.101178
36. Malongweni, S.O. & van Tol, J.J., 2022. Fire, Herbivores, and Vegetation Type Shape Soil Biochemistry in Sodic Patches of a Semi-Arid Savanna Ecosystem. *Land*. https://doi.org/10.3390/land11081148
37. Mamera, M., van Tol, J.J. & Aghoghovwia, M.P., 2022. Treatment of faecal sludge and sewage effluent by pinewood biochar to reduce wastewater bacteria and inorganic contaminants leaching. *Water Research.* https://doi.org/10.1016/j.watres.2022.118775
38. Chichongue, Ó., van Tol, J.J., Ceronio, G.M., du Preez, C.C. & Kotzé, E., 2022. Short-Term Effects of Tillage Systems, Fertilization, and Cropping Patterns on Soil Chemical Properties and Maize Yields in a Loamy Sand Soil in Southern Mozambique. *Agronomy*, 12, 1534. https://doi.org/10.3390/agronomy12071534
39. Bouma, J., Bonfante, A., Basile, A., van Tol, J., Hack-ten Broeke, M.J.D., Mulder, M., Heinen, M., Rossiter, D.G., Poggio, L. & Hirmas, D.R., 2022. How can pedology and soil classification contribute towards sustainable development as a data source and information carrier? *Geoderma*. https://doi.org/10.1016/j.geoderma.2022.115988.
40. Smit, I.E. & van Tol, J.J., 2022. Impacts of Soil Information on Process-Based Hydrological Modelling in the Upper Goukou Catchment, South Africa. *Water* 2022, 14, 407. https://doi.org/10.3390/w14030407
41. Harrison, R.L., van Tol, J.J. & Toucher, M., 2022. Using hydropedological characteristics to improve modelling accuracy in Afromontane catchments. *Journal of Hydrology: Regional Studies.* https://doi.org/10.1016/j.ejrh.2021.100986
42. Mamera, M., van Tol, J.J., Aghoghovwia, M.P., Nhantumbo, A.B.J.C., Chabala, L.M., Cambule, A., Chalwe, H., Mufume, J.C., Rafael, R.B.A., 2021. Potential Use of Biochar in Pit Latrines as a Faecal Sludge Management Strategy to Reduce Water Resource Contaminations: A Review. *Appl. Sci.* 11, 11772. https://doi.org/10.3390/app112411772.
43. Clark, V.R., Mukwada, G., Hansen, M., Adelabu, S., Magaiza, G., Le Roux, A., Bredenhand, E., Otomo, P.V., Steenhuisen, S., Franke, A., van Tol, J., Mathinya, N. & Makombe, R., 2021. The

Afromontane Research Unit: Driving connections and capacity building for the sustainable development of Southern African Mountains. *Mountain Research and Development*. 42, 1 – 5. doi.org/10.1659/MRD-JOURNAL-D-21-00038.

44. Van Tol, J.J., Bieger, K. & Arnold, G., 2021. A Hydropedological approach to simulate streamflow and soil water contents with SWAT+. *Hydrological Processes.* DOI:10.1002/hyp.14242.
45. Seboko, K.R., Kotze, E., van Tol, J.J. & van Zijl, G.M., 2021. Characterization of Soil Carbon Stocks in the City of Johannesburg. *Land*, 10, 83. https://doi.org/10.3390/land10010083
46. Van Zijl, G.M., Turner, D., Paterson, G., Koch, J., van Tol, J.J., Barichievy, K., Clarke, C., du Plessis, M & van Deventer, P., 2020. The new soil classification system in South Africa, its history, important changes made and implications for users. *South African Journal of Plant and Soil, 37, 331 – 342.* https://doi.org/10.1080/02571862.2020.1815244.
47. Mamera, M., van Tol, J.J., Aghoghovwia, M.P. & Kotze, E., 2020. Sensitivity and Calibration of the FT-IR Spectroscopy on Concentration of Heavy Metal Ions in River and Borehole Water Sources. *Applied Sciences* 10, 7785; doi:10.3390/app10217785
48. Chingongue, O, van Tol, J.J., Ceronio, G. & Du Preez, C., 2020. Effects of tillage systems and cropping patterns on soil physical properties in Mozambique. *Agriculture* 10(448) doi:10.3390/agriculture10100448.
49. Nebo, G.I., Manyevere, A., Araya, T. & van Tol, J.J., 2020. Short-term impact of conservation agriculture on soil strength and saturated hydraulic conductivity in the South African semiarid areas. *Agriculture* 10(414) doi:10.3390/agriculture10090414.
50. Van Tol, J.J., Julich, S., Bouwer, D. & Riddell, E.S., 2020. Hydrological response in a savanna hillslope under different rainfall regimes, *Koedoe* 62(2), a1602. https://doi.org/10.4102/koedoe.v62i2.1602.
51. Van Tol, J.J., van Zijl, G.M. & Julich, S., 2020. Importance of detail soil information for hydrological modelling in an urbanised environment. *Hydrology*, 7, 34; doi:10.3390/hydrology7020034.
52. Bouwer, D., Le Roux, P.A.L. & Van Tol, J.J, 2020. Identification of hydropedological flowpaths in Stevenson–Hamilton catena from soil morphological, chemical and hydraulic properties, *Koedoe* 62(2), a1584. https://doi.org/10.4102/ koedoe.v62i2.1584 .
53. Mamera, M., van Tol, J.J., Aghoghovwia, M.P. & Mapetere, G.T., 2020. Community faecal management strategies and perceptions on sludge use in agriculture. *International Journal of Environmental Research and Public Health. 7*(11), 4128; https://doi.org/10.3390/ijerph17114128
54. Riddell, E., Nel, J., Van Tol, J., Fundisi, D., Jumbi, F., Van Niekerk, A. et al., 2020. Groundwater–surface water interactions in an ephemeral savanna catchment, Kruger National Park, *Koedoe* 62(2), a1583. https://doi.org/10.4102/koedoe. v62i2.1583
55. Janecke, B.B., Van Tol, J.J., Smit, I.P.J., Van Aardt, A.C., Riddell, E.S., Seaman, M.T. et al., 2020. Biotic and abiotic connections on a granitic catena: Framework for multidisciplinary research, *Koedoe* 62(2), a1600. https://doi.org/10.4102/ koedoe.v62i2.1600
56. Parwarda, C., van Tol, J.J., Tibugari, H. & Mandumbu, R., 2020. Characterisation of soil physical properties and resistance to erosion in different areas of soil associations. *African Crop Science Journal,* 28, 93 – 109. https://dx.doi.org/10.4314/acsj.v28i1.8
57. Van Tol, J.J., 2020. Hydropedology in South Africa: advances, applications and research opportunities. *South African Journal of Plant and Soil.* 37, 23 – 33. https://doi.org/10.1080/02571862.2019.1640300
58. Parwarda, C., Magomani, M.I. & van Tol, J.J., 2020. Impacts of different prescribed fire frequencies on selected soil chemical properties in a semi-arid savannah thornveld. *Cogent Environmental Science 6(1):1868171.* DOI:10.1080/23311843.2020.1868171

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60. Van Zijl, G.M., van Tol, J.J., Bouwer, D., Lorentz, S.A. & Le Roux, P.A.L. 2020. Combining Historical Remote Sensing, Digital Soil Mapping and Hydrological Modelling to Produce Solutions for Infrastructure Damage in Cosmo City, South Africa. *Remote Sensing, 12, 433.* doi:10.3390/rs12030433.
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Books and peer reviewed Chapters in Books

1. Mamera, M. & van Tol, J.J., 2025. Biochar enhanced sludge management. *In* Nidheesh, P.V., Vithanage, M., Sreedharan, V., Bolan, N., Gao, B. & Bhatnagar A. (Eds): Biochar Amendments for Environmental Rehabilitation. *CRC Press*. 155 – 165. https://doi.org/10.1201/9781003344803
2. Harrison, R.L., & van Tol, J.J., 2022. Digital soil mapping for hydropedological purposes of the Cathedral Peak Research Catchments, South Africa. *In:* Adelabu, S. et al. (Eds): Remote sensing of African Mountains. Chapter 10. Springer Nature.
3. Mathinya, N.V., Clark, V.R., van Tol, J.J. & Franke, A.C., 2022. Resilience and sustainability of the Maloti-Drakensberg Mountain System: A case study on the Upper uThukela catchment. *In* .Misiune, I., Depellegrin, D. & Vigil, L.E. (eds) Human-Nature Interactions, Springer, Switzerland. 155 – 167.
4. Du Preez, C.C., van Huyssteen, C.W., Kotze, E. & van Tol, J.J., 2020. Ecosystem services in sustainable food systems: operational definitions, concepts and applications, definitions. *In* Rusinamhodzi, L (ed). The Role of Ecosystem Services in Sustainable Food Systems. Elsevier, United Kingdom.
5. Van Tol, J.J., Lorentz, S.A., van Zijl, G.M. & Le Roux, P.A.L., 2018. The contribution of hydropedological assessments to the availability and sustainable water, for all (SDG#6). *In* Lal, R., Horn, R. & Kosaki, T. (eds). Soil and Sustainable Development Goals. Catena-Schweizerbart, Stuttgart. 102 - 117.
6. Soil Classification Working Group, 2018. Soil Classification: A Natural and Anthropogenic System for South Africa. ARC-Institute for Soil, Climate and Water, Pretoria.
7. Akpan, W. van Tol, JJ, Malambile, M & Nqalo, N. 2017. Science, ethnoscience and a dam: (Mis)reading the potential impacts of the Ntabelanga Dam, South Africa. *In* Akpan, W &

Moyo, P. (eds.) Revisiting Environmental and Natural resource questions in Sub-Saharan Africa. Cambridge Scholars Publishers. 1 – 24.

8. Van Zijl, G.M., van Tol, J.J. & Riddell, E.S., 2016. Digital mapping for hydrological modelling. *In:* Zhang, G., Brus, D., Liu, F., Song, X. & Lagacherie, P. (eds), Digital Soil Mapping Across Paradigms, Scales and Boundaries. Springer, Singapore. 115 – 129.
9. Van Tol, J.J., Le Roux, P.A.L. & Hensley, M., 2011. Soil indicators of hillslope hydrology. *In*: B.O Gungor (eds), Principles-Application and Assessments in Soil Science. Intech, Turkey. 209 – 240.

Other publications

1. Van Tol, J.J., Franke, A.C., & Le Roux, J.J., 2023. Soil Erosion: Southern Africa's water tower is endangered. *Food & Agricultural Policy, Welternährung.*
2. Van Tol, J.J., Bouwer, D. & Le Roux, P.A.L., 2021. DWS guidelines for hydropedological surveys and minimum requirements. *Department of Water and Sanitation*.
3. Van Tol, J.J. & van Zijl, G.M., 2020. Regional soil information for hydrological modelling. *Water Wheel,* April 2021.
4. Van Tol, J.J., Le Roux, P.A.L. & Lorentz, S.A., 2017. The science of hydropedology – linking soil morphology with hydrological processes. *Water Wheel*, June/July 2017.

PRESENTED CONFERENCE PAPERS (N >80)

Selected *International*:

- Van Tol, J.J., Kotzé, J.J. Using SWAT+ modelling for landslide early warning prediction in South Africa. SWAT Conference, 17 – 20 June 2026, Thessaloniki, Greece.
- *Keynote:* Van Tol, J.J., Bieger, K., Arnold, J. Enhancing Hydropedological Models with Hydropedological Approaches for Improved Catchment Process Representation. International Conference on Water and Environmental Sustainability. 12 & 13 August 2024. Richards Bay, South Africa.
- van Tol, J., Kotze, J.J., Niedrist, G., Schneiderbauer, S., Delves & Clark, V. Alpine wetland degradation in the northern Maloti-Drakensberg: On the need for baseline research. 19 – 21 May 2024, Florence, Italy.
- Smit, I.E., Van Zijl, G.M., Van Tol, J.J. Examining the value of hydropedological insight on hydrological modelling in the Sabie catchment, South Africa. SWAT Conference, 26-30 June 2023, Aarhus University, Denmark.
- Van Tol, J.J., Bieger, K., Arnold, J. Using hydropedology to assist hydrological modelers. 30 July – 5 August, 2022. Glasgow, Scotland.
- Bieger, K., Schürz, C., Navarro, E.M., Gómez, A.S., van Tol, J. & Arnold J.G. Zonal calibration of SWAT+ models using soft data in R. Kirkham Conference. 28 Augustus – 2 September. Skukuza, South Africa.
- van Tol, J., Niedrist, G., Schneiderbauer, S., Delves, J., Hilpold, A., Szarzynski, J. & Clark, V. Establishing A Long-Term Socioecological Research Platform in the Maloti-Drakensberg: The Need, Focus and Lessons from the international community. Southern African Mountain Conference. 14 – 17 March 2022. Champagne Castel, South Africa.
- *Invited:* Van Tol, J.J., Bieger, K., Arnold, J., Le Roux, P.A.L., Lorentz, S., van Zijl. Hydropedological interpretation of soil information to serve the hydrological community. ASA, CSSA and SSSA International Annual Meeting. 7 – 10 November, 2021. Salt Lake City, Utah, USA.

- Strydom, T., Smit, I. & van Tol, J.J. Vegetation cover and physiognomy effects on C and N dynamics in long-term burnt and unburnt soils of a semi-arid savanna system. 1st International Congress on Fire in the Earth System: Humans and Nature. 3-7 November 2021, Valencia, Spain.
- Van Tol, J.J., & Lorentz, S.A. The application of hydropedological surveys to quantify the near surface impacts from mining wastes. 11th ICARD/IMWA Conference. 10 – 14 September 2018, Pretoria South Africa.
- *Invited:* Van Tol, J.J., Lorentz, S.A., van Zijl, G.M. & Le Roux, P.A.L. The contribution of hydropedological assessments to the sustainable management of water for all. 21st World Congress of Soil Science. 12 – 17 August 2018, Rio de Janeiro, Brazil.
- Van Tol, J.J., Lorentz, S.A. & Le Roux, P.A.L. Examples of hydropedological applications. 14th International Water Association Specialist Conference. 9 – 11 October 2017. Skukuza, Kruger National Park, South Africa.
- Van Tol, J.J & Lorentz, S.A. Understanding groundwater/surface-water interactions through hydropedological interpretations of soil distribution patterns. IAHS Scientific Assembly, 10 – 14 July, 2017, Port Elizabeth, South Africa.
- Lorentz, S.A., van Tol, J.J. & Le Roux, P.A.L. Using Hydropedology Surveys to Guide Process Based Hydrological Modelling in South Africa. IAHS Scientific Assembly, 10 – 14 July, 2017, Port Elizabeth, South Africa.
- Lorentz, S.A., van Tol, J.J. & Le Roux, P.A.L. Water and Solute Flux Simulation Using Hydropedology Survey Data in South African Catchments. European Geosciences Union, General Assembly, 23 – 28 April 2017, Vienna, Austria.
- Van Tol, J.J., van Zijl, G.M & Riddell, E.S. Application of Hydropedological insights in hydrological modelling. 3rd International Conference on Hydropedology. 16 – 19 August 2016, Beijing, China.
- Van Tol, J.J., Le Roux, P.A.L., Lorentz, S.A. & Hensley, M. Hydropedological classification of hillslopes to assist Environmental Impact Assessments. IAIAsa 20th Annual Conference. 11 – 14 August 2015, Champagne Castle, South Africa.
- Omar, M.Y., van Tol, J.J. & Le Roux, P.A.L. Effects of stream channel incision on soil water levels and soil morphology in a wetland in Hogsback, South Africa. International conference on building a new generation of agricultural scientists. 1 – 5 December, 2014, Kenyatta University, Kenya.
- Van Zijl, G.M., van Tol., J.J & Riddell, E.S. Digital soil mapping for hydrological modelling. The 6th Global Workshop on Digital Soil Mapping. 11 – 14 November 2014, Nanjing, China.
- Van Tol, J.J., Le Roux, P.A.L., Hensley, M. & Lorentz, S.A. Hydropedological classification of soilscapes in South Africa. 2nd International conference on Hydropedology, 22 – 27 July, Leipzig, Germany.
- Bouwer, D., van Tol, J.J. & Le Roux, P.A.L. Hydrological response model of a complex soilscape in the Weatherley catchment, South Africa. Eurosoil, 2 – 6 July 2012, Bari, Italy.
- Le Roux, P.A.L., van Tol, J.J., Hensley, M. & Lorentz, S.A., Soil indicators of hillslope hydrology. European Geosciences Union, General Assembly, 3 – 8 April 2011. Vienna, Austria.

FUNDED RESEARCH PROJECTS

1. Van Tol, J.J., et al. ESSPR project (R3 000 000).
2. Van Tol, J.J., & Kotze, E. Below ground carbon storage of Forest4People project. TU Munich (2023 – 2025) (R1 020 000).
3. Van Tol, J.J., Kotze, J.J. & Le Roux, J.J. Towards a Landslide Early Warning System for South Africa (LEWSSA). Water Research Commission (2023 – 2025). (R1 400 000).
4. Van Tol, J.J., Job, N., Bouwer, D., Murugan, S. & Le Roux, P.A.L., 2023. Hydropedological Assessment Guidelines: Theory and application in a South African wetland management context. Integrating hydropedology in wetland delineation and management guidelines. WRC Report No. TT 925/23. Water Research Commission (2021 – 2024). (R800 000).
5. Van Zijl, G.M., van Tol, J.J., Smit, I.E. Towards a hydrological soil map for South Africa. Water Research Commission (2021 – 2024). (R1 500 000).
6. van Aardt, A., Van Tol, J.J. & Matthews, N. Can carbon credits pay for soil restoration in Marakele National Park. Multidisciplinary research fund (2022 – 2023). (R70 000).
7. Van Tol, J.J. Developing a hydrological soil map and deriving resource areas critical to freshwater ecosystem support in selected catchments of South Africa. SANBI (2020 – 2021. (R550 000).
8. Van Tol, J.J. Hydropedological interpretation and application of regional soil information for water resource management. NRF Y-rated programme (2019 – 2021). (R300 000).
9. Van Tol, J.J., Chabala, L. Benefits of Using Biochar in Feacal Sludge Management in Pit Latrines. South Africa / Mozambique / Zambia Trilateral Joint Science and Technology Research (2019 – 2021). (R300 000).
10. Van Tol, J.J., van Zijl, G.M., Kotze, E., Establishing soil rehabilitation guidelines for important NRM areas. Department of Environmental Affairs (2019 – 2021). (R2 400 000).
11. Van Tol, J.J., Akpan, W., Maroyi, A., Mutengwende, N., Huchermeyer, N., Ngesi, S., Nqandeka, H.M., Mamera, M., Bradley, G. & Rowntree, K.M., 2018. The Mzimvubu Water Project: Baseline indicators for long-term impact monitoring. WRC project No. K5/2433. *Water Research Commission.* (R1 800 000).
12. Van Tol, J.J., van Zijl, G.M., Manyevere, A., Kanuka, G., Du Plessis, C., 2018. Characterisation and mapping of erodibility of soils in selected land types in support of the Ntabelanga and Laleni Ecological Infrastructure Project (NLEIP). Department of Environmental Affairs, National Resource Management. (R2 000 000).
13. Titshall, L., Zadorozhnaya, V., Botha, G., Crous, J., Le Roux, P.A.L., van Tol., J.J., van Zijl, G.M., et al. 2017. Understanding the role of regolith in site water balance and nutrient supply resilience for use in improved water and nutrient supply risk mapping for plantations. *Forestry South Africa.*
14. Le Roux, P.A.L., Hensley, M., Lorentz, S.A., van Tol, J.J., van Zijl, G.M., Kunene, B.T., Bouwer, D., Freese C.S., Tinnefeld, M & Jacobs, C.C. 2015. Hydrology of South African Soils and Hillslopes (HOSASH). WRC project No. K5/2021. *Water Research Commission.* (R5 000 000)
15. Van Tol, J.J., Akpan, W., Lange, D., Bokuva, C., Kanuka, G., Ngesi, S., Rowntree, K.M., Bradley, G. & Marroi, A. 2014. Conceptualising long term monitoring to capture environmental, agricultural and socio-economic impacts of the Mzimvubu Water Project in the Tsitsa River. WRC project No: KV 328/14. *Water Research Commission.* (R200 000)
16. Van Tol, J.J., 2014. Hydrology of Hogsback hillslopes and open-air laboratory. *Govan Mbeki Research and Development Centre.* (R60 000)
17. MT Seaman, M Watson, MF Avenant, AR Joubert, JM King, CH Barker, S Esterhuyse, D Graham, ME Kemp, PA le Roux, B Prucha, N Redelinghuys, L Rossouw, K Rowntree, F

Sokolic, L van Rensburg, B van der Waal, J van Tol & AT Vos, 2013. Testing a Methodology for Environmental Water Requirements for non-perennial rivers: The Mokolo Case Study. WRC Report TT579/13. *Water Research Commission*.

18. Esterhuyse, S., Adendorff, J., Avenant, M., Bragg, C., Cillie, D., Enke, G., Hutter, N., Kemp, M., Kijko, A., Louw, H., Nell, A., Ouzman, S., Prinsloo, H., Redelinghuys, N., Reynolds, D., Smit, A., Sokolic, F., Van Soelen, B., Van Tol, J., Vos, T and Watson, M. 2012. Report on the background review of impacts related to hydraulic fracturing and available databases for vulnerability indicators. WRC Report K5/2149. *Water Research Commission*.
19. Van Tol, J.J. & Coetzee, K., 2012. Hydropedological survey of Taylors Halt and Slagspruit sites. *Investigation into pollution from on-site dry sanitation systems*. WRC project K5/2115. *Water Research Commission*.
20. Le Roux, P.A.L., Van Tol, J.J., Kunene, B.T., Hensley, M., Lorentz, S.A., Van Huyssteen, C.W., Hughes, D.A., Evison, E., Van Rensburg, L.D. & Kapangaziwiri, E., 2011. Hydropedological interpretation of the soils of selected catchments with the aim of improving efficiency of hydrological models: WRC Project K5/1748. *Water Research Commission*. (R1 800 000).

CONSULTANCY PROJECTS (N > 120)

Selected projects:

- Van Tol, J.J., 2025. Agricultural assessment for the Kotulo Tsatsi PV project, Northern Cape Province. *Landscape Dynamics.*
- Van Tol, J.J., 2025. Agricultural assessment for access road to substation, Warmbad, Limpopo Province. *Licebo Environmental & Mining*.
- Van Tol, J.J. & Lombard, W.A., 2024. Agricultural Assessment for Christiana Protea Mining Project, Free Sate. *LW Consultants.*
- Van Tol, J.J., 2024. Agricultual compliance statement for oxidation ponds, Carnavon, Northern Cape. *EarthWorth Environmental Consultants*
- Van Tol, J.J. & Lombard, W.A., 2024. Agricultural Assessment and Compliance Statements for the Xhariep Pipeline and associated infrastructure, Free state Province. *Zutari*.
- Van Tol, J.J., 2023. Assessing soil health and extent of pollution around Rietpan, Free State Province. *MVB Consulting.*
- Van Tol, J.J., Hydropedological Assessment of Swartklip, Khayalitsha, Western Cape. *GEOSS Consulting.*
- Van Tol, J.J. & Bouwer, D., 2022. Hydropedological assessment of the Klipfontein View Clinic, Gauteng. *NTC Group.*
- Van Tol, J.J., 2021. Soil Quality Indicators and Success criteria to facilitate mine closure. *Redco Environmental Services.*
- Van Tol, J.J. & Mc Clean, C., 2021. Report on irrigation suitability of selected portions of the farm Kameelhoek, Postmasburg, Northern Cape. *AngloAmerican/EXM*
- Van Tol, J.J., 2021. Hydropedological assessment of the Kuiper wetland, Stanford/Hermanus, Western Cape. *GNEC.*
- Van Tol, J.J., 2021. SWAT+ modelling of the Weltevreden open-cast mine. *SAS Environmental.*
- Van Tol, J.J., 2020. Extent of pollution in selected soils in Chingola, Copperbelt Province, Zambia. *KLM Consultants.*
- Van Tol, J.J. & Bouwer, D., 2019. Hydropedological survey of the VOPAK site, Port of Richards Bay, KwaZulu Natal. *SRK Consultants.*

- Van Tol, J.J. & Bouwer, D., 2019. Report on the reuse of effluent waste and lime in the City of Umhlathuze. *Natural Resource Stewardship Programme, GIZ*.
- Van Tol, J.J. & Bouwer, D., 2019. Hydropedological survey of the proposed Dense Media Separation Stockpiles at Der Brochen, Limpopo Province. *SRK Consulting*.
- Van Zijl, G.M., Bouwer, D., van Tol, J.J., Lorentz, S.A. & Le Roux, P.A.L., 2018 Cosmo City Hydropedological report. *Joburg Roads Agency.*
- Van Tol, J.J., Prefeasibility study for ethanol production from sugarcane in Northern KwaZulu-Natal. *Green Cemba*.
- Van Tol, J.J., Van Zijl, G.M. & Barnard, J.H., 2018. Prefeasibility agronomic report for Khomanani irrigation schemes. *Kruger 2 Canyons.*
- Van Tol, J.J. & Le Roux, P.A.L., 2018. Hydropedological survey of Emhakhazeni mining sites near Belfast, Mpumalanga. *The Biodiversity Company.*
- Van Tol, J.J., Job, N., Rossouw, P.S., Haworth, S. & Cowden, C., 2016. Transient Wetland Research Approach. *Tongaat Hulett Developments: Amanzimnyama Farm.*
- Van Tol, J.J., 2014. Report on the agricultural potential of the proposed Castle Wind Farm and associated infrastructure near De Aar, Northern Cape. *Savannah Environmental.*
- Van Tol, J.J., 2012. Disaggregation of land types for determination of erosion sensitivity of selected sites in the Eastern Cape for afforestation. *Sigwale and Associates*
- Le Roux, P.A.L., Van Zijl, G.M., Bouwer, D. & van Tol, J.J., 2012. Layout of the ATCF II forestry development, Nampula, Mozambique. *ATCF II.*
- Kunene, B.T., Le Roux, P.A.L., van Tol, J.J., Hensley, M., Bouwer, D. & van der Merwe, R.H., 2010. Soil hydrology dynamics and catchment morphology of selected catchments in Lesotho.
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- Le Roux, P.A.L. & Van Tol, J.J., 2008. Actions required for Hotazel pit water dewatering and gardening project: Action 1 Prefeasibility study.

LEADERSHIP AND MEMBERSHIPS

- President of the Soil Science Society of South Africa (SSSSA: 2023 - 2025).
- Council member of SSSSA since 2018
- Chair of the International Union of Soil Sciences Working Group on Hydropedology (2023 -). (Previously vice-chair (2020 – 2023).
- Chair of the Southern African Plant and Soil Scientific Committee (SAPSSC)
- Management Board member of South African Journal of Plant and Soil.
- Chair of Henry Lin Travel Awards committee – for Soil Science Society of America (2022)
- Head of Soil Science section in Department of Soil, Crop and Climate Sciences.
- Part of UFS Academic Leadership Programme (ALP) for 2023/2024.
- Director of Digital Soils Africa (Pty) LTD.
- NRF rated researcher: C2
- Board member of the South African Soil Surveyors Organisation (SASSO).
- South African Council of Natural Scientific Professions (SACNASP) – *Pr.Sci.Nat.*
- International Union of Soil Sciences (IUSS).

ORGANISATIONAL AND COMMUNITY SERVICE

- Associated editor: South African Journal of Plant and Soil
- Editor for Special Editions in *Vadose Zone Journal* and *Koedoe*
- Member of the Soil Classification Working Group of South Africa
- Chair of scientific committee of Combined Congress 23' and member of scientific committee of Kirkham, SAMC and GCC5 international conferences.
- Chairperson of the Local Organising Committee (Convenor) for the Combined Congress 2014, Grahamstown (360 delegates).
- Afromontane Research Unit (ARU) research champion tasked with establishment of Long Term Socio-Ecological Research Platform in Northern Drakensberg.
- Invited delegate to develop bilateral research call between China and SA in Beijing (2016).
- Invited delegate to promote groundwater/surface water interactions at the African Groundwater Network in Uganda (2017).
- Invited member of Rectors delegation to University of Lesotho (2022).
- NAS committee member for internal NRF reviews and revision of promotion policy.
- Several congress sessions chaired such as at the Combined Congress, Kirkham Congress and IUSS Congress in Glasgow.
- Reviewer of >50 (national and international) manuscripts, including *Geoderma, Journal of Hydrology, Vadose Zone Journal Hydrology and Earth System Sciences*.
- Organise and co-present a short course in advanced soil survey techniques (UFS – 2009).
- Departmental representative in the Faculty Higher Degree and Research Committee (UFH).
- Reference group member on several Water Research Commission projects.
- Reviewer of WRC project proposals (n > 8).
- Panel member and reviewer of NRF research projects.

AWARDS

- 2025: Soil Science Society of South Africa (SSSSA) Combined Congress - Best Paper on Innovation Technology (co-author)
- 2025: Southern Africa Mountain Conference (SAMC) - 3rd Place at PhD level (Supervisor of winner)
- 2024: South African Hydrological Society (SAHS) Conference - Best Oral Presentation (Supervisor of winner)
- SSSSA silver medal: Best paper by author over 30 years: Combined Congress, 20 – 23 January, 2020, Bloemfontein.
- Best paper on innovative technology (*co-author*): Combined Congress, 20 – 23 January, 2020, Bloemfontein.
- Vice-Chancellor's Developing Researcher Award, University of Fort Hare, 2014.
- SANCHIAS gold medal: Best paper by author < 35 years. 17th SANCHIAS Symposium, 1 – 3 September, 2014, Bellville.
- SANCHIAS silver medal: Best paper by young researcher (*co-author*): 17th SANCHIAS Symposium, 1 – 3 September, 2014, Bellville.

- SSSSA silver medal: Best paper on innovative research. Combined Congress, 20 – 23 January 2014, Grahamstown.
- SSSSA silver medal: Best paper by authors under 30: Combined Congress, 16 – 19 January 2012, Potchefstroom.
- Prestige PhD bursary: Academic Cluster (Water Management in Water Scarce Areas), UFS (2010).
- SSSSA silver medal: Best paper by authors under 30: Combined Congress, 19 – 21 January 2010, Bloemfontein.
- Best paper on new technologies (*co-author*): Combined Congress, 19 – 21 January 2010, Bloemfontein.
- Best presentation by young researcher (*runner-up*): 14th SANCHIAS Symposium, 21 – 23 September 2009, Pietermaritzburg.
- Best presentation by young researcher (*runner-up*): 13th SANCHIAS Symposium, 6 – 7 September 2007, Cape Town.
- SSSSA silver medal: Best final year Soil Science student in South Africa – 2006.

ADDITIONAL CAPACITY BUILDING

- Certificate in Environmental Law – University of Pretoria, 2017.
- Enrolled in Post Graduate Diploma in Higher Educational Teaching (PGDHET) – UFH.
- Workshop on Post Graduate Supervision, Govan Mbeki Research and Development Centre (GMRDC), UFH, 2014.
- SPSS software short course, UFH, 2014.
- Catchment Science Summer School, 21 – 26 August 2011, University of Aberdeen, Scotland.
- HYDRUS short course, December 2010, Kruger National Park.
- Numerous (> 10) SASSO workshops.

VISION

'Food and water for Africa'

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Jacobus Johannes van Tol

Registration Number: 400274/13

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003 (Act 27 of 2003)
in the following field(s) of practice (Schedule 1 of the Act)

Soil Science (Professional Natural Scientist)

Effective **28 August 2013** Expires **31 March 2027**

President of Council

Chief Executive Officer

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Draft EIA

December 2025

AN ECOLOGICAL REPORT ON THE FLORA: ON THE FOLLOWING FARMS IN THE NORTHERN CAPE: TWEEFONTEIN: REMAINDER OF FARM TWEEFONTEIN 373, AND KALKFONTEIN: PORTION 4 (PORTION OF PORTION 2) OF FARM KALKFONTEIN

A report commissioned by Digital Soils Africa

SPARAXIS ENVIRONMENTAL PTY (LTD)
Springfield 30
5 Paddy Goodrick Street
Bloemfontein
9301

Cell: 083 667 0169
andri.vanaardt@gmail.com

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CONDITIONS RELATING TO THIS REPORT

Declaration of interest

Sparaxis Environmental PTY (Ltd) and its members/co-workers:

- Have no vested interest in the property studied, nor is it affiliated with any other person/body involved with the property and/or proposed development.

- Is not a subsidiary, legally or financially, of the proponent.

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- Reserve the right to modify aspects pertaining to the present investigation should additional information become available through ongoing research and/or further work in this field.

- Is committed to biodiversity conservation but concomitantly recognise the need for economic development. We reserve the right to form and hold our own opinions within the constraints of our specialities and experience and, therefore, will not submit willingly to the interests of other parties or change our statements to appease them

The study was undertaken by Dr AC van Aardt (PhD UFS) who is registered as a Professional Natural Scientist (Reg. No. 131584 Ecological Sciences and Botanical Sciences) and Mr M Muller (MSc Botany).

She has the following qualifications

SPECIALIST	**QUALIFICATION**
Dr A.C. van Aardt	PhD – Botany MSc – Botany BSc Hons (Botany) BSc (Botany & Zoology)
M Muller	MSc – Botany BSc Hons Environmental Science BSc (Geography and Environmental Sciences)

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Factors limiting the quality of this report

The formal site visit was undertaken on 18 December 2025. This was during the rainy season which also permits the flowering and growth of plants. Although some plants had flowers, inflorescences and seeds it was not the case for all. Grass identification was particularly challenging since most did not have inflorescences or leaves sufficient for identification. Plants that had flowers or had remnants of flowers at the time of the visit could be identified. Some of the more rare and cryptic species may have been overlooked due to their inconspicuous growth forms. Many of the rare and endangered succulent species can only be distinguished (in the veld) from their very similar relatives on the basis of their reproductive parts. These plants flower during different times of the year. Multiple visits to any site during the different seasons of the year could, therefore, increase the chances to record a larger portion of the total species complex associated with the area. The survey of the study site is, however, considered as successful with a correct identification of the vegetation units and their ecological sensitivity.

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- The technology described in any report;
- Recommendations delivered to the Client.

Approach

Conclusions reached, and recommendations made are based not only on the occurrence of individual species, but more appropriately on habitats and ecosystem processes. Planning must, therefore, allow for the maintenance of species, habitats and ecosystem processes, even if Red Data or endemic plant or animal species are absent.

Dr A.C. van Aardt
Sparaxis Environmental Pty (Ltd)

INTRODUCTION

A complex of extensive plains with dwarf shrubs, grasses, succulents, geophytes and trees along drainage line is a description of the Nama-Karoo. Although the area has a low floristic diversity there is a high diversity of plant life forms. This biome is however known for its low vegetation cover that is associated with aridity. The karoo and karoo-like environments which include Griqualand West, are harsh environments that are unpredictable, with indigenous plants and animals that were selected over hundreds of thousands of years. This area occurs in the north-central parts of South Africa, mainly in the Northern Cape, although it also includes parts of the North-West and the Free State Provinces. The Griqualand West area is semi-arid with a few perennial rivers; however, the most prominent is the Orange River. Associated with water and processes the Orange River is linked to the control of creation, maintenance and development of peculiar habitats. These habitats normally form along flowing and stagnant freshwater bodies where they can be experiencing seasonal or permanent inundation and/or flooding that either occur regularly, irregularly or result in catastrophic events. There is, however, a lack of knowledge in terms of vegetation in the Griqualand West areas, even though it has been known since the mid-20th century that this area has a high floristic diversity. Knowledge of this extradentary ecosystem will enable better management and decision-making about sustainable development.

Vegetation forms the most obvious external feature on which ecosystems are classified and defined. Uncontrolled and ill-planned development is one of the biggest threats to naturally evolved life on Earth. Development worldwide in the past and at present is responsible for the destruction of various plant and animal species, as well as the habitats in which they occur. The lack of knowledge about the vegetation of the Griqualand West area, therefore, makes it vulnerable to uninformed development. Therefore, a balance needs to be developed between the needs of humans and the conservation of natural habitats or resources. This balance is one of the biggest challenges faced by decision-makers in the country.

Preventing the destruction of any ecosystem requires a need for systematic planning and co-ordination of human activities, and development should be prioritised. The

planning should include studies of the natural environment, which include soil, water, vegetation, animals and cultural as well as historical aspects.

The plant community is seen as an important unit in any ecosystem and, therefore, forms the basis for environmental planning and the compilation of environmental management plans. Plant species assemblages are an indication of the habitat, ecosystem health, and rarity of the ecosystem, and are an important part of an Environmental Impact Assessment.

AIMS OF THE STUDY

This report aims to present ecological information on the flora that could have been present on the farms Tweefontein and Kalkfontein where pivots have already been erected in the Northern Cape, South Africa (hereafter referred to as the study area).

The objectives of this study were to:

- Identify, describe, and delineate the different vegetation units present on the property
- Compile a map of the vegetation units present in the area
- Indicate the presence of protected plant species or suitable habitat
- Identify alien invasive plant species
- Provide a sensitivity map of the study area (where applicable).

STUDY AREA

Location

The study sites are located north-east of Prieska between the R386 to Niekerkshoop and the R357 to Douglas on the banks of the Orange River (Figure 1). Both farms Tweefontein and Kalkfontein, occur along the Orange River forming their southern boundaries, with natural vegetation to the west and north of Tweefontein. On the eastern boundary, Tweefontein borders Kalkfontein. Kalkfontein only has natural vegetation to the north; the eastern boundary borders another agricultural field.

The study areas fall within the Nama Karoo Biome and the Inland Azonal Vegetation of Mucina and Rutherford (2006). The farm Tweefontein falls within the Inland Azonal

Vegetation known as the Upper Gariep Alluvial Vegetation type (Aza 4). The farm Kalkfontein, falls within two different vegetation types namely the Inland Azonal Vegetation known as the Upper Gariep Alluvial Vegetation (Aza 4) that comprises most of the farm. The north-eastern tip of the farm falls within the least threatened Northern Upper Karoo (NKu 3) of the Nama Karoo Biome. The Inland Azonal Vegetation, known as the Upper Gariep Alluvial Vegetation (Aza 4) that is present on both farms, is regarded as vulnerable (Mucina and Rutherford, 2006). The size of the study areas is approximately 32.7 ha (Magoras) and 106 ha (Kalkfontein).

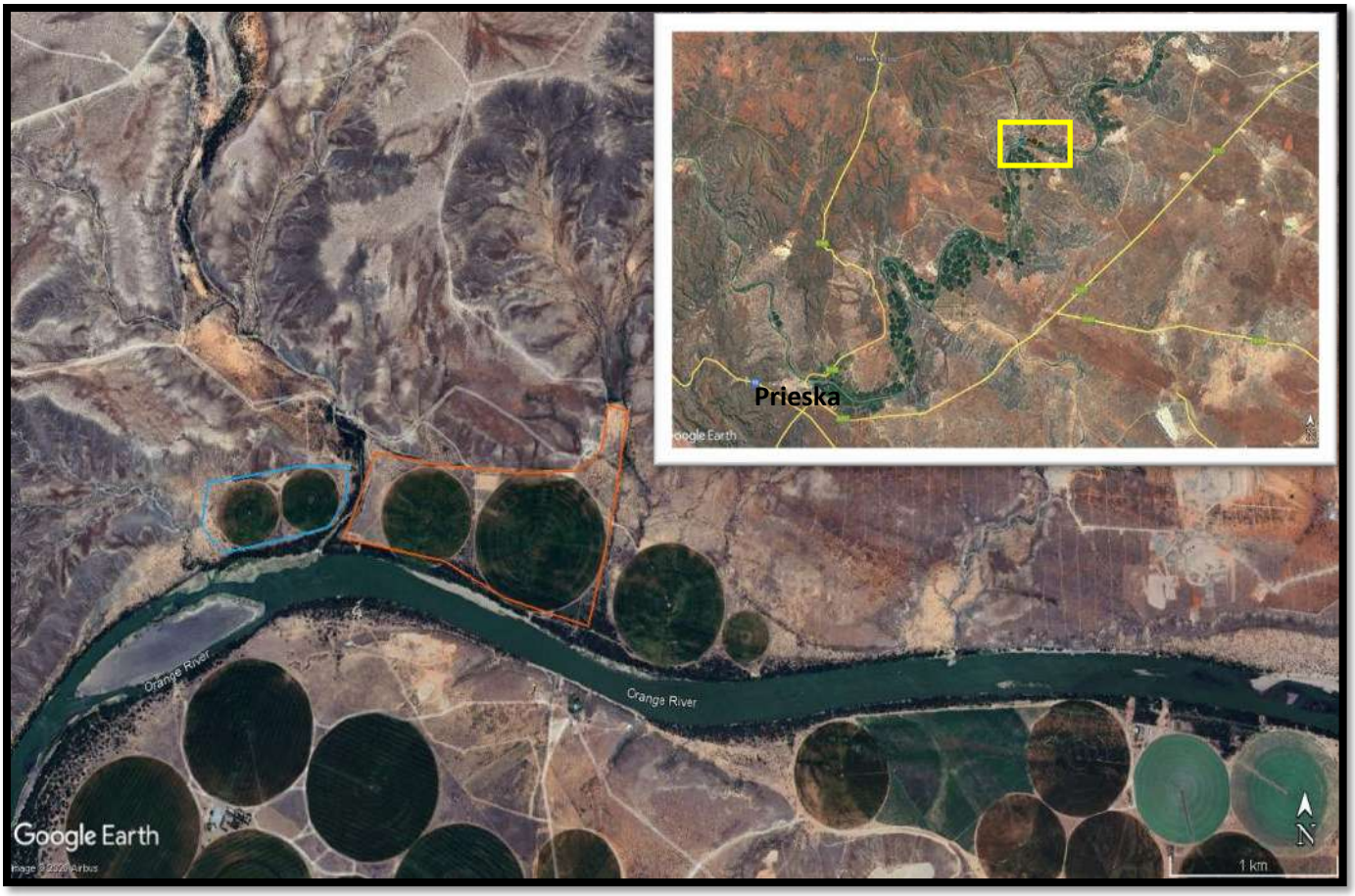

Figure 1: Locality of the study sites, Tweefontein in blue and Kalkfontein in orange (Source: Google Maps)

Existing impacts on the study site include:

Both Tweefontein and Kalkfontein had existing disturbances in the form of erected pivots, solar panels and farm sheds. We thus only investigated the vegetation surrounding the pivots and the natural vegetation in the surrounding areas.

In order to get an overview of what the natural vegetation looked like, Mucina and Rutherford (2006) were consulted, and the dominant species in each of the vegetation types present in the study areas are listed below.

Upper Gariep Alluvial Vegetation (Aza4) next to the Orange River should include species such as: *Acacia karroo, Celtis africana, Salix mucronata subsp. mucronata, Royena lycioides [Diospyros lycioides], Melianthus comosus and Melica decumbens*.

The Northern Upper Karoo (Nku3) that is present in the most northern parts of the Kalkfontein farm should contain dominant species such as: *Lycium cinereum, Chrysocoma ciliata, Lasiociphon polycephalus [Gnidia polycephala], Pentzia calcarea, Pentzia globosa, P. incana, P. spinescens, Rosenia humilis, Thesium hystrix, Aristida adscensionis, A. congesta, A. diffusa, Enneapogon desvauxii, Eragrostis lehmanniana, E. obtusa, E. truncata, Sporobolus fimbriatus* and *Stipagrostis obtusa.*

METHODS

VEGETATION

Principles of the Braun-Blanquet survey technique were used to do the survey and describe plant communities as ecological units. Relevant literature was used to obtain an overview of the vegetation of the site. The ecological sensitivity of the plant communities was assessed and categorised according to the habitat and plant species assemblages. Aerial photographs were used to study the site, and a preliminary delineation of the possible different vegetation units was done. These vegetation units were verified on foot at the site, and vegetation sample plots were placed in each.

Data recorded included:

Data gathered included the physiognomy and floristic composition (species richness and canopy cover of each species) of each species. A list of plant species present, including trees, shrubs, grasses, forbs, geophytes and succulents were compiled. All identifiable plant species were listed. Additional notes were made of any features that might be of ecological significance.

Red data and protected species

An investigation was carried out on rare and protected plants that might possibly occur in the region. The National Red List of Threatened Plants of South Africa, Lesotho and Swaziland, compiled by the Threatened Species Programme, South African National Biodiversity Institute (SANBI), was used. The Northern Cape Nature Conservation Act (No. 9 of 2009) was also consulted, as well as The Red List of South African Plants compiled by SANBI (2020). The New Plants of South Africa (SANBI 2016) was also used.

The presence of rare and protected species or suitable habitat was recorded during the field visit.

Data processing

Vegetation data were classified to identify, describe, and map vegetation units. Description of the vegetation units includes tree, shrub, and herbaceous layers. Conservation priority for each vegetation unit was assessed by evaluating plant species composition in terms of the present knowledge of the vegetation of the Nama Karoo Biome and Inland Azonal Vegetation of South Africa. Five conservation priority categories were used for the different vegetation units:

High	Area with natural vegetation with a high species richness and habitat diversity; presence of viable populations of red data plant species OR suitable habitat for such species; presence of unique habitats; less than 5% pioneer/alien plant species present. These areas are ecologically valuable and important for ecosystem functioning. This land should be conserved and managed, and is not suitable for development purposes.
Medium-high	Natural area with a relatively high species richness and diversity; not a threatened or unique ecosystem; moderate habitat diversity; between 5-10% pioneer/alien plant species present; that would need low financial input and management to improve its current condition; and where low-density development could be considered with limited impact on the vegetation / ecosystem. It is

	recommended that larger sections of the vegetation be maintained**.**
Medium	An area with a relatively natural species composition; not a threatened or unique ecosystem; moderate species diversity; between 11-20% pioneer/alien plant species present; that would need moderate to major financial input to rehabilitate to an improved condition; and where medium density development could be considered with limited impact on the vegetation / ecosystem. Where possible, certain sections of the vegetation could be maintained**.**
Low-medium	Area with relatively natural vegetation, though a common vegetation type; moderate to low species and habitat diversity; previously or currently degraded or in secondary successional phase; between 20-40% pioneer and/or alien plant species; low ecosystem functioning; low rehabilitation potential.
Low	A totally degraded and transformed area with a low habitat diversity and ecosystem functioning; no viable populations of natural plants; >40% pioneer and/or alien plant species present; very low habitat uniqueness; whose recovery potential is extremely low; and on which development could be supported with little to no impact on the natural vegetation / ecosystem.

RESULTS OF THE VEGETATION SURVEY

Vegetation units at Tweefontein

Two pivots were present at this farm, and the remaining vegetation around it was investigated (Figure 1). The study area can be divided into three different vegetation units (Figure 2) that could be identified. The vegetation in the vicinity of the Orange River was included since the river plays an important role in the ecological functioning of the area.

1. Riparian vegetation unit
2. Disturbed pivot vegetation unit
3. Natural vegetation unit

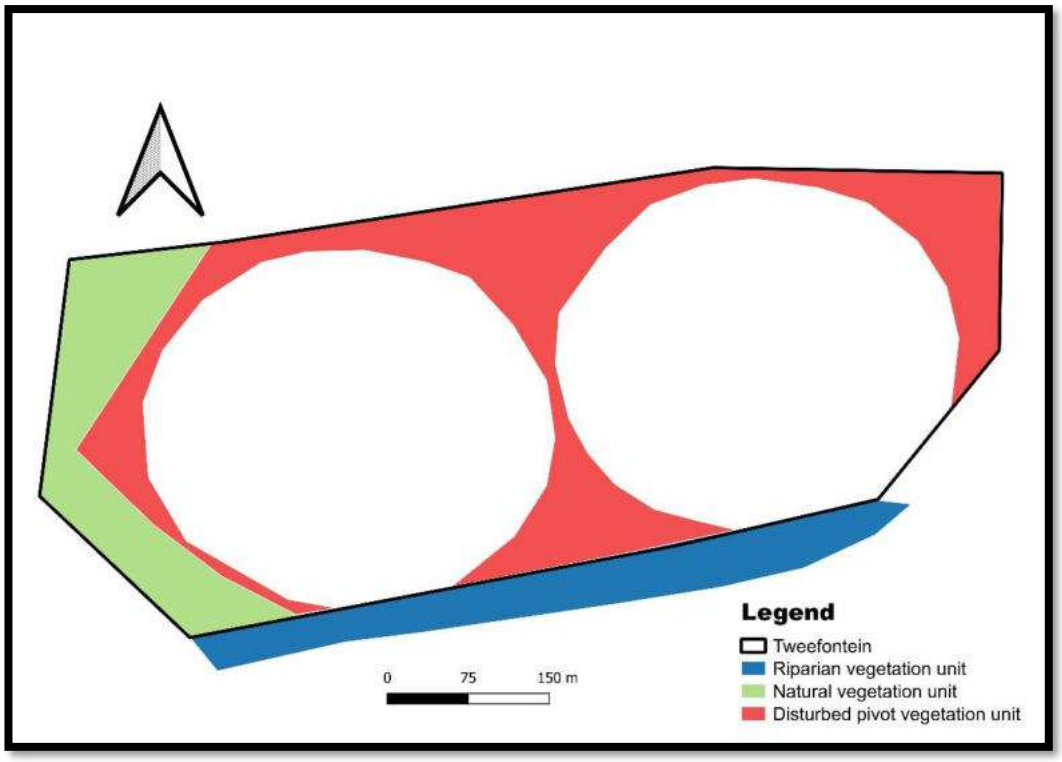

Figure 2: Different vegetation units identified at the Tweefontein farm.

1. Riparian vegetation unit

Figure 3: Riparian vegetation unit indicating the dominance of trees and shrubs that create an impenetrable unit.

Status	Natural with some anthropogenic disturbance
Vegetation structure	The vegetation is composed of trees and shrubs with a few grasses and herbs.
Topography	Sloping in a southern direction towards the Orange River
Rock cover	No rock cover, mostly sandy soils
Conservation priority	High

This vegetation unit (Figure 3) occurs on the southern boundaries of both the farms, Tweefontein (2.94 ha) and Kalkfontein (10.7 ha). The slope of this unit is in a southerly direction towards the Orange River. Protected species include *Mesembryanthemum junceum, M. coriarium* and *M. guerichianum* listed under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur.

The vegetation of this area is dominated by trees such as *Vachellia karroo, Ziziphus mucronata, Searsia lancea, Searsia pendulina,* and scattered individuals of **Neltuma glandulosa [*Prosopis glandulosa].* Shrubs include *Lycium hirsutum* and *L. cinereum.* Prominent grasses include *Bromus catharticus*, *Eragrostis lehmannina, Phragmites australis and Setaria verticillata.* The herbs found were mostly alien invasive species.

Protected species:

Family	**Species**	**Growth form**
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum junceum*	Succulent

Invasive Alien plant species

Family	**Species**	**Growth form**
Amaranthaceae	**Alternanthera pungens*	Herb
Amaranthaceae	*Chenopodium *album*	Herb
Asteraceae	*Bidens *bipinnata*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Fabaceae	**Neltuma glandulosa*	Tree/shrub
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Poaceae	*Bromus *catharticus*	Graminoid

List of species found during the study:

The following is a list of plant species identified during the survey, where * indicates alien invasive species.

Family	Species	Growth form
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum junceum*	Succulent
Amaranthaceae	**Alternanthera pungens*	Herb
Amaranthaceae	*Atriplex semibaccata*	Dwarf shrub
Amaranthaceae	*Chenopodium *album*	Herb
Amaranthaceae	*Exomis microphyllum*	Succulent
Amaranthaceae	*Salsola kali*	Herb
Anacardiaceae	*Searsia lancea*	Tree/shrub
Anacardiaceae	*Searsia pendulina*	Tree shrub
Asparagaceae	*Asparagus laricinus*	Shrub
Asteraceae	*Bidens *bipinnata*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Asteraceae	*Nolletia chrysocomoides*	Dwarf shrub
Brassicaceae	*Lepidium africanum*	Herb
Fabaceae	*Vachellia karroo*	Tree/shrub
Fabaceae	*Senegalia mellifera*	Tree/shrub
Fabaceae	**Neltuma glandulosa*	Tree/shrub
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Poaceae	*Bromus *catharticus*	Graminoid
Poaceae	*Eragrostis lehmanniana*	Graminoid
Poaceae	*Phragmites australis*	Graminoid
Poaceae	*Setaria verticillata*	Graminoid
Poaceae	*Tragus berteronianus*	Graminoid
Portulacaceae	*Portulaca oleracea*	Succulent
Rhamnaceae	*Ziziphus mucronata*	Tree/shrub
Solanaceae	*Lycium cinereum*	Shrub
Solanaceae	*Lycium hirsutum*	Shrub
Zygophyllaceae	*Tribulus terrestris*	Herb

2. Disturbed pivot vegetation unit

Figure 4: Disturbed pivot vegetation unit.

Status	Disturbed
Vegetation structure	Vegetation is mostly dominated by succulents with some herbs and scattered shrubs.
Topography	Sloping in a southerly direction towards the Orange River, but seems to be relatively flat.
Rock cover	Small-sized rocks present on sandy soils
Conservation priority	Low-Medium

This vegetation unit (Figure 4) occurs in the immediate vicinity of the pivots on the farm and covers an area of approximately 7.27 ha within the study area. The vegetation unit is relatively flat but slopes slightly in a southern direction towards the Orange River.

The vegetation is mostly dominated by the succulents *Mesembryanthemum guerichianum, Portulaca *oleracea, Portulaca quadrifida* and *Exomis microphyllum.* Scattered shrubs that are also prominent include *Pentzia incana, P. spharocephala,*

Roepera pubescens and *Tetraena microcarpa.* Very few grasses and herbs occur in this vegetation unit, and there are also various bare soil patches. Protected species include *Mesembryanthemum coriarium* and *M. guerichianum* listed under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur. *Boscia albitrunca* is listed as a protected tree under both the Northern Cape Ordinance and the National Forest Act of 1998. Declared alien invasive species that are present in this vegetation unit include **Xanthium spinosum, *Datura ferox, *D. innoxia* and **D. stramonium.*

Protected species:

Family	**Species**	**Growth form**
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Capparaceae	*Boscia albitrunca*	Tree/shrub

Invasive Alien plant species

Family	**Species**	**Growth form**
Amaranthaceae	Salsola kali	Herb
Asteraceae	Erigeron *bonariensis	Herb
Asteraceae	*Xanthium spinosum	Herb
Brassicaceae	*Lepidium didymum	Herb
Fabaceae	*Neltuma glandulosa	Tree/shrub
Nyctaginaceae	Boerhavia *cordobensis	Herb
Papaveraceae	*Argemone ochroleuca	Herb
Poaceae	Sorghum *halepense	Graminoid
Portulacaceae	Portulaca *oleracea	Herb
Solanaceae	*Datura ferox	Shrug
Solanaceae	*Datura innoxia	Shrub
Solanaceae	*Datura stramonium	Shrub

List of species found during the study:

The following is a list of plant species identified during the survey, where * indicates alien invasive species.

Family	**Species**	**Growth form**
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Amaranthaceae	*Atriplex semibaccata*	Dwarf shrub
Amaranthaceae	*Exomis microphyllum*	Succulent
Amaranthaceae	*Salsola kali*	Herb
Anacardiaceae	*Searsia lancea*	Tree/shrub

Family	Species	Growth form
Asparagaceae	*Asparagus laricinus*	Shrub
Asteraceae	*Erigeron *bonariensis*	Herb
Asteraceae	*Pentzia incana*	Shrub
Asteraceae	*Pentzia sphaerocephala*	Shrub
Asteraceae	**Xanthium spinosum*	Herb
Brassicaceae	**Lepidium didymum*	Herb
Brassicaceae	*Lepidium englerianum*	Herb
Capparaceae	*Boscia albitrunca*	Tree/shrub
Celastraceae	*Gymnosporia buxifolia*	Tree/shrub
Fabaceae	**Neltuma glandulosa*	Tree/shrub
Molluginaceae	*Kewa salsoloides*	Dwarf shrubs
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Papaveraceae	**Argemone ochroleuca*	Herb
Poaceae	*Eragrosits echinochloidea*	Graminoid
Poaceae	*Eragrostis lehmanniana*	Graminoid
Poaceae	*Setaria verticillata*	Graminoid
Poaceae	*Sorghum *halepense*	Graminoid
Portulacaceae	*Portulaca *oleracea*	Herb
Portulacaceae	*Portulaca quadrifida*	Succulent
Solanaceae	**Datura ferox*	Shrub
Solanaceae	**Datura innoxia*	Shrub
Solanaceae	**Datura stramonium*	Shrub
Solanaceae	*Lycium bosciifolium*	Shrub
Solanaceae	*Lycium cinereum*	Shrub
Zygophyllaceae	*Roepera pubesecens*	Shrub
Zygophyllaceae	*Tetraena microcarpa*	Dwarf shrub
Zygophyllaceae	*Tribulus terrestris*	Herb

3. Natural vegetation unit

Figure 5: Near natural vegetation unit occurring on the western parts of the study area.

Status	Near natural
Vegetation structure	Vegetation is dominated by trees with a very prominent shrub layer. Vegetation cover on the ground is sparse but contains various herbs and grasses.
Topography	This terrain is sloping in various directions and is not even. There is a slight slope to the west – due to a tributary the Orange River occurring in that direction. There is also a slope towards the south, where the Orange River flows. The slope thus depends on where you are in the landscape.
Rock cover	Some areas contain rocks, other is mostly sandy
Conservation priority	Medium-high

This vegetation unit (Figure 5) is located on the western side of the study site and covers approximately 3.11 ha. Depending on your position in the landscape, it might

slope westward towards the tributary of the Orange River or southward towards the Orange River itself.

The vegetation can be regarded as near-natural dominated by *Senegalia mellifera* as either trees or shrubs, while the shrub layer is dominated by *Roepera pubescens, Tetraena microcarpa, Pentzia incana* and *Aizoon plinthoides.* Grasses and herbs are sparse. Scattered individuals of the protected tree *Boscia albitrunca* (listed as a protected tree under both the Northern Cape Ordinance and the National Forest Act of 1998) is also present in this vegetation unit. Other protected species include *Mesembryanthemum noctiflorum, M. guerichianum, Aizoon plinthoides* and *Ammocharis* sp., listed under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur.

Protected species:

Family	**Species**	**Growth form**
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum noctiflorum*	Succulent
Aizoaceae	*Aizoon plinthoides*	Dwarf shrub
Amaryllidaceae	*Ammocharis* sp.	Bulb
Capparaceae	*Boscia albitrunca*	Tree/shrub

Invasive Alien plant species

Family	**Species**	**Growth form**
Amaranthaceae	*Salsola kali*	Herb
Nyctaginaceae	*Boerhavia *cordobensis*	Herb

List of species found during the study:

The following is a list of plant species identified during the survey, where * indicates alien invasive species.

Family	**Species**	**Growth form**
Acanthaceae	*Pogonospermum divaricatum*	Shrub
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum noctiflorum*	Succulent
Aizoaceae	*Aizoon plinthoides*	Dwarf shrub
Amaranthaceae	*Atriplex semibacatta*	Dwarf shrub
Amaranthaceae	*Exomis microphylla*	Succulent
Amaranthaceae	*Salsola kali*	Herb
Amaranthaceae	*Salsola tuberculata*	Dwarf shrub

Family	Species	Growth form
Amaryllidaceae	*Ammocharis* sp.	Bulb
Asparagaceae	*Asparagus larisinus*	Shrub
Asteraceae	*Dicoma capensis*	Herb
Asteraceae	*Pentzia incana*	Shrub
Asteraceae	*Pentzia sphaerocephala*	Shrub
Bigoniaceae	*Rhigozum trichotomum*	Shrub
Boraginaceae	*Ehretia alba*	Shrub
Capparaceae	*Boscia albitrunca*	Tree/shrub
Fabaceae	*Vachellia karroo*	Tree/shrub
Fabaceae	*Senegalia mellifera*	Tree/shrub
Fabaceae	*Indigofera alternans*	Herb
Malvaceae	*Hermannia coccocarpa*	Herb
Malvaceae	*Hermannia spinosa*	Herb
Molluginaceae	*Kewa salsoloides*	Dwarf shrug
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Poaceae	*Cenchrus ciliaris*	Gramminoid
Poaceae	*Enneapogon desvauxii*	Graminoid
Poaceae	*Eragrostis echinochloidea*	Graminoid
Poaceae	*Stipagrostis ciliata*	Graminoid
Poaceae	*Stipagrostis obtusa*	Graminoid
Poaceae	*Tragus berteronianus*	Graminoid
Portulacaceae	*Portulaca quadrifida*	Succulent
Rhamnaceae	*Ziziphus mucronata*	Tree/srhub
Schrophulariaceae	*Aptosimum indivisum*	Dwarf shrub
Scrophulariaceae	*Peliostomum leucorrhizum*	Dwarf shrub
Solanaceae	*Lycium cinereum*	Shrub
Zygophyllaceae	*Roepera pubesecens*	Shrub
Zygophyllaceae	*Tetraena microcarpa*	Dwarf shrub

Vegetation units at Kalkfontein

Two actively cultivated pivots and two areas that contained pivots before were present at this farm, and the remaining vegetation around it was investigated (Figure 1). The study area can be divided into five different vegetation units (Figure 6) that were identified. The vegetation in the vicinity of the Orange River was included since the river plays an important role in the ecological functioning of the area.

1. Riparian vegetation unit
2. Succulent shrubland vegetation unit
3. Karroid shrubland vegetation unit
4. Grassy vegetation unit
5. Old fields vegetation unit

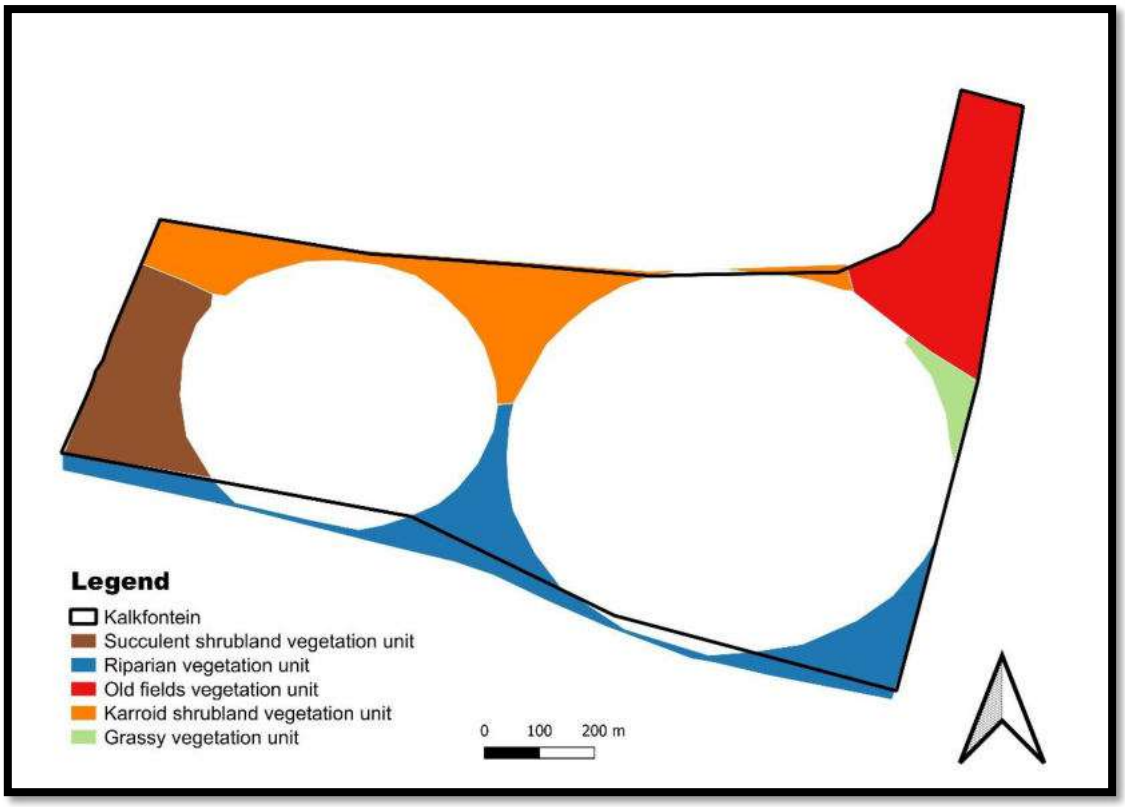

Figure 6: Different vegetation units identified at the Kalkfontein farm.

1. **Riparian vegetation unit**

This unit is the same as the unit identified on the Tweefontein farm and the content will therefore be a repetition.

Figure 7: Riparian vegetation unit indicating the dominance of trees and shrubs that create an impenetrable unit.

Status	Natural with some anthropogenic disturbance
Vegetation structure	The vegetation is composed of trees and shrubs with a few grasses and herbs.
Topography	Sloping in a southern direction towards the Orange River
Rock cover	No rock cover, mostly sandy soils
Conservation priority	High

This vegetation unit (Figure 7) occurs in the southern boundaries of both the farms, Tweefontein (2.94 ha) and Kalkfontein (10.7 ha). The slope of this unit is in a southerly direction towards the Orange River. Protected species include *Mesembryanthemum junceum, M. coriarium* and *M. guerichianum* listed under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur.

The vegetation of this area is dominated by trees such as *Vachellia karroo, Ziziphus mucronata, Searsia lancea, Searsia pendulina,* and scattered individuals of **Neltuma glandulosa [*Prosopis glandulosa].* Shrubs include *Lycium hirsutum* and *L. cinereum.* Prominent grasses include *Bromus catharticus*, *Eragrostis lehmannina, Phragmites australis and Setaria verticillata.* The herbs found were mostly alien invasive species.

Protected species:

Family	**Species**	**Growth form**
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum junceum*	Succulent

Invasive Alien plant species

Family	**Species**	**Growth form**
Amaranthaceae	**Alternanthera pungens*	Herb
Amaranthaceae	*Chenopodium *album*	Herb
Asteraceae	*Bidens *bipinnata*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Fabaceae	**Neltuma glandulosa*	Tree/shrub
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Poaceae	*Bromus *catharticus*	Graminoid

List of species found during the study:

The following is a list of plant species identified during the survey, where * indicates alien invasive species.

Family	Species	Growth form
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum junceum*	Succulent
Amaranthaceae	**Alternanthera pungens*	Herb
Amaranthaceae	*Atriplex semibaccata*	Dwarf shrub
Amaranthaceae	*Chenopodium *album*	Herb
Amaranthaceae	*Exomis microphyllum*	Succulent
Amaranthaceae	*Salsola kali*	Herb
Anacardiaceae	*Searsia lancea*	Tree/shrub
Anacardiaceae	*Searsia pendulina*	Tree shrub
Asparagaceae	*Asparagus laricinus*	Shrub
Asteraceae	*Bidens *bipinnata*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Asteraceae	*Nolletia chrysocomoides*	Dwarf shrub
Brassicaceae	*Lepidium africanum*	Herb
Fabaceae	*Vachellia karroo*	Tree/shrub
Fabaceae	*Senegalia mellifera*	Tree/shrub
Fabaceae	**Neltuma glandulosa*	Tree/shrub
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Poaceae	*Bromus *catharticus*	Graminoid
Poaceae	*Eragrostis lehmanniana*	Graminoid
Poaceae	*Phragmites australis*	Graminoid
Poaceae	*Setaria verticillata*	Graminoid
Poaceae	*Tragus berteronianus*	Graminoid
Portulacaceae	*Portulaca oleracea*	Succulent
Rhamnaceae	*Ziziphus mucronata*	Tree/shrub
Solanaceae	*Lycium cinereum*	Shrub
Solanaceae	*Lycium hirsutum*	Shrub
Zygophyllaceae	*Tribulus terrestris*	Herb

2. Succulent shrubland vegetation unit

Figure 8: Succulent shrubland vegetation unit

Status	Near natural
Vegetation structure	The vegetation is mostly dominated by shrubs that are succulent, and others are woody. Scattered trees also occur in this vegetation unit. While the grass layer are dominated by *Cenchrus ciliaris.*
Topography	Sloping towards the Orange River in the south or the tributary of the Orange River to the west. It all depends on your position in the landscape.
Rock cover	Limited rocks present, soils were mostly sandy.
Conservation priority	Medium

This vegetation unit (Figure 8) is present in the north-western corner area and covers approximately 6.72 ha of the study area. Within this vegetation unit, there are also solar panels present, which already caused a disturbance in the south-western corner. Shrubs dominate this vegetation unit and are either succulent (*Caroxylon aphyllum [Salsola aphylla], Mesembryanthemum coriarium* and *Exomis microphylla*) or woody

(*Lycium bosciifolium, L. cinereium* and *Pentzia* incana). The scattered tree layer contains individuals of *Vachellia karroo, Senegalia mellifera* and *Ziziphus mucronata.* The grass layer is dominated by *Cenchrus ciliaris.* Protected species in this vegetation unit include *Mesembryanthemum coriarium* and *M. guerichianum* both protected under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur.

Figure 9: *Exomis microphyllla* dominating certain parts of the Succulent shrubland vegetation unit.

In certain areas of this vegetation unit, *Exomis microphylla* (Figure 9) dominates the vegetation with little to no shrubs and trees present.

Protected species:

Family	Species	Growth form
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent

Invasive Alien plant species

Family	Species	Growth form
Amaranthaceae	*Chenopodium *album*	Herb
Amaranthaceae	*Salsola kali*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Portulacaceae	*Portulaca *oleracea*	Herb

List of species found during the study:

The following is a list of plant species identified during the survey where * indicates alien invasive species:

Family	Species	Growth form
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Amaranthaceae	*Chenopodium *album*	Herb
Amaranthaceae	*Exomis microphylla*	Succulent
Amaranthaceae	*Caroxylon aphyllum*	Succulent
Amaranthaceae	*Salsola kali*	Herb
Asparagaceae	*Asparagus laricinus*	Shrub
Asteraceae	*Erigeron *bonariensis*	Herb
Asteraceae	*Helichrysum argyrosphaerum*	Herb
Asteraceae	*Nolettia chrysocomoides*	Herb
Asteraceae	*Pentzia incana*	Shrub
Boraginaceae	*Ehretia alba*	Shrub
Boraginaceae	*Heliotropium lineare*	Herb
Brassicaceae	*Lepidium englerianum*	Herb
Fabaceae	*Indigofera alternans*	Herb
Fabaceae	*Senegalia mellifera*	Tree/shrub
Fabaceae	*Vachellia karroo*	Tree
Limeaceae	*Limeum argute-carinatum*	Dwarf shrub
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Poaceae	*Cenchrus ciliaris*	Graminoid
Poaceae	*Eragrostis echinochloidea*	Graminoid
Poaceae	*Eragrostis lehmanniana*	Graminoid
Poaceae	*Stipagrostis ciliata*	Graminoid
Poaceae	*Stipagrostis obtusa*	Graminoid
Poaceae	*Tragus berteronianus*	Graminoid
Portulacaceae	*Portulaca *oleracea*	Herb
Rhamnaceae	*Ziziphus mucronata*	Tree/shrub
Solanaceae	*Lycium bosciifolium*	Shrub
Solanaceae	*Lycium cinereum*	Shrub
Zygophyllaceae	*Tribulus terrestris*	Herb
Zygophyllaceae	*Tribulus zeyheri*	Dwarf shrub

3. Karroid shrubland vegetation unit

Figure 10: Karroid shrubland vegetation unit.

Status	Near natural
Vegetation structure	The vegetation is dominated by shrubs with scattered trees. The ground layer is sparsely covered with grasses and herbs.
Topography	Sloping towards the Orange River in the south, however, the pivots prevent natural connections.
Rock cover	Some rocks are present; however, the area is mostly sandy
Conservation priority	Medium-high

This vegetation unit (Figure 10) is present on the northern boundary of the study area, where it borders natural vegetation that is similar. The area covers approximately 9.64 ha. The shrub layer is dominated by various karroid shrubs such as *Lycium cinereum, L. bosciifolium, Pentzia incana, P. sphaerocephala, Eriocephalus ericoides, Roepera pubescens* and Tetraena macrocarpa. Scattered trees such as *Vachellia karroo,*

Senegalia mellifera, Ziziphus mucronata and *Searsia pendulina* are also present. The herb and grass layer are sparse; however, the prominent grasses are *Aristida congesta, Eragrostis echinochloidea, Stipagrostis ciliata* and *Stipagrostis obtusa.*

Mesembryanthemum coriarium, M. guerichianum, M. noctiflorum, Aizoon plinthoides and *Nerine* sp area all protected under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur.

Protected species:

Family	**Species**	**Growth form**
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum noctiflorum*	Succulent
Aizoaceae	*Aizoon plinActhoides*	Dwarf shrub
Amaryllidaceae	*Nerine* sp.	Bulb

Invasive Alien plant species

Family	**Species**	**Growth form**
Amaranthaceae	**Alternanthera pungens*	Herb
Amaranthaceae	*Salsola kali*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Solanaceae	**Datura ferox*	Shrub

List of species found during the study:

The following is a list of plant species identified during the survey, where * indicates alien invasive species:

Family	**Species**	**Growth form**
Acanthaceae	*Barleria rigida*	Dwarf shrub
Acanthaceae	*Pogonospermum divaricatum*	Herb
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum noctiflorum*	Succulent
Aizoaceae	*Aizoon plinthoides*	Dwarf shrub
Amaranthaceae	**Alternanthera pungens*	Herb
Amaranthaceae	*Exomis microphylla*	Succulent
Amaranthaceae	*Caroxylon aphyllum*	Succulent
Amaranthaceae	*Salsola kali*	Herb

Family	Species	Growth form
Amaryllidaceae	*Nerine* sp.	Bulb
Anacardiaceae	*Searsia pendulina*	Tree/shrub
Asteraceae	*Erigeron *bonariensis*	Herb
Asteraceae	*Eriocephalus ericoides*	Shrub
Asteraceae	*Pentzia incana*	Shrub
Asteraceae	*Pentzia sphaerocephala*	Shrub
Boraginaceae	*Ehretia alba*	Shrub
Fabaceae	*Vachellia karroo*	Tree/shrub
Fabaceae	*Senegalia mellifera*	Tree/shrub
Fabaceae	*Indigofera alternans*	Herb
Limeaceae	*Limeum argute-carinatum*	Dwarf shrub
Malvaceae	*Hermannia cococcarpa*	Herb
Malvaceae	*Hermannia spinosa*	Dwarf shrub
Molluginaceae	*Kewa salsoloides*	Dwarf shrub
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Poaceae	*Aristida congesta*	Graminoid
Poaceae	*Cenchrus ciliaris*	Graminoid
Poaceae	*Eragrostis echinochloidea*	Graminoid
Poaceae	*Eragrostis lehmanniana*	Graminoid
Poaceae	*Fingerhutia africana*	Graminoid
Poaceae	*Stipagrostis ciliata*	Graminoid
Poaceae	*Stipagrostis obtusa*	Graminoid
Portulacaceae	*Portulaca quadrifida*	Succulent
Rhamnaceae	*Ziziphus mucronata*	Tree/shrub
Scrophulariaceae	*Peliostomum leucorrhizum*	Dwarf shrub
Solanaceae	**Datura ferrox*	Shrub
Solanaceae	*Lycium bosciifolium*	Shrub
Solanaceae	*Lycium cinereum*	Shrub
Zygophyllaceae	*Roepera pubescens*	Shrub
Zygophyllaceae	*Tetraena microcarpa*	Dwarf shrub
Zygophyllaceae	*Tribilus terrestris*	Herb

4. Grassy vegetation unit

Figure 11: The Grassy vegetation unit found at the study area.

Status	Disturbed
Vegetation structure	The vegetation is dominated by grasses. Among the grasses, although not easily visible, are some shrubs that are woody or succulent.
Topography	Sloping towards the Orange River in the south.
Rock cover	Some rocks are present; however, the area is mostly sandy.
Conservation priority	Low

This vegetation unit (Figure 11) is present on the eastern boundary, more or less in the middle of the study area. This vegetation unit is very small and approximately 1.1 ha in size. The vegetation is surrounded by natural vegetation to the east and degraded old lands to the north. The vegetation is dominated by the grass *Eragrostis echinochloideae* a pioneer species. Although the shrubs that are present are not visible, they are the succulent shrubs *Mesembryanthemum coriarium* and *M. junceum,* as well as the woody shrubs **Neltuma glandulosa [*Prosopis glandulosa], Lycium*

cinereum and *L. hirsutum. Mesembryanthemum coriarium, M. guerichianum,* and *M. noctiflorum* are all protected under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur.

Protected species:

Family	Species	Growth form
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthemum junceum*	Succulent

Invasive Alien plant species

Family	Species	Growth form
Amaranthaceae	*Chenopodium *album*	Herb
Amaranthaceae	*Salsola kali*	Herb
Fabaceae	**Neltuma glandulosa*	Tree/shrub
Papaveraceae	**Argemone ochroleuca*	Herb

List of species found during the study:

The following is a list of plant species identified during the survey, where * indicates alien invasive species:

Family	Species	Growth form
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Mesembryanthmum junceum*	Succulent
Amaranthaceae	*Atriplex semibaccata*	Dwarf shrub
Amaranthaceae	*Chenopodium *album*	Herb
Amaranthaceae	*Salsola kali*	Herb
Asparagaceae	*Asparagus larisinus*	Shrub
Asteraceae	*Nidorella resedifolia*	Herb
Brassicaceae	*Lepidium englerianum*	Herb
Fabaceae	**Neltuma glandulosa*	Tree/shrub
Papaveraceae	**Argemone ochroleuca*	Herb
Poaceae	*Eragrostis echinochloideae*	Graminoid
Poaceae	*Eragrostis lehmanniana*	Graminoid
Poaceae	*Stipagrostis obtusa*	Graminoid
Solanaceae	*Lycium cinereum*	Shrub
Solanaceae	*Lycium hirsutum*	Shrub
Zygophyllaceae	*Tribulus terrestris*	Herb

5. Old fields vegetation unit

Figure 12: The Old fields vegetation unit.

Status	Disturbed and degraded
Vegetation structure	The vegetation has various open patches of bare soil with other areas containing some grasses or shrubs, while other areas have scattered trees with grasses and herbs as ground cover.
Topography	Sloping towards the Orange River in the south.
Rock cover	Rock presence was minimal, and the soil exhibited significant hardness, potentially due to compaction associated with prior agricultural activities.
Conservation priority	Low-medium

This vegetation unit (Figure 12) is present in the northern corner of the eastern boundary. This vegetation unit occupies approximately 8.98 ha of the study area. It is clear that this area had previously been a cultivated and was completely transformed. No single species dominates the vegetation, which is discontinuous and characterized by multiple patches of bare soil. These patches are highly crusted or compacted.

Although no species dominate the vegetation, one does find remnants of layers similar to the surrounding natural vegetation. These layers include a grass and herb layer, a shrub layer and a tree layer. Protected species under the Northern Cape Ordinance, Schedule 2, because of the families in which they occur are *Mesembryanthemum coriarium, M. guerichianum* and *Aizoon plinthoides*.

Protected species:

Family	**Species**	**Growth form**
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Aizoon plinthoides*	Dwarf shrub

Invasive Alien plant species

Family	**Species**	**Growth form**
Amaranthaceae	*Salsola kali*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Papaveraceae	**Argemone ochroleuca*	Herb
Solanaceae	**Datura ferox*	Shrub

List of species found during the study:

The following is a list of plant species identified during the survey, where * indicates alien invasive species:

Family	**Species**	**Growth form**
Acanthaceae	*Pogonospermum divaricatum*	Herb
Aizoaceae	*Mesembryanthemum coriarium*	Succulent
Aizoaceae	*Mesembryanthemum guerichianum*	Succulent
Aizoaceae	*Aizoon plinthoides*	Dwarf shrub
Amaranthaceae	*Atriplex semibaccata*	Shrub
Amaranthaceae	*Exomis microphylla*	Succulent
Amaranthaceae	*Salsola kali*	Herb
Asteraceae	*Erigeron *bonariensis*	Herb
Asteraceae	*Nidorella resedifolia*	Herb
Asteraceae	*Pentzia incana*	Shrub
Asteraceae	*Pentzia sphaerocephala*	Shrub
Boraginaceae	*Heliotropium lineare*	Herb
Brassicaceae	*Lepidium englerianum*	Herb
Brassicaceae	*Lepidium capensis*	Herb
Fabaceae	*Vachellia karroo*	Tree/shrub
Fabaceae	*Senegalia mellifera*	Tree/shrub

Family	Species	Growth form
Lamiaceae	*Leucas capensis*	Dwarf shrub
Limeaceae	*Limeum argute-carinatum*	Dwarf shrub
Malvaceae	*Radyera urens*	Shrub
Melianthaceae	*Melianthus comosus*	Tree/shrub
Nyctaginaceae	*Boerhavia *cordobensis*	Herb
Papaveraceae	**Argemone ochroleuca*	Herb
Pedaliaceae	*Sesamum triphyllum*	Herb
Poaceae	*Aristida congesta*	Graminoid
Poaceae	*Cenchrus ciliaris*	Graminoid
Poaceae	*Enneapogon desvauxii*	Graminoid
Poaceae	*Eragrostis echinochloidea*	Graminoid
Poaceae	*Fingerhutia africana*	Graminoid
Poaceae	*Pogonarthria squarrosa*	Graminoid
Poaceae	*Stipagrostis ciliata*	Graminoid
Poaceae	*Stipagrostis obtusa*	Graminoid
Portulacaceae	*Portulaca quadrifida*	Succulent
Rhamnaceae	*Ziziphus mucronata*	Tree/shrub
Solanaceae	**Datura ferox*	Shrub
Solanaceae	*Lycium bosciifolium*	Shrub
Solanaceae	*Lycium hirsutum*	Shrub
Zygophyllaceae	*Tetraena microcarpa*	Dwarf shrub
Zygophyllaceae	*Tribilus terrestris*	Herb

DISCUSSION

VEGETATION

Vegetation types

The vegetation types present in the study occur within the Nama Karoo Biome, namely the Northern Upper Karoo (NKu 3) considered as **least threatened.** As well as the Inland Azonal Vegetation known as the Upper Gariep Alluvial Vegetation (Aza 4) (Figure 13) (Mucina and Rutherford, 2006).

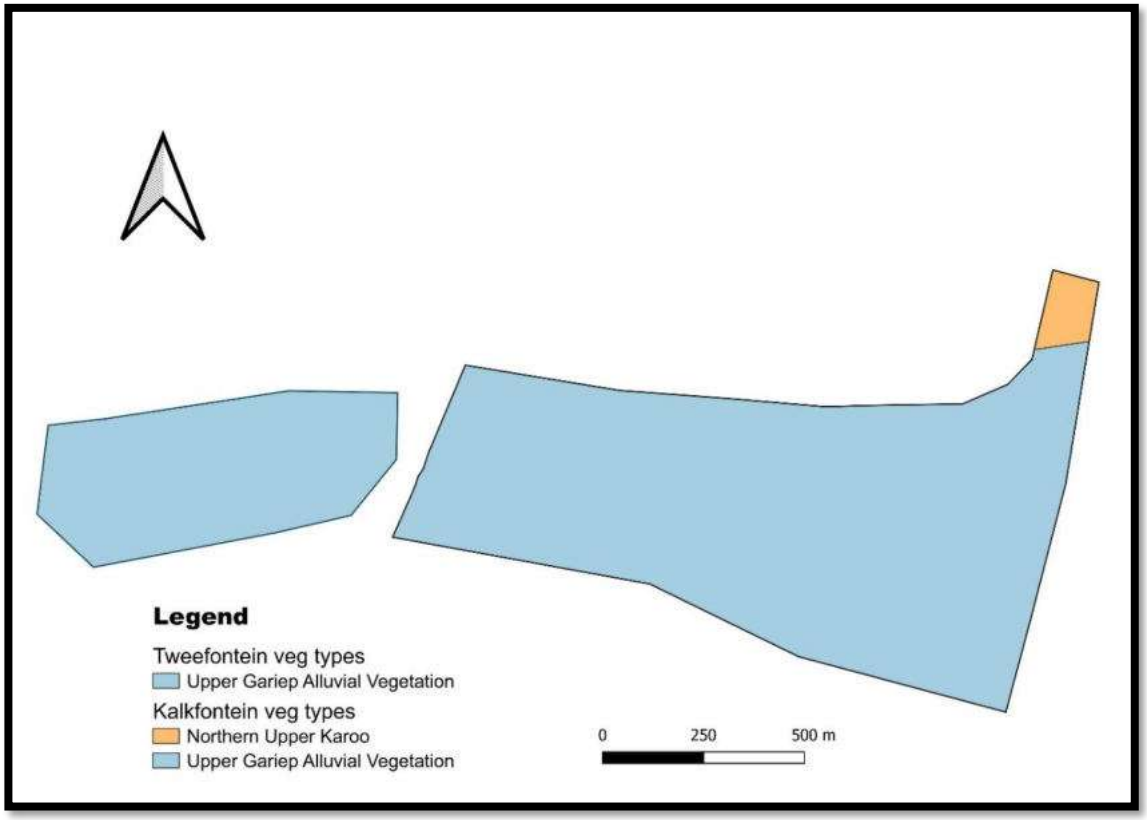

Figure 13: Location of the study area within the Upper Gariep Alluvial Vegetation (AZa 4) and Northern Upper Karoo (NKu 3) vegetation types after Mucina and Rutherford (2006).

Only 3% of the Upper Gariep Alluvial Vegetation (Aza 4) is statutorily conserved in Tussen Die Riviere, Gariep Dam and Oviston Nature Reserves. More than 20% has already been transformed for cultivation and the building of dams.

Important taxa according to Mucina and Rutherford (2006), include Small trees: *Vachellia karroo, Celtis africana, Salix mucronata* subsp. *mucronata*. Tall shrubs: Royena lycioides [*Diospyros lycioides], Melianthus comosus, Searsia pyroides*. Low Shrubs: *Asparagus setaceus, Asparagus suaveolens*. Woody climber: *Clematis*

brachiata. Succulent shrubs: *Lycium arenicola, L. hirsutum*. Herbs: *Rubia cordifolia Cineraria dregeana, C. lobata*. Graminoids: *Melica decumbens*.

The Northern Upper Karoo (NKu 3) is considered **least threatened,** however there are no statutory conserved areas in this vegetation type. Around 4% has been cleared for cultivation or irreversibly transformed by the building of dams. There is also an increase in human settlements in the northeastern parts of the vegetation type. **Prosopis glandulosa,* one of the 12 agriculturally most important invasive alien plants in South Africa, is widely distributed in this vegetation type.

Important taxa according to Mucina and Rutherford (2006) include Small Trees: *Acacia mellifera* subsp. *detinens, Boscia albitrunca.* Tall Shrubs: *Lycium cinereum, Lycium horridum, L. oxycarpum, L. schizocalyx, Rhigozum trichotomum.* Low shrubs: *Chrysocoma ciliata, Lasiosiphon polycephalus [Gnidia polycephala], Pentzia calcarea, P. globosa, P. incana, P. spinescens, Rosenia humilis, Amphiglossa trifloral, Aptosimum marlothii, A. spinescens, Asparagus glaucus, Barleria rigida, Berkheya annectens, Eriocephalus ericoides* subsp. *ericoides, E. glandulosus, E. spinescens, Euryops asparagoides, Filicia muricata, Helichrysum lucilioides, Hermannia spinosa, Leucas capensis, Limeum aethiopicum, Melolobium candicans, Microloma armatum, Osteospermum leptolobum, O. spinescens, Pegolettia retrofracta, Pentzia lantana, Phyllanthus maderaspatensis, Aizoon plinthoides [Plinthus karooicus], Petronia glauca, P. sordida, Selago geniculata, S. saxatilis, Tetragonia arbuscula, Zygophyllum lichtensteinianum.* Succulent shrubs: *Hertia pallens, Salsola calluna, S. glabrescens, S. rabieana, S. tuberculata, Zygophyllum flexuosum.* Semiparasitic shrubs: *Thesium hystrix.* Herbs: *Chamaesyce inaequilatera, Convolvulus sagittatus, Dicoma capensis, Gezania krebsiana, Hermannia comosa, Indigofera alternans, Lessertia pauciflora, Radyera urens, Sesamum capense, Sutera pinnatifida, Tribulus terrestris, Vahlia capensis.* Succulent herb: *Psilocaulon coririum.* Geophytic herb: *Moraea pallida.* Graminoids: *Aristida adscensionis, A. congesta, A. diffusa, Enneapogon desvauxii, Eragrostis lehmanniana, E. obtusa, E. truncata, Sporobolus fimbriatus, Stipagrostis obtusa, Eragrostis bicolor, E. porosa, Fingerhuthia africana, Heteropogon contortus, Stipagrostis ciliata, Themeda triandra, Tragus berteronianus, T. koeleroides, T. racemosus.*

Biogeographically Important Taxa: Herb: *Convolvulus boedeckerianus*. Tall Shrub: *Gymnosporia szyszylowiczii* subsp. *namibiensis.*

Endemic Taxa: Succulent shrubs: *Lithops hookeri, Stomatium pluridens*. Low shrubs: *Atriplex spongiosa, Galenia exigau*. Herb: *Manulea deserticola*

Vegetation units

Vegetation unit 1 (Riverine vegetation unit) occurring on both **Tweefontein and Kalkfontein farms** has a well-developed tree layer, dominated by *Vachellia karroo, Ziziphus mucronata, Searsia lancea, Searsia pendulina,* and scattered individuals of **Neltuma glandulosa [*Prosopis glandlosa].* The shrub layer is mostly dominated by *Lycium hirsutum and L. cineureum.* Prominent grasses include Bromus **catharticus*, *Eragrostis lehmannina, Phragmites australis and Setaria verticillata.* The herbs are mostly alien invasive species which might be due to disturbance because of flooding along the banks of the Orange River. From an ecological perspective the area has a high conservation value because riverine systems are important corridors connecting ecosystems. At both Tweefontein and Kalkfontein Farms these areas are minimally disturbed with mainly pumps going into the river, thus these areas still have their ecological integrity. This integrity should be kept intact as this riparian environment plays an important role in the broader environment as a natural corridor for the movement of fauna and flora, as well as the provisioning of water. Various invasive species were found in this vegetation unit, which include: **Alternathera pungens, Chenopodium *album, Bidens *bipinnata, Erigeron *bonariensis, *Neltuma glandulosa [*Prosopis glandulosa], Boerhavia *cordobensis* and *Bromus *catharticus.*

Vegetation units at Tweefontein farm

Vegetation unit 2 (Disturbed pivot vegetation unit) has been affected when the pivots of the area were set up. Although the vegetation does contain components of the surrounding natural vegetation, it is mostly dominated by *Mesembryanthemum guerichianum, Portulaca *oleracea, Portulaca quadrifida* and *Exomis microphyllum,* which are all succulents. Some scattered shrubs include *Pentzia incana, P. spharocephala, Roepera pubescens* and *Tetraena microcarpa,* however, these are in low numbers. Ecologically, this vegetation unit has previously been degraded and is

currently in a secondary successional phase. There are also various declared alien invasive species present in this vegetation unit, namely **Xanthium spinosum, *Datura ferox, *D. innoxia* and **D. stramonium.* It is however surrounded by natural vegetation to the west and north of the study site. An intact individual of the protected *Boscia albitrunca* was also found between the pivots.

Vegetation unit 3 (Natural vegetation unit) is still in a near natural state, dominated by a tree layer mostly composed of *Senegalia mellifera* and a shrub layer that contains species such as *Roepera pubescens, Tetraena microcarpa, Pentzia incana* and *Aizoon plinthoides.* Grass and herb cover are spares which result in a lot of bare ground that does not have any vegetation cover. Various individuals of the protected *Boscia albitrunca* were present in this vegetation unit. Ecologically, this vegetation unit is still natural with moderate habitat diversity, thus still performing its ecological function in the environment. There is still intact natural vegetation that is similar to this vegetation unit towards the west of the study site. Very limited individuals of the NEMBA declared alien invasive *Salsola kali* were found within this vegetation unit. Another alien invasive species also found here was *Boerhavia *cordobensis.*

Vegetation unit at Kalkfontein farm

Vegetation unit 2 (Succulent shrubland vegetation unit) is seen as natural, although the presence of solar panels in the south-western corner is an indication of disturbance that already exists in this vegetation unit. The vegetation is mostly dominated by succulent shrubs such as *Caroxylon aphyllum [Salsola aphylla], Mesembryanthemum coriarium* and *Exomis microphylla*; however, there are also some woody shrubs such as *Lycium bosciifolium, L. cinereium* and *Pentzia* incana. Scattered trees are also present in this vegetation unit (*Vachellia karroo, Senegalia mellifera* and *Ziziphus mucronate). Chenchrus ciliaris* is the dominant grass in this vegetation unit. Ecologically, this vegetation unit contains natural species that are not threatened or unique. It still performs its ecological function, however, within the environment studied for both farms, there are no similar vegetation units nearby. Alien invasive plants include *Chenopodium *album, Salsola kali* (NEMBA declared alien invasive), *Erigeron *bonariensis, Boerhavia *cordobensis* ans *Portulaca *oleracea.*

Vegetation unit 3 (Karroid shrubland vegetation unit) has a prominent shrub layer composed of *Lycium cinereum, L. bosciifolium, Pentzia incana, P. sphaerocephala, Eriocephalus ericoides, Roepera pubescens* and *Tetraena microcarpa*. It also has a prominent but scattered tree layer composed of trees such as *Vachellia karroo, Senegalia mellifera, Ziziphus mucronata* and *Searsia pendulina.* Although the grass and forb layer spares, prominent grasses include *Aristida congesta, Eragrostis echinochloidea, Stipagrostis ciliata* and *Stipagrostis obtusa.* Ecologically, this vegetation unit can be seen as near-natural and still performing its function. This vegetation unit is also bordered by similar vegetation to the north of the study site. Furthermore, this vegetation unit has a relatively high richness and diversity with limited alien invasive species such as **Alternanthera pungens, Salsola kali* (NEMBA declared alien invasive species), *Erigeron *bonariensis, Boerhavia *cordobensis* and **Datura ferox*

Vegetation unit 4 (Grassy vegetation unit) is mostly dominated by the pioneer grass *Eragrostis echinochloideae* which is indicative of pervious disturbance in the area. The shrub layer, although not very visible or prominent, is dominated by natural species also found in the surrounding environment and includes *Mesembryanthemum coriarium, M. junceum, Lycium cinereum* and *L. hirsutum.* The NEMBA declared alien invasive **Neltuma glandulosa [*Prosopis glandulosa]* also occurs as a shrub in this vegetation unit. Ecologically, this vegetation unit can be regarded as degraded, with a low habitat diversity and ecosystem function, mostly dominated by pioneers. Alien invasives include *Chenopodium *album, Salsola kali* (NEMBA declared alien invasive species), **Neltuma glandulosa* and **Argemone ochroleuca.*

Vegetation unit 5 (Old fields vegetation unit) can be seen as disturbed and degraded. It is clear that this area has been cultivated before. There are, however, a lot of species present from the surrounding environment, indicating this vegetation unit is in a secondary successional phase, and the recovery potential is low. Development in this vegetation unit will not impact the natural vegetation / ecosystem since it is already degraded. There is no dominating species in this vegetation unit, nor is the vegetation cover continuous. There are, however, remnants of natural species from the

surrounding vegetation that form various vegetation layers that include grasses, herbs, shrubs and trees.

Declared Alien Invasive Plant Species (AIP's)

Farm			Tweefontein			Kalkfontein				
Vegetation unit			1	2	3	1	2	3	4	5
Family	**Species**	**NEMBA**								
Amaranthaceae	Salsola kali	1b		x	x		x	x	x	x
Asteraceae	*Xanthium spinosum	1b		x						
Fabaceae	*Neltuma glandulosa	3	x	x		x			x	
Papaveraceae	*Argemone ochroleuca	1b							x	x
Solanaceae	*Datura ferox	1b		x				x		x
Solanaceae	*Datura innoxia	1b		x						
Solanaceae	*Datura stramonium	1b		x						

Alien species pose a risk to the natural environment, locally as well as in the surrounding areas. These species are indicative of degraded conditions in the areas where they occur. Alien plant species outperform the indigenous plant species in terms of reproduction and establishment; furthermore, they also cause deterioration of the habitat in terms of soil water content, soil pH and erosion. Various species from NEMBA's category 1b were found in the study area. According to section 70(1)(a) of the Act, these species must be controlled or irradiated where possible. Category 3 species is also present and regarded as proven invaders and must be controlled (Henderson, 2020).

Protected and Specially protected species

A list of possible protected species that were recorded in the larger region is listed below.

(Please note that the list is confidential and may not be made available for public perusal)

Species	Conservation status	Comments
Nerine sp	Amaryllidaceae family is protected	Found
Ammocharis sp.	Amaryllidaceae family is protected	Found
Boschia albitrunca	Least concern	Found
Aizoon plinthioides	Aizoaceae family is protected	Found

Species	Conservation status	Comments
Mesembryanthemum junceum	Aizoaceae family is protected	Found
Mesembryanthemum coriarium	Aizoaceae family is protected	Found
Mesembryanthemum guerichianum	Aizoaceae family is protected	Found

Ecosystem classification

The study area falls within the greater Griqualand West Centre of Endemism (Frisby, 2016; Frisby et al., 2019; van Staden et al., 2020). The focus areas of the centre of endemism are the core areas with higher numbers of endemic and restricted flora. The core areas include the Northern Ghaap Plateau and Kuruman Hills sub-centre, the Southern Kalahari and the Langeberg sub-centre and the Southern Ghaap Plateau and the Kimberley-Prieska valley sub-centre. The study areas fall within the boundaries of the Griqualand West Centre of Endemism (Frisby, 2016; Frisby et al., 2019; van Staden et al., 2020).

Critical Biodiversity Areas

The study area does not fall within any of the Critical Biodiversity Areas identified by the Northern Cape Biodiversity Spatial Plan of 2024 (Figure 14). The western part of the Kalkfontein farm forms part of the Ecological Support Areas identified in the 2024 Northern Cape Biodiversity Spatial Plan. This forms part of the Succulent shrubland vegetation unit and the Karroid vegetation unit identified during the study.

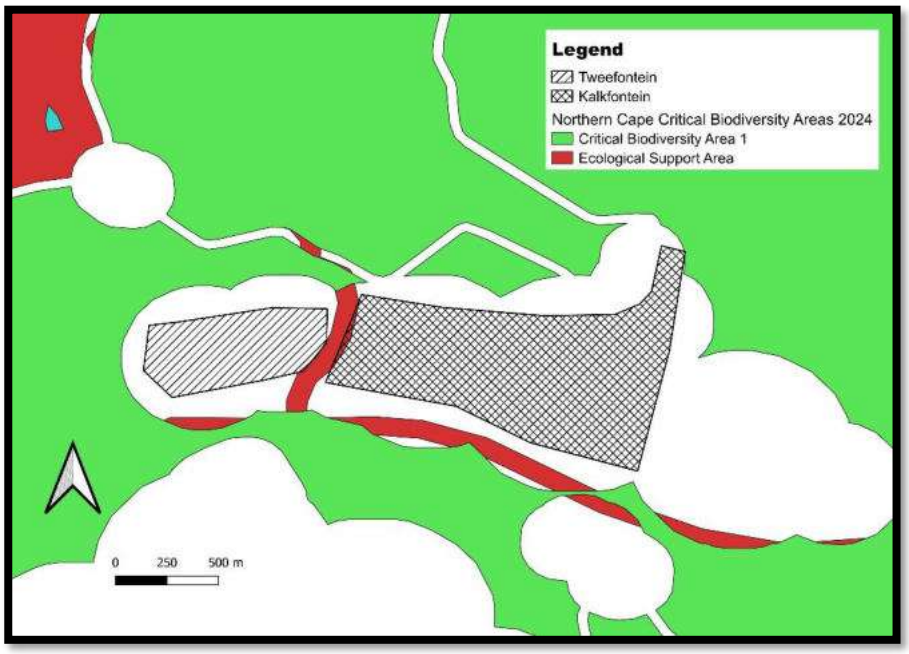

Figure 14: Study area falling within the Critical Biodiversity Areas identified by the Northern Cape in 2024.

However, the 2016 version of the Critical Biodiversity Areas indicated that the study area falls within two of the Critical Biodiversity Areas identified by the Northern Cape. These are Critical Biodiversity Area 1 (Tweefontein and Kalkfontein) and Critical Biodiversity Area 2 in the most northern parts of the Kalkfontein farm (Figure 15).

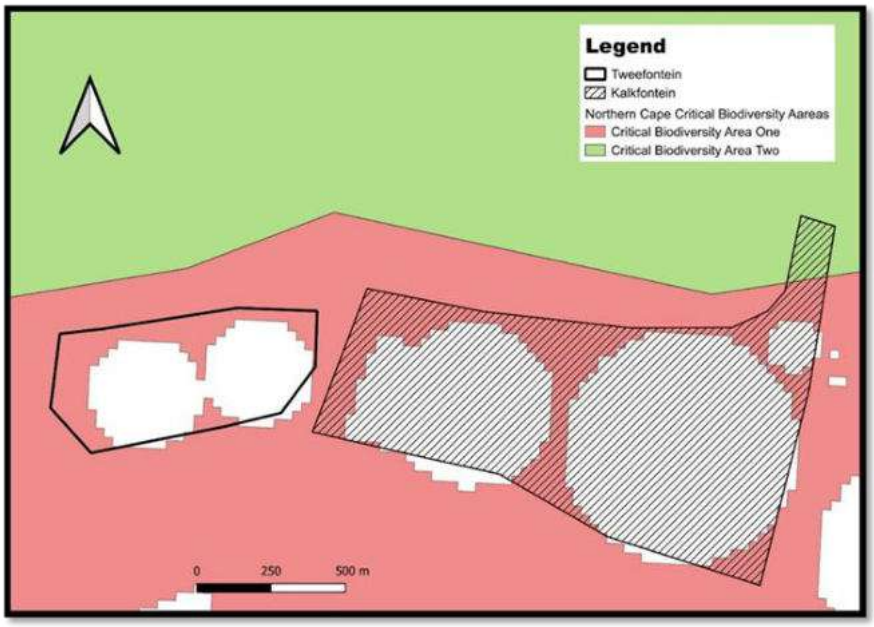

Figure 15: Study area falling within the Critical Biodiversity Areas identified by the Northern Cape in 2016.

Critical Biodiversity Area 1 is areas in a natural condition. These areas are required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure and must be maintained in a natural or near-natural state with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate. When looking at Critical Biodiversity Area 2, these areas are required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure. These areas need to be maintained in a functional, natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate. Ecological Support areas are seen as areas that support the Critical Biodiversity and connect core areas that serve as important corridors.

CONCLUSION AND RECOMMENDATIONS

The study is located north-east of Prieska on the banks of the Orange Rivers between the R386 to Niekerkshoop and the R357 to Douglas. Both farms, Tweefontein and Kalkfontein, occur on the northern banks of the Orange River. The western and northern boundaries of Tweefontein are composed of natural vegetation, but to the east, Tweefontein borders Kalkfontein. Kalkfontein only borders on natural vegetation to the north, while the eastern boundary contains agricultural fields in the form of pivots where crops are planted. Various structures such as sheds, pumping stations and solar panels were present at the study sites.

Two farms were studied during this investigation. Both Tweefontein and Klakfontein border on the Orange River and therefore contain the Riparian vegetation unit (Vegetation unit 1 on both farms). These units have some disturbance in the form of access areas to the Orange River for the extraction of water and has thus been affected by anthropogenic influences. These ecosystems play an important role as corridors for the movement of fauna and flora, as well as the provisioning of water and should therefore be considered as areas with a high conservation priority and high sensitivity.

Vegetation units 2 on Tweefontein and 4 and 5 on Kalkfontein can all be seen as disturbed vegetation units with severe anthropogenic impacts in the form of clearing

for the setting up of pivots where crops are currently grown, or areas were crops has been grown in the past (Kalkfontein, vegetation unit 5) and is in the process of recovering naturally at the moment. Vegetation unit 2 on Tweefontein and 5 on Kalkfontein both have a low-medium conservation priority due to the presence of some natural components of the vegetation that are in later successional phases, resulting in them having a low to medium sensitivity as well. However, vegetation unit 4 on Kalkfontein has a low conservation priority and a low sensitivity due to the dominance of mostly pioneer grasses.

Near natural vegetation units were found on Tweefontein (vegetation unit 3) and Kalkfontein (vegetation units 2 and 3). These vegetation units all contain various species indicated by Mucina and Rutherford (20026) that are naturally occurring within the area. Furthermore, these units are also still performing their respective ecological functions. Their conservation priorities vary from medium to medium-high because of their mostly intact vegetation. These vegetation units also have a medium sensitivity.

According to the Northern Cape Biodiversity Spatial Plan (2024) the study areas does not fall within any Critical Biodiversity Areas, but the western boundary of Kalkfontein forms part of an Ecological Support area. From a plant ecological point of view vegetation units 1 of both Tweefontein and Kalkfontein are natural with some human disturbance. Both vegetation units contain protected species as well as the category 3 alien invasive *Neltuma galndulosa [*Prosopis glandulosa]. These vegetation units are associated with water courses and can therefore be regarded as having a high biodiversity importance and a medium to high ecological sensitivity.

On Tweefontein vegetation unit 2 occurs between existing pivots that over the years have become degraded due to agricultural and anthropogenic influences. This area contains various category 1 and 3 alien invasive plants such as different species of *_Datura, Salsola kali, *Xanthium spinosa, *Argemone ochroleuca_ and *_Neltuma glandulosa_. These plant species are indicative of transformed vegetation with low conservation value and species richness. One must however take note of the protected _Boscia albitrunca_ individual that is also present within this vegetation unit. This vegetation unit has a very low biodiversity importance value.

Vegetation unit 3 on the Tweefontein farm is regarded as near natural with a moderate species richness consisting of climax and secondary successional species. This vegetation unit is thus regarded as having a high biodiversity importance. There are a few alien invasives such as *Salsola kali* and *Boerhavia*cordobensis* that should be removed as a high priority to prevent further encroachment into the area and the displacement of the native vegetation. The presence of the protected tree, *Boscia albitrunca*¸ further emphasize the high conservation value of this vegetation type, since there were various individuals found in the area. This vegetation unit is also still connected to natural vegetation on the western side of the study area.

Near natural vegetation were found in vegetation units 2 and 3 on the Kalkfontein farm. This vegetation has a medium to medium high conservation value since it contains various sub-climax and secondary successional species with a moderate species richness. These vegetation units thus have a medium to high diversity importance. There are however various individuals of the category 1 alien invasive species **Datura ferox* and *Salsola kali* present in these vegetation units which should be removed where possible.

Vegetation unit 4 and 5 on Kalkfontein farm are both disturbed with unit 4 having a low conservation value and 5 being disturbed. Vegetation unit 4 occurs between existing pivots and has become degraded over the years. This vegetation unit contains various individuals of the category 1 alien invasive **Argemone ochroleuca* and the category 3 alien invasive **Neltuma glandulosa [Prosopis glandulosa].* These species are indicative of transformed vegetation with a low conservation value and species richness. With regards to vegetation unit 5 there are various open patches indicative of areas that have been cultivated before and left to be reclaimed by nature. There were, however, no attempts at restoration or management of these areas after cultivation stopped. Vegetation unit 5 from a vegetation point of view can be seen as degraded and transformed with a very low conservation value and species richness. Both these vegetation units have a very low biodiversity importance value.

Although no threatened species, nor suitable habitat were found during the vegetation surveys, there are various protected species present in all of the vegetation units found

during this study. Permits must be obtained for the removal of these species from the different vegetation units. These species should be replanted in suitable habitat outside the study area, under the supervision of a qualified plant ecologist. In vegetation units 2 and 3 on Tweefontein, larger individuals of the protected tree *Boscia albitrunca* must be retained as far as practically possible and if not, then permits must be obtained for their removal.

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agriculture, environmental affairs,
rural development and land reform

Department:
agriculture, environmental affairs,
rural development and land reform .
NORTHERN CAPE PROVINCE
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

Application for authorization in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 as amended.

	(For official use only)
File Reference Number:	
NEAS Reference Number:	
Date Received:	

1. Project title:

Development of the remainder of the Farm Tweefontein 373 and Portion 4 (Ptn of Ptn 2) of the Farm Kalkfontein 374, Prieska, Siyathemba Local Municipality, Northern Cape province.

2. Details of the specialist:

Project Specialist:	Andri Corné van Aardt		
Trading name (if any):	Sparoxis Environmental (Pty) Ltd		
Business reg. no./ID. no.:	2020/804051/07		
Contact person:	Andri van Aardt		
Physical address:	Spring Field 30, 5 Paddy Goodall Street, Pentagon Park		
Postal address:	N/A		
Postal code:	9301	**Cell:**	083661 0169
Telephone:	N/A	**Fax:**	N/A
E-mail:	andri.vanaardt@gmail.com		
Qualifications:	PhD Botany		
Professional affiliation (s) (if any)	SACNASP 731584		

3. Details of the consultant

Project consultant/firm:	Digital Soils Africa (Pty) Ltd		
Business reg. no./ID. no.:	2012/111217/07		
Contact person:	Natalie Sharp		
Postal address:	45 Church Street, Walmer		
Postal code:	6070	**Cell:**	082 414 0472
Telephone:	082 414 0472	**Fax:**	
E-mail:	natalie@dsafrica.co.za		

4. Declaration by the specialist appointed in terms of the Environmental Impact Assessment Regulations, 2014 as amended.

I, Andri Lorné van Aardt, declare that --

- I act as the independent specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Name of company (if applicable): Savannah Environmental (Pty) Ltd

Date: 02/06/2026

Signature of the Commissioner of Oaths:

Date: 2026.06.02

Designation: Sergeant

Official stamp (below):

SUID-AFRIKAANSE POLISIEDIENS
COMMUNITY SERVICE CENTRE
02 -06- 2026
BAYSWATER
SOUTH AFRICAN POLICE SERVICE

Curriculum Vitae

ANDRI CORNÈ VAN AARDT

850316 0043 08 4

PERSONAL INFORMATION

SURNAME	Van Aardt
FULL NAMES	Andri Cornè
TELEPHONE NUMBER	Cell phone: 083 667 0169 Work: 051 401 2641
E-MAIL ADDRESS	andri.vanaardt@gmail.com
GENDER	Female
DATE OF BIRTH	16 March 1985
NATIONALITY	South African Citizen
HOME LANGAUGE	Afrikaans
OTHER LANGUAGES	English (Read, Write and Speak)

QUALIFICATIONS

High School

SCHOOL	Hoërskool Staatspresident Swart, BRANDFORT
HIGHEST GRADE PASSED	Grade 12
YEAR	2003
SUBJECTS	Afrikaans, English, Biology, Physical Science, Mathematics, Computyping, Physiology.

Tertiary Education

INSTITUTE	University of the Free State
DEGREES	**BSc Botany** (2006) (Botany & Zoology) **BSc Honours Botany** (2007) **MSc Botany** (2010) with distinction **PhD Botany** (2016) – Vegetation ecology of the putative Palaeo-Kimberley and Palaeo-Modder rivers and their catchments, Free State, South Africa

Completed Soil Science as an undergraduate subject to complement my Ph.D. research.

Complementary Education

- Attended the African Pollen Database meeting, presented by the Institute de Recherche pour le Developpement, Bondy France.
- Workshop on Palaeofire knowledge for current and future ecosystem management. Presented by the Global Paleofire Working Group. Presented in Montreal, Canada.
- Workshop on Analysing palaeoecological data with R. Presented by Prof. Steve Juggins at the AFQUA 2015 Conference and workshops, Cape Town, South Africa.
- AllWet RES Summer School in Germany. Presented by DAAD Higher Education Cooperation Program. "Welcome to Africa", presented at various wetlands in Germany.
- Wetland Management: Introduction & Delineation Short Course (Rietvlei Nature Reserve, Pretoria) presented by the Centre for Environmental Management, UFS at Rietvlei Nature Reserve in Pretoria.
- GIS Intermediate Short Course at the Centre for Environmental Management at the University of the Free State, Bloemfontein, South Africa.
- Determination of the present ecological state within the eco-classification process Course at the Centre for Environmental Management, UFS in Bloemfontein, South Africa.
- GIS and GPS Course at the Centre for Environmental Management, UFS in Bloemfontein, South Africa.
- Aquatic Biodiversity Winter School at: The Institute for Aquatic Biodiversity in Grahamstown, South Africa.

Fieldwork experience

As a researcher and consultant in the field of vegetation ecology I am involved in various projects involving various vegetation types and biomes in South Africa. This includes plant community descriptions, ecological interpretation and mapping of vegetation. I have worked and conducted fieldwork in various provinces (Free State, Eastern Cape, Northern Cape, Limpopo, Mpumalanga) of our country. This fieldwork was conducted in nature reserves or on privately owned farms which most of the time require extensive ground truthing. During this fieldwork I usually collection plant specimens for identification and processing in a scientific manner. I am familiar with the use of various methods to conduct research and can select the appropriate methodology depending on the nature of the question that needs to be answered. I have compiled seven environmental impact assessment reports that deals with the specialist study of vegetation. I also compiled a technical report that determined the veld condition and grazing capacity for a mine. As a researcher I have also reported on my own research, that were submitted to various national and international scientific journals. I have also been involved in reviewing various articles related to my field of specialization which is vegetation ecology.

RESEARCH

Research Links

Orchid:	https://orcid.org/0000-0003-0227-7567
ResearchGate	https://www.researchgate.net/profile/Andri-Van-Aardt
Google Scholar	https://scholar.google.co.za/citations?user=q29rf6oAAAAJ&hl=en

Peer Reviewed Publications

1. Sithole, J.V., Dayaram, A., **van Aardt, A.C.** 2025. Phytosociology of Golden Gate Highlands: A focus on Drakensberg-Amathole Afromontane Fynbos. *Koedoe 67(1), a1857.* doi.org/ 10.4102/koedoe.v67i1.1857
2. **Van Aardt, A.C.**, Scott, L., Grundling, P.-L., Grundling, A.T., Woodborne, S. 2024. Revisiting past savanna environments: Pollen analysis of the Colbyn wetland on the southern African central plateau. *Review of Palaeobotany and Palynology* IF 1.7. Q1
3. **Van Aardt, A.C.**, de Jager, J.C.L., van Tol, J.J. Submitted. Firebreaks and their effect on vegetation composition and diversity in grasslands of Golden Gate Highlands Park, South Africa. *Diversity* IF 2.5. Q2.
4. Gharbi, D., Berman, D., Neumann, F.H., Hill T., Sidla, S., Cilliers, S.S., Staats, J., Esterhuizen, N., Ajikah, L., Moseri, M., Quick, J.L, Hilmer, E., **Van Aardt, A.,** John, J., Garland, R., Finch J., Hoek W., Bamford M.5, Seedat, Y.R, Manjra, I.A, Peter, J. 2024. Ambrosia (ragweed) pollen – a growing aeroallergen of concern in South Africa. *World Allergy Organization Journal* IF 5.1. Q2
5. Goder-Goldberger, M., Gilead I., Boaretto E., Edeltin L., Horwitz L.K., Jacoby-Glass, Y., Lavi R., Neumann F.H., Porat, N., Toffolo, M., **Van Aardt, A.C.**, Zilberman, T., Crouvi, O. 2023. Living in an Ecotone: Late Middle Paleolithic occupations in the lower Besor Basin, north-western Negev Desert, Israel. *Antiguity* 97: 1-8. IF 1.953. Q1.
6. Esterhuizen, N., Berman, D., Neumann, F., Ajikah, L., Quick, L., Hilmer, E., **Van Aardt, A.,** Hoek, W., John, J., Garland, R., Hill, T., Finch, J., Bamford, M., Seedat, R., Manjra, A., and Peter, J. Accepted. The South African Pollen Monitoring Network: Insights from two years of national aerospora sampling (2019-2021). *Clinical and Translational Allergy* IF3.57. Q2
7. Lombard, M and **van Aardt A.C**. 2023. Method for generating foodplant fitness landscapes: With a foodplant checklist for southern Africa and its application to Klasies River. *Journal of Archaeological Sciences* 149: 1-12 IF 3.216.Q1
8. Scott, L., Neumann, F.H., **van Aardt, A.C.** and Botha, G.A. 2023. Palaeoenvironmental sequences surrounding Border Cave, South Africa, and review of conditions during Middle and Later Stone Age occupation. *Quaternary Science Reviews* 300:1-12 IF 4.112. Q1
9. Lombard, M and **Van Aardt, A.C.** 2022. Taking stock of foodplants growing in the Cradle of Humankind Fossil Hominin Site, South Africa. *African Archaeological Review* 39: 59-77 IF 1.29. Q1
10. Scott, L., Sobol, M., Neuman, F.H., Gil Romera, G., Fernández-Jalvo, Y., Bousman, C.B., Horwitz, L.K. and **Van Aardt, A.C.** 2022. Late Quaternary palaeoenvironments in the central semi-arid region of South Africa from pollen in cave, pan, spring, stream and dung deposits. *Quaternary International* 614: 84-97 IF 2.199. Q1

11. Brown, L.R., **Van Aardt, A.C.**, Janecke, B.B. 2020. A tribute to Pieter Johannes (Johann) du Preez. *Koedoe* 62(2), a1640. DOI: 10.4102/koedoe.v62i2.1640. IF 0.900. Q3 (Tribute)
12. Janecke, B.B., Van Tol, J.J., Smit, I.P.J., **Van Aardt, A.C.**, Riddell, E.S., Seaman, M.T., Swart, W.J., Du Preez, P.J. and Le Roux, P.A.L. 2020. Biotic and abiotic connections on a granite catena: Framework for multidisciplinary research. *Koedoe* 62(2), a1585 DOI: 10.4102/koedoe.v62i2.1600. IF 0.900. Q3
13. Theron E.J, **van Aardt A.C.**, du Preez P.J. 2020. Vegetation distribution along a granite catena, southern Kruger National Park, South Africa. *Koedoe* 62(2), a1588. DOI 10.4102/koedoe.v62i2.1588. IF 0.900. Q3
14. **Van Aardt A.C.**, Codron, D., Theron, E.J., du Preez P.J. 2020. Plant community structure and possible vegetation changes after drought on a granite catena in the Kruger National Park, South Africa. *Koedoe* 62(2), a1585 DOI: 10.4102/koedoe.v62i2.1585. IF 0.900. Q3
15. Scott L., **van Aardt A.C.**, Brink, J. S., Toffolo, M. B, Ochando, J. Carrión, J. S. 2020. Palynology of Middle Stone Age spring deposits in grassland at the Florisbad hominin site, South Africa. *Review of Palaeobotany and Palynology* 265: 13-26. IF 1.904. Q2
16. **Van Aardt, A.C.,** Scott, L and du Preez, PJ. 2017. Western Free State vegetation ecology: From past to present. *South African Journal of Botany* 109, 372. IF: 1.792. Q2 (Abstract)
17. **Van Aardt, A.C.**, Scott, L., Du Preez, P.J. 2016. Towards addressing the disjunction between palaeo- and modern ecology in the western Free State. *Quaternary International* 404: 190. IF: 2.481. Q1 (Abstract)
18. **Van Aardt, A.C.**, Bousman, C.B., Brink, J.S, Brook, G.A., Jacobs, Z., du Preez, P.J., Rossouw, L. and Scott, L. 2015. First chronological, palaeoenvironmental and archaeological data from the Baden-Baden fossil spring complex in the western Free State, South Africa. *Changing Climates, Ecosystems and Environments within Arid Southern African and Adjoining Regions*: *Palaeoecology of Africa*. CRC Press. PP117-152 (Chapter in a book)

Popular Journals

K.J. Brown, M.J. Power, M. Slowinski, **A.C. van Aardt**, O. Blarquez and P. Grondin. Workshop Report: Applying Palaeofire Records in Ecological Management. *Wildfire Magazine.* 27.1 February 2018

Conference Presentations

- **Van Aardt, A.C.,** de Jager, J.C.L., van Tol, J.J. Effect of annual burning on diversity and vegetation composition of Golden Gate Highlands National Park. 59th Annual Congress of the Grassland Society at Gariep Forever Resort 22-26 July 2024.
- **Van Aardt, A.C.,** Scott, L., Grundling, P-L., Grundling, A., Woodborne, S. Late Holocene paleoenvironmental reconstruction of the Savanna-Grassland ecotone, Gauteng, South Africa. XXIV Biennieal Congress Cango Valley, South Africa of the South African Society for Quaternary Research 19-24 May 2024.
- Sithole, J.V., Dayaram, A., **van Aardt, A.C.** 2024. Influence of Aspect on the Drakensberg Amathole-Afromontane Fynbos (Gd6) vegetation composition, Golden Gate Highlands National Park. 49th South African Association of Botanists (SAAB) Conference, Richardsbay Campus, University of Zululand, 7-11 January 2024.

- **Van Aardt, A.C.,** de Jager, J.C.L., Giddy, J.N., Dayaram., A. 2023. Karroid Islands in a sea of grasses, Free State Province, South Africa. 65th Annual Symposium of the International association of vegetation science, Coffs Harbour, Australia, 3 – 8 September 2023.
- Scott, L. and **van Aardt, A. C**. 2022. Updating the African Pollen Database (APD) for the Quaternary in the South African interior. workshop of the French Institute of South Africa (IFAS), Pleistocene Archaeology and Palaeoecology of the Free State, Florisbad, Free State, 14 July 2022.
- Müller, M., van Tol, J.J. **van Aardt, A.C.** 2022. Community distribution along topographical units in the Golden Gate Highlands National Park, Free State Province, South Africa. South African Mountain Conference, Champagne Sports Resort, KwaZulu-Natal, 14 – 17 March 2022
- McLean, C.C., van Tol, J.J., **van Aardt, A.C.**, Kotze, E., Edwards, A., Swart, W., Kotze, J.J. 2022. Quantifying soil degradation through microbial activity of alpine soils in the Northern Drakensberg, South Africa. South African Mountain Conference, Champagne Sports Resort, KwaZulu-Natal, 14 – 17 March 2022
- Ferreira, E.L., **van Aardt, A.C.**, Joubert, L. 2022. Possible effect of community composition on pollination rewards in three Nemesia species from Namaqualand. South African Association of Botanists 28th Annual Conference, 17-20 January 2022
- Nienaber, K, **Van Aardt, A.C.** Van Tol, J.J. 2021. Phytosociological classification of wetland vegetation in the Golden Gate Highlands National Park, Free State Province, South Africa. National Wetland Indaba 2021. Online. 20-21 October 2021
- Scott, L., Gil-Romera, G., Neumann, F. H., Sobol, M., Horwitz, L. K., **van Aardt, A.**, Fernandez-Jalvo, Y. 2019. Diverse modes of pollen taphonomy and late Quaternary palaeo-environments in the Kalahari. Session: Wonderwerk Cave and Related Research Projects in the Northern Cape Province. ASAPA 2019 (Association of Southern African Professional Archaeologists), Kimberley, South Africa, 2-4 July, 2019.
- **Van Aardt, AC,** du Preez, P.J. and Scott,L. 2019. Major plant communities and physical environment in the catchments of the putative palaeo-Kimberley and palaeo-Modder Rivers, Free State South Africa.
  16th Kimberley Biodiversity Research Symposium in Kimberley
- **Van Aardt, A.C.,** Scott, L., Theron, E.J., and Rossouw, L. 2019. Charred Cuticles in Tswaing Crater lake deposits: A palaeoenvironmental indicator? Oral communications. XXII Biennial Congress of the South African Society for Quaternary Research in Mossel Bay.
- **Van Aardt, A.C.,** Scott, L., Brink, J., Toffolo, B., Tomas, J.O. and Carrion, J. 2018. Palynological reconstruction of middle Pleistocene environments at Florisbad, Free State Province, South Africa. Oral communication
  Proceedings of the 20th Biennial Conference of the Palaeontological Society of Southern Africa in Bloemfontein.
- **Van Aardt, A.C.,** Scott, L and du Preez, PJ. 2017. Western Free State vegetation ecology: From past to present. Oral communication
  43rd Annual Conference of the South African Association of Botanists, University of Cape Town, Cape Town, South Africa.
- **Van Aardt, A.C.**, Scott, L. and Du Preez, P.J. 2015. *Towards addressing the disjunction between palaeo- and modern ecology in the western Free State*. Poster.
  AFQUA conference and workshops: The African Quaternary: environments, ecology and humans.

- **Van Aardt, A.C.**, Du Preez, P.J. and Scott, L. 2015. *Vegetation analysis of the catchments of two putative palaeo-rivers in the western Free State, South Africa.* Oral communication.
  41st Annual Conference of the South African Association of Botanists (SAAB).
- **Van Aardt, A.C.**, Scott, L., Bousman, C.B., Brink, J.S., Jacobs, Z. and Du Preez, P.J. 2014. *Palynological analysis of the spring mound Baden-Baden in the western Free State, South Africa.* Poster.
  From Past to Present: Changing Climates, Ecosystems and Environments of Arid Southern Africa; A Tribute to Louis Scott Conference.
- **Van Aardt, A.C.**, Du Preez, P.J., Scott, L. and Collins, N.B. 2013. *A vegetation and environmental analysis of the Palaeo-Kimberley, Palaeo-Modder Rivers and the surrounding area, Free State Province, South Africa.* Oral communication.
  1st African Water Symposium on Water Conflict. Centre for Environmental Management, University of the Free State.
- **Van Aardt, A.C.**, Du Preez, P.J., Scott, L. and Collins, N.B. 2012. *A vegetation and environmental analysis of the Palaeo-Kimberley, Palaeo-Modder Rivers and the surrounding area, Free State Province, South Africa.* Oral communication and a poster.
  9th Annual Inkaba yeAfrica GEO-FUTURE Workshop in Germany.
- **Van Aardt, A.C.** and Du Preez, P.J. 2011. *A vegetation and environmental analysis of the Palaeo-Kimberley, Palaeo-Modder Rivers and the surrounding area, Free State Province, South Africa.* Oral communication and a poster.
  INKABA yeAfrica – 8th Annual Workshop at GeoSynthesis 2011 Conference in Cape Town.
- **Van Aardt, A.C. and** Du Preez, P.J. 2011. *Classification of the riparian Communities along the Vet River, Free State Province, South Africa*. Poster.
  2nd Regional Conference of the Southern African Young Water Professionals at the CSIR international Convention Centre, Pretoria, South Africa.

Consulting and Technical Reports

Technical Reports

2025

Veld condition and Grazing capacity assessment for the Voorspoed Mine, Kroonstad, Free State Province by Dr A.C. van Aardt, J.V. Sithole and S. Crouse.

Environmental Impact Assessment reports

2025/2026

- An Ecological Report on the Flora: On the Farm Uitdraai Boerdery in the Northern Cape
- An Ecological Report on the Flora: On the following farms in the Northern Cape: Bloukrans: Portion 1 & 7 of farm Muishoek no.34, Goue Akker: Portion 6, 13 & 15 of farm Muishoek no.34, and Montery: Portion 13 & 28 of farm Muishoek
- An Ecological Report on the Flora: On the following farms in the Northern Cape: Tweefontein: Remainder of farm Tweefontein 373, and Kalkfontein: Portion 4 (Portion of Portion 2) of farm Kalkfontein

- An Ecological Report on the Flora: On the farms Erf 1 and Erf 971 Prieska in the Northern Cape

2022

- An Ecological Report on the Flora: Remainder of Farm Naauwtesfontein No.78, Hopetown
- A Follow up Ecological Report on the Flora: Remainder of Farm Naauwtesfontein No.78, Hopetown
- An Ecological report on the Flora: On Portion 2 (A Portion of Portion 1) of the farm Clydesdale 156, Division of Herbert in the Northern Cape.

2021

- An Ecological Report on the Flora: Portion 18 (Portion of Portion 15) of the farm Uitdraai no 33, Prieska

Peer review, Committees and Memberships

Manuscripts reviewed

- Royal Society Open Science
- Plant Ecology
- Vegetation Classification and Survey
- South African Journal of Science
- Scientific Reports
- Bothalia
- Folia Geobotanica

Scientific Committees

Southern African Mountain Conference 2022 – reviewer of abstracts
The 5th National Global Change Conference 2023 – reviewer of abstracts
Southern African Mountain Conference 2025 – reviewer of abstracts

Memberships

- South African Association of Botanists since 2018
- South African Society for Quaternary Scientists since 2018
- South African Council for Natural Scientific Professions – Ecological and Botanical Sciences (131584) since 2021
- International Association for Vegetation Science has been part of the African Chapter since 2022

Gesertifiseer 'n ware afskrif van die
oorspronklike dokument
Certified a true copy of the original document
05 March 2024
PATSON WALIWONA MANDA
HONEY PROKUREURS BLOEMFONTEIN
Commissioner of Oaths / Kommissaris van Ede
Practising Attorney / Praktiserende Prokureur R.S.A.

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

IT IS HEREBY CERTIFIED THAT, IN ACCORDANCE WITH THE STATUTES AND RULES OF THE UNIVERSITY, AND PURSUANT TO THE SUBMISSION OF A THESIS ENTITLED

HIERMEE WORD VERKLAAR DAT NADAT AAN DIE STATUTE EN REËLS VAN DIE UNIVERSITEIT VOLDOEN IS, ONDER MEER DEUR DIE VOORLEGGING VAN 'N PROEFSKRIF GETITEL

VEGETATION ECOLOGY OF THE PUTATIVE PALAEO-KIMBERLEY AND PALAEO-MODDER RIVERS AND THEIR CATCHMENTS, FREE STATE, SOUTH AFRICA

THE DEGREE DIE GRAAD

PHILOSOPHIAE DOCTOR

with specialisation in Botany
met spesialisasie in Plantkunde

HAS BEEN CONFERRED UPON
TOEGEKEN IS AAN

VAN AARDT, Andri Corné

AS WITNESS OUR RESPECTIVE SIGNATURES AND THE SEAL OF THE UNIVERSITY BELOW.

AS BEWYS DAARVAN PLAAS ONS ONS ONDERSKEIE HANDTEKENINGE EN DIE SEËL VAN DIE UNIVERSITEIT HIERONDER.

VICE- CHANCELLOR / VISEKANSELIER

DEAN / DEKAAN

REGISTRAR / REGISTRATEUR

BLOEMFONTEIN
2016-06-30
2004025140

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SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Andri Corné van Aardt

Registration Number: 131584

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule 1 of the Act)

Ecological Science (Professional Natural Scientist)
Botanical Science (Professional Natural Scientist)

Effective **8 September 2021** Expires **31 March 2027**

President of Council

Chief Executive Officer

To verify this certificate scan this code

APPENDIX F – PLOUGHING CERTIFICATE

Draft EIA

agriculture
Department:
Agriculture
REPUBLIC OF SOUTH AFRICA

Directorate: Land and Soil Management, PO Box 2303, Kimberley, 8300
97 Kenilworth road, De Beers, Kimberley, 8301

From: Head of Office - Kimberley
Tel: (053) 807 2613 • **Fax:** (053) 807 2630 • **e-mail:** JanHarmV@dalrrd.gov.za
Enquiries: J.H.Vorster • **Ref:** 13/10/6/3 – T2 **Date issued:** 25-02-2026

Permit no. C0009 JHV/NC/2025

Mr. Jaco Gous

PO Box 303

Prieska

8940

RE: PERMISSION FOR CULTIVATION OF VIRGIN SOIL IN TERMS OF REGULATION 2 OF THE CONSERVATION OF AGRICULTURAL RESOURCES ACT, 1983, ACT 43 OF 1983, ON THE FARM UNIT: REMAINDER OF TWEEFONTEIN NO. 373, SITUATED WITHIN SIYATHEMBA LOCAL MUNICIPALITY, PIXLEY KA SEME DISTRICT MUNICIPALITY, NORTHERN CAPE PROVINCE.

With reference to your application in terms of the provision of Regulation 2 of the Conservation of Agricultural Resources Act 1983 (Act 43 of 1983), **permission is hereby granted to cultivate 35 ha in total on the remainder of the Farm Tweefontein 373 – Prieska.**

Crop type: Cash crops – Maize

The permit area is situated within GPS co-ordinates as indicated below: Also see the attached map.

-29.410112° 23.017534° -29.409187° 23.024927° -29.411515° 23.024784°

-29.412539° 23.024133° -29.413802° 23.018215° -29.411998° 23.016146°

Conditions and/or restrictions:

1. Water run-off control systems must be constructed in conjunction with the removal of natural vegetation to prevent erosion due to soil loss caused by water.
2. Sub-surface drainage system must be installed at the first signs of water logging and or salinity. Monitoring protocols will be recommended for early detection of water logging.
3. Cultivation should be restricted to high potential soils only.
4. Areas of cultivation must exclude all rocky outcrops and 10m horizontal from the natural waterways.
5. The clearing of natural vegetation for the irrigation development will trigger other environmental legislation and listed activities.

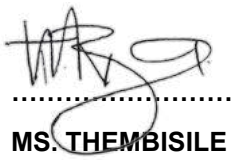
Camp/Land no./Area	Size	Soil depth	Soil forms	Soil Horison	Slope
Area indicated at co-ordinates as provided above.	35 ha	Varied 2.0 – 3. m	Oakleaf	Orthic A Deep Neocutanic	Avg < 1 %

Additional conditions in terms of CARA:

- **In terms of Regulation 7.(1) of the Conservation of Agricultural Resources Act (CARA) Act 43 of 1983,** subject to the provisions of the National Water Act, 1998 (Act 36 of 1998), and sub regulation (2) of this regulation, **no land user shall utilize the vegetation in a vlei, marsh or water sponge or within the flood area of a water course or within 10 metres horizontally outside flood area** in a manner that causes or may cause the deterioration of or damage to the natural agricultural resources.
- **If any signs of erosion (wind or water) appear necessary, soil protection control system must be constructed to** protect the cultivated land on his farm unit effectively against excessive soil loss as a result of erosion through the action of water or wind.
- Irrigation on the property must be done in such a manner that **no salination and/or water logging occur on the above mentioned or adjacent properties.**
- If salination and/or water logging do occur on the property or adjacent properties, the **land user will be held responsible to resolve the salination and/or water logging and any additional measures to prevent the repetition of salination and/or water logging on the above mentioned or adjacent properties.**
- **This permit does not exempt the land user from complying with other pieces of legislation regarding this activity**
- Your attention is drawn to the fact that above mentioned conditions are granted in terms of Act 43 of 1983. Failure to comply with the conditions is an offence and may lead to prosecution. If you experience any problem with the interpretation of this letter or any other problem concerning the above mentioned, do not hesitate to contact our office on the above-mentioned address.

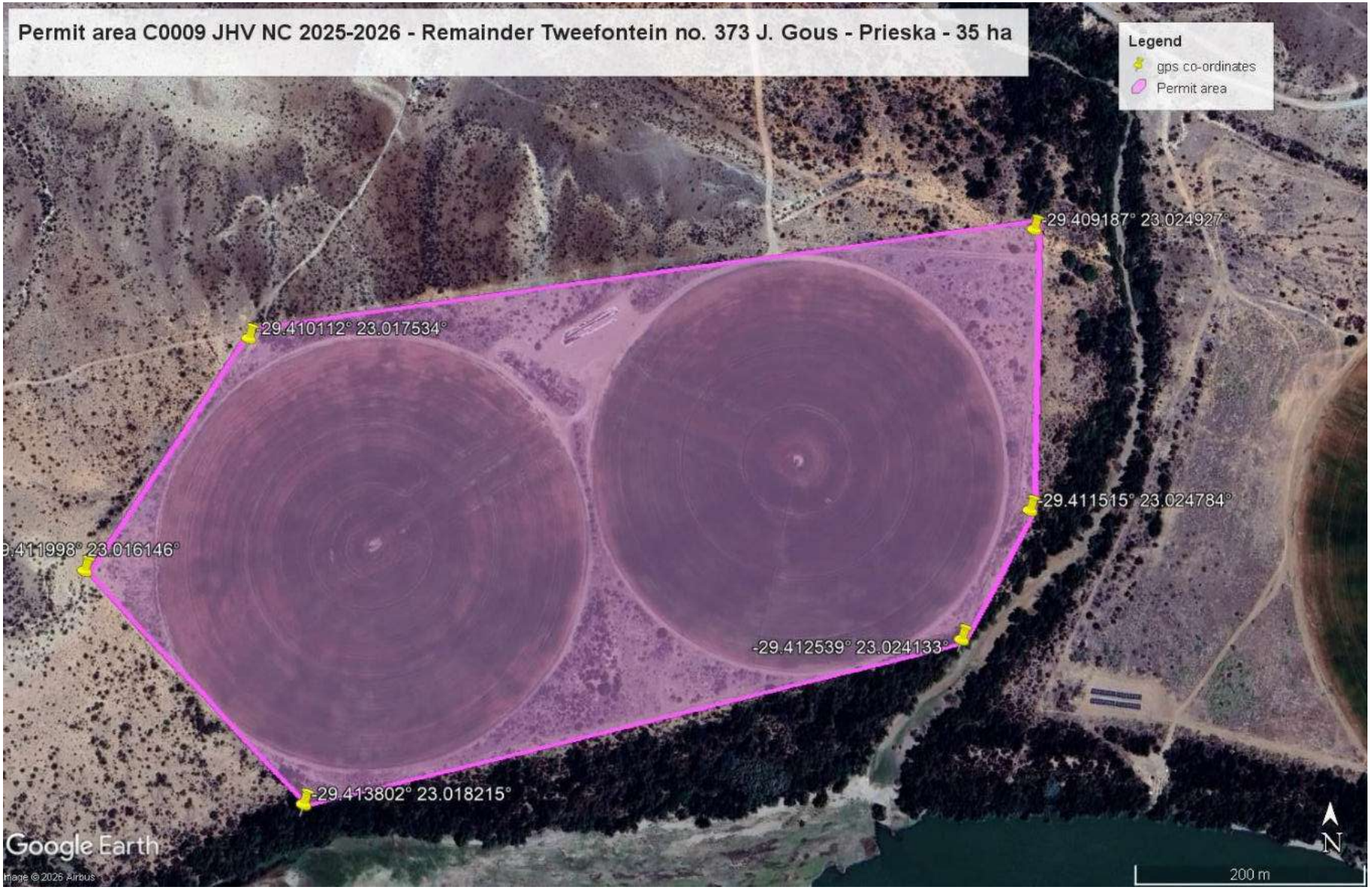
Should you feel aggrieved by this decision you may lodge an appeal in writing within 14 days of receipt of this letter to: The Director: Land and Soil Management, Private bag X120, Pretoria. 0001

Yours faithfully,



……

MS. THEMBISILE MABUZA
CONTROL RESOURCE AUDITOR
ON BEHALF OF: EXECUTIVE OFFICER: ACT NO. 43 OF 1983
DIRECTORATE: LAND AND SOIL MANAGEMENT


Permit area C0009 JHV NC 2025-2026 - Remainder Tweefontein no. 373 J. Gous - Prieska - 35 ha
Legend
gps co-ordinates
Permit area
-29.409187° 23.024927°
-29.410112° 23.017534°
-29.411515° 23.024784°
.411998° 23.016146°
-29.412539° 23.024133°
-29.413802° 23.018215°
Google Earth
Image © 2026 Airbus
N
200 m

APPENDIX G – WATERUSE LICENSE

Draft EIA

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

National Register of Water Use Registration Record 25178888

Water Use Registration Record 25178888 is issued in terms of the regulations requiring that a Water Use be registered, promulgated under Section 26(1)(c) of the National Water Act(Act 36 of 1998) to:

Applicant

Applicant Type:	COMPANY
Name:	TEMDALE BOERDERY (PTY) LTD
Enterprise Type	PRIVATE COMPANY
Business Registration Number:	1999/023793/07
Postal Address:	PO BOX 303 PRIESKA 8940
VAT Registration Number:	4920185511

Water Management Area

Name:	ORANGE

Register Status

Status:	ACTIVE

Water Uses

See attached Annexure(s)

Water Use No.	Water Use	Volume	Volume Start Date	Volume End Date
1	21(a)	1 170 000 CUBIC METRES PER YEAR	2017/09/01	

Office: Lower Orange - Northern Cape
Upington Office
Regional Office: Free State Region

2023-02-02
LOWER ORANGE
WATER MANAGEMENT AREA
Date stamp of issuing office
DEPARTMENT WATER AND SANITATION

DISCLAIMER :
This Registration Record:
1 is not an acknowledgement of an entitlement to the registered water use;
2 may NOT be used to create the impression that it is proof of a water use entitlement. By virtue of section 22(1) of the National Water Act, the only documents that may be used as proof of a water use entitlement, are:
2.1 a licence;
2.2 an official document stating the extent of existing lawful water use pursuant to sections 33 or 35 of the National Water Act;
2.3 a general authorisation as published in the Gazette; or
2.4 Schedule 1 of the National Water Act
Notes:
- If an entitlement for the specific water use referred to in this Registration Record has been confirmed by the Department, it may be indicated as such in this Registration Record.
- If the responsible authority has dispensed with the requirement for a licence for a specific water use, no water use entitlement is needed for that use under the National Water Act.
3 Is issued without alterations or erasures and is invalid if it contains alterations not in conformity with the Department's official copy; and in substitution of any Registration Record the Department may have previously issued and the information is valid as at the date of issue.

National Register of Water Use Registration Record 25178888

Taking water from a water resource in terms of Section 21(a) of the National Water Act

Water Use Identification

Register Number:	25178888
Water Use Number:	1
Water Use Start Date:	2017/09/01
Water Use Status Date:	2023/02/01
Water Use Status:	REGISTERED

Lawfulness Authentication

Finding:	LAWFULNESS STILL TO BE DETERMINED
Finding Date:	2023/01/31
Finding Reason:	UNVERIFIED
Finding Confirmed:	YES

Succession/Transfer Details

Succession/Transfer Type:	SUCCESSION IN TITLE	
Source Part2 Details:	**Register No.**	**WUN**
	25012192	2

Water Use Details

Water Use Sector(s)(i.e. Purpose(s) of Water Use):	AGRICULTURE: IRRIGATION	
Source Type:	SCHEME	
Point of Abstraction:	**Latitude**	**Longitude**
	29.4143° south	23.0064° east
Datum Type:	CAPE (MODIFIED CLARKE 1880)	
Quaternary Drainage Region:	D71D	
Scheduled Use	NO	
Irrigation Area:	117 HECTARES	

Scheme Details

Scheme Name:	MIDDLE ORANGE
Scheme Management Parameter Name:	LOWER ORANGE BETWEEN DOUGLAS & BOEGOEBERG
Servitude Volume:	

Registered Volumes

Start Date	End Date	Registered Volume (m³)	Time Interval
2017/09/01		1170000	PER YEAR

National Register of Water Use Registration Record 25178888

Taking water from a water resource in terms of Section 21(a) of the National Water Act

Water Use Identification

Register Number:	25178888
Water Use Number:	1
Water Use Start Date:	2017/09/01
Water Use Status Date:	2023/02/01
Water Use Status:	REGISTERED

Property Where Water Use Occurs

Property Name:	TWEEFONTEIN 373 PORTION 0 (REMAINING EXTENT)
Property Number:	373
Portion of Property:	0
SG Cadastral Code:	C03100000000037300000
Deeds Office:	KIMBERLEY
Registration Division:	HAY
Registration Division Province:	NORTHERN CAPE
Surveyor General Office:	CAPE TOWN

WUN/Property Relationship Details

Relationship Start Date	Relationship End Date
2017/09/01	

National Register of Water Use Registration Record 25178888

Taking water from a water resource in terms of Section 21(a) of the National Water Act

Water Use Identification

Register Number:	25178888
Water Use Number:	1
Water Use Start Date:	2017/09/01
Water Use Status Date:	2023/02/01
Water Use Status:	REGISTERED

DISCLAIMER :
This Registration Record:

1 is not an acknowledgement of an entitlement to the registered water use;
2 may NOT be used to create the impression that it is proof of a water use entitlement. By virtue of section 22(1) of the National Water Act, the only documents that may be used as proof of a water use entitlement, are:
  2.1 a licence;
  2.2 an official document stating the extent of existing lawful water use pursuant to sections 33 or 35 of the National Water Act;
  2.3 a general authorisation as published in the Gazette; or
  2.4 Schedule 1 of the National Water Act.
  Notes:
  - if an entitlement for the specific water use referred to in this Registration Record has been confirmed by the Department, it may be indicated as such in this Registration Record.
  - if the responsible authority has dispensed with the requirement for a licence for a specific water use, no water use entitlement is needed for that use under the National Water Act.
3 is issued without alterations or erasures and is invalid if it contains alterations not in conformity with the Department's official copy; and in substitution of any Registration Record the Department may have previously issued and the information is valid as at the date of issue.

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

National Register of Water Use Registration Record 25178879

Water Use Registration Record 25178879 is issued in terms of the regulations requiring that a Water Use be registered, promulgated under Section 26(1)(c) of the National Water Act(Act 36 of 1998) to:

Applicant

Applicant Type:	COMPANY
Name:	TEMDALE BOERDERY (PTY) LTD
Enterprise Type	PRIVATE COMPANY
Business Registration Number:	1999/023793/07
Postal Address:	PO BOX 303 PRIESKA 8940
VAT Registration Number:	4920185511

Water Management Area

Name:	ORANGE

Register Status

Status:	ACTIVE

Water Uses

See attached Annexure(s)

Water Use No.	Water Use	Volume	Volume Start Date	Volume End Date
1	21(a)	609 000 CUBIC METRES PER YEAR	2017/09/01	

Office: Lower Orange - Northern Cape
Upington Office
Regional Office: Free State Region

2023-02-02
LOWER ORANGE
WATER MANAGEMENT AREA
DEPARTMENT WATER AND SANITATION

Date stamp of issuing office

DISCLAIMER :
This Registration Record:
1 is not an acknowledgement of an entitlement to the registered water use;
2 may NOT be used to create the impression that it is proof of a water use entitlement. By virtue of section 22(1) of the National Water Act, the only documents that may be used as proof of a water use entitlement, are:
2.1 a licence;
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2.3 a general authorisation as published in the Gazette; or
2.4 Schedule 1 of the National Water Act.
Notes:
- If an entitlement for the specific water use referred to in this Registration Record has been confirmed by the Department, it may be indicated as such in this Registration Record.
- If the responsible authority has dispensed with the requirement for a licence for a specific water use, no water use entitlement is needed for that use under the National Water Act.

3 Is issued without alterations or erasures and is invalid if it contains alterations not in conformity with the Department's official copy; and in substitution of any Registration Record the Department may have previously issued and the information is valid as at the date of issue.

National Register of Water Use Registration Record 25178879

Taking water from a water resource in terms of Section 21(a) of the National Water Act

Water Use Identification

Register Number:	25178879
Water Use Number:	1
Water Use Start Date:	2017/09/01
Water Use Status Date:	2023/02/01
Water Use Status:	REGISTERED

Lawfulness Authentication

Finding:	LAWFULNESS STILL TO BE DETERMINED
Finding Date:	2023/01/30
Finding Reason:	UNVERIFIED
Finding Confirmed:	YES

Succession/Transfer Details

Succession/Transfer Type:	SUCCESSION IN TITLE	
Source Part2 Details:	**Register No.**	**WUN**
	25012209	2

Water Use Details

Water Use Sector(s)(i.e. Purpose(s) of Water Use):	AGRICULTURE: IRRIGATION	
Source Type:	SCHEME	
Point of Abstraction:	**Latitude**	**Longitude**
	29.407° south	23.03849° east
Datum Type:	CAPE (MODIFIED CLARKE 1880)	
Quaternary Drainage Region:	D71D	
Scheduled Use	YES	
Irrigation Area:	60.9 HECTARES	

Scheme Details

Scheme Name:	MIDDLE ORANGE
Scheme Management Parameter Name:	LOWER ORANGE BETWEEN DOUGLAS & BOEGOEBERG
Servitude Volume:	
Scheduled Quota	10000 CUBIC METRES PER HECTARE PER ANNUM

Registered Volumes

Start Date	End Date	Registered Volume (m³)	Time Interval
2017/09/01		609000	PER YEAR

National Register of Water Use Registration Record 25178879

Taking water from a water resource in terms of Section 21(a) of the National Water Act

Water Use Identification

Register Number:	25178879
Water Use Number:	1
Water Use Start Date:	2017/09/01
Water Use Status Date:	2023/02/01
Water Use Status:	REGISTERED

Property Where Water Use Occurs

Property Name:	KALKFONTEIN 374 PORTION 4
Property Number:	374
Portion of Property:	4
SG Cadastral Code:	C03100000000037400004
Deeds Office:	KIMBERLEY
Registration Division:	HAY
Registration Division Province:	NORTHERN CAPE
Surveyor General Office:	CAPE TOWN

WUN/Property Relationship Details

Relationship Start Date	Relationship End Date
2017/09/01	

National Register of Water Use Registration Record 25178879

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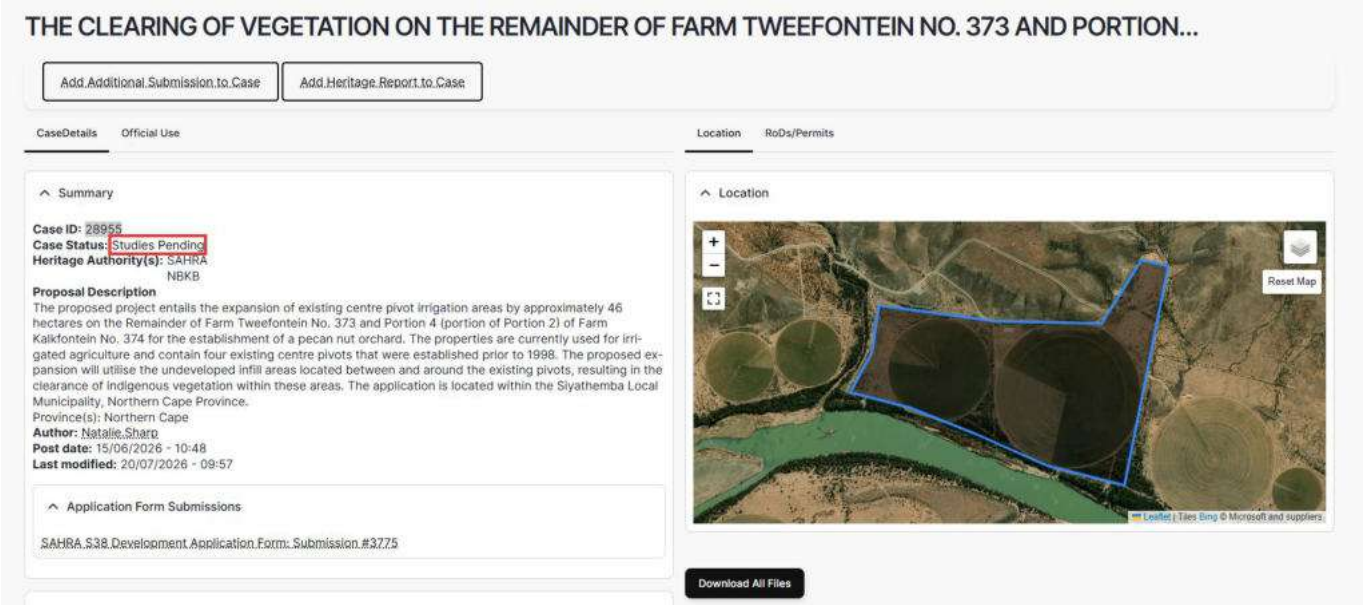
APPENDIX H – SAHRIS SUBMISSION

The application was submitted in June 2026 and according to the SAHRIS system, the case is still pending.



Draft

45 Church Street
Walmer
6070

APPENDIX I – PHOTO RECORD

Tweefontein site

www.dsafrica.co.za natalie@dsafrica.co.za

45 Church Street
Walmer
6070

www.dsafrica.co.za natalie@dsafrica.co.za

45 Church Street
Walmer
6070

Kalkfontein site

www.dsafrica.co.za natalie@dsafrica.co.za

45 Church Street
Walmer
6070

www.dsafrica.co.za natalie@dsafrica.co.za