IRRIGATION BASED AGRICULTURAL ACTIVITIES ON FARMS KARUCHAS AND STARNBERG, OTJOZONDJUPA REGION

ENVIRONMENTAL ASSESSMENT SCOPING REPORT

Assessed by:

Assessed for:

F Blume

March 2026

Project:	**IRRIGATION BASED AGRICULTURAL ACTIVITIES ON FARMS KARUCHAS AND STARNBERG OTJOZONDJUPA REGION: ENVIRONMENTAL ASSESSMENT SCOPING REPORT**	
	Final March 2026	
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Report Approval	 **Quzette Bosman-Faul** **Environmental & Social Practitioner**	

EXECUTIVE SUMMARY

Geo Pollution Technologies (Pty) Ltd was appointed by F Blume (the Proponent) to undertake an environmental assessment for irrigation activities on farms Starnberg FMB/01147, and Karuchas FMB/00542 in the Otjozondjupa Region. Existing activities on the farm are focussed on irrigated and dry land crop cultivation as well as livestock farming and charcoal production. The Proponent currently utilizes an area of approximately 152 ha for cultivation, of which 82.2 ha is irrigated by means of centre pivot, dripper and sprinkler systems utilising abstracted groundwater, and the remaining 70 ha is used for dry land crop production. The main operational activities related to agriculture include:

- land preparation,
- planting,
- water abstraction and irrigation,
- fertilizer application and pest control,
- harvesting, and transporting activities specific to each crop,
- cattle, sheep and potentially other livestock farming, and
- bush clearing and charcoal production (only as part of rangeland management).

All historically cleared areas for crop cultivation and rangeland improvement across the farm, including the existing and potential irrigation areas amount to approximately 877 ha. Pending the outcome of a hydrogeological specialist study, the total hectares of land to be irrigated simultaneously, may be increased. For irrigation, water is abstracted from three production boreholes. Two of these boreholes are on the farm Starnberg FMB/01147 and the remaining one in on Karuchas FMB/00542. Two of the three boreholes are registered with the Ministry of Agriculture, Fisheries, Water and Land Reform and the Proponent has applied for a water use license for water abstraction. The main produce cultivated are vegetables and maize for local and international markets.

The environmental assessment determines all environmental, safety, health and socio-economic impacts associated with the continued and planned agricultural activities on the farms. Relevant environmental data was compiled by making use of primary data (hydrogeological specialist study), secondary data and from a reconnaissance site visit. Potential environmental impacts and associated social impacts were identified and are addressed in this report.

The project area is located amidst other farms and due to the nature and location of the Proponent's agricultural activities, limited impacts can be expected on the surrounding environment. Regular environmental performance monitoring is thus recommended to ensure regulatory compliance and the implementation of corrective measures when necessary, especially with regards to water abstraction. The Proponent's operations play a role in contributing to the Namibian agricultural sectors and provide valuable employment opportunities in the region.

The main concerns related to the operations are potential groundwater, surface water and soil contamination, decreased groundwater availability, ecological and social impacts. A safety, health, environmental and quality policy coupled to an environmental management plan will contribute to effective management procedures, to prevent and mitigate impacts. All regulations relating to agriculture, labour, and health and safety relevant legislation should be adhered to. Groundwater and soil pollution must be prevented at all times. All staff must be made aware of the importance of biodiversity and poaching or illegal harvesting of animal and plant products prohibited. Groundwater abstraction permits must be strictly adhered to. Any waste produced must be burned or removed from site and disposed of at an appropriate facility or re-used or recycled where possible. Hazardous waste must be disposed of at an approved hazardous waste disposal site. By appointing local employees and by implementing monitoring and training programs, the positive socio-economic impacts can be maximised while preventing mitigating negative impacts.

The environmental management plan included in Section 9 of this document should be used as an on-site reference document during all phases (planning, operations (including maintenance) and decommissioning) of the development. All monitoring and records kept should be included in six monthly reports to ensure compliance with the environmental management plan and the Ministry of Environment, Forestry and Tourism's requirements. Parties responsible for transgression of the

environmental management plan should be held responsible for any rehabilitation that may need to be undertaken. A safety, health, environmental and quality policy should be used in conjunction with the environmental management plan. Operators and responsible personnel must be taught the contents of these documents. Local or national regulations and guidelines must be adhered to and monitored regularly as outlined in the environmental management plan.

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LIST OF ABBREVIATIONS

AEZ	Agro-Ecological Zone
CHIRPS-2	Climate Hazards Group Infra-Red Precipitation with Station data
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EMA	Environmental Management Act No 7 of 2007
EMP	Environmental Management Plan
EMS	Environmental Management System
IAPs	Interested and Affected Parties
IUCN	International Union for Conservation of Nature
MERRA-2	Modern-Era Retrospective analysis for Research and Applications v2
MEFT	Ministry of Environment, Forestry and Tourism
MAFWLR	Ministry of Agriculture, Fisheries, Water and Land Reform
MSDS	Material Safety Data Sheet
NCRST	National Commission on Research, Science and Technology
NDP	National Development Plan
OML	Otavi Mountain lands
PPE	Personal Protective Equipment
SANS	South African National Standards
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization
°C	Degrees Celsius
cmol/kg	Centimoles per kilogram
g/L	Grams per Litre
Ha	Hectare
Km	Kilometre
km²	Square kilometres
kV	Kilovolt
kWh	Kilowatt-hour
kWh/m²/day	Kilowatt-hours per square meter
L	Litres
M	Metre
m/s	Metre per second
m^2/d	Square metre per day
m^3	Cubic metres
mamsl	Metres Above Mean Sea Level
mbs	Metres below surface
mg/cm^3	Milligrams per cubic centimetre
Mm	Millimetres
mm/a	Millimetres per annum
mm/a	Millimetres per annum
Ppm	Parts per million

GLOSSARY OF TERMS

Alternatives - A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

Assessment - The process of collecting, organising, analysing, interpreting and communicating information relevant to decision making.

Competent Authority - A body or person empowered under the local authorities act or Environmental Management Act to enforce the rule of law.

Construction - The building, erection or modification of a facility, structure or infrastructure that is necessary for the undertaking of an activity, including the modification, alteration, upgrading or decommissioning of such facility, structure or infrastructure.

Cumulative Impacts - In relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Environment - As defined in the Environmental Assessment Policy and Environmental Management Act - "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values".

Environmental Impact Assessment (EIA) - process of assessment of the effects of a development on the environment.

Environmental Management Plan (EMP) - A working document on environmental and socio-economic mitigation measures, which must be implemented by several responsible parties during all the phases of the proposed project.

Environmental Management System (EMS) - An Environment Management System, or EMS, is a comprehensive approach to managing environmental issues, integrating environment-oriented thinking into every aspect of business management. An EMS ensures environmental considerations are a priority, along with other concerns such as costs, product quality, investments, PR productivity and strategic planning. An EMS generally makes a positive impact on a company's bottom line. It increases efficiency and focuses on customer needs and marketplace conditions, improving both the company's financial and environmental performance. By using an EMS to convert environmental problems into commercial opportunities, companies usually become more competitive.

Evaluation - The process of ascertaining the relative importance or significance of information, the light of people's values, preference and judgements in order to make a decision.

Green Scheme - The Green Scheme is an initiative conducted by the Ministry of Agriculture, Fisheries, Water and Land Reform to encourage the development of irrigation based agronomic production in Namibia with the aim of increasing the contribution of agriculture to the country's Gross Domestic Product. Its aim is also to simultaneously achieve the social development and upliftment of communities located within suitable irrigation areas and to also promote the human resources and skills development within the irrigation sub-sector. Such initiative could possibly enhance cross-border investment and facilitate the exchange of relevant and limited resources with neighbouring countries in this regard.

Hazard - Anything that has the potential to cause damage to life, property and/or the environment. The hazard of a particular material or installation is constant; that is, it would present the same hazard wherever it was present.

Interested and Affected Party (IAP) - any person, group of persons or organisation interested in, or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity.

Mitigate - The implementation of practical measures to reduce adverse impacts.

Proponent (Applicant) - Any person who has submitted or intends to submit an application for an authorisation, as legislated by the Environmental Management Act no. 7 of 2007, to undertake an activity or activities identified as a listed activity or listed activities; or in any other notice published by the Minister or Ministry of Environment, Forestry and Tourism.

Public - Citizens who have diverse cultural, educational, political and socio-economic characteristics. The public is not a homogeneous and unified group of people with a set of agreed common interests and aims. There is no single public. There are a number of publics, some of whom may emerge at any time during the process depending on their particular concerns and the issues involved.

Scoping Process - process of identifying: issues that will be relevant for consideration of the application; the potential environmental impacts of the proposed activity; and alternatives to the proposed activity that are feasible and reasonable.

Significant Effect/Impact - A impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

Stakeholder Engagement - The process of engagement between stakeholders (the Proponent, authorities and IAPs) during the planning, assessment, implementation and/or management of proposals or activities. The level of stakeholder engagement varies depending on the nature of the proposal or activity as well as the level of commitment by stakeholders to the process. Stakeholder engagement can therefore be described by a spectrum or continuum of increasing levels of engagement in the decision-making process. The term is considered to be more appropriate than the term “public participation”.

Stakeholders - A sub-group of the public whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. The term therefore includes the Proponent, authorities (both the lead authority and other authorities) and all interested and affected parties (IAPs). The principle that environmental consultants and stakeholder engagement practitioners should be independent and unbiased excludes these groups from being considered stakeholders.

Sustainable Development - “Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations” – the definition of the World Commission on Environment and Development (1987). “Improving the quality of human life while living within the carrying capacity of supporting ecosystems” – the definition given in a publication called “Caring for the Earth: A Strategy for Sustainable Living” by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme and the World Wide Fund for Nature (1991).

1 BACKGROUND AND INTRODUCTION

Geo Pollution Technologies (Pty) Ltd was appointed by F Blume (the Proponent) to undertake an environmental assessment for the existing agricultural activities on farms Starnberg FMB/01147, and Karuchas FMB/00542 in the Otjozondjupa Region (Figure 1-1). The main commercial activities of the Proponent on the farm includes crop cultivation and livestock farming. For purposes of crop cultivation, the Proponent utilizes approximately 152 ha for irrigation and dryland farming. Pending the outcome of a hydrogeological specialist study, the total hectares of land to be irrigated simultaneously, may be increased. Irrigation are from two production boreholes by means of centre pivot irrigation systems. The main operational activities include:

- land preparation,
- water abstraction and irrigation,
- fertilizer application and pest control,
- harvesting,
- packaging and transporting activities specific to each crop,
- cattle, sheep and potentially other livestock farming, and
- bush clearing and charcoal production (only as part of rangeland management).

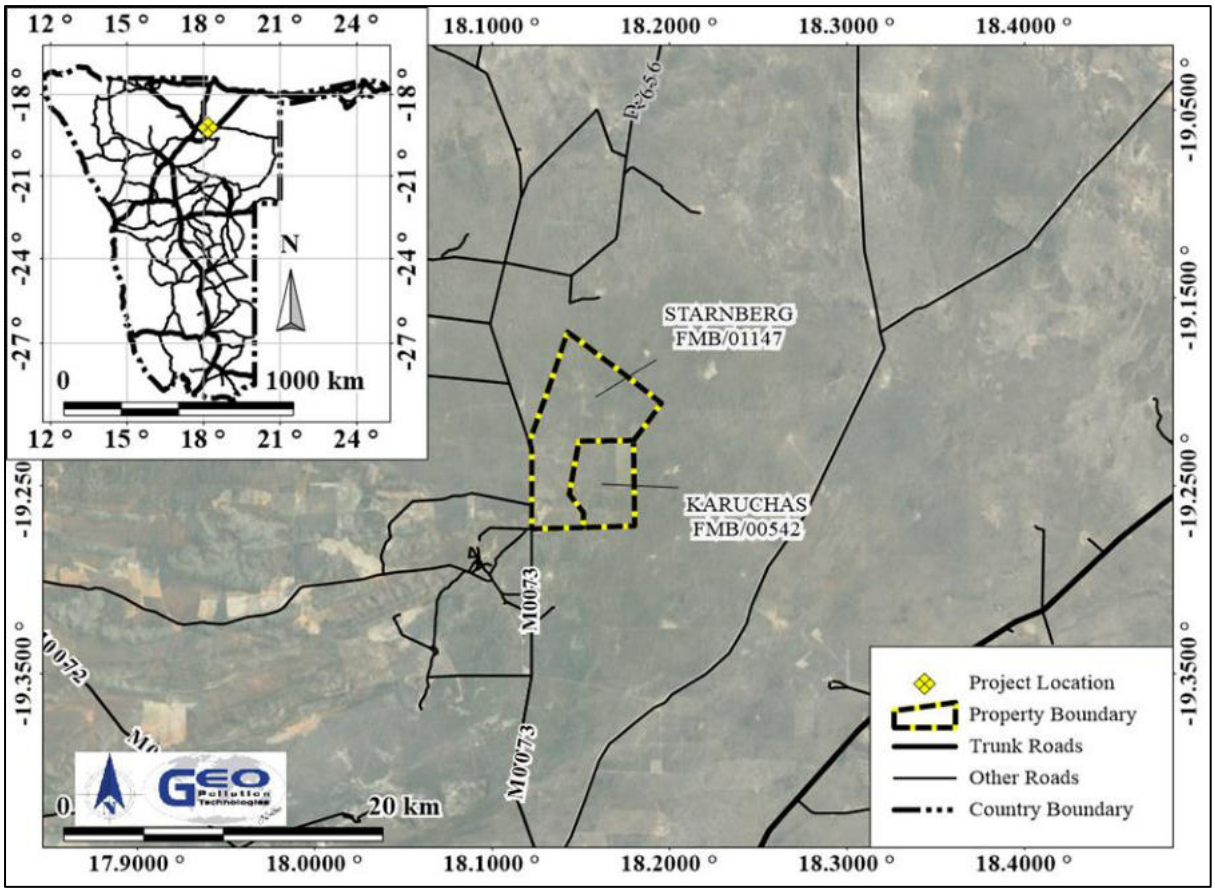

Figure 1-1 Project location

A detailed project description is provided in Section 4. The potential impacts of the project on the environment, resulting from various operational, maintenance and construction, and possible decommissioning activities, were determined through the risk assessment as presented in this report.

The environment, being defined in the Environmental Management Act as “land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, paleontological or social values”. The

environmental assessment was conducted to apply for an environmental clearance certificate in compliance with Namibia's Environmental Management Act (Act No 7 of 2007) (EMA).

Project Justification – Traditionally farms in the region were used for cattle ranching with limited dryland crop cultivation. However, in the area, including on the Proponent's farm, farming activities were diversified to include irrigation-based and dryland crop cultivation. The Proponent has a well-established irrigation and agriculture development, which sees an optimisation of crop production by means of irrigation, augmented by rainwater. This addition is proposed in an effort to increase resilience in food production for Namibia. Namibia aims at increasing sustainable food production and ensuring food security in the country. Furthermore, agriculture is an important employment sector for Namibia, adding to roughly a third of the workforce. Existing and planned agricultural activities require employment, which is required to be maintained for continued operations. Pivot irrigation systems also require significant investment costs and therefore the development of the irrigation areas, has ensured a sizeable investment into the area and the Abenab District.

Benefits of the agricultural activities conducted by the Proponent include.

- Food production and enhanced food security.
- Employment and supporting of livelihoods of both unskilled and skilled labourers.
- Technological development and investment in agricultural practices.
- Generation of income that contributes to the national treasury and a positive trade balance through the export of produce to international markets.
- Support for economic resilience in the area through diversified business activities and opportunities.

2 SCOPE

The scope of this report is to, in compliance with the requirements of EMA:

1. Present a detailed project and environmental description related to the Proponent's activities.
2. Determine the potential environmental impacts emanating from the Proponent's activities and potential future decommissioning of such activities.
3. Identify a range of management actions to mitigate the potential adverse impacts to acceptable levels.
4. Provide sufficient information to the relevant competent authority and the Ministry of Environment, Forestry and Tourism (MEFT) and related authorities to make an informed decision regarding the project and the issuing of an environmental clearance certificate.

3 METHODOLOGY

Methods employed to investigate and report on potential impacts of the Proponent's activities on the social and natural environment include:

1. Detailed infrastructure and operational procedures received from the client are presented in this report.
2. Baseline information about the site and its surroundings were obtained from existing secondary information as well as from a reconnaissance site visit.
3. As part of the scoping process to determine potential environmental impacts, interested and affected parties (IAPs) were consulted about their views, comments and opinions, all of which are presented in this report.
4. As per the findings of this environmental assessment, a scoping report with an environmental management plan (EMP) were prepared and this will be submitted to the MEFT.

4 OPERATIONS AND RELATED ACTIVITIES

Agricultural activities, focussing on local food production, have constituted the core of the Proponent's operations. Agricultural activities have been conducted on the farms for the past 30 years with the

Proponent continuing and gradually expanding and diversifying agricultural activities for the past 25 years. Primarily wheat and maize are produced throughout the year. Vegetable crops like tomatoes, and cabbages are also produced under micro-sprayers. Along with sorghum and Lablab-beans (*Lablab purpureus*) for added cattle feed and/or to act as crop cover. Livestock farming involves mainly cattle while there is also some game on the farm. However, game farming and related fencing is not an active pursuit of the Proponent. Existing and planned operations are reliant on support infrastructure and resources, all of which are described below.

4.1 LAND CLEARING

The farm is a known agricultural unit for, more than 50 years. Cattle and sheep ranching has dominated the general land use with limited crop cultivation. Initial land clearing was conducted to accommodate dryland cropping on the southern portions of the Farm Starnberg FMB/0147. More recent agricultural activities have seen an expansion of the cleared areas for irrigation based crop cultivation, while also realising rangeland improvement through bush-thinning activities. Such activities are especially required for sheep husbandry, which forms part of the farming operations. Bush clearing is also conducted around crop fields to allow for implements to manoeuvre and to reduce competition for groundwater. Approximately 150 ha across the faming unit has been cleared for irrigation and dryland crop production, while approximately 877 ha is managed rangelands. Additional areas have been identified for future rangeland improvement. The areas described above are presented in Figure 4-1. Vegetation was also cleared, and is maintained so, next to fences to accommodate firefighting.

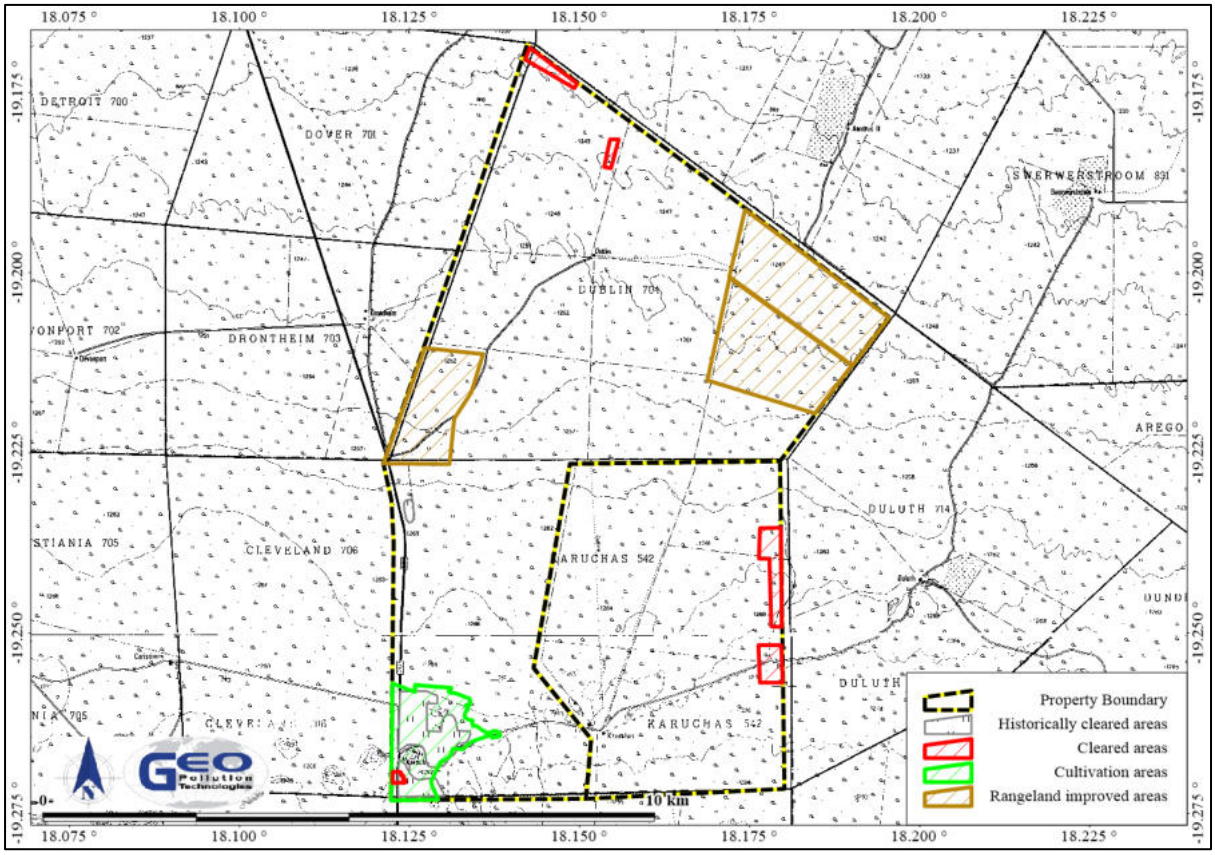

Figure 4-1 Cleared areas on the farm

Photo 4-1 Pivot irrigation surrounded by dryland crops to maximize cleared area

Photo 4-2 Cleared areas adjacent to irrigated centre pivot field

Photo 4-3 Fire break

Photo 4-4 Rangeland improved and maintained area

4.2 ARABLE FARMING

A variety of crops are planted on a rotational basis across the farm. Apart from the maize, cotton and wheat, which are the main commercial crops cultivated, vegetables like tomatoes, cabbage, potatoes, and onions are also cultivated. Sorghum, Lablab-beans (*Lablab purpureus*) or varieties thereof, is planted to improve soil health and provide additional feed for cattle. Figure 4-2 depicts the cultivated fields in relation to cleared areas.

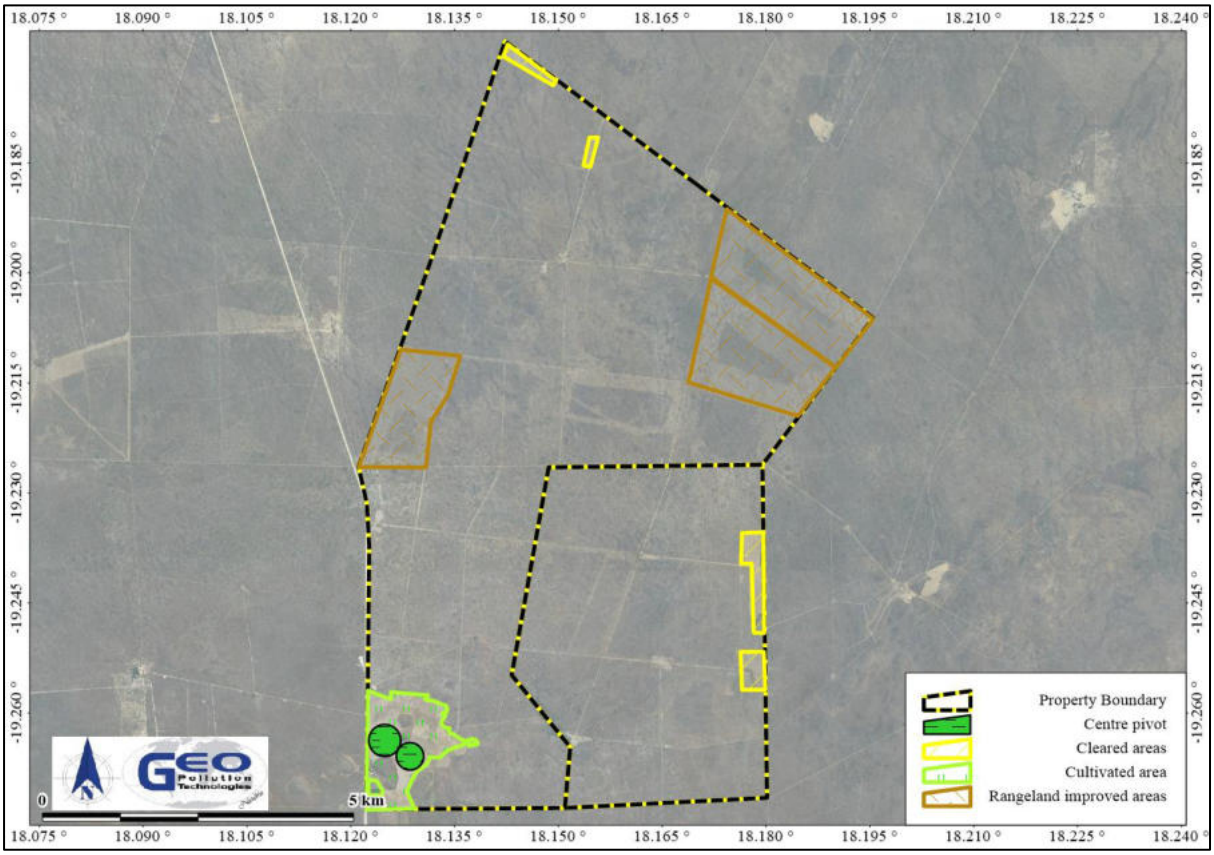

Figure 4-2 Cultivated and cleared areas

Each crop has a different planting and cultivation regime. Furthermore, there are significant variation on how dryland crops are cultivated vs irrigated crops. The Proponent conducts standard agriculture for all dryland crop cultivation; therefore, tillage is conducted during land preparation. This planting only commences once good rains have fallen. After planting and before complete germination, all of the planted sections need to be treated with herbicides to prevent weeds from overwhelming the future seedlings. Once the maize plants have broken the soil surface, herbicides such as Round-up can no longer be used. Various combinations of chemicals and herbicides are then employed to try and stem weed growth among the maize. The farm faces challenges with weeds such as Itch-grass / tarentaalgras (*Rottboellia cochinchinensis*). Apart from weed control, pesticides area also employed to protect the crop field from insects such as the fall-army worm. Pesticides are administered as per the specified application procedures for the corresponding pest by means of tractor spraying. To ensure correct and safe application of pesticides, a pesticide plan is implemented and regularly updated. The Proponent requires a minimum amount of pesticides as compared to conventional agricultural production.

Photo 4-5 Soil prepared for vegetable planting

Photo 4-6 Water-stressed dryland maize

Land preparation and cultivation of irrigated crops are similar to dryland crops. Due to compaction, pivot fields require tillage activities to loosen the soil for planting. Conventional planting follows once the ground is irrigated to achieve the optimal moisture content for germination Herbicide and pesticide use is similar to that of dryland cultivation. However, chemical application is now conducted through the specialised drone system. The drone is flown over the crop filed while releasing the preloaded pesticide. The Proponent utilises a broad-spectrum herbicide, Nicosulfuron (60 g/L). Additional pests can be associated with irrigation-based land such as Red spider mite (*Tetranychus urticae*) which presents a severe challenge. It is best to spray these inspects using drone technology, however, the climatic conditions required for the insecticide application are rare to achieve in the area during the summer months. Therefore application not always results in successful prevention.

Photo 4-7 Drone used for pesticide application

Photo 4-8 Pesticide application through drown spraying techniques

The produce is cultivated inside of a nursery, to germinate the seeds into seedlings. Inside of the nursery micro-sprinklers are used to water these seedlings, until they have matured enough to be planted out in the fields. The fields are irrigated via sprinklers. Produces are planed throughout the entire year.

Fertilizers are applied as required and according to the specifications for application. For irrigated fields, fertilisers are mixed with water in a large mixing tank. Once the desired mixing ratio is achieved, the fertiliser is fed into the irrigation system for administration onto the crops. The

Proponent utilises a low-soluble-nutrient fertilizer which may be readily absorbed by crops and requires less water. Harvesting of all commercial produce comprise conventional methods which employ conventional harvesting machines. Maize is stored in a maize dam while non-commercial rest is cut and baled for animal feed. Cattle are allowed to graze harvested dry-land fields.

Although not specifically related to arable farming, the Proponent also caters for bees through the accommodation and maintenance of beehives on the farm.

Photo 4-9 Nursery for seedlings

Photo 4-10 Micro-sprinklers systems in nursery

Photo 4-11 Chemical storage

Photo 4-12 Fertiliser mixing tank

4.3 LIVESTOCK

The remainder of the farming unit is used for livestock rearing. Cattle and sheep are herded and managed as a separate business unit. A dedicated workforce manages all operations related to the sheep and cattle, which includes predator protection, watering equipment, lambing or calving support, flock vaccinations, hoof care, pasture management and meat marketing. At the end of each day all of the sheep are herded back to their holding pens, around the farmer's main operations. The cattle and sheep are allowed to roam freely across the farms but in separate camps. A feedlot is employed at times to provide for additional support during droughts. Livestock are used to fertilise crop fields after harvesting, when they are allowed to graze on the maize stover or on resting / fallow crop fields.

Photo 4-13 Cattle on farm

Photo 4-14 Waterhole for game – pumped from a Borehole

Photo 4-15 Salt lick block

Photo 4-16 Watering hole

4.4 CHARCOAL PRODUCTION

The Proponent, with a permit from the Directorate of Forestry, conducts rangeland improvement through the harvesting of wood, focussing on invasive species. This wood is then used for value addition activities such as charcoal production. Apart from the economic incentive of selling charcoal to international markets, the clearing of rangeland affected by invader bush increases the carrying capacity of the land for livestock farming. Charcoal is produced in conventional steel kilns the kilns are filled with cut wood and ignited. After the content has burned for some hours, the kiln is closed with a steel lid. In some instances, sand is placed on top of the kiln to seal the unit. When the kiln has cooled down, it is opened and toppled over to expose the charcoal for cooling. The charcoal mound is left to further cool down before it is packed and stacked in a designated area. All wood is transported to a dedicated burning area. Once cooled and packed, the charcoal is stored under a sheet to protect it against the rain until it is loaded for transport. Charcoal is exported to national and international clients. The Proponent continuously harvest and produce charcoal as invader bush regrows / establish, thus ensuring sustainability in the charcoal production venture, while simultaneously improving rangeland for livestock farming.

Photo 4-17 Packed charcoal

Photo 4-18 Charcoal shielded from climatic condition

4.5 SUPPORT INFRASTRUCTURE

Operations as outlined above, require support infrastructure or resources. The most crucial of these relate to water required for irrigation and potable use. Related support infrastructure is detailed below. Water and related irrigation systems are discussed in Section 4.6 while labour and related aspects are detailed in Section 4.7.

All operations on the farm are provided with **electricity** from a 100 kV Cenerod line. A 120 kWh photovoltaic solar system. 60 kWh are used at the house and the surrounding operations while the remaining 60 kWh is used elsewhere on the farm where power is needed. This includes providing power for the centre pivots and pumps, and other boreholes around the farm. There is an additional 100 kW generator available with a 100 *l* fuel storage available for when the additional capacity is needed. Employee houses are serviced with electricity. The power line has a 9 m wide servitude which is kept clean by the Proponent for the portions of the power line over their farm. **Fuel** is stored in an above ground undercover tank with a capacity of 2200 *l*, this tank is installed within the implement storage area. Mainly used for tractors and farming related operations.

Photo 4-19 Solar panel used at boreholes

Photo 4-20 Fuel storage tanks

Photo 4-21 CENORED grid connection

Photo 4-22 Photovoltaic solar system

Water is pumped from various boreholes for irrigation, stock watering and domestic use. Storage of water is determined by its use. While irrigation boreholes have no storage structures, stock watering rely on reservoirs while domestic use employ raised water storage tanks. All offices and employees' houses are provided with septic tank and french drain systems to accommodate wastewater. **Waste disposal** mainly comprises of sorting and processing of all of the waste generated by the permanent workers and the farming operations. The waste is then taken to the municipal landfill site to be disposed-off. Due to a lack of any recyclers in the area, recycling of certain wastes is not possible. However, where possible, certain waste items are not discarded, but rather re-used for alternative purposes. This includes the re-use of old oil when not collected by oil recycling companies. All spoiled produce are made available as animal feed while general leaves and food wastes is composted/ Any hazardous waste is stored in suitable bunded areas.

Photo 4-23 French drain

Photo 4-24 Stock watering reservoir

Photo 4-25 Water tanks for domestic use

Photo 4-26 Compost bags

A **storage and maintenance area** is located on the farm and comprise of a shed and storerooms where implements and other maintenance material are stored under roof and on an impermeable surfaces. Any maintenance and or minor repairs are conducted on site and within these areas. Unused equipment and related materials are stored in an access-controlled area. Offices and employee houses are all located on the farming unit as well. All pesticides and herbicides are stored in a dedicated **chemical store**. The chemical store is access controlled. Fertilisers are

stored in an open area within the storage shed, separate from all other chemicals or materials, on an impermeable layer. All areas have firefighting equipment and safety signs where required. A summary of the support infrastructure components are presented in Table 4-1.

Photo 4-27 Equipment storage and maintenance shed

Photo 4-28 Equipment and fertilizer storage shed

Photo 4-29 Firefighting equipment

Photo 4-30 Nitrogen based fertilizer bags

Photo 4-31 Chemical storage room entrance and related safety signs

Photo 4-32 Personal protection equipment

Table 4-1 Summary of infrastructure components related to agricultural operations

Project Component	Current Provision	Future Provision
Electricity Provision	Estimated 100 kVA mainly sourced from Cenored	No significant increase expected
Photovoltaic Solar System	120 kVA	No planned expansions
Water Provision	Groundwater abstraction from various boreholes	An increase in water allocation may be applied for
Water Storage	Various stock watering reservoirs and water tanks	No storage reservoirs planned for irrigation related activities
Equipment and General Storage	One existing storage complex	No additional storage proposed
Sanitation	Current septic tank and french drain systems catering for existing staff compliment	Additional septic tank and french drains may be required for planned expansions
Landfill	None	No additional sites planed
Fuel Storage	One diesel tank with a capacity of 2,200 *l* located in a bund wall	No additional tanks will be erected for the foreseeable future
Chemical Storage Area	One chemical storage unit	No additional chemical storage unit planned

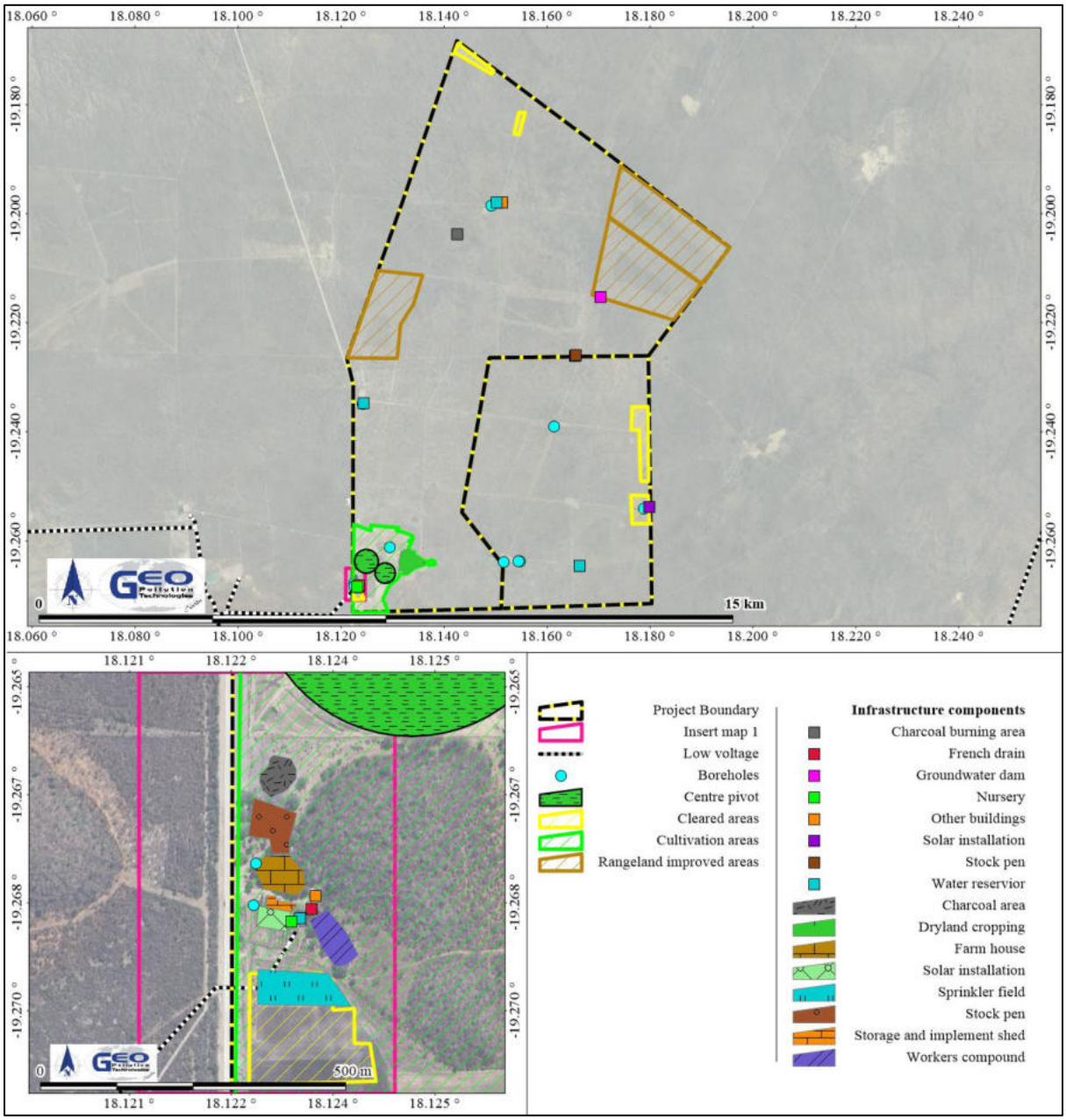

Figure 4-3 Map with infrastructure components

4.6 Irrigation and Water Supply

The Proponent utilises groundwater for all aspects of operations. Existing and proposed irrigation on crops, make up the bulk of the water use and is the determining factor in terms of water use and related permitting. The irrigation systems employed on the farm is centre pivots; dripper and sprinkler systems. The Proponent utilises three fixed centre pivots. The largest pivot has a span length of 54 m with an overhang of 18 m.

Phocaides (2007) provides a description of the centre pivot, being a low to medium pressure, fully mechanised, automated irrigation of permanent assemble. It basically comprises a sprinkler pipeline (usually of high tensile galvanized light steel or aluminium pipes) supported above ground by mobile A-frame towers, long spans, steel trusses and/or cables (Photo 4-33). The pipeline is connected to a central tower with the “pivot mechanism” and main control panel. Moveable systems are mounted on wheels which allows it to be dragged from one field and fixed water supply point, to the next. The entire active irrigation system remains self-propelled to

slowly rotate around the central tower while dispensing water through sprinklers (emitters) connected to the pipeline (Photo 4-34 to Photo 4-35). An automatic alignment system ensures the irrigation pipeline remains straight while a drive system enables the system movement. Small variations to the emitter sequence may be done when moving between different crops which may have different irrigation requirements. The Proponent has approximately 35 ha of pivot related irrigation fields on the farm and would like to further develop another 35 ha. An schematic diagram of a basic pivot system is presented in Figure 4-4.

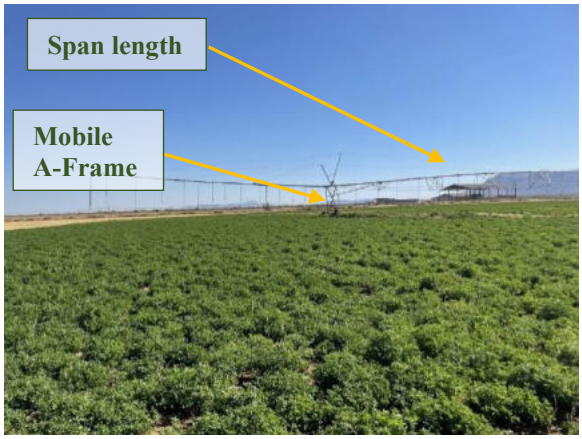

Photo 4-33 Typical centre pivot system

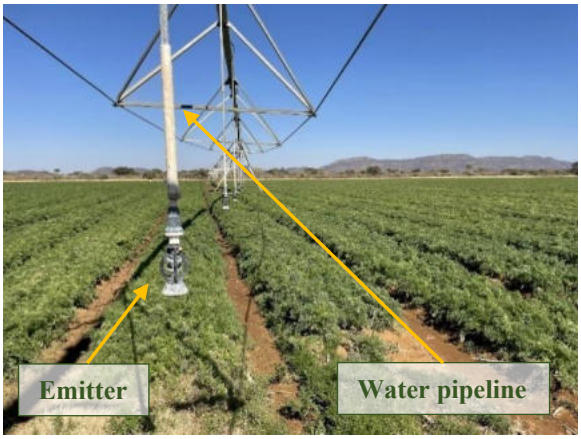

Photo 4-34 Typical centre pivot system close up

Photo 4-35 Typical emitters used by the centre pivot system

Photo 4-36 Typical centre pivot base

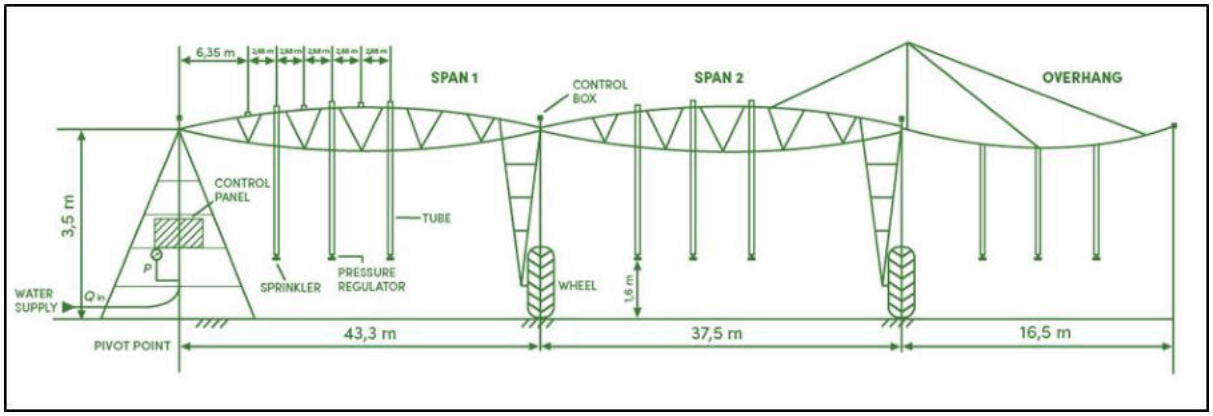

Figure 4-4 Diagram of a typical centre pivot irrigation system (AGRIVI, 2022)

The Proponent has a dual sprinkler and dripper irrigation system set up on the one filed. This is utilised on a much smaller scale as compared to the centre pivot system. The dual irrigation

system is implemented to combat high temperatures and wilting of crops. Currently 2 ha of sprinkler irrigation field is used for vegetable production like tomatoes, butternuts and cabbage, with an additional planned 5 ha in the future. The combined dripper and sprinkler system can be seen in the below photos (Photo 4-37 to Photo 4-42). The Proponent also plans to plant citrus and pomegranate trees in the future.

Photo 4-37 Pivot with sprinkler system over newly planted vegetables

Photo 4-38 Pivot with sprinkler system over mature maize

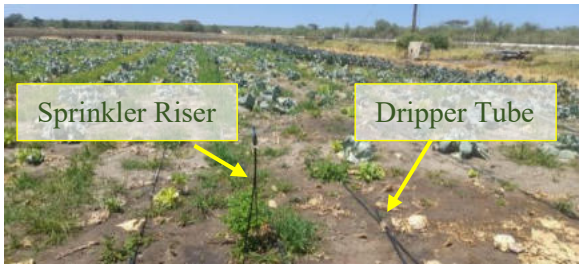

Photo 4-39 Combined drip and sprinkler irrigation

Photo 4-40 Gyro emitters of the sprinkler system

Photo 4-41 Plant nursery with sprinkler system

Photo 4-42 Plant nursery with sprinkler system

During the recognisance site visit, al known boreholes on the farm were documented. Thirteen boreholes and one spring were visited and data gathered about their status, use and physical description. Coordinates of all boreholes and springs were recorded and mapped, as presented in Figure 4-5. Of the boreholes surveyed, two are used for irrigation purposes. The spring is used to supply water to the cattle and game wandering on the farming unit.

The Proponent intends to apply for an abstraction permit for the three-abstraction borehole across the two farming units. The application will apply for the abstraction of up to 800,000 m³ per year for irrigation purposes.

Table 4-2 Summary of borehole information obtained from the Proponent

Map Ref	Borehole Name	Farm portion	Use	Borehole Depth (m)	Yield (m^3/h)	Water Level (mbs)
S01	WW38580	Starnberg FMB/01147	Stock watering	65	5.00	56
S02	WW38586	Starnberg FMB/01147	Not Used	65	1.50	45
S03	WW40101	Starnberg FMB/01147	Domestic/Stock watering	140	1.50	45

Map Ref	Borehole Name	Farm portion	Use	Borehole Depth (m)	Yield (m^3/h)	Water Level (mbs)
S04	WW38585	Starnberg FMB/01147	Stock watering	65	3.50	51
S05	WW38581	Starnberg FMB/01147	Irrigation	120	60.00	44
S06		Starnberg FMB/01147	Irrigation/Domestic	84	120.00	44
S07		Starnberg FMB/01147	Stock watering	120	5.00	39
K01	WW38584	Karuchas FMB/00542	Stock watering	65	4.00	44
K02	WW27261	Karuchas FMB/00542	Irrigation	100	150.00	30
K030		Karuchas FMB/00542	Monitoring	100		51
K04	WW38583	Karuchas FMB/00542	Stock watering	65	3.00	12
K05		Karuchas FMB/00542	Not Used	100		
K06		Karuchas FMB/00542	Monitoring	100		12
K07	Spring (Karuchas)	Karuchas FMB/00542	Stock	Surface water		

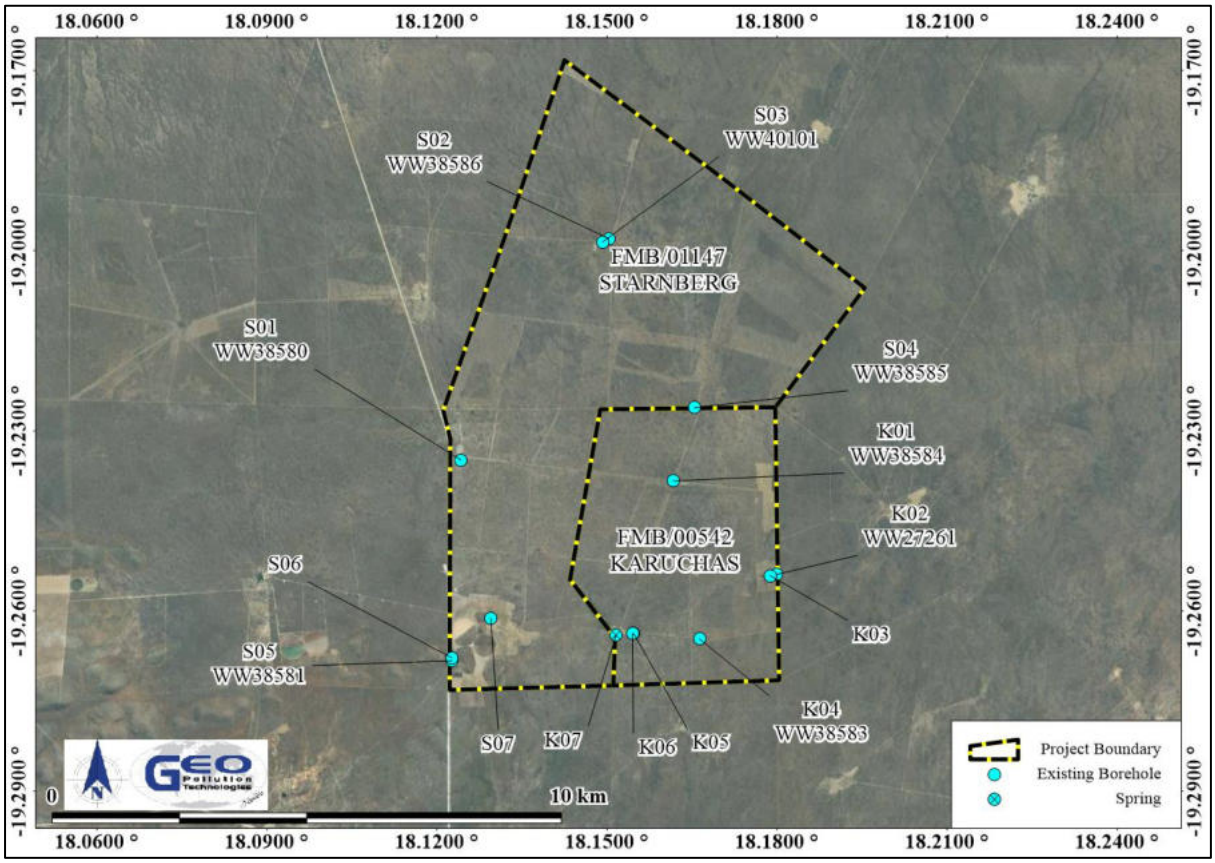

Figure 4-5 Locations of boreholes

Photo 4-43 S01 Liefling, stock watering

Photo 4-44 S03 Dublin solar, stock watering

Photo 4-45 S04 Maria pos, stock watering

Photo 4-46 S05 Huis pos, domestic water

Photo 4-47 S07 Kruis pos, stock watering

Photo 4-48 K03 Solar pos, irrigation

Photo 4-49 K04 Oos pos, stock watering

Photo 4-50 K07 Spring, stock watering

4.7 EMPLOYMENT

All operations on the farm are reliant on labour. Operations currently require 7 permanent employees and up to 72 seasonal employees. The majority of the seasonal work force is employed to harvest invader bush and produce charcoal, while the rest of the seasonal employees, assist with the cultivation and harvesting of vegetables. All employees are provided with housing, running warm water, electricity, and flush toilets. There are dedicated permanent housing units, for the permanent staff. All employees are further provided with personal protective equipment (PPE) when appropriate, while support is provided in terms of education, etc. Limited contractors are used as the Proponent's focus is to provide employment as well as to build and equip their own workforce with knowledge and skills related to the various components of operations. Informative signs like dangerous snakes, charcoal production and three felling is also provided, to keep the employees informed while on the site.

Photo 4-51 Permanent employee housing

Photo 4-52 Temporary staff ablution facilities

Photo 4-53 Dangerous snakes of Namibia signs

Photo 4-54 Tree felling and charcoal burning process

5 ALTERNATIVES

The Proponent has incorporated various possible revenue generating activities on the property to ensure a robust and sustainable operational unit. A combination of agriculture and related activities are implemented, thereby significantly reducing possible feasible alternatives. Alternatives considered and described below, relate mostly to the implementation of the various project components but also include:

- Location alternatives.
- Project implementation and design alternatives.
- No-go alternative.

5.1 LOCATION ALTERNATIVES

The location of the irrigation areas is well suited for crop production due to the availability of water and suitability of soils. Boreholes are already in place and land clearing and field establishment have already been completed for existing operations. The soil developed for agricultural use is well suited for that purpose as the soil has a sandy loam texture, with excilent drainage potential. It should be noted that the farming unit is limited to general agricultural practises. No location alternatives are therefore considered feasible, as the Proponent owns the property on which operations are conducted and proposed.

5.2 PROJECT IMPLEMENTATION AND DESIGN ALTERNATIVES

Alternatives are continually considered to optimise crop production and irrigation. Boreholes are already in place and no surface water is available. Therefore, there are no alternative water sources for the irrigation operations. However, there are a number of alternatives with regard to the application of the water used. The most pertinent relates to crop irrigation methods. Furthermore, the type and variation of crops cultivated are also considered as alternatives.

5.2.1 Irrigation Methods

When considering alternative irrigations systems, the most viable irrigation option is not only based on the irrigation system's design efficiency, but should include environmental constrains and operating costs. Some systems are simply not viable due to climatic and topographical features as well as cost implications. For example, flood irrigation is not viable on steeper gradients and are more expensive due to water pumping costs.

The type of produce cultivated also plays a determining role. It will not be feasible to install highly efficient yet expensive irrigation systems for crops with lower economic yields. In turn, some crops will not produce such high yields when cultivated under less efficient systems. Table 5-1 depicts different types of irrigation systems as per the South African Irrigation Institute's suggested efficiencies (IWRM Plan Joint Venture Namibia, 2010). The estimated average costs are based on 35 ha units and although outdated, estimates are still useful for comparisons purposes. Flood systems are not viable irrigation methods, these have been included for comparison with regards to capital cost and design efficiency.

Table 5-1 Irrigation system efficiency (IWRM Plan Joint Venture Namibia, 2010)

Irrigation System	Design Efficiency	Capital Costs (R /ha)
Flood: Furrow	65%	13,000
Flood: Border	60%	17,600
Flood: Basin	75%	18,800
Sprinkler: Dragline	75%	24,800
Sprinkler: Quick-coupling	75%	22,500
Sprinkler: Permanent	85%	34,500
Sprinkler: Travelling boom	80%	23,200
Sprinkler: Centre pivot	85%	43,300
Sprinkler: Linear	85%	69,400
Sprinkler: Micro sprinkler	85%	36,300
Micro: Spray	90%	53,200
Micro: Drip	95%	46,300

In the Abenab district, climatic and soil conditions necessitate an irrigation system with a high rate of water deposition (due to evaporation and soil salinization). In addition the groundwater has a high percentage of calcium carbonate which results in high maintenance of the irrigation system. Conventional drip irrigation systems are not suited for such water quality and the Proponent is gradually replacing high maintenance emitters. For purposes of maize irrigation, centre pivot and sprinkler systems are suitable. Further differentiation between sprinkler emitters play an additional role in water conservation. The Proponent has started implementing a lieper sprinkler which is able to emit water in an upward direction under the leaves, thereby reducing evaporation and increasing water efficiency.

Photo 5-1 Pivot irrigation system employed by the Proponent (photo: A Blume)

Photo 5-2 Lieper Sprinkler emitter employed by the Proponent (photo: A Blume)

The existing butterfly sprinkler system used on some of the cabbage, is gradually being replaced by the lieper system as well in efforts to further improve water efficiency. All irrigation is adjusted and implemented according to rainfall. During higher rainfall periods, less water is irrigated.

5.2.2 Soil Preparation

Traditionally, soil is prepared for planting by tilling and ploughing. These processes break the top layer of soil at varying depths and mix residual plant material into the soil. It also uproots weeds and provide for loose soil. There is nowadays however a shift in the approach to soil preparation that has some advantages over traditional tilling. Conservation tillage practises aim at less disturbance of the soil and have advantages of less erosion, less evaporation and save on time and costs of traditional tilling. Conservation tillage can either be partial tillage, as is the case with strip-tilling, or no tilling at all. With strip-tillage, only narrow strips are tilled in the area where planting will take place. The areas, between planted rows are left untilled, and with residual plant material from the previous harvest. With no-tillage, seeds are planted on the field with no soil preparation at all. The Proponent already employs standard ploughing-and-tilling practises. Because of the soil compaction that is cause by the centre pivot systems, there were no other alternatives considered.

5.2.3 Crop Selection (Maize and Cotton)

The main challenges faced by the Proponent in maize cultivation, relates to the removal of weeds and extermination of pests such as Tarentaalgras / Itch-grass (*Rottboellia cochinchinensis*), Red Spider Mite (*Tetranychus urticae*) and the fall armyworm. Cotton cultivation has, similar challenges in the form of weeds and bollworm. The use of pesticides to control weeds and insect pests have its limitations. Herbicides can be broad spectrum, i.e. effective against all plants, or selective, i.e. targeting only selected plants based on morphological, physiological, or biochemical characteristics. A common form of selectivity

is between herbicides targeting broad-leaved flowering plants (*dicotyledons*) and those targeting grasses and grass-like flowering plants (*monocotyledons*). Thus, maize can for example be sprayed post-emergent with a broad-leaved herbicide. This will however not target and kill grasses. For cotton, the opposite is true. Ideally, one would like to spray a broad-spectrum herbicide, like a glyphosate, that kills both broad-leaved and grass-like plants.

Insect control with insecticides also has its limitations and disadvantages. Insecticides are mostly non-selective and will kill both beneficial and pest species. Insecticides can also not be sprayed on food crops that are near harvesting as the insecticide may remain in the produce and thus pose human health risks. Furthermore, insecticides applied by spraying, does not always reach and kill the insects that burrows into the fruit, or as is the case with maize and cotton, the maize ear and cotton boll.

5.3 NO GO ALTERNATIVE

Agriculture has been a core activity in the region for decades. Maize is supplied to Namibian mills and the stover used for fodder. Currently, within the restriction of pesticides available in Namibia and the significant infestation of invader grass species, the production of maize is challenging. If maize is for example harvested along with the grass seeds, the entire harvest is downgraded, becoming not economically feasible when considering input costs. This could be disastrous to Namibia who already is a nett importer of maize.

Should the project not receive an environmental clearance certificate, there would be a loss in capital investment and a loss in employment. This will lead to a decrease in the spending power of the local community. Finally, less revenue will be generated for Namibia and more money will be required for importing of feed and food. However, the most important aspect of the no go alternatives will be the lack of staple food production for the local market.

6 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS

All projects, plans, programmes and policies with potential adverse impacts on the environment require an environmental assessment, as per the Namibian legislation. This promotes protection of the environment as well as sustainable development. The legislation and standards provided in Table 6-1 to Table 6-4 govern the environmental assessment process in Namibia, and are relevant to the assessed development.

Table 6-1 Namibian law applicable to the development

Law	Key Aspects
The Namibian Constitution	♦ Promotes the welfare of people ♦ Incorporates a high level of environmental protection ♦ Incorporates international agreements as part of Namibian law
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232 of 2007	♦ Defines the environment ♦ Promotes sustainable management of the environment and the use of natural resources ♦ Provides a process of assessment and control of activities with possible significant effects on the environment
Environmental Management Act Regulations Act No. 7 of 2007, Government Notice No. 28-30 of 2012	♦ Commencement of the Environmental Management Act ♦ List activities that require an environmental clearance certificate ♦ Provides Environmental Impact Assessment Regulations

Law	Key Aspects
Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act Act No. 36 of 1947; Government Notice No. 1239 of 1947	♦ Governs the registration, importation, sale and use of fertilizers, farm feeds, agricultural remedies and stock remedies ♦ Various amendments and regulations
Seed and Seed Varieties Act 23 of 2018 Act No. 23 of 2018, Government Notice No. 368 of 2018	♦ Provides for restrictions on the importation of seed ♦ Not in force yet
Water Resources Management Act Act No. 11 of 2013, Government Notice No. 322 of 2013	♦ Provides for management, protection, development, use and conservation of water resources ♦ Prevention of water pollution and assignment of liability
Forest Act Act 12 of 2001, Government Notice No. 248 of 2001	♦ Makes provision for the protection of the environment and the control and management of forest fires ♦ Provides for the licencing and permit conditions for the removal of woody and other vegetation as well as the disturbance and removal of soil from forested areas
Forest Regulations: Forest Act, 2001 Act No. 12 of 2001, Government Notice No. 170 of 2015	♦ Declares protected trees or plants ♦ Issuing of permits to remove protected tree and plant species ♦ Issuing of permits for harvesting of trees for wood and charcoal production and transport
Soil Conservation Act Act No. 76 of 1969, Government Notice No. 494 of 1970	♦ Laws relating to the combating and prevention of soil erosion, the conservation, improvement and manner of use of the soil and vegetation and the protection of the water sources in Namibia
Biosafety Act Act No. 7 of 2006, Government Notice No. 210 of 2016	♦ Regulates activities involving the research, development, production, marketing, transport, application and other uses of genetically modified organisms and specified products derived from genetically modified organisms ♦ Prohibits planting of genetically modified organisms without registration
Petroleum Products and Energy Act Act No. 13 of 1990, Government Notice No. 45 of 1990	♦ Regulates petroleum industry ♦ Makes provision for impact assessment ♦ Petroleum Products Regulations (Government Notice No. 155 of 2000) ♦ Prescribes South African National Standards (SANS) or equivalents for construction, operation and decommissioning of petroleum facilities (refer to Government Notice No. 21 of 2002)
Local Authorities Act Act No. 23 of 1992, Government Notice No. 116 of 1992	♦ Defines the powers, duties and functions of local authority councils
Public and Environmental Health Act Act No. 1 of 2015, Government Notice No. 86 of 2015	♦ Provides a framework for a structured more uniform public and environmental health system, and for incidental matters ♦ Deals with Integrated Waste Management including waste collection disposal and recycling, waste generation and storage, and sanitation

Law	Key Aspects
Labour Act Act No 11 of 2007, Government Notice No. 236 of 2007	♦ Provides for Labour Law and the protection and safety of employees ♦ Labour Act, 1992: Regulations relating to the health and safety of employees at work (Government Notice No. 156 of 1997)
Hazardous Substances Ordinance Ordinance No. 14 of 1974	♦ Applies to the manufacture, sale, use, disposal and dumping of hazardous substances as well as their import and export ♦ Aims to prevent hazardous substances from causing injury, ill-health or the death of human beings
Pollution Control and Waste Management Bill (draft document)	♦ Not in force yet ♦ Provides for prevention and control of pollution and waste ♦ Provides for procedures to be followed for licence applications

Table 6-2 Guiding documents, directives and standards

Standard or Code	Key Aspects
South African National Standards (SANS)	♦ The Petroleum Products and Energy Act prescribes SANS standards for the construction, operations and demolition of petroleum facilities ♦ SANS 10089-3:2010 is specifically aimed at storage and distribution of petroleum products at fuel retail facilities and consumer installations ♦ SANS 10131 (2004) is aimed at above-ground storage tanks for petroleum products ♦ Provide requirements for spill control infrastructure
Department of Water Affairs and Forestry Code of Practice: Volume 1 Septic Tank Guidelines (General Guidelines July 2008)	♦ It defines french drains and septic tanks ♦ Gives location consideration and tank design guidance ♦ Septic tanks are- not allowed between two and five meters from a building and or a boundary ♦ It specifically states that in rocky areas secondary treatment must be provided for soak aways

Table 6-3 Relevant multilateral environmental agreements

Agreement	Key Aspects
Stockholm Declaration on the Human Environment, Stockholm 1972	♦ Recognizes the need for a common outlook and common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment
United Nations Framework Convention on Climate Change (UNFCCC)	♦ The Convention recognises that developing countries should be accorded appropriate assistance to enable them to fulfil the terms of the Convention
Convention on Biological Diversity, Rio de Janeiro, 1992	♦ Under article 14 of The Convention, EIAs must be conducted for projects that may negatively affect biological diversity
International Treaty on Plant Genetic Resources for Food and Agriculture, 2001	♦ Promotes conservation, exploration, collection, characterization, evaluation and documentation of plant genetic resources for food and agriculture ♦ Promote the sustainable use of plant genetic resources for food and agriculture

Table 6-4 Standards or codes of practise

Agreement	Key Aspects
South African National Standards (SANS)	♦ The Petroleum Products and Energy Act prescribes SANS standards for the construction, operations and demolition of petroleum facilities ♦ SANS 10089-3:2010 is specifically aimed at storage and distribution of petroleum products at fuel retail facilities and consumer installations o Provide requirements for spill control infrastructure

Listed activities, which require an ECC application (Government Regulation No 29 of 2012) related to this project, include the following:

Section 1 of Government Notice No. 29 of 2012: Energy, Transmission and Storage Activities

♦ 1(a) The construction of facilities the generation of electricity: The Proponent uses a photovoltaic solar system for some aspects of the operations. The panels are fixed to dedicated structures.

Section 2 of Government Notice No. 29 of 2012: Waste Management, Treatment, Handling and Disposal Activities

♦ 2.1 The construction of facilities for waste sites, treatment of waste and disposal of waste: The Proponent has septic tank and soak away systems to collect and dispose of sewage and wastewater from employee housing.

Section 4: Forestry Activities

♦ 4 The clearance of forest areas, deforestation, afforestation, timber harvesting or any other related activity that requires authorisation in terms of the Forest Act, 2001 (Act No 12 of 2001) or any other law. The farming units has been previously cleared, while some of the cleared areas have been rangeland improved and actively being managed (spanning a timeframe of 50 years).

Section 7: Agriculture and Aquaculture Activities

♦ 7.5 Pest control: The Proponent use conventional pest control products as approved by the Namibian government for some of the produce. These may include herbicides and pesticides and will vary according to season and pests encountered during a year.

Section 8 of Government Notice No. 29 of 2012: Water Resource Developments

♦ 8.1. The abstraction of ground or surface water for industrial or commercial purposes: Groundwater is abstracted for current and proposed commercial operations.

♦ 8.7 Irrigation schemes for agriculture excluding domestic irrigation: No *irrigation scheme* was developed, however, *irrigation systems* are used on the farm. Irrigation on the farm does not contribute to, or is part of any irrigation scheme, as proclaimed by the Namibian Government.

Section 9 of Government Notice No. 29 of 2012: Hazardous Substance Treatment, Handling and Storage

♦ 9.1 The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974." Fuel is stored on site for daily operations.
♦ 9.2 Any process or activity which requires a permit, licence or other form of authorisation, or the modification of or changes to existing facilities for any process or activity which requires an amendment of an existing permit, licence or authorisation or which requires a new permit, licence or authorisation in terms of a law governing the generation or release of emissions, pollution, effluent or waste. The Proponent stores more than 2,200 *l* in aboveground storage tanks.

- 9.5 Construction of filling stations or any other facility for the underground and aboveground storage of dangerous goods, including petrol, diesel, liquid petroleum gas or paraffin. Fuel is stored on site, in aboveground storage tanks for daily operations.

Additional national planning legislation considered include:
- National Development Plans (NDPs).
- Ministry of Agriculture, Water & Forestry Strategic Plan 2017/18-2021/22.
- Namibia's Climate Change Adaptation.

The rationale behind the NDPs is to introduce an element of flexibility within the Ministry planning system by fast tracking development in areas where progress is insufficient. It also incorporates new development opportunities and aims to address challenges that have emerged after the formulation of various NDPs. In the latest Development Plan, the amount of hectares developed for irrigation, is a key performance indicator for the plan's Economic Progression's strategic objectives, which are aimed:

"*to increase productivity during the strategic period through the implementation of appropriate technologies e.g. Comprehensive Conservation Agriculture (CCA) and mechanization in order to ensure food security at both household and national level."*

Additional strategies included for the Agriculture Sector and Food Security include:

- Increase agricultural production for cereals, horticulture and livestock
- Promote the planting of drought resistance varieties

The above ties in with NDPs which purposes to set out a roadmap for achieving envisioned rapid industrialization while adhering to the four integrated pillars of sustainable development as identified in the plan. Irrigation activities contribute primary to the "Economic Progression" pillar by increasing the volumes of locally produced goods. One of the focus areas of the economic progression pillar of NDPs is agriculture and food security. The NDPs aims to decrease the amount of food insecure individuals, increase food production and increase the share of value addition in crop and livestock farming. Development and operations of irrigation activities on the farm are in line with all of these strategies as identified in the NDPs. The operation contributes to the amount of productive, irrigated land in Namibia, provides employment, and most crucially, produces crops for local markets.

Namibia's Climate Change Adaptation Communication to the United Nations Framework Convention on Climate Change, identifies adaptation actions (amongst others) for the agriculture and water sectors. The Proponent has specifically considered the following actions:

- Develop improved crop varieties that adapt to climate change (Climate-Resilient Agriculture);
- Promote the diversification of crops to hedge against erratic rainfall and shorter seasons (Climate-Smart Agriculture); and
- Improve water demand management, particularly at the local level and in the agricultural sectors.

7 ENVIRONMENTAL CHARACTERISTICS

This section lists pertinent environmental characteristics of the study area and provides a statement on the potential environmental impacts on each.

7.1 LOCALITY AND SURROUNDING LAND USE

The project area (19.2684 °S, 18.1229°E) is located in the Grootfontein constituency approximately 33 km north of Grootfontein along the M0073 road. The project area consists of farm Karuchas FMB/00542 and farm Starnberg FMB/01147. Presently there is one active exclusive prospecting license (EPL) across the project area (EPL8643). With a second EPL (EPL 7781) only crossing a small portion of the eastern border. EPL 8643 is registered for dimension stone, nuclear fuel minerals, base and rare metals, precious metals, industrial minerals and semi-precious stones. There also exist an active mineral rights claim four base and rare metals, semi-precious minerals and industrial minerals that overlaps the entirety of the project area.

Surrounding properties are all similar in nature and used for crop cultivation and livestock rearing (commercial farming). No national or proclaimed conservation areas, protected areas or communal conservancies are located close to the project. The adjacent properties are listed in the table below and their locations are depicted in Figure 7-1.

Table 7-1 Adjacent properties

Number on Map	Farm Name and/or Number
1	CALAIS FMB/00833
2	DOVER FMB/00701
3	DRONTHEIM FMB/00703
4	CLEVELAND FMB/00706
5	ABENAB FMB/00707
6	AURITSAB FMB/00708
7	DUNKIRCHEN FMB/00716
8	DULUTH FMB/00714
9	SWERWERSTROOM FMB/00831
10	AANDRUS FMB/00832/00REM
11	AANDRUS FMB/00832/00001

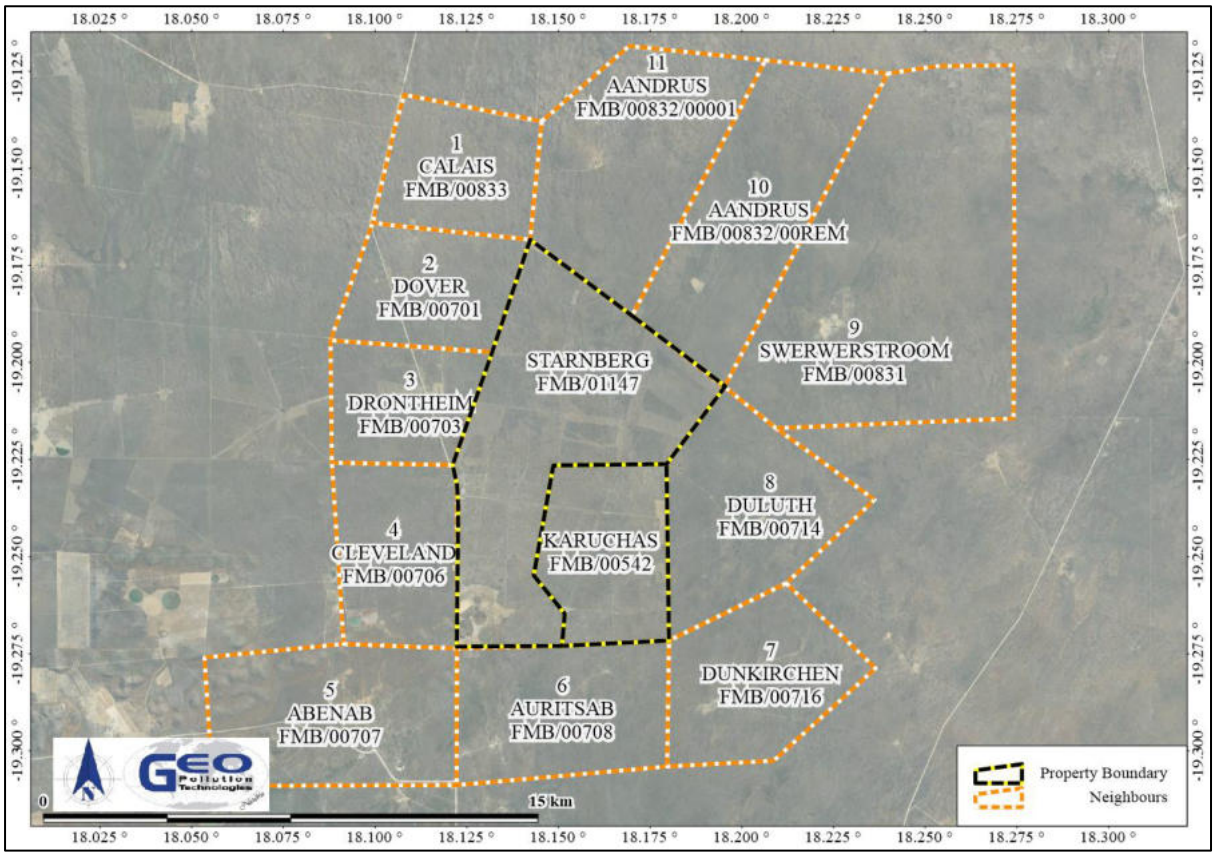

Figure 7-1 Properties adjacent to the project area

Implications and Impacts

The location is well suited for the agricultural activities. It is already zoned for agricultural use and is located in an area suitable for irrigation. Consideration should be provided toward prospecting activities proposed across plantations which are not allowed as per the section 1 of the Minerals (Prospecting and Mining) Act 33 of 1992 as amended by the Minerals (Prospecting and Mining) Amendment Act 8 of 2008.

7.2 CLIMATE

A general lack of weather stations in Namibia, especially in rural areas, is problematic when attempting to get accurate climate data and descriptions for specific locations. Most of the weather stations that were operational in the mid to late 1900's have been closed. Climate descriptions are thus based on old measured data, crudely extrapolated for Namibia, and modelled data from satellite imagery. The following is thus a general description of the expected climatic conditions on the farming area. Geographical features such as hills, river courses, low and high laying areas can significantly influence localised weather and especially temperatures. Data was extracted from the 2022 Atlas of Namibia unless otherwise specified (Atlas of Namibia Team, 2022).

According to the Köppen-Geiger Climate Classification system the project is located in a hot semi-arid climate (BSh) (http://koeppen-geiger.vu-wien.ac.at/present.htm). This means that the area receives precipitation below potential evapotranspiration, but not as low as a desert climate and has a mean annual temperature of at least 18°C.

Average rainfall received is 450-500 mm/a with a variation of 30-40 %. Monthly rainfall peaks in January. The potential evapotranspiration is 2400 - 2500 mm/a. By dividing the mean annual potential evapotranspiration into the mean annual precipitation, an aridity index value for the area was computed as 0.2, which indicates the area to be Semi-Arid. The average annual minimum temperature is 6-8 °C, while the average annual maximum temperature is 32-34 °C, with an average annual temperature range of 26-28 °C. An average diurnal temperature (difference between daily minimum and maximum temperature) for this area is around 16-18 °C. Direct normal solar irradiance for the area is 6.563 kWh/m²/day.

Long term precipitation data was obtained from the CHIRPS-2 database (Funk et al., 2015). The CHIRPS-2 dataset (Climate Hazards Group Infra-Red Precipitation with Station data version 2) consist of long term precipitation data (1981 to near-present) obtained from satellite imagery and in-situ station data and therefore represents more recent data. Data is averaged over an area of roughly 5 km by 5 km. This averaging effect should be kept in mind during data analyses as high precipitation from single thunder storm cells would be averaged out, thereby providing a reduced daily maximum precipitation value.

The average annual precipitation for the last 43 years was calculated as 522 mm/a, with a coefficient of variance of 27%. Heavier precipitation (single day events) occur between Jan and Feb, with a single event of 74 mm in Apr (last 43 years data) being the highest. Daily and seasonal precipitation data (Funk et al., 2015) is presented in Table 7-2 and in Figure 7-2. Seasonal (July to June) total precipitation, centred on the average line for the last 43 years, is presented, with the daily total precipitation and the seasonal cumulative precipitation. From the figure it is clear that 6 out of the last 10 seasons were below the average.

Table 7-2 Precipitation statistics (Funk et al., 2015)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (mm)	12	36	21	5	0	0	0	0	0	0	8	16
Maximum (mm)	293	227	175	126	13	1	0	0	11	45	115	166
Average (mm)	123	123	92	34	2	0	0	0	1	17	47	83
Variability (%)	55	43	40	84	210	267	663	663	204	72	48	48
Daily maximum (mm)	40	43	50	74	7	0	0	0	6	21	33	37
Average rain days	14	13	8	3	1	0	0	0	1	4	9	11

Season July - June average: 522 mm | Season coefficient of variation: 27 %

Date range: 1981-July-1 to 2025-June-30 | Lat: 19.22533°S; Long: 18.14966°E

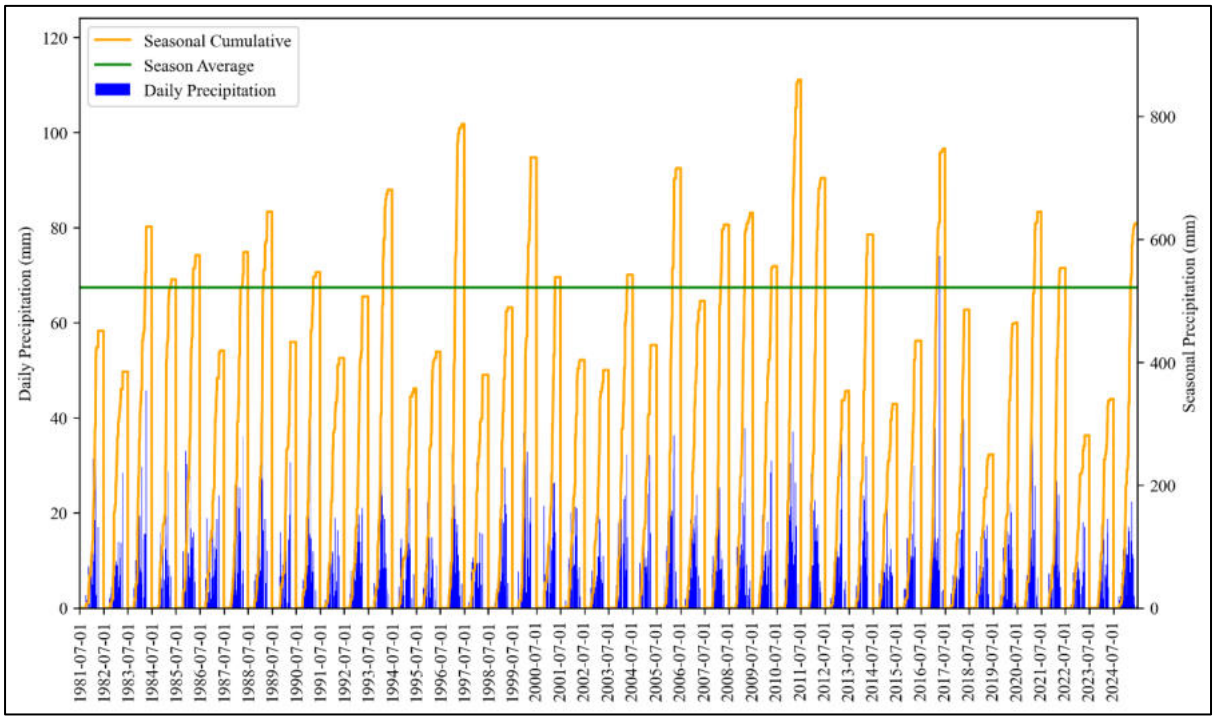

Figure 7-2 Daily and seasonal Precipitation (Funk et al., 2015)

Similar to precipitation data, temperature data is also lacking for the project area, with the Atlas of Namibia presenting only crude, large scale averages. To have an idea of temperatures in the area, monthly temperature data was retrieved from the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) data set for a height of 2 m above surface (Ronald Gelaro, et al., 2017). This data set is a NASA atmospheric reanalysis, incorporating satellite data integration and aims at historical climate analyses at 0.5° x 0.625° spatial resolution. This translates to roughly 3,640 km², which still is a large area, but is somewhat less crude than the Atlas data.

Table 7-3 presents statistics of daily data abstracted from the MERRA-2 data set for the last 41 years. The lowest temperature of 0.2°C was recorded in July. The average annual minimum temperature is 7°C. A maximum temperature of 42.1°C was measured in November, while the average annual maximum temperature is 38.3°C. The average annual temperature range is 23.6°C while the average diurnal temperature (difference between daily minimum and maximum temperature) for this area is around 23°C. Direct normal solar irradiance for the area is 7.84 kWh/m²/day.

Table 7-3 Temperature statistics based on Merra-2 data

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (°C)	9	9	8	5	2	-2	-1	2	4	6	6	9
Maximum (°C)	40	39	39	36	33	31	30	34	37	40	40	40
Average (°C)	25	24	24	22	19	16	16	19	23	26	26	26
Diurnal (°C)	13	12	13	15	17	18	18	19	19	17	15	14
Average days < 0°C	0	0	0	0	0	0	0	0	0	0	0	0

Winds are predominantly from a west-south-westerly and western direction for the majority of the year. Very strong winds have been experienced at times, associated with thunderstorms, however it is not the norm. Localised winds are influenced by the topography as well as seasonal land use.

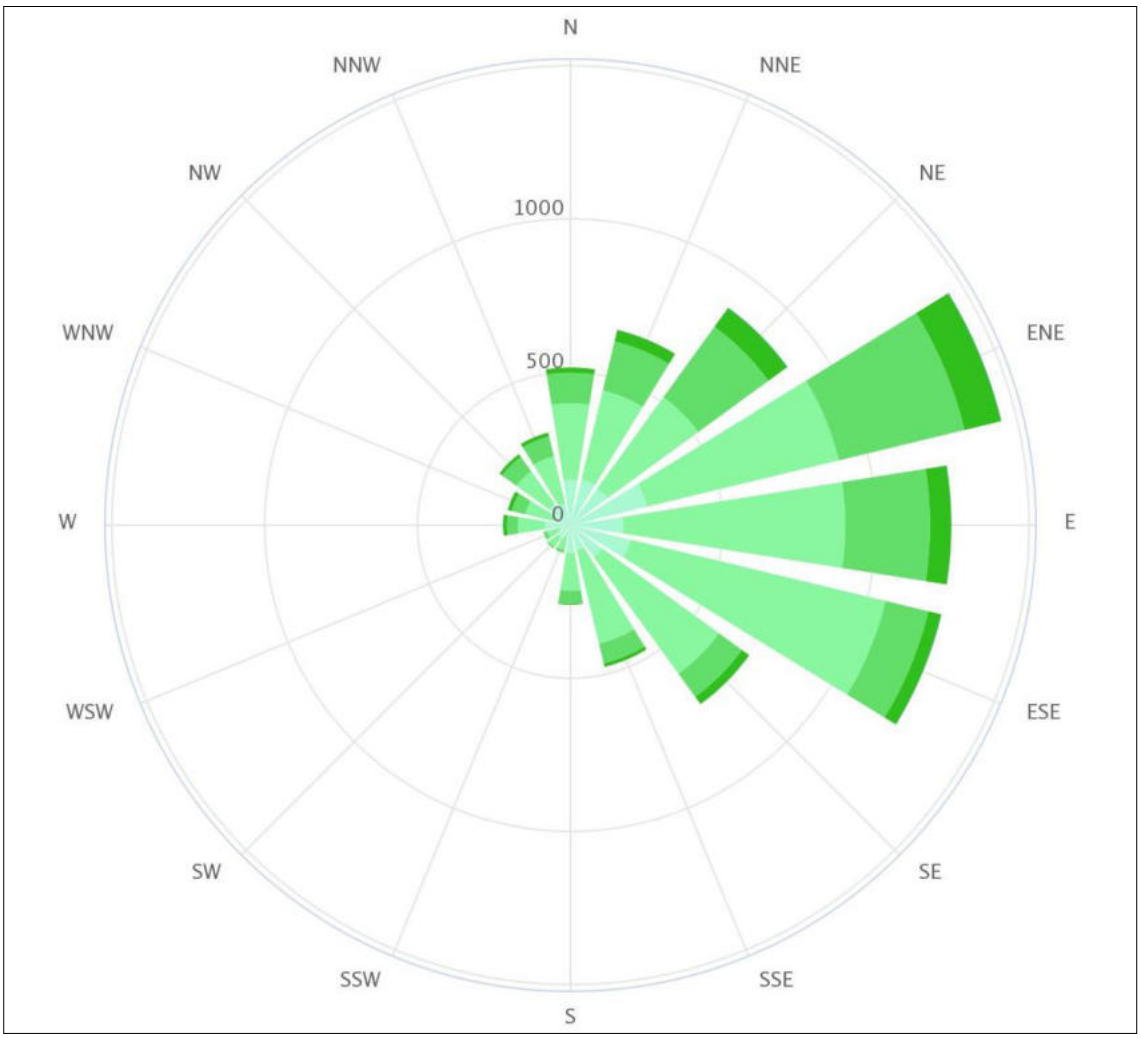

Figure 7-3 Modelled wind rose for Abenab (Meteoblue, 2023)

Implications and Impacts

Rainfall events are often thunderstorms with heavy rainfall that can occur in short periods of time ("cloud bursts"). Rainfall in the area is above the Namibian average, but varies significantly year on year. Heavy rainfall can lead to soil erosion when improper agricultural practises are employed while dry seasons will necessitate greater reliance on groundwater resources. Recurring drought conditions may impact on groundwater availability due to reduced aquifer recharge.

Hot dry winds increase the risk of crop damages as well as fire risks and related severity. General winds may carry chemicals and pollen of crops in mainly a western direction while the solar radiation values are high enough to reliably support future construction of photovoltaic solar panels. Occasional frost necessitate frost management measures. Climate change contributors are largely related to the mechanised systems and synthetic fertilisers used as part of operations. Effects of climate change to consider during the proposed operations over the next 30 years include increased frequency of droughts (changing rainfall patterns) and higher temperatures (World Bank, 2021).

7.3 TOPOGRAPHY AND DRAINAGE

The farm is part of the Karstveld landscape, an area dominated by limestone with little or no surface run-off and a strong development of sinkholes, dolines and caves. The general description of little to no run-off relates to the fact that most of the rainfall in the area rapidly drains into the ground and underground cavities. Drainage and soils of the Karstveld landscape are influenced by its topography.

According to the topographical representation (Figure 7-4) of the area, the area has a slight to undulating slope of less than 5%. The topographical elevation on the project area ranges between 1,243 mamsl in the north to 1,292 mamsl in the south. In the southwestern corner of the project area there are a couple of small low-lying hills. This resulted in a change of 49 m in elevation across a distance of 11.5 km. The average change in slope in the northern parts of the project area is 0.8%. The slope can thus be described as flat to undulating with a maximum slope change of 3.6% to the south. The change in slope direction corresponds well with the inferred groundwater flow direction of the area as indicated in Figure 7-7.

The surface drainage network normally correlates with the change in topography. This resulted in a drainage network that drains to the north of the project area. Due to the flat characteristics of the project area, a poor drainage network was formed.

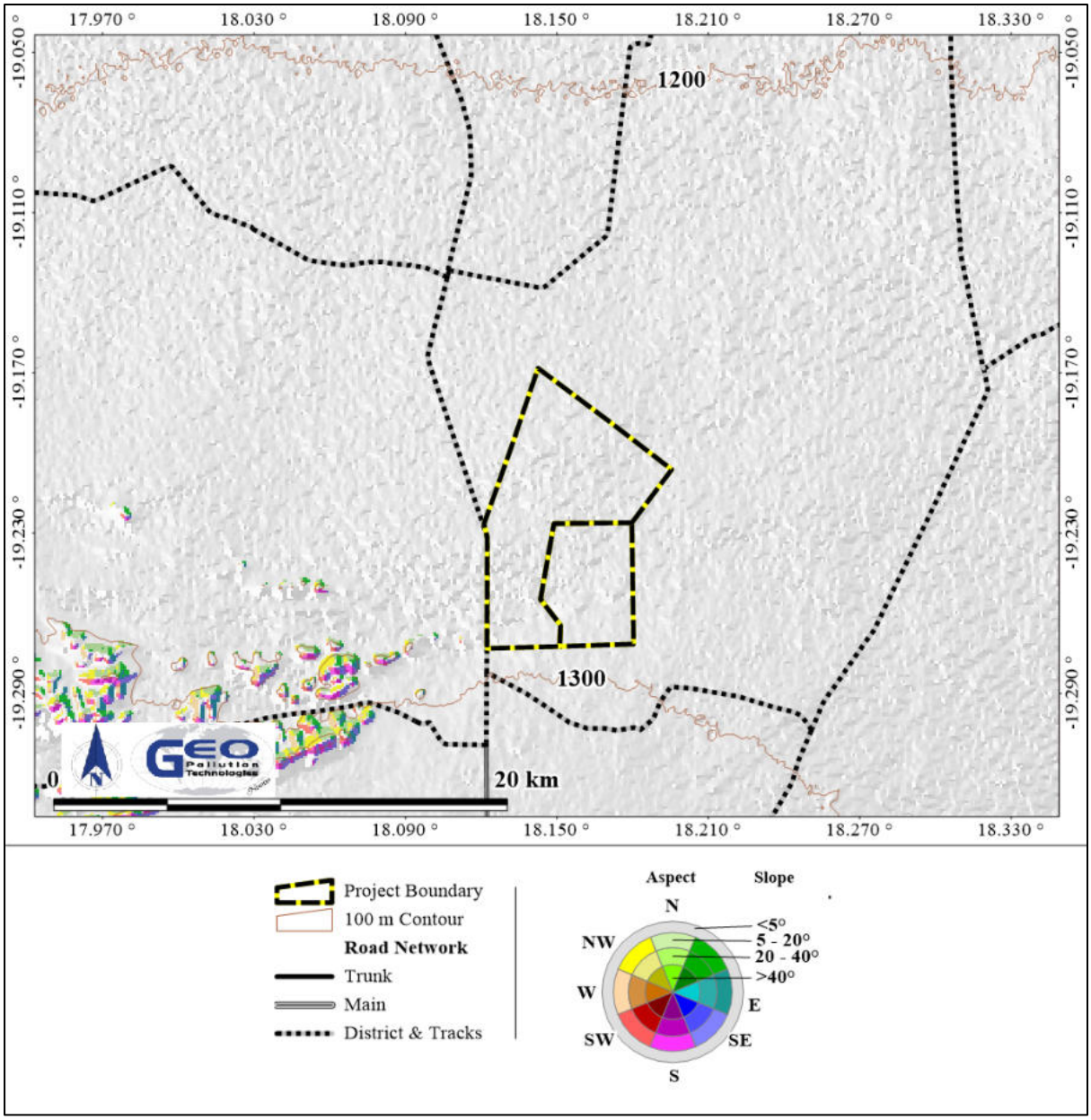

Figure 7-4 Aspect slope

Photo 7-1 Hills southwest of the project area

Photo 7-2 The undulating slope as can be seen to the north.

Implications and Impacts

The project area is generally flat and well suited for pivot-based irrigation. The lack of major surface runoff and drainage may lead to pooling in localised areas during heavy rainfall events. This can negatively impact soil quality and crop production. However, during dry periods, clayey soils crack open and in some instances causes deep open cavities. In addition, different soil types loose heat at different rates. Loose sandy soils may cool more quickly than heavy, dense clayey soils. Sandy soils therefore have a higher risk of radiation frost.

7.4 GEOLOGY AND HYDROGEOLOGY

The geology underlaying the project area formed during the Namibian, Quaternary and Tertiary Age. Locally the geology from the Quaternary and Tertiary Age comprises of the Kalahari Group deposits which consists of sand, calcrete and gravel (Figure 7-6). The Kalahari Group sediments originate mainly from fluvial deposition with some reworking through aeolian processes. Kalahari sediments at the project area form only a surface cover. The Kalahari Group sediments here commonly overlie pre-Kalahari rocks of the Damara Sequence (Namibian Age).

At the project area the Damara Sequence consists of dolostone (bedded and massive) and limestones of the Elandshoek (NEl) and Maieberg (NMa) Formations respectively (Figure 7-6), which belongs to the Tsumeb Subgroup, Otavi Group. Some small outcrops of laminated dolostone from the Berg Aukas Formation, Abenab Subgroup, Otavi Group is also present on Farm Karuchas. The project area falls within the Northern Platform Zone of the Damara Sequence. A tectonostratigraphic zone in which the carbonate-dominated Otavi Group was deposited in a lagoon like environment. Predominant east-west-trending anticlinal structures are common.

Moderate folding of the strata occurred during the Pan African Orogeny (680 - 450 Ma) and resulted in the formation of synclines and anticlines, generally trending east - west. The development of joints and fractures in the rocks are associated with the folding, which have an impact on the hydrogeological characterization of the area. Major faults and geological structures can be found in the region with the Adelaide Syncline transecting the project area.

Various northeast striking magnetic dykes (subsurface) are known to be present in the area surrounding the project location, as inferred from aeromagnetic data. These dykes seem to be related to the Paresis intrusion which are situated just south of Otjiwarongo, with dykes radiating from this intrusion. Geophysical-interpreted dykes can also occur in the area and strike towards the northeast. The nature of these dykes tend to be mineralised faults with high hydraulic conductivity values. Both the Remnant dykes (8 km to the west) and Tsumeb (further to the west) represented a major exploration target for the NamWater exploration water supply programme to Windhoek. The dykes are thought to have shattered the host rocks during its formation (Hoad, 1992). Where dolomite is the host rock, it forms a zone favourable for the development of karst features and groundwater accumulation.

Several known karst features are present in the region. The mineralised karst chimneys of the Abenab – and Abenab West Mine (Bäumle, 2003) is approximately 3.5 km to the southwest of the project area and are hydrothermal deposit that represents a highly mineralized zone of which metals like vanadium as well as lead, copper and zinc were mined until 1958 (von Bezing *et. al.*, 2014). No sinkholes or caves have been documented near the project area (<30 km).

A number of springs are present in the Otavi Mountainland (OML) and most of these springs are related to the contact zones between relatively impermeable formations of the Grootfontein Metamorphic Complex and more permeable formations of the Damara Sequence. The Karuchas spring has been documented on Farm Karuchas (Figure 7-5), with several other documented springs (i.e. Auritsab) to the south of the project area. Based on the interpretation of the structural geology at the project area, it is assumed that these springs are a product of the inferred groundwater level, the local anticline and syncline structures and the topography.

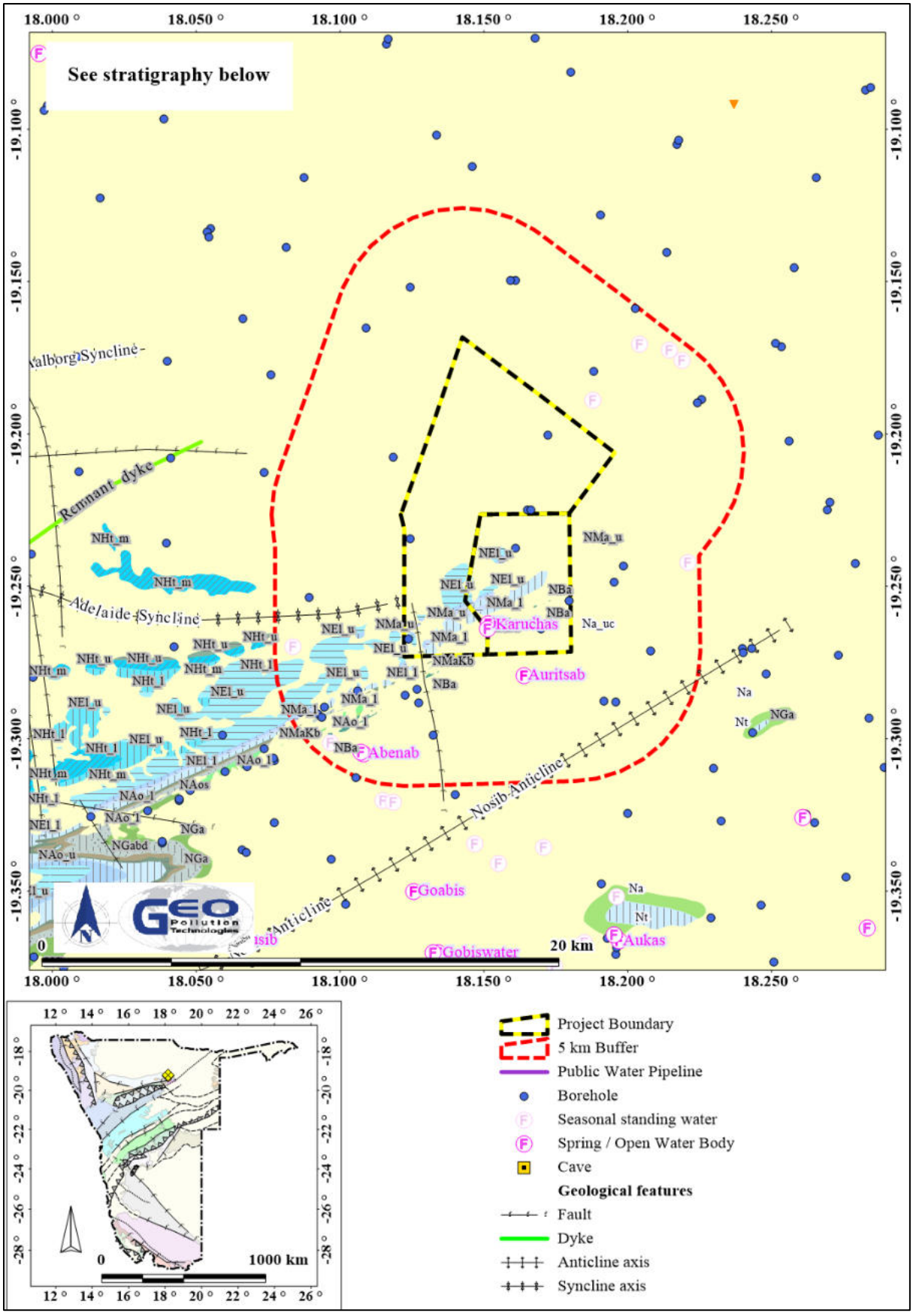

Figure 7-5 1:250,000 Geological map

Age	Lith Code	Supergroup	Group	Subgroup	Formation	Description
Quaternary	Qs		Kalahari			Sand, gravel, and calcrete
Namibian	NHt_u	Damara	Otavi	Tsumeb	Huttenberg	Dolostone (bedded)
	NHt_m					Dolostone (bedded) and phyllite
	NHt_l					Dolostone (bedded), and chert (algal)
	NEl_u				Elandshoek	Dolostone (bedded)
	NEl_l					Dolostone (massive)
	NMa_u				Maieberg	Dolostone (bedded)
	NMa_l					Limestone/marl (bedded)
	NMaKb					Dolostone
	NAo_u			Abenab	Auros	Dolostone
	NAo_l					Dolostone (cherty)
	NGu				Gruis	Dolostone (bedded)
	NGa				Gauss	Dolostone (massive)
	NGabd					Dolostone (bedded)
	NBa				Berg Aukas	Dolostone (laminated light/dark)

Figure 7-6 Stratigraphy

A number of springs are present in the Otavi Mountain land (OML) and most of these springs are related to the contact zones between relatively impermeable formations of the Grootfontein Metamorphic Complex and more permeable formations of the Damara Sequence. The nearest spring is located on the southern half of the project area. The spring in indicated on Figure 4-5 as well as on Figure 7-7. No caves or lakes are known of in close proximity (<10 km radius) to the project area.

The project area is located inside of the Grootfontein-Otavi-Tsumeb subterranean groundwater control area. Furthermore, the project area overlays two sub-divisions of the groundwater control area, the Tsumeb – B2 (Farm Starnberg) and Nosib – C (Farm Karuchas) sub-division. This is according to the Government proclamation 278 of 31 December 1976 (Extension) (Heyns, 2008).

The project area is situated in the Owambo Groundwater Basin. Localised groundwater flow may take place along preferred flow paths in different directions, but the larger scale groundwater flow is expected to be in a northern direction (Figure 7-7). Local flow patterns may vary due to groundwater abstraction. Groundwater flow is expected to take place through primary porosity in the surface cover, while it is expected to flow along fractures, faults, dykes/mineralised faults or along contact zones (secondary porosity) and other geological structures present within the underlying formations (hard rock formations). Contact zones in the area occur between permeable and impermeable formations and create favourable conditions to promote groundwater flow (Heyns, 2008).

The aquifer associated with the project area falls within the Karst Area IV aquifer zoning, which has a high hydraulic conductivity. Bäumle (2003) described the Elandshoek Formation and the Hüttenberg Formation as the most productive aquifers within the investigation area, with the Tschudi Formation considered as an aquitard. Pumping test analysis yields an average transmissivity of 1,725 m^2/d for the Hüttenberg and typical storage coefficients in the order of 5 x 10-4 to 1 x 10-3. Although high volume abstraction currently takes place in the Otavi Mountain Land, the only significant cones of depression known to exist were at the Tsumeb mine (Hoad, 1992) and at the Kombat mine, which is situated much further to the west and southwest respectively.

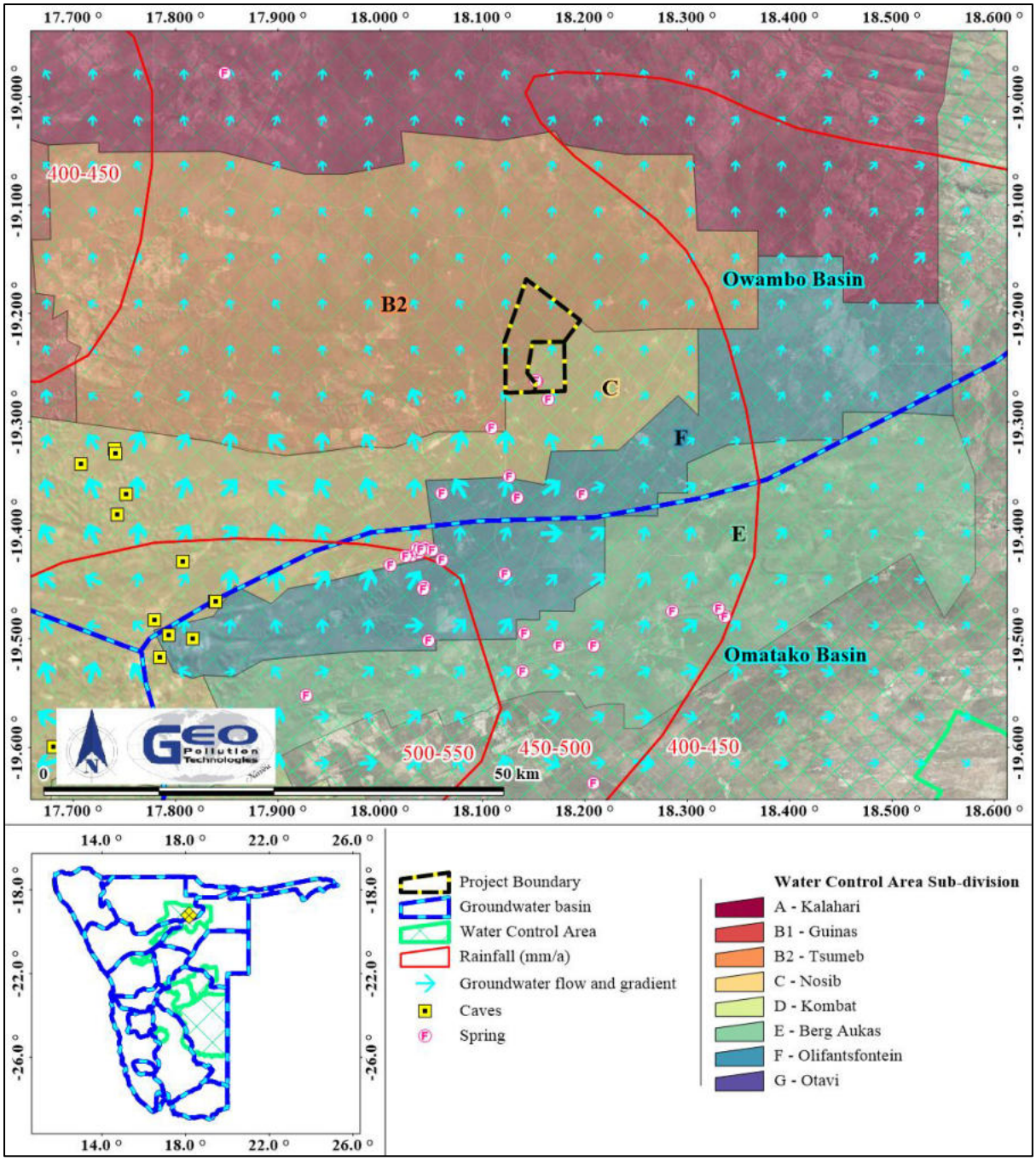

Figure 7-7 Groundwater catchments and water control areas

Table 7-4 presents groundwater statistics for 12 boreholes in a 5 km radius around the project area. The groundwater information was obtained from Department of Water Affairs (DWA) borehole database. This database is generally outdated, and more boreholes might be present. The average depth of 6 of the 12 boreholes are 93.92 m below surface and the yield of 6 of the 12 boreholes ranges between 4.3 and 52 m³/h. The average groundwater level of 11 of the 12 known boreholes is 26.45 m below surface, ranging between 1.2 and 45 m below surface. Groundwater quality falls mainly under Group A category, which indicates that the water is of an excellent quality, based on the provided parameters.

Table 7-4 Groundwater statistics

	Depth (m)	Yield m^3/h)	Water level (m)	Water Strike (m)	TDS (ppm)	SO4 (ppm)	NO3 (ppm)	F (ppm)
Data Points	6	6	11	4	7	7	5	7
Minimum	37	4.3	1.2	12	490	4	1	0.1
Average	93.9	27.3	26.5	33.9	600	13	8	0
Maximum	120	52	45	42	795	20	25	0.3
Group A	*0-50*	*>10*	*0-10*	*0-10*	*0-1000*	*0-200*	*0-10*	*0-1.5*
%	17%	83%	18%	0%	100%	100%	60%	100%
Group B	*50-100*	*5-10*	*10-50*	*10-50*	*1000-1500*	*200-600*	*10-20*	*1.5-2.0*
%	17%	0%	82%	100%	0%	0%	20%	0%
Group C	*100-200*	*0.5-5*	*50-100*	*50-100*	*1500-2000*	*600-1200*	*20-40*	*2.0-3.0*
%	67%	17%	0%	0%	0%	0%	20%	0%
Group D	*>200*	*0-0.5*	*>100*	*>100*	*>2000*	*>1200*	*>40*	*>3*
%	0%	0%	0%	0%	0%	0%	0%	0%
12 boreholes in a 5 km radius from				**-19.227103**		**18.147951**		

Statistical grouping of parameters is for ease of interpretation, except for the grouping used for sulphate, nitrate and fluoride, which follow the Namibian guidelines for the evaluation of drinking-water quality for human consumption, with regard to chemical, physical and bacteriological quality. In this case the groupings has the following meaning:

Group A: Water with an excellent quality

Group B: Water with acceptable quality

Group C: Water with low health risk

Group D: Water with a high health risk, or water unsuitable for human consumption.

Groundwater quality data is presented in Figure 7-8 as Maucha plots. From the figure it is clear that the groundwater of the project location is mostly of a calcium-magnesium-bicarbonate type water which suggest the water is recently recharged. Groundwater quality from the project area reflect an aquifer that is typical of a dolomitic hard rock formation host where rapid groundwater recharge takes place.

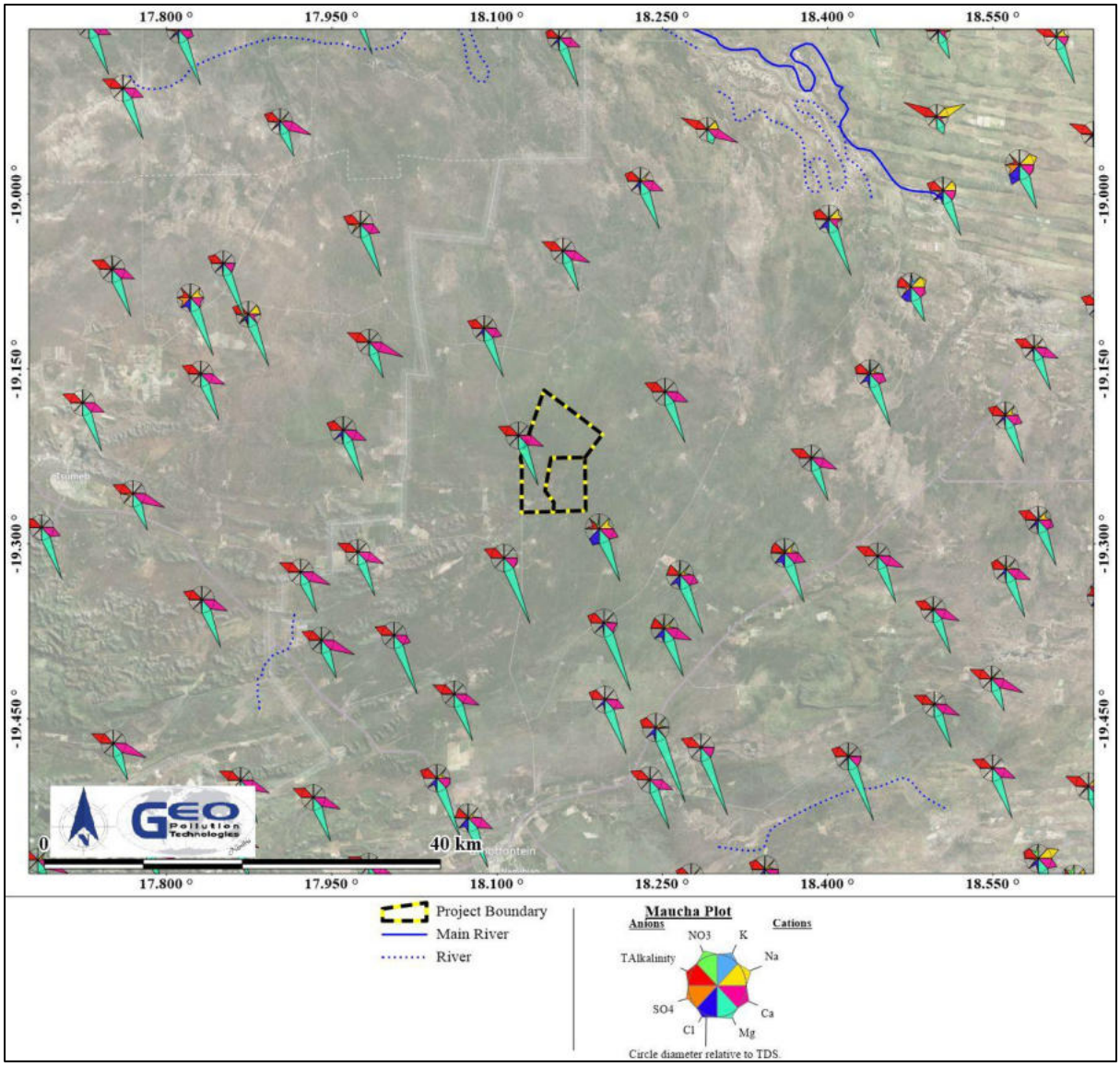

Figure 7-8 Groundwater quality

Implications and Impacts

A risk to groundwater pollution is expected due to the geological sensitivity of the area. Groundwater is utilized in the area and such users would be at risk if groundwater contamination occurs. Irresponsible irrigation methods like over-irrigation may result in higher demands for fertiliser and pesticide which in turn will increase nitrates and pesticide concentration in the groundwater. Over application of the herbicide RoundUp™ is specifically a common expressed concern when planting RoundUp™ ready maize or cotton.

Over abstraction may also impact on other users of the aquifer. The hydrogeological specialist study however indicates that water levels, under current groundwater abstraction rates, are stable.

7.5 SOIL AND AEZ

The dominant soil type for this area is Cambic Calcisol which refers to the soil type commonly found in arid or semi-arid regions with dry seasons. They form in calcium and magnesium rich alluvial, colluvial and aeolian deposits and are alternately dampened by rain and dried by evaporation which results in soft masses or hard layers of calcrete. In addition to this, the calcisol of this particular area is known for having subsurface soil layers of pedogenic change without appreciable illuviated material. The composition of soil in this particular area is roughly 65-70% sand, 10-15% silt and 25-30% clay which gives it the characteristics and texture of Sandy Clay

Loam soil. Bulk density was computed to be 1400-1450 mg/cm³ which means that the soil will affect the root growth of various plants, but not necessarily restrict it. Soils in this area typically reach depths of 140-150 cm, have a pH of 4.6-5.5 and a cation exchange capacity of 7-10 cmol/kg. Furthermore, this region has a water capacity of 20-40 mm at root depth.

Photo 7-3 Loamy agricultural soil

Photo 7-4 Sandy soil type

The farm is situated within the Kalk-2 Agro-Ecological Zone (AEZ) with an average growing period of 86 to 105 days. The Kalk-2 AEZ is ranked 2nd in Namibia in terms of agricultural potential and is deemed most suitable for short-maturing crops and large stock grazing. The Kalk-2 area is generally not regarded as suitable for cropping and this is true for some parts of the farm. The areas under irrigation around Abenab are however located in patches where sufficiently deep, quality soil is present for irrigation of crops.

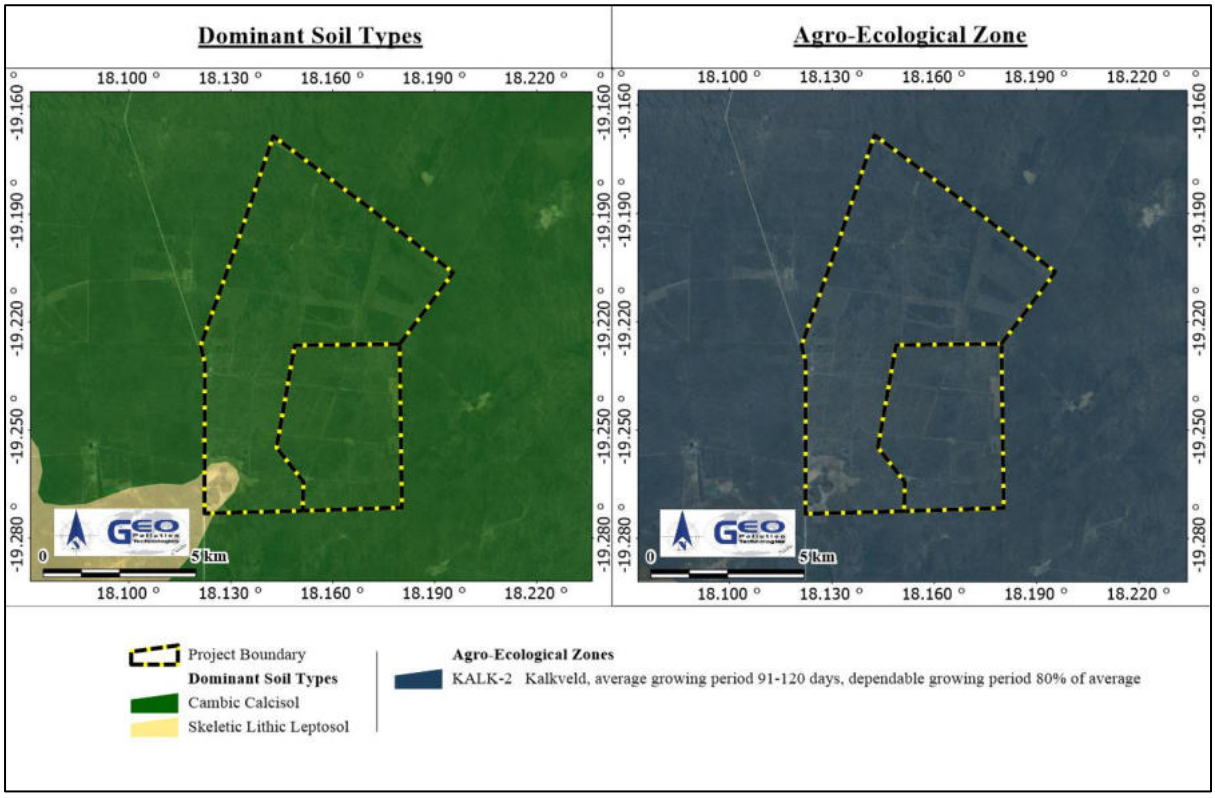

Figure 7-9 Dominant Soil Types and Agro Ecological Zone (Atlas of Namibia Project, 2002)

7.6 PUBLIC WATER SUPPLY

The Proponent and surrounding farming communities are completely reliant on groundwater as a source of potable water supply. The boreholes tap into the Owambo Basin and are located within the Tsumeb-Otavi-Grootfontein Subterranean Water Control Area.

Implications and Impacts

Groundwater is a valuable resource in the farming area and is controlled by a water abstraction permit system as regulated by the Ministry of Agriculture, Fisheries, Water and Land Reform. Groundwater contamination may negatively impact surrounding boreholes, widely utilised for public water supply. No alternative water supply options exist if extensive contamination or deterioration of groundwater occur.

7.7 ECOLOGY

This region is located in the Acacia sub-biome of the Tree-and-shrub Savana Biome. This biome is known for being dominated by Acacias that grow in its arid environment along with short shrubs and grasses that grow in the shallow soils of the area's hills. The Karstveld vegetation type, comprising mixed woodland species with an average tree height of 3 to 4.5 m, is documented for this area. Typically, 30 to 35% of this vegetation type is covered by woody plants. The Karstveld forms part of the floristic group of Zambesian domain. The area hosts up to 167.0 species of flora with 40-45 % of the area being covered by woody plants and with Cropland being the main vegetation that covers the land. A total of 11.0 plant species are considered endemic to the area, with None species considered to be locally endemic Tree height range is 3.0-3.5 m.

Plant diversity is expected to be in the vicinity of 35 to 167 species. This area, compared to the surrounding area, is sparse in terms of species diversification. Trees such as *Acacia flecki, Boscia albitrunca, Carissa edulis, Searsia lancea* and a variety of other trees are characteristic of the Karstveld vegetation type. The farm is located across quarter degree squares 1918AA and 1918AC. According to the Tree Atlas Project, 104 different tree species across the two quarter degrees (Curtis & Mannheimer 2005). A summary of those trees protected by legislation in Namibia, 17 in total, is presented in Table 7-5.

Not all the trees listed are expected to occur within the vicinity of the farm. A complete tree list is presented in Appendix B.

Table 7-5 Trees with conservation concerns in quarter degree squares 1918AA and 1918AC (Curtis & Mannheimer, 2005)

Name	Common Name	Notes
Acacia erioloba	Camel-thorn	Protected by forestry legislation.
Albizia anthelmintica	Worm-cure Albizia; Aru	The low numbers of young trees recorded are a concern, as is the number of dead trees in some areas. It is Protected by forestry legislation.
Aloe littoralis	Windhoek Aloe	Potentially threatened by pachycaul trade. Protected by the Nature Conservation Ordinance and listed in CITES Appendix II.
Berchemia discolor	Bird Plum	Protected by forestry legislation, as well as by traditional Owambo cultures for its fruit and shade. The population does not appear to be in any real danger at the moment, but communities could be encouraged to plant this species.
Boscia albitrunca	Shepherd's Tree	Although widespread and hardy, it is heavily utilised by people and animals. The difficulty that young plants have in becoming established is a concern, but fortunately there appears to be a healthy and widespread population of young plants. Protected by forestry legislation.
Combretum imberbe	Leadwood	Although heavily utilized by people, regrowth is good and growth of young trees is vigorous. Because of its religious importance and many uses, it is protected locally. Old specimens warrant protection as monuments. Protected by forestry legislation.

Name	Common Name	Notes
Cyphostemma juttae	Blue Kobas, Namibian grape, Wild grape	Endemic with very small population and threatened with pachycaul trade. Least concern according to IUCN criteria. Protected by Nature Conservation Ordinance. Protected by forestry legislation.
Erythrina decora	Namib Coral-tree	Endemic to Namibia and very uncommon throughout its range. Worthy of Protection. Very few young trees. Protected by forestry legislation.
Ficus cordata subsp cordata	Namaqua Rock-fig	Protected by forestry legislation.
Hyphaene petersiana	Makalani Palm	Should be monitored due to extensive harvesting. Protected by forestry legislation.
Lannea discolor	Live-long	Protected by forestry legislation.
Maerua schinzii	Ringwood Tree	Increasingly impacted by humans and giraffes. Protected by forestry legislation.
Schinziophyton rautanenii	Manketti; Mongongo nut; False balsa	Increased use for carving might be a concern. Great food value. Greatly damaged by veld fires. Protected by forestry legislation.
Sclerocarya birrea	Marula	Protected locally by communities that use them. Protected by forestry legislation.
Searsia marlothii	Bitter Karee	None
Spirostachys africana	Tamboti	Protected by forestry legislation.
Ziziphus mucronata	Buffalo-thorn	Protected by forestry legislation.

Photo 7-5 Large and mature trees surrounding the spring

Photo 7-6 Bush encroached areas

The Otavi Mountainland present suitable habitats for a number of bat species which have been documented to range across the project area. These bats include the following species: Dent's Horseshoe Bat (*Rhinolophus denti*), Striped Leaf-nosed Bat (*Macronycteris vittatus*) and the Greater Long-fingered Bat (*Miniopterus inflatus)*. The project area further falls within the habitat for a number of additional species of concern which may occur within the area. Some of the IUCN Red List of threatened species which are more likely to occur on site are listed in Table 7-6.

Additionally 217 species of mammals were identified in Namibia, 76 - 90 species occur in the area. Species are considered to be endemic when 75 % to 100 % of individuals, or their distributions is falling within the country. Between 3 - 4 species of mammals are considered to be endemic to the area. Around 7 - 8 species of large herbivores are expected to occur naturally in the area. Namibia has 32 carnivore species (mammals in the taxonomic order *Carnivora*). This includes 6 large species (african wild dog, lion, leopard, cheetah, brown hyaena and spotted hyaena) and 26 medium-sized and small species. Between 18 - 20 carnivore species are expected to occur naturally in the area. A total of 676 bird species has been recorded in Namibia, with 141 - 170 bird species expected to occur in the area. Seventy-eight of Namibia's bird species are on the IUCN's Red list, signalling significant threats to these species. Degradation of habitats, poisoning of scavengers and collision with above surface suspended cables, like power lines, all contribute to impacts on these species. Areas are recognised as 'important bird areas' when high concentrations of birds occur, particularly with significant numbers of threatened or endemic species or with more than 1 % of the global population of any species. Twenty-one areas in

Namibia are designated as important bird areas. The project area does not fall within an important bird area.

Table 7-6 IUNC Red listed species which may occur in the area

Species Name	Common Name	IUCN Red List Status
Sagittarius serpentarius	Secretary bird	Threatened
Torgos tracheliotos	Lappet-faced Vulture	Endangered
Falco vespertinus	Red-footed Falcon	Vulnerable
Neophron percnopterus	Egyptian Vulture	Endangered (Breeding area)
Aquila nipalensis	Steppe Eagle	Endangered
Acinonyx jubatus	Cheetah	Vulnerable
Trigonoceps occipitalis	White-headed Vulture	Critically Endangered
Smutsia temminckii	Temminck's Pangolin	Vulnerable
Parahyaena brunnea	Brown Hyaena	Near Threatened
Numenius arquata	Eurasian Curlew	Near Threatened
Calidris ferruginea	Curlew Sandpiper	Near Threatened
Glareola nordmanni	Black-winged Pratincole	Near Threatened
Macronycteris vittatus	Striped Leaf-nosed Bat	Near Threatened
Ardeotis kori	Kori Bustard	Near Threatened

The probability of some of these species are more likely to occur in the uncultivated portions of the farm such as the higher elevations, where wildlife can roam freely and undisturbed. These areas are protected by the Proponent and aim at providing all and any wildlife with a secure area, away from noisy and or disturbing activities. Various antelope species, predators and large game are known to be present on the farm.

Since the property borders farming operations who also have their own “conservation” (less disturbed) areas, an ecological corridor exists between them and the Proponent which see some species crossing to and from. These include antelope species such as kudu and oryx, but also include predator species. Jackal, caracal, leopard and cheetah are known to be on and around the farm.

Photo 7-7 Wildlife tracks

Photo 7-8 Wildlife drinking holes

Implications and Impacts

Pollution of the soil and groundwater by hazardous chemicals and/or the excessive use of fertilizers and pesticides may negatively impact the local ecology. Irresponsible use of pesticides to kill vermin such as jackal may further impact on already threatened vulture populations as well as other scavengers. Pesticides may also magnify (biomagnification) in higher trophic levels, especially top predators. This may lead to reproductive and other physiological defects and ultimately declining populations. Over-abstraction of groundwater may lead to ecosystem changes as groundwater levels decrease. Uncontrolled and unplanned fires may destroy ecological resources and threaten wildlife.

7.8 LOCAL ECONOMY

The Otjozondjupa Region’s economy is a diverse representation of various sectors and industries within the region. These include (but are not limited to) mining, tourism and agriculture; all of which have shown potential to be developed. Portions of the constituency which are closer to the

urban areas, has more economic diversity. However, the agricultural sector, specifically the irrigation farms around the town of Grootfontein, are large economic contributors, if not the largest in the constituency. Not only does it create jobs, but it has also been one of the driving forces of infrastructure development and related capital expenditure, which are on-going in planning considerations. Continued employment increases individuals' economic resilience and provides for increased social security benefits.

In evaluating water use in primary economic activities such as agriculture, it is useful to consider the entire value-chain, i.e. the upstream and downstream activities. Intensive irrigated production schemes are strong economic drivers, as witnessed by the influx of workers to such areas.

Water quality will have an effect on the productivity of operations, therefore the economic benefits of ensuring that the water quality and quantity of the groundwater reserve remains at its best, is an essential component of the agricultural process. If water treatment is required, then the cost of production will increase, resulting in a decrease in revenue and feasibility. The same can be said for the quality of the soil, as lowered quality soil will be less economically productive and contaminated soil, such as found in some areas within the constituency, not usable at all. Water and soil are paramount for the continued functioning of the agricultural project and therefore provide a vital ecosystem service to the Proponent.

Regionally, skilled agriculture and fisheries provide the most employment (31%). The data presented in Table 7-7 was obtained from the Namibia Statistics Agency as per the census in 2011. Updated data related to the different industries' employment statistics, has not yet been released as part of 2023 census data. It should be noted that although fisheries falls within the agriculture sector, it does not contribute to employment in the Otjozondjupa Region. The economy of the area relies largely on commercial livestock farming supplemented with crop production and charcoal manufacturing. Livelihoods in the constituency are varied, engaging sectors such as construction, wholesale and retail, administrative (public and defence) and manufacturing.

Table 7-7 Main industry of employed population aged 15 years and above for the Grootfontein Constituency and Otjozondjupa Region (Namibia Statistics Agency, 2011)

Main Industry	Grootfontein Constituency	Otjozondjupa Region
Total	8,463	40,477
Agriculture Forestry and Fishing	2,464	12,526
Mining And Quarrying	216	1,879
Manufacturing	355	2,547
Electricity Gas Steam and Air conditioning supply	37	92
Water Supply Sewerage Waste Management and Remediation activities	23	208
Construction	323	2,147
Wholesale and Retail trade; Repair of motor vehicles and motorcycles	454	2,872
Transportation and Storage	223	1,398
Accommodation and Food Service activities	133	1,114
Information and Communication	23	221
Financial Insurance Activities	119	695
Real estate Activities	0	8
Professional Scientific and Technical activities	71	366
Administrative and Support service activities	789	3,339
Public Administration and Defence; compulsory social security	2,114	4,927
Education	265	1,800
Human Health and Social work activities	221	974
Arts Entertainment and Recreation	19	156
Other Services activities	266	835
Activities of Private Households	307	2,206

Main Industry	Grootfontein Constituency	Otjozondjupa Region
Activities of extraterritorial organisation and bodies	1	12

Implications and Impacts

Operations on the farm sustain valuable full time as well as seasonal employment opportunities in a constituency which relies on the agricultural sector. The project contributes to the local and national agricultural sector and specifically in terms of the planned growth in the irrigation sector as envisioned by the local government. Employment and remuneration of such a large workforce within the area stimulates additional economic growth.

7.9 DEMOGRAPHIC PROFILE

The project area is located in the Grootfontein Constituency of the Otjozondjupa Region. Goods and services are mainly sourced from Grootfontein. For demographic information of the 2023 population and housing census, refer to Table 7-8 (Namibia Statistics Agency, 2023) which includes the details for the Grootfontein Constituency in relation to the National and regional averages, compared to the census data of 2011.

Although the project falls within the Grootfontein Constituency, the nature of the area is rural. Unemployment in the Grootfontein Constituency is lower at 34.9% compared to the national and regional averages while the literacy rate is also lower.

Table 7-8 Demographic characteristics of the Grootfontein Constituency, the Otjozondjupa Region (Namibia Statistics Agency, 2011; 2023)

	2011		2023	
	Grootfontein Constituency	**Otjozondjupa Region**	**Grootfontein Constituency**	**Otjozondjupa Region**
Population (Males)	12,748	73,902	18,705	113,280
Population (Females)	12,130	70,001	18246	107,531
Population (Total)	24,878	143,903	36,951	220,811
Population density (people/km2)	2.2	1.4	3.3	2.1
Unemployment (15+ years)	30,8%*	37%*	Tbd	Tbd
Literacy (15+ years)	80.5%	83%	Tbd	Tbd

* Calculated as per the economically active segment of the population Tbd: To be determined

Implications and Impacts

The project contributes mainly to demographic processes indirectly in requiring seasonal employment. These will be amplified should the Proponent initiate cotton cultivation. Temporary migration in the area changes the demographic profile of the Project as well as the surrounding area. Employment in a rural area works against urbanisation of the surrounding sectors. Skills development, training and exposure to best practises in terms of wildlife management and irrigation, benefit employees during the operational phase over and above having access to economic resources and food. Increased access to such resources may increase the fertility rate of the local population. The concentration of the workforce requires planning of governmental services (such as education clinics and public services) to ensure adequate resources.

7.10 CULTURAL, HERITAGE AND ARCHAEOLOGICAL ASPECTS

There are no cultural or heritage aspects known to be present on the farm. The proximity of the farm to Grootfontein allows for easy integration to cultural and related services for employees. The greater area has been cited to contain a number of caves and dolomite cavities which have been studied for, not only the unique habitats they present, but also the geological evidence related climate.

Implications and Impacts

Existing and proposed areas of operations are not close to any caves or related features. However should any archaeological resources be found, such resources should be reported for investigation. Over abstraction of groundwater should be avoided to ensure no water bearing caves downstream of operations are impacted by dewatering.

8 PUBLIC CONSULTATION

Consultation with the public forms an integral component of an environmental assessment investigation and enables interested and affected parties (IAPs) e.g. neighbouring landowners, local authorities, environmental groups, civic associations and communities, to comment on the potential environmental impacts associated with projects and to identify additional issues that they feel should be addressed in the environmental assessment.

Public participation notices were advertised, twice in two weeks, in the national papers: The notices appeared in the Republikein and the Namibian Sun on 22 and 29 February 2024. A site notice was placed on site and notification letters were hand-delivered or e-mailed to neighbours as well as the relevant ministries. See Appendix C for proof of the public participation processes and registered IAPs.

9 ASSESSMENT AND MANAGEMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts that are expected from the operational, construction, care and maintenance, and potential decommissioning activities of the farming unit. An EMP based on these identified impacts is presented in this section.

For each impact, an environmental classification was determined based on an adapted version of the Rapid Impact Assessment Method (Pastakia, 1998). Assessment of impacts is based on the following categories: importance of condition (A1); magnitude of change (A2); permanence (B1); reversibility (B2); and cumulative nature (B3) (Table 9-1).

The environmental classification is calculated as follows:

Environmental classification = A1 x A2 x (B1 + B2 + B3).

The environmental classifications of impacts and the respective classes are provided in Table 9-2.

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures).

Table 9-1 Assessment criteria

Criteria	Score
Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect	
Importance to national/international interest	4
Important to regional/national interest	3
Important to areas immediately outside the local condition	2
Important only to the local condition	1
No importance	0
Magnitude of change/effect (A2) – measure of scale in terms of benefit/disbenefit of an impact or condition	
Major positive benefit	3
Significant improvement in status quo	2
Improvement in status quo	1
No change in status quo	0
Negative change in status quo	-1

Significant negative disbenefit or change	-2
Major disbenefit or change	-3
Permanence (B1) – defines whether the condition is permanent or temporary	
No change/Not applicable	1
Temporary	2
Permanent	3
Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition	
No change/Not applicable	1
Reversible	2
Irreversible	3
Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.	
Light or No Cumulative Character/Not applicable	1
Moderate Cumulative Character	2
Strong Cumulative Character	3

Table 9-2 Environmental classification (Pastakia 1998)

Environmental Classification	Class Value	Description of Class
72 to 108	5	Extremely positive impact
36 to 71	4	Significantly positive impact
19 to 35	3	Moderately positive impact
10 to 18	2	Less positive impact
1 to 9	1	Reduced positive impact
0	-0	No alteration
-1 to -9	-1	Reduced negative impact
-10 to -18	-2	Less negative impact
-19 to -35	-3	Moderately negative impact
-36 to -71	-4	Significantly negative impact
-72 to -108	-5	Extremely negative impact

9.1 Risk Assessment and Environmental Management Plan

The EMP provides management options to ensure impacts of the agricultural and related activities on the farming unit are minimised. An EMP is a tool used to take pro-active action by addressing potential problems before they occur. This should limit corrective measures needed, although additional mitigation measures might be included if necessary. The environmental management measures are provided in the tables and descriptions below. These management measures should be adhered to during the execution of various activities on the farming unit. This section of the report is also presented as a stand-alone document for easy reference. All personnel taking part in the operations of the farm should be made aware of the contents of this section, so as to plan the operations accordingly and in an environmentally sound manner.

The objectives of the EMP are:

- to include all components related to operational and possible construction activities of the farming unit;
- to prescribe the best practicable control methods to lessen the environmental impacts associated with the farm;
- to monitor and audit the performance of operational personnel in applying such controls; and

- to ensure that appropriate environmental training is provided to responsible operational personnel.

Various potential and definite impacts will emanate from the operations, maintenance/construction and decommissioning phases. The majority of these impacts can be mitigated or prevented. The impacts, risk rating of impacts, as well as prevention and mitigation measures are listed below.

As depicted in the tables below, impacts related to the operational phase are expected to mostly be of medium to low significance and can typically be mitigated to have a low significance. The extent of impacts are largely site specific to local and are not of a permanent nature. Due to the nature of the surrounding areas, cumulative impacts are possible and the most important of these are potential groundwater and biodiversity/ecological impacts.

9.1.1 Planning

During the phases of planning for the operations, maintenance/construction and decommissioning of the farming unit, it is the responsibility of the Proponent to ensure they are and remain compliant with all legal requirements. The Proponent must also ensure that all required management measures are in place prior to, and during all phases, to ensure potential impacts and risks are minimised. The following actions are recommended for the planning phase and should continue during all other phases of the project:

- Ensure that all the necessary permits from the various ministries, local authorities and any other bodies that governs the operations, maintenance/construction and decommissioning activities on the farm remain valid. These include the water abstraction permit, and a consumer installation certificate.
- Ensure all appointed contractors and employees enter into an agreement, which includes the EMP. Ensure that contractors, sub-contractors, employees and all personnel present on site understand the contents of the EMP.
- Make provisions to have a Health, Safety and Environmental (HSE) Coordinator to implement the EMP and oversee occupational health and safety as well as general environmental related compliance.
- Make provision for a community liaison officer to deal with complaints.
- Have the following emergency plans, equipment and personnel on site, where reasonable, to deal with all potential emergencies:
    - EMP, risk management plan, emergency response plan and HSE manuals;
    - Adequate protection and indemnity insurance cover for incidents;
    - Procedures, equipment and materials required for emergencies (e.g. firefighting, first aid, etc.).
- Establish and maintain a fund for future ecological restoration, specifically for instances of environmental damage caused during operations including pollution remediation where required. Should project activities cease completely, and future land-use will not involve agriculture, the funds should be utilised to remove all redundant infrastructure and waste.
- Establish and/or maintain a reporting system to report on aspects of operations, maintenance/construction, and decommissioning as outlined in the EMP. Keep monitoring reports on file for bi-annual submission to MEFT in support of environmental clearance certificate renewal applications. This is a requirement by MEFT.
- Appoint a specialist environmental consultant to update the environmental assessment and EMP and apply for renewal of the environmental clearance certificate prior to expiry.

9.1.2 Revenue Generation in the Professional Sector

Consulting and professional services are engaged with for assistance in applications for new permits and renewal of existing permits such as the water licensees, fuel storage and environmental clearance certificates. In addition, specialist irrigation systems, pumps and implements used by the agricultural project, require specialist and professional services. Such services may further be extended to pest control for operations, and accounting and legal services for administrative processes. All of these services are paid for and therefore the agricultural project contributes to revenue generation in the local and national sectors. In addition, during many of these processes, such as per the renewal of water licenses, information is generated which informs and facilitates planning of the Proponent as well as affected parties and governmental agencies.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Planning	Employment and contribution to local and national economy	3	2	3	3	2	48	4	Definite
Daily Operations	Contracted services and contribution to local and national economy	2	1	3	3	1	14	2	Definite
Indirect Impacts	Increased economic resilience in the professional sector	3	1	3	1	1	15	2	Highly Probable

Desired Outcome: Contribution to national treasury and increased economic resilience in the local and national professional sector.

Actions

Enhancement:

- Contract local Namibians where possible.
- Adhering to permit and license conditions on reporting.
- Deviations from this practice must be justified.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Service providers' contracts or agreements or records be kept.
- All reporting, monitoring and information sharing records kept on file.

9.1.3 National Development Goals: Water, Agriculture and Land Use Planning

The agricultural project pins down key development goals and challenges which were identified as part of the Namibian development goals. It may be considered as an agricultural / irrigation project which aims at generating income from foreign sectors by providing the most value per resource (water, soil and labour). In addition, the project is located in line with the regional planning initiatives which identified the location as an area for agricultural development. The project will further contribute to the national climate change combatting initiatives through crop diversification and proposed resilient crop cultivation. Developing of the agricultural sector was identified as one of the core plans within the NDPs for Namibia. The agricultural project therefore is considered to be a positive contributor to achieving national development goals.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Planning	Project implementation in line with the NDP and regional land use planning	4	1	2	1	1	16	2	Highly Probable
Daily Operations	Expansion of the agricultural sector in the Region. Project implementation in line with the regional land use planning	3	2	2	2	2	36	4	Highly Probable
Indirect Impacts	Contributing to achieving the goals set out in Vision 2030 for Namibia	3	1	3	3	3	27	3	Highly Probable

Desired Outcome: Continued contribution to the development of the region as well as implementation of project activities in line with NDPs and Vision 2030.

Actions

Enhancement:

- Liaison with local and national governmental agencies through appropriate financial and social responsibility reporting.
- Increase recycling initiatives and incorporate additional greenhouse gas reduction activities such as conservation tillage and climate smart agriculture.
- Infrastructure maintenance and development such as, road servitude, water- and sanitation system developments (provision to employees) and node development. Where possible, public and private partnership regarding projects should be considered.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- All project contributions towards regional development, inclusive of communications held with relevant authorities, to be kept on file.
- Monitoring of borehole water levels and water abstraction (monthly) and submit to the relevant custodian on a quarterly basis.

9.1.4 Skills and Development

Training is essential to all aspects of the operations. Relative to responsibility, every employee requires the skillset to conduct tasks which form part of the operation. General skills in cattle handling, for example, may be acquired through on the job training and guidance from skilled workers. Progressive training in terms of, for example, safe pesticide application or specialised equipment handling (such as tractor operator) may require additional resources to aid in the training such as demonstrations, manuals and explanations. The skills and training of employees allow them to conduct certain tasks safely and or according to the required standard for continued operations.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Employment and transfer of skills, technological advancements	2	1	2	3	1	12	2	Definite
Daily Operations	Employment and transfer of skills	2	1	2	3	2	14	2	Definite
Indirect Impacts	Employment and transfer of skills in Namibia's agricultural sector	2	1	2	3	3	16	2	Definite

Desired Outcome: To see an increase in skills of local Namibians, as well as development and technological advancements in the agricultural industry.

Actions

Enhancement:

- Sourcing of employees and contractors must first be at local level and if not locally available, regional or national options should be considered. Deviations from this practice must be justified.
- Inform employees about parameters and requirements for references upon employment.
- Provide managerial references for unofficial training or skills transfer when conducted.
- Relative to their responsibilities, provide on-farm training for all staff involved in irrigation management, including but not limited to:
  - Correct agricultural techniques
  - Emergency procedures
  - System monitoring for problem identification
  - System maintenance
- Relative to their responsibilities, provide on-farm training for all staff involved in pesticide application / agrochemical , including but not limited to:
  - The safe transport, handling and storage of pesticides
  - Warning and advice pictograms commonly used on pesticide labels
  - Disposal of leftover pesticide and or pesticide containers
- Ensure first-aid and fire-fighting training for a portion of the workforce.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Keep records of all training provided to employees.
- Ensure that all training is certified or managerial references provided (proof provided to the employees) inclusive of training attendance, completion and implementation.
- Include all information in a bi-annual report.

9.1.5 Revenue Generation and Employment

Skilled and unskilled labour are required for the operations and maintenance/construction activities associated with the farming unit. Importantly, employment provided is permanent and long term and in some instances, generational. Livelihoods are thus sustained and the spending power of the local community increased. Through continued long term employment, economic resilience is enhanced of individual employees.

Through employment, the Proponent also contributes to the social security while significant contributions are also made to the Namibian Revenue Services. Revenue is generated through the sale of products on national and international markets.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Employment and contribution to local and national economy	2	1	2	2	2	12	2	Definite
Daily Operations	Employment contribution to local and national economy	2	1	3	3	1	14	2	Definite
Indirect Impacts	Decrease in unemployment, contribution to local economy	3	1	3	3	3	27	3	Definite

Desired Outcome: Contribution to national treasury and provision of employment to local Namibians.

Actions

Enhancement:

- The Proponent must employ local Namibians where possible.
- If the skills exist locally, employees must first be sourced from the area, then the region and then nationally.
- Deviations from this practice must be justified.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Bi-annual summary report based on employee records.

9.1.6 Agricultural Produce

The project is in line with the objectives of Namibia's NDPs and contributes to the economy of, and food security in, Namibia. Locally produced crops decrease the amount of crops that needs importing.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction and Daily Operations	Contribution to economy, contribution to food security in Namibia	1	2	3	3	2	16	2	Definite
Indirect Impacts	Reduced import needs, contribution towards a positive trade balance, spread of knowledge and skills, increased crop productivity	1	2	3	3	3	18	2	Definite

Desired Outcome: Maximum contribution to the food security and economy of Namibia. Provide a positive contribution to the trade balance of Namibia by reducing the amount of imported produce and exporting higher value products.

Actions:

Enhancement:

- Teach employees on sustainable farming practices to enable the spread of knowledge and skills and thereby increase the productivity of small-scale farming as well.
- Diversification and continuous improvement to maximise sustainability of the farm.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Bi-annual reporting on educational programmes and training conducted.

9.1.7 Health, Safety and Security

Daily operational and intermittent maintenance and construction activities on the farming unit are reliant on human labour. Such activities have varying degrees of health and safety risks. Examples include the operation of vehicles and machinery with moving parts, such as harvesters, and the handling of hazardous chemicals with inherent health hazards, such as pesticides and fuel, when ingested, inhaled or physical contact occur. Encounters with wild animals, and especially venomous species like snakes, may pose risks to employees. The provision of personal protective equipment, and the intended use thereof, is paramount. Security risks relates to unauthorized entry on the farming unit, theft and sabotage.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Physical injuries, exposure to chemicals and criminal activities	1	-2	3	3	1	-14	-2	Probable
Daily Operations	Physical injuries, exposure to chemicals and criminal activities	1	-2	3	3	2	-16	-2	Probable

Desired Outcome: To prevent injury, health impacts and theft.

Actions

Prevention:

- Implement and maintain an integrated health and safety management system, to act as a monitoring and mitigating tool.
- Comply with all health and safety standards as specified in the Labour Act and related legislation.
- Clearly label dangerous and restricted areas as well as dangerous equipment and products such as agrochemicals.
- Lock away or store all equipment and goods on site in a manner suitable to discourage criminal activities (e.g. theft).
- Provide all employees with required and adequate personal protective equipment (PPE) where required.
- Ensure that all personnel receive adequate training on the operational procedures of equipment and machinery and the handling of hazardous substances.
- Train selected personnel in first aid and ensure first aid kits are available on site.
- The contact details of all emergency services must be readily available.
- Implement a maintenance register for all equipment whose malfunction can lead to injury or exposure to hazardous substances.
- Apply and adhere to all industry specific health and safety procedures and regulations applicable to the handling of food produce for markets.

Mitigation:

- Treat all minor work-related injuries immediately and obtain professional medical treatment if required.
- Assess any safety problems and implement corrective action to prevent future occurrences.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Record any incidents with the actions taken to prevent future occurrences.

- Compile a bi-annual report of all incidents reported. The report should contain dates when training was conducted and when safety equipment and structures were inspected and maintained.

9.1.8 Fire

Construction activities, failing electrical infrastructure, mechanical operations and fires outside of designated areas, may increase the risk of the occurrence of unplanned and / or uncontrolled fires, which may spread into the nearby fields and surrounding farms. Lightning may cause natural fires during the dry season. Farming operations do not present the same fire risk as operations which include charcoal production in the greater area. Uncontrolled fires which have generated in other areas will present a risk to existing and prosed operations.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Fire risk	1	-2	2	2	1	-10	-2	Probable
Daily Operations	Fire risk	1	-2	2	2	1	-10	-2	Probable

Desired Outcome: To prevent property damage, veld fires, possible injury and impacts caused by uncontrolled fires.

Actions

Prevention:

- Maintenance of firebreaks, especially along fences and the power line servitude.
- Prepare a holistic fire protection and prevention plan. This plan must include evacuation plans and signage, an emergency response plan and a firefighting plan.
- Ensure fire-fighting equipment are maintained in good working order at all times. Ensure such equipment is readily available / unobstructed access.
- Personnel training (safe operational procedures, firefighting, fire prevention and responsible housekeeping practices).
- Ensure all flammable chemicals are stored according to material safety data sheet (MSDS) and SANS instructions and all spills or leaks are cleaned immediately.
- Maintain regular site, mechanical and electrical inspections and maintenance.
- Maintain firefighting equipment and promote good housekeeping.
- Notify the farmers' association as well as all surrounding farmers if planned burns (e.g. to create firebreaks) are planned.
- Allow fires used for purposes such as cooking (by staff) in designated areas only.

Mitigation:

- Implement the fire protection and firefighting plan in the event of a fire.
- Quick response time by trained staff will limit the spread and impact of fire.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Maintain a register of all incidents on a daily basis. Include measures taken to ensure that such incidents do not repeat themselves.
- Compile a bi-annual incidents report. The report should also contain dates when fire drills were conducted and when firefighting equipment were tested and training given.

9.1.9 Noise

Noise is generated by various operational and possible construction activities. Machinery like generators, machinery, vehicles and harvesters cause elevated noise levels that may result in hearing impairment after long term exposure. Activities are generally remote from receptors other than the Proponent, his employees and their families residing on the farming unit. The nature of the noise is related mainly to the ongoing operations and mechanical maintenance, typically on a farm.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Excessive noise generated from construction activities – nuisance and hearing loss	1	-1	2	2	1	-10	-1	Probable
Daily Operations	Noise generated from the operational activities – nuisance and hearing loss	1	-1	2	2	1	-10	-1	Definite

Desired Outcome: To prevent any nuisance and hearing loss due to noise generated.

Actions

Prevention:

- Follow Health and Safety Regulations of the Labour Act and/or World Health Organization (WHO) guidelines on maximum noise levels (Guidelines for Community Noise, 1999) to prevent hearing impairment.
- Regularly service all machinery to ensure minimal noise production.

Mitigation:

- Hearing protectors as standard PPE for workers in situations with elevated noise levels.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Health and Safety Regulations of the Labour Act and WHO Guidelines.
- Maintain a complaints register.
- Bi-annual report on complaints and actions taken to address complaints and prevent future occurrences.

9.1.10 Waste Production

Various waste streams result from the operational and possible construction and maintenance activities. Waste may include hazardous waste associated with hydrocarbon products and chemicals, as well as soil and water contaminated with such products. Construction waste may include building rubble and discarded equipment. Domestic waste will be generated by the residents and employees on the farm. Most of the farming related waste can be re-used and or recycled, however certain waste, such as empty pesticide containers are hazardous and should be disposed of according to hazardous waste requirements.

Waste presents a contamination risk and when not removed regularly may become a health and/or fire hazard and attract wild animals and scavengers. Sewage is a form of liquid biological waste that needs disposal.

Since no official waste disposal facilities, especially for hazardous waste, are available, all waste that cannot be re-used are burned at dedicated waste sites.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Excessive waste production, littering, illegal dumping, contaminated materials	1	-2	2	2	2	-12	-2	Definite
Daily Operations	Excessive waste production, littering, contaminated materials	1	-2	2	2	2	-12	-2	Definite

Desired Outcome: To reduce the amount of waste produced and prevent pollution and littering.

Actions

Prevention:

- Implement waste reduction measures. All waste that can be re-used/recycled must be kept separate.
- Ensure adequate temporary storage facilities for disposed waste are available.
- Prevent windblown waste from entering the environment.
- Prevent scavenging (human and non-human) of waste at the storage facilities.
- Educate employees on the importance of proper waste handling and disposal.

Mitigation:

- Waste should be disposed of regularly and at appropriately classified disposal facilities, this includes hazardous material (empty chemical containers and contaminated materials, soil and water).
- Discarded waste should be disposed of and burned regularly at a dedicated site to reduce health and pollution risks.
- Empty chemical containers that may present a contamination/health risk must be treated as hazardous waste. Workers should not be allowed to collect such containers for purposes of storing water or food. This can be achieved by puncturing or crushing such containers prior to disposal.
- Liaise with the applicable authorities regarding waste and handling of hazardous waste.
- Ensure all ablution facilities are connected to properly constructed septic tank systems to prevent groundwater contamination.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Maintain a register of disposal of hazardous waste. This should include type of waste, volume as well as disposal method/facility.
- Record any complaints received regarding waste with notes on actions taken.
- All information to be included in a bi-annual report.

9.1.11 Ecosystem and Biodiversity Impact

Agriculture and related activities are ongoing on the farming unit. Possible expansion is planned on existing cleared areas and no further impacts on vegetation are thus expected from additional land clearing. Rangeland improvement is an ongoing endeavour as part of the aftercare program, while cattle numbers are continually evaluated to avoid the risk of overgrazing.

Irresponsible pesticide use, for example as method of vermin control, may impact on scavengers such as vultures and in the long run on top predators through biomagnification in higher trophic levels. Similarly, the use of insecticide on crop fields may also affect non-target species. Over-abstraction of groundwater may potentially have devastating effects on plant and animal populations reliant on it. It not only include the drying up of springs, dying of trees and migration or dying of animals, but also the lowering of cave water levels.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Impact on fauna and flora. Loss of biodiversity	2	-1	3	2	2	-14	-2	Probable
Daily Operations	Impact on fauna and flora. Loss of biodiversity – poaching, poisoning, etc.	2	-1	2	2	2	-12	-2	Probable

Desired Outcome: To avoid pollution of, and impacts on, the ecological environment.

Actions.

Prevention:

- Strictly adhere to pesticide application instructions and use pesticides only for the purposes for which it is registered and marketed. Importantly, pesticides should not be used to kill vermin unless specifically registered for that purpose, and even then alternative, environmentally friendly methods should be investigated and used.
- Restrict access to pesticides, insecticides and any other material which can be used by poachers.
- Prevent spray drift by applying pesticides during calm weather conditions.
- Ensure the employees applying pesticides are trained and / or skilled in the application thereof.
- Educate all contracted and permanent employees on the value of biodiversity and strict conditions prohibiting harvesting and poaching of fauna and flora must be part of employment contracts. Include prohibitions or regulations on the collection of firewood.
- Regular inspection of fences, game footpaths and other sites for snares, traps or any other illegal activities.
- Ensure all fuel, oil, hydraulic fluid and waste oil handling (e.g. servicing of vehicles or refuelling) is conducted on impermeable or bunded areas or make use of drip trays where such structures are not present.

Mitigation:

- For construction activities, if any, contain construction material to a designated laydown area and prevent unnecessary movement out of areas earmarked for clearing and construction.
- Report any extraordinary animal sightings to the MEFT.
- Prevent scavenging of waste by fauna.
- Take disciplinary action against any employees failing to comply with contractual conditions related to poaching and the environment.

Responsible Body:

- Contractor
- Proponent

Data Sources and Monitoring:

- Report on all extraordinary animal or plant sightings or instances of poaching.
- Keep frequent records of borehole water levels and abstracted water volumes to identify any trends or consistent reduction in water levels.
- Compile a bi-annual report on all monitoring results.

9.1.12 Soil Disturbance and Contamination

Without good and suitable soil, existing and proposed farming operations will not be possible. All farming operations have an impact on the soil, some by a lesser degree and others more extensively. Cattle require drinking posts. At these sites there is usually an accumulation of manure which undergoes frequent trampling. Similarly, septic tank-french drain systems may affect the soil, especially if not properly constructed and maintained. In these areas the soil structure and composition may be affected. Overgrazing may lead to soil degradation and erosion. However, crop cultivation has a much more significant impact on not only soil structure, but also composition. Land preparation techniques involve tillage of all areas while infrastructure establishment may necessitate earthworks. Once the dryland crop field have been established, the Proponent further employs no-till (conservation tillage) practises, limiting further soil disturbance. Irrigated fields, however, have higher occurrences of soil compaction which require conventional tillage. Soil is compacted by mechanical activities such as planting, crop spraying and harvesting as well as livestock being allowed on the field after harvesting.

Once crop fields have been established, the addition of agrochemicals may change the soil composition. Fertiliser is added for certain elements lacking in the existing soil while pesticides may remain in the soil until broken down. In some instances, the irrigation itself, which is often more than the natural rainfall, may further alter the soil composition as the water dissolves of reacts with elements of the soil.

Apart from the crop and cattle related activities, hydrocarbon spills and leaks from machinery, equipment or failing fuel storage infrastructure may also affect the soil composition. All of the processes have the potential to contaminate the soil rendering it less feasible for crop cultivation.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery.	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Over application of fertilizer, pesticides, herbicides, etc. Sewerage system malfunction.	2	-1	2	2	1	-10	-2	Improbable

Desired Outcome: To prevent the contamination, compaction, erosion, or structure disturbance of soil.

Actions

Prevention:

- Appoint reputable contractors.
- Vehicles may only be serviced on a suitable spill control structure.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.
- Follow prescribed dosage of fertilizers and pesticides / herbicides and to avoid over application. Where possible application decision should be based on soil testing and plant analysis. Fertiliser application should consider soil temperature and moisture content and not be applied to severely compacted soils.
- Maintain sewerage systems and conduct regular monitoring.
- All hazardous waste must be removed from the site and disposed of timeously at a recognised hazardous waste disposal facility, including any polluted soil or water.

- All hazardous chemicals and fuel should be stored in a sufficiently bunded area, as per MSDS requirements.
- Where possible, soil compaction from stock grazing and/or heavy machinery movement should be minimised.
- Restrict heavy machinery to designated areas.
- Retain appropriate indigenous vegetation buffers along soil berm and cut-off trenches.
- Increased crop residue left in the soil where possible.

Mitigation:
- All spills must be cleaned up immediately.
- Consult relevant MSDS information and a suitably qualified specialist where needed.

Responsible Body:
- Proponent
- Contractors

Data Sources and Monitoring:
- Maintain MSDS for hazardous chemicals.
- Continued visual monitoring for soil compaction.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained.
- Registers be kept by the Proponent on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.
- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- All spills or leaks must be reported on and cleaned up immediately.

9.1.13 Groundwater and Surface Water Contamination

Leakages and spillages of hazardous substances from vehicles, waste oil handling and accidental fuel, oil or hydraulic fluid spills during the operational phase may contaminate the environment. Increase of nutrient levels (from over application of fertilizers or pesticides) in the soil that can leach to the groundwater. Runoff from over-irrigation and or rainfall events may carry chemical components, such as fertilisers and or pesticides from the site. Pollution due to sewerage system overflow or leakage may further put the groundwater at risk.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery.	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Over application of fertilizer, pesticides, herbicides, etc. Sewerage system malfunction.	2	-1	2	2	1	-10	-2	Improbable

Desired Outcome: To prevent the contamination of groundwater, surface water and soil.

Actions

Prevention:

- Appoint reputable contractors.
- Vehicles may only be serviced on a suitable spill control structure.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- All hazardous chemicals and fuel should be stored in a sufficiently bunded area, as per MSDS requirements.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.
- Follow prescribed dosage of fertilizers and pesticides / herbicides and to avoid over application.
- Maintain sewerage systems and conduct regular monitoring.
- All hazardous waste must be removed from the site and disposed of timeously at a recognised hazardous waste disposal facility, including any polluted soil or water.
- Train and or guide persons involved with the sewerage systems, or any related effluent system, in terms of maintenance and operation to ensure the system is operated effectively.

Mitigation:

- All spills must be cleaned up immediately.
- Consult relevant MSDS information and a suitably qualified specialist where needed.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Maintain MSDS for hazardous chemicals.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained.
- Groundwater should be sampled and analysed to test for nitrate concentrations from the fertilizers and for traces of chemicals used in pesticides and herbicides.
- Registers be kept by the Proponent on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.

- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- All spills or leaks must be reported on and cleaned up immediately.

9.1.14 Groundwater Abstraction

Groundwater abstraction is a very sensitive topic in a dry country where the value of land is drastically reduced if no or unusable groundwater is present on the land. Abstraction of groundwater must be done in a sensible way not to impact on other groundwater users that depend on such groundwater. This includes water abstracted for human and animal use, irrigation, and also ecosystems that depend on groundwater. A typical groundwater balance was compiled to illustrate the potential consequences of over abstraction of groundwater, see Appendix A. Recharge to the area is considered to be comparatively high.

In a typical groundwater environment, a water balance would consist of inflow and outflow of the groundwater system. Over time, an equilibrium (or steady state) is normally reached with rising water tables following good recharge events and declining water tables when recharge is below average. Inflow into the system would typically be from infiltration following rainfall in the area and in upstream areas. Outflow would be comprised of water leaving the system through springs and as outflow over the lower boundary of the groundwater system as well as evapotranspiration losses. Groundwater abstraction through boreholes is important as this is normally necessary to sustain human and animal demands where such users became essentially dependant on the abstracted groundwater as a reliable and sustainable source.

Typical consequences of over abstraction will include a lowering in the water table. This may further lead to the drying up of boreholes, springs, and shallow wells. Vegetation will also be impacted where such vegetation has access to groundwater.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2)Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Over-abstraction of the local aquifer, decrease in the local hydraulic head.	2	-2	2	2	2	-24	-3	Probable

Desired Outcome: To utilise the groundwater sustainably.

Actions

Prevention:

- Spread the water abstraction points over a larger area to diffuse the impact.
- Monthly water level monitoring as well as rainfall measured and recorded.
- Maintain safe abstraction rates prescribed by test pump evaluations (an abstraction permit with prescribed rates from the MAFWLR is a requirement for this project).
- All irrigation infrastructure meets water license requirements related to flow meters, and limits on flow rate, volume and area irrigated.
- Regular maintenance of the irrigation system and related infrastructure be conducted. Where flow meters need to be replaced, the MAFWLR should be informed accordingly.
- Continual monitoring for blocked nozzles or emitters, leaking hydrants or hoses, irrigator alignment etc.
- Soil moisture assessment conducted along with daily visual checks for excessive runoff or ponding.

Mitigation:

- Reduce abstraction when the water levels nears 5 m below the average rest water level of each borehole.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Monthly boreholes rest water level monitoring.
- Rainfall records
- Baseline values should be reviewed every three years based on all historic water level data.
- A summary report on all monitoring results must be prepared.
- The Proponent supply monitoring returns to the MAFWLR, as required by the permit.

9.1.15 Visual Impact

Agricultural activities are, and will continued to be, conducted across farmland that have already been used for this purpose over the last 60 years, or longer. Cultivated areas are demarcated on old topographic maps, indicating that the area has long since been recognised as an agricultural area. Satellite imagery of 1985 confirm these agricultural areas on the property which is surrounded by similar operations. Expansion areas will therefore add to the existing landscape character. Apart from the landscape character, the radio mast, as recently erected by the Proponent for communication purposes, can be seen from a distance. The structure, which is 24 m high have greater bearing on aviation navigation. Therefore, the Civil Aviation Authority was notified about its presence. No further requirements related to its operations were received. The mast, although visible from nearby receptors such as neighbours, is unlikely to cause any visual disturbance. The structure has no highly reflective aspects and is not located close to a public road.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Aesthetic appearance and integrity of the site	1	-1	2	2	2	6	-1	Probable
Daily Operations	Change in landscape character and aviation navigational interest	1	-1	2	2	2	6	-1	Probable

Desired Outcome: To minimise aesthetic impacts associated with the farm.

Actions

Mitigation:

- Regular waste disposal, good housekeeping and routine maintenance on infrastructure will ensure that the longevity of structures are maximised and maintain a low visual impact.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Compile a bi-annual report of all complaints received and actions taken.

9.1.16 Cumulative Impact

Possible negative cumulative impacts (i.e. the build-up of minor impacts to become more significant) associated with the operational phase and any maintenance/construction activities are mainly linked to traffic, reduction in soil and groundwater quality and groundwater availability. The cumulative increase in employees in the area may put more pressure on biodiversity as a result of poaching or harvesting of plant and animal products. The cumulative positive impacts from farming in the Otjozondjupa Region relates to increased and sustained employment, revenue generation and overall improved living conditions and livelihoods as a result of increased spending power.

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Construction and Operations (Negative)	Waste production, pollution, social ills, traffic, etc.	2	-1	2	2	1	-10	-2	Probable
Daily Construction and Operations (Positive)	Employment, skills development, revenue generation	2	1	2	2	1	10	2	Definite

Desired Outcome: To minimise cumulative all impacts associated with the farm.

Actions

Mitigation:

- Addressing each of the individual impacts as discussed and recommended in the EMP would reduce the cumulative impact.
- Reviewing biannual reports for any new or re-occurring impacts or problems would aid in identifying cumulative impacts. Planning and improvement of the existing mitigation measures can then be implemented.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Reviewing monitoring results based on all other impacts will give an overall assessment of the impacts of the operational phase.

9.2 DECOMMISSIONING AND REHABILITATION

Closure and decommissioning of agricultural and related activities on the farm as a whole is not foreseen during the validity of the environmental clearance certificate or in the near future. However, it is more likely that certain components may be decommissioned. Decommissioning is therefore included for this purpose as well as the fact that construction activities may also include modification and decommissioning of infrastructure. Future land use after decommissioning should be assessed prior to decommissioning and rehabilitation initiated if the land would not be used for future purposes. Should decommissioning occur at any stage, rehabilitation of the area may be required. Decommissioning will entail the complete removal of all infrastructure including buildings and irrigation infrastructure. Any pollution present on the site must be remediated. The impacts associated with this phase include noise and waste production as structures are dismantled. Noise must be kept within WHO standards. Waste should be contained and disposed of at a dedicated waste disposal site and not dumped in the surrounding areas. The EMP for the farm will have to be reviewed at the time of full decommissioning to cater for changes made to the site and to implement guidelines and mitigation measures.

9.3 ENVIRONMENTAL MANAGEMENT SYSTEM

The Proponent could implement an environmental management system (EMS) for their operations. An EMS is an internationally recognized and certified management system that will ensure ongoing incorporation of environmental constraints. At the heart of an EMS is the concept of continual improvement of environmental performance with resulting increases in operational efficiency, financial savings and reduction in environmental, health and safety risks. An effective EMS would need to include the following elements:

- A stated environmental policy which sets the desired level of environmental performance;
- An environmental legal register;
- An institutional structure which sets out the responsibility, authority, lines of communication and resources needed to implement the EMS;
- Identification of environmental, safety and health training needs;
- An environmental program(s) stipulating environmental objectives and targets to be met, and work instructions and controls to be applied in order to achieve compliance with the environmental policy;
- Periodic (internal and external) audits and reviews of environmental performance and the effectiveness of the EMS; and
- The EMP.

10 CONCLUSION

Agricultural and related activities as performed on farming unit, by the Proponent, contributes positively to the economy of Namibia. Food is produced for national markets and the sale of livestock for meat production to both local and international markets. A number of employment opportunities are sustained and skills development within the local workforce occur. Revenue is generated that contributes to the Namibian economy.

Negative impacts associated with operational and intermittent maintenance and construction activities on the farming unit, as summarised in section 9, can successfully be mitigated. Implementing a HSE policy will contribute to effective management procedures to prevent and mitigate impacts. All regulations relating to the agricultural and related activities of the Proponent, including health and safety legislation, should be adhered to and implemented where applicable. Groundwater and soil pollution must be prevented at all times and over abstraction of groundwater prevented. Fire prevention should be key, fire response plans must be in place, and regular firefighting training provided to key employees. All staff must be made aware of the importance of biodiversity and the poaching or illegal harvesting of animal and plant products prohibited. This includes the proper handling and correct application of pesticides. Any waste produced must be properly disposed, re-used, or recycled where possible.

The EMP (Section 9) should be used as an on-site reference document for the operations of the farm. Parties responsible for transgression of the EMP should be held responsible for any rehabilitation that

may need to be undertaken. The Proponent could use an in-house Health, Safety, Security and Environmental Management System in conjunction with the EMP. All operational personnel must be taught the contents of these documents.

Should the Directorate of Environmental Affairs agree with the impacts and related mitigation measures, they may issue an environmental clearance certificate to the Proponent. The environmental clearance certificate will render this document legally binding on the Proponent. The assessment process's aim is not to stop the farming activities, or any of its components, but to rather determine its impact and guide sustainable and responsible development as per the spirit of the EMA.

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Appendix A: Hydrogeological Specialist Study

FARMS KARUCHAS NO. 542 AND STARNBERG NO. 1147, OTJOZONDJUPA REGION

HYDROGEOLOGICAL SPECIALIST STUDY

Assessed by:

Assessed for:

F Blume

October 2025

Project:	**FARMS KARUCHAS NO. 542 AND STARNBERG NO. 1147, OTJOZONDJUPA REGION - HYDROGEOLOGICAL SPECIALIST STUDY**	
Report Version/Date	V1 October 2025	
Prepared for	F Blume PO Box 26 Grootfontein Namibia	
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Cite this document as:	Botha P, Botha S & Schoeman GH. October 2025. Farms Karuchas no. 542 and Starnberg no. 1147, Otjozondjupa Region - Hydrogeological specialist study	
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Report Approval	 Pierre Botha Managing Director	

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List of Abbreviations

CHIRPS-2	Climate Hazards Group Infra-Red Precipitation with Station data version 2
cm	Centimetre
cmol/kg	Centimole per kilogram
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
g/cm³	Grams per cubic centimetre
ha	Hectare
km	Kilometre
km²	Square kilometre
kWh/m²/day	Kilo watt hours per metre squared per day
m	Metre
m³/h	Cubic metre per hour
Ma	Million years
mamsl	Metres Above Mean Sea Level
MAR	Mean Annual Rainfall
MAWLR	Ministry of Agriculture, Water and Land Reform
mbs	Metres below surface
MERRA-2	Modern-Era Retrospective analysis for Research and Applications version 2
mg/cm³	Milligrams per cubic centimetre
mg/kg	Milligram per kilogram
mm	Millimetre
mm/a	Millimetre per annum
NASA	National Aeronautics and Space Administration
No	Number
OML	Otavi Mountain Land

1 INTRODUCTION

Geo Pollution Technologies (Pty) Ltd was appointed by Mr. F Blume (the Proponent) to undertake a hydrogeological specialist study for farms Karuchas FMB/00542 and Starnberg FMB/01147 (Figure 3-1) located in the Otjozondjupa Region. The farms will further be known as the project area. The main commercial activities of the Proponent on the project are includes crop cultivation, livestock farming and charcoal production. For purposes of crop cultivation, the Proponent utilizes approximately 152 ha for irrigation and dryland farming. Pending the outcome of this hydrogeological specialist study, the total hectares of land to be irrigated simultaneously, may be increased. Irrigation are from production boreholes by means of centre pivot irrigation systems.

2 SCOPE OF WORK

The aims of the study were to:

1. Conduct a hydrogeological assessment based on data obtained from an in-field hydro-census survey.
2. Gather historic information and compile a hydrogeological assessment based on the information.
3. Prepare a specialist report of the investigation.

3 METHODOLOGY

Obtain and review relevant available geological and hydrogeological information/reports for the investigation area. Review and delineation of hydrogeological catchment and sub-catchments within the investigation area. This will be based on historic groundwater level data contained in the Department of Water Affairs (DWA) database and from hydro-census data gathered on behalf of the Proponent. Prepare a specialist report of the investigation.

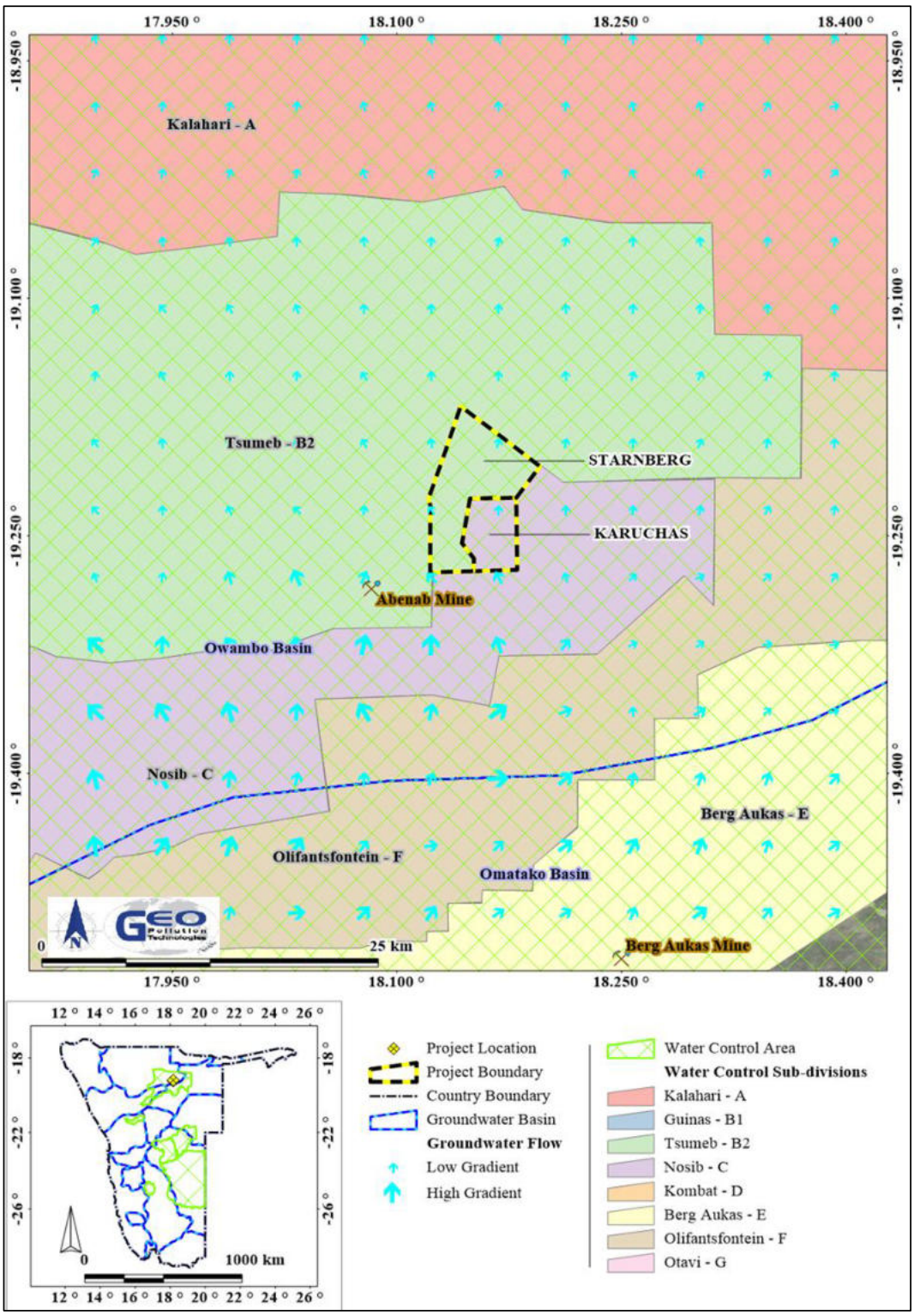


Figure 3-1 Project location and hydrogeological characterisation

4 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS

To protect the environment and achieve sustainable development, all projects, plans, programmes and policies deemed to have adverse impacts on the environment require an environmental impact assessment (EIA), as per the Namibian legislation. The key legislation provided in Table 4-1 govern the environmental assessment process in Namibia and/or are relevant to the project.

Table 4-1. Namibian Law applicable to the project

Law	Key Aspects
The Namibian Constitution	♦ Incorporate a high level of environmental protection. ♦ Land, water and natural resources below and above the surface of the land and in the continental shelf and within the territorial waters and the exclusive economic zone of Namibia shall belong to the State if they are not otherwise lawfully owned.
Environmental Management Act Act No. 7 of 2007, Government Notice No. 232 of 2007	♦ Defines the environment. ♦ Promote sustainable management of the environment and the use of natural resources.
Water Resources Management Act Act No. 11 of 2013	♦ Provide for management, protection, development, use and conservation of water resources. ♦ Prevention of water pollution and assignment of liability.
Soil Conservation Act Act No. 76 of 1969	♦ Law relating to the combating and prevention of soil erosion, the conservation, improvement and manner of use of the soil and vegetation and the protection of the water sources Namibia.

Relevant water resource development and related activities listed as activities requiring an environmental clearance certificate are (Government Notice No. 29 of 2012):

Section 8: Water resource developments:

- 8.1 The abstraction of ground or surface water for industrial or commercial purposes.
- 8.2 The abstraction of groundwater at a volume exceeding the threshold authorised in terms of a law relating to water resources.
- 8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems.
- 8.7 Irrigation schemes for agriculture excluding domestic irrigation.
- 8.8 Construction and other activities in water courses within flood lines.
- 8.9 Construction and other activities within a catchment area.

The relevance of 8.2 is not clear as to under which act such a threshold is defined, if any. The Water Resources Management Act (Act No. 11 of 2013) do not define such a threshold and existing water control areas in which abstraction permits would be required, was not repealed. The repealed Water Act (Act No. 54 of 1956) only requires abstraction permits within water control areas, see Figure 3-1. According to the new Water Resource Management Act (Act No. 11 of 2013) an abstraction licence is now required regardless of whether the project is located within a water control area or not. Abstraction licenses are currently issued by the Ministry of Agriculture Water and Land Reform (MAWLR). The project falls inside a control area; thus, an abstraction permit is a requirement.

Within the Water Resources Management Act (Act No. 11 of 2013) it is clearly stipulated that the purification and disposal of industrial water and effluents as well as the disposal of effluents by local authorities is subjected to the requirements of the Act. Agricultural activities is not subjected to the

requirements of the Act, making the implementation of 8.6 questionable. The return period for flood lines is not provided for, nor a definition of flood lines to make 8.8 applicable. It is however in the Proponent's best interest to ensure that the project area is outside a flood risk area. All land in Namibia is in some form of catchment area, making the practical implementation of 8.9 questionable. It however remains important to consider all activities that would/may impact on the groundwater.

5 DESCRIPTION OF NATURAL ENVIRONMENT

5.1 HYDROGEOLOGICAL LOCATION

The project area comprises of the farms Starnberg FMB/01147 and Karuchas FMB/00542) and are located within the Owambo Groundwater Basin (Figure 3-1). Starnberg is located in the Tsumeb (B2) sub-division of water control area while the Karuchas is located in Nosib (C) sub-division (MAWLR, 2013). The flow direction of the local groundwater is in a northerly direction.

According to Figure 3-1 the Karuchas spring has been recorded on the southern portion of farm Karuchas, with more springs further to the south. During the site visit the location and status of only one of these springs could be determined.

Implications and Impacts

Groundwater Basin committees will likely be formed under the Water Resources Management Act, Act No. 11 of 2013. This will likely give more powers to groundwater users in a basin to ensure sustainability of groundwater usage, but also encourage the optimal usage of groundwater. The project area falls inside a declared water control area and permits are required for drilling and rehabilitation of boreholes as well as for groundwater abstraction.

5.2 CLIMATE

There is a general lack of weather stations and data in Namibia. To overcome this problem, there are a few solutions available. One is to make use of satellite precipitation observation data like CHIRPS 2 or to obtain in-situ observation data/measurements from farmers/individuals in the project area. The second option is not always possible, but when the data is available, it can provide a more precise depiction of the local climatic conditions of the area.

According to the Köppen-Geiger Climate Classification system the project is located in a hot semi-arid climate (BSh) (http://koeppen-geiger.vu-wien.ac.at/present.htm) (Kottek *et al*., 2006). This means that the area receives precipitation below potential evapotranspiration, but not as low as a desert climate and has a mean annual temperature of at least 18°C.

Additionally, long-term precipitation data was obtained for the project area from the CHIRPS-2 (Climate Hazards Group Infra-Red Precipitation with Station data version 2) database (Funk *et al*., 2015). The CHIRPS-2 dataset (Climate Hazards Group Infra-Red Precipitation with Station data version 2) consist of long-term precipitation data (1981 to near-present) obtained from satellite imagery and in-situ station data and therefore represents more recent data. Data is averaged over an area of roughly 5 km by 5 km. This averaging effect should be kept in mind during data analyses as high precipitation from single thunderstorm cells would be averaged out, thereby providing a reduced daily maximum precipitation value.

The Atlas of Namibia average rainfall for the area is 450 to 500 mm/a with a variation of 30 to 40% (Atlas of Namibia, 2022). Based on the CHIRPS-2 dataset (Table 5-1 and in Figure 5-1) the rainfall is well within this range with 465 mm/a, but also with a smaller coefficient of variance of 29%. Both datasets indicate monthly rainfall peaking in January to February. CHIRPS-2 also indicates heavier precipitation (single day events) occurring between January to April, with a single daily maximum of 49 mm in March being the highest. The cumulative seasonal (July to June) precipitation is presented with the average for the last 43 years (Figure 5-1) together with the total daily precipitation. From Figure 5-1 it is clear that the rainfall for 7 of the last 10 seasons were all below average. The potential evapotranspiration is 2,400 to 2,500 mm/a. By dividing the

mean annual potential evapotranspiration into the mean annual precipitation, an aridity index value for the area was computed as 0.2, which indicates the area to be Semi-Arid.

Table 5-1 Rainfall statistics based on CHIRPS-2 data (Funk *et al.*, 2015)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (mm)	16	29	25	0	0	0	0	0	0	0	8	16
Maximum (mm)	285	216	156	111	7	1	0	0	7	45	99	154
Average (mm)	114	108	82	29	1	0	0	0	1	16	41	73
Variability (%)	57	46	44	83	187	346	656	656	191	71	50	48
Daily maximum (mm)	44	45	49	48	6	0	0	0	6	22	31	37
Average rain days	14	12	8	3	0	0	0	0	1	4	8	11

Season July - June average: 465 mm | Season coefficient of variation: 29 %

Date range: 1981-July-1 to 2024-June-30 | Lat: 19.26840°S; Long: 18.12290°E

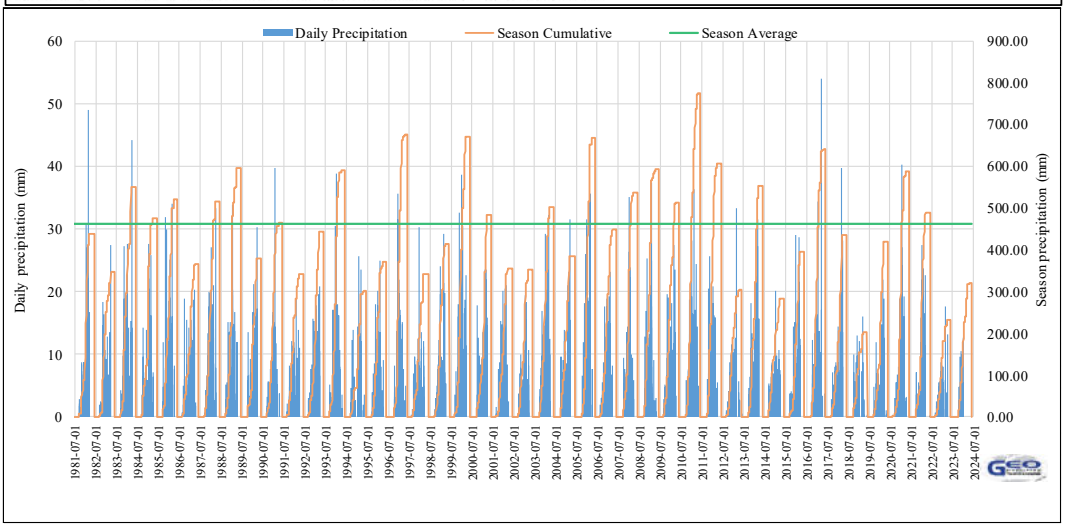
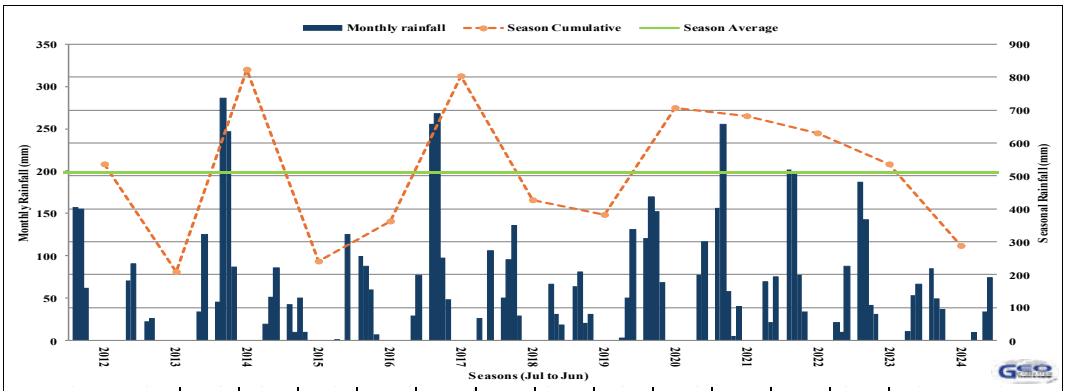


Figure 5-1 Daily and seasonal rainfall from CHIRPS-2 data (Funk *et al.*, 2015)

The Proponent has provided local observed rainfall measurements recorded over the last 13 years (2012-Near present) across several location in the area. The data is summarised in Figure 5-2. Seasonal correlation between these datasets were observed.



Total 13 Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Rainfall (mm/a)		
Average Rainfall (mm)	114.88	140.23	80.27	27.08	3.08	0.00	0.00	0.00	0.69	16.69	35.85	90.77	Min	Avg	Max
Maximum Rainfall (mm)	256	286	247	87	40	0	0	0	9	69	77.5	131	208	509.5	823
Year of maximum rainfall	2017	2014	2014	2014	2021	2012	2012	2012	2024	2021	2020	2019	Years above average: 7		

Figure 5-2 Localised rainfall observations provided by the Proponent

Similar to precipitation data, temperature data is also lacking for the project area, with the Atlas of Namibia presenting only crude, large scale averages. To have an idea of temperatures in the area, monthly temperature data was retrieved from the Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) data set for a height of 2 m above surface (Gelaro *et al*., 2017). This data set is a NASA atmospheric reanalysis, incorporating satellite data integration and aims at historical climate analyses at 0.5° x 0.625° spatial resolution. This translates to roughly 3,640 km², which still is a large area, but is somewhat less crude than the Atlas data.

Table 5-2 presents statistics of daily data abstracted from the MERRA-2 data set for the last 41 years. A minimum temperature of -1.5°C was recorded in June and a maximum temperature of 40.31°C was measured in November. The average annual temperature is between 26-28°C while the average diurnal temperature (difference between daily minimum and maximum temperature) for this area is between 16-18°C. Direct normal solar irradiance for the area is 6.563 kWh/m²/day.

Table 5-2 Temperature statistics based on Merra-2 data

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (°C)	9	9	8	5	2	-2	-1	2	4	6	6	9
Maximum (°C)	40	39	39	36	33	31	30	34	37	40	40	40
Average (°C)	25	24	24	22	19	16	16	19	23	26	26	26
Diurnal (°C)	13	12	13	15	17	18	18	19	19	17	15	14
Average days < 0°C	0	0	0	0	0	0	0	0	0	0	0	0

Implications and Impacts

Rainfall events are often thunderstorms with heavy rainfall that can occur in short periods of time ("cloud bursts"). Rainfall in the area is above the Namibian average but varies significantly year on year. Heavy rainfall can lead to soil erosion when improper agricultural practises are employed, while dry seasons will necessitate greater reliance on groundwater resources. Recurring drought conditions may impact on groundwater availability due to reduced aquifer recharge. Pollutants that enter the groundwater can pollute this valuable resource. Rainfall is important for groundwater recharge.

5.3 TOPOGRAPHY & DRAINAGE

The project area falls partly within the Karstveld landscape and partly within the Kalahari Sandveld. The Karstveld landscape is characterised as an area dominated by limestone with little or no surface run-off and a strong development of sinkholes, dolines and caves, while the Kalahari Sandveld, is characterised as a flat, basin of sedimentation, much of which is characterized by aeolian landforms, including linear dunes and pans. The landscape formed through the accumulation of sand from river flow in a wetter climate during post Gondwana breakup. These sediments were reworked during a subsequent drier period. Today relict dunes remain at places from this former drier climate period. Ground surface elevation falls between 1,200 to 1,300 m above sea level and the area falls within the Etosha Pan catchment.

According to Figure 5-3, the area has a slight to undulating slope of <5%. The topographical elevation decreases slightly to the north. The slope direction corresponds well with the inferred groundwater flow direction of the area as indicated in Figure 3-1.

The surface drainage network is poorly developed and locally drains to the north of the project area into the Etosha Pan catchment.

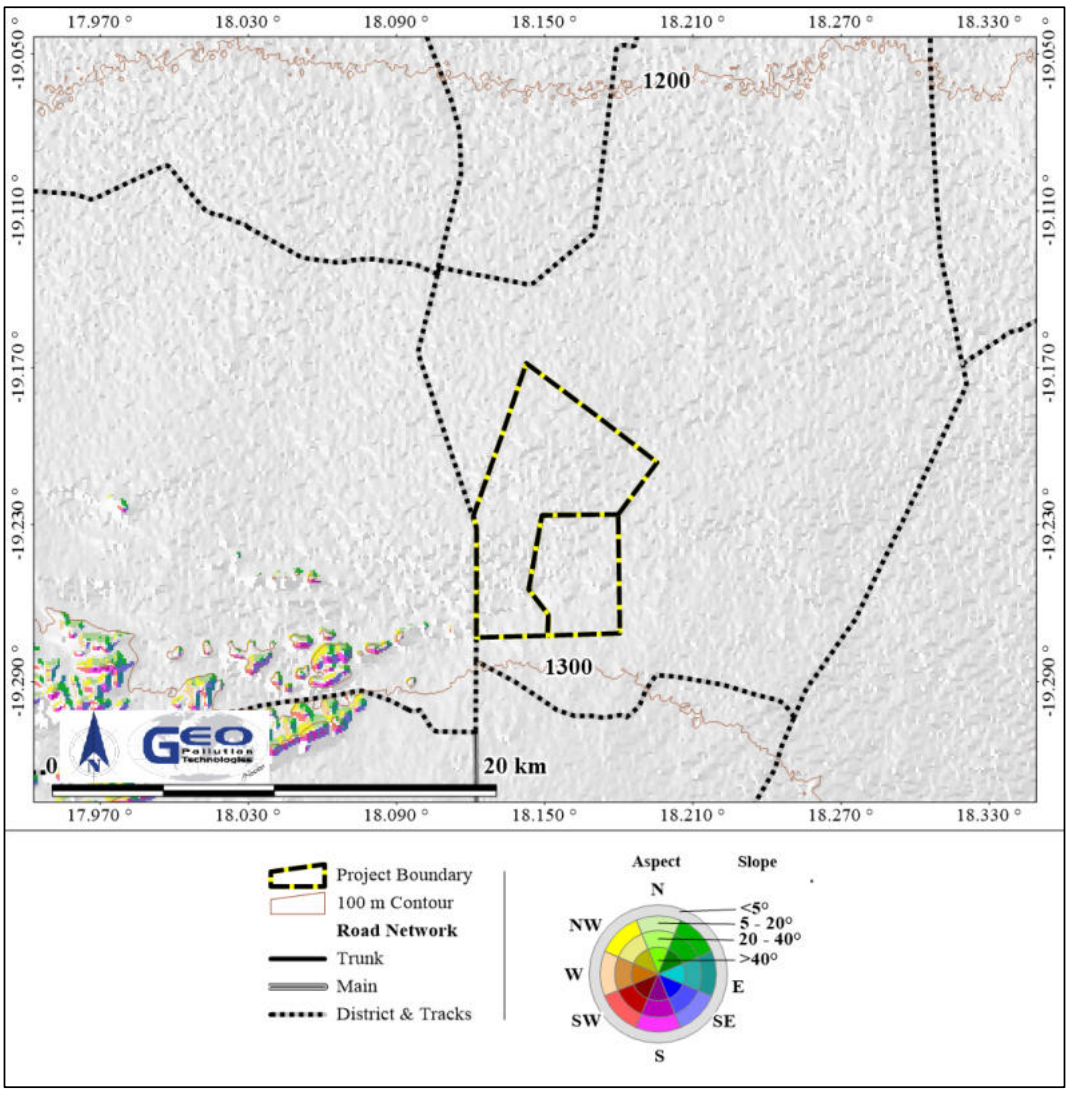


Figure 5-3 Aspect slope and surface drainage

Implications and Impacts

The area is generally flat and suitable for agricultural activities. The lack of major surface runoff and drainage may lead to pooling and even flooding of plains during heavy rainfall events. This may negatively impact soil quality and potential cause contamination. The risk of erosion is relatively low.

5.4 GEOLOGY

Dominant soil and rock types for the region underlaying the project area is presented in Figure 5-4. Dominant soil type for this area is Cambic Calcisol which refers to the soil type commonly found in arid or semi-arid regions with dry seasons. They form in calcium and magnesium rich alluvial, colluvial and aeolian deposits and are alternately dampened by rain and dried by evaporation which results in soft masses or hard layers of calcrete. In addition to this, the calcisol of this particular area is known for having subsurface soil layers of pedogenic change without appreciable illuviated material. The composition of soil in this particular area is roughly

65 - 70% sand, 10 - 15% silt and 25 - 30% clay which gives it the characteristics and texture of Sandy Clay Loam soil. Bulk density was computed to be 1,400 - 1,450 mg/cm³ which means that the soil will affect the root growth of various plants, but not necessarily restrict it. Soils in this area typically reach depths of 140 - 150 cm, have a pH of 4.6 - 5.5 and a cation exchange capacity of 7 - 10 cmol/kg. Furthermore, this region has a water capacity of 20 - 40 mm at root depth.

The dominant rock type underlaying the project area is a thin surface cover of Kalahari sediments, providing suitable soil for crop production. Dominant rock type in the area include dolomite and limestone with the weathered product producing the soils as described.

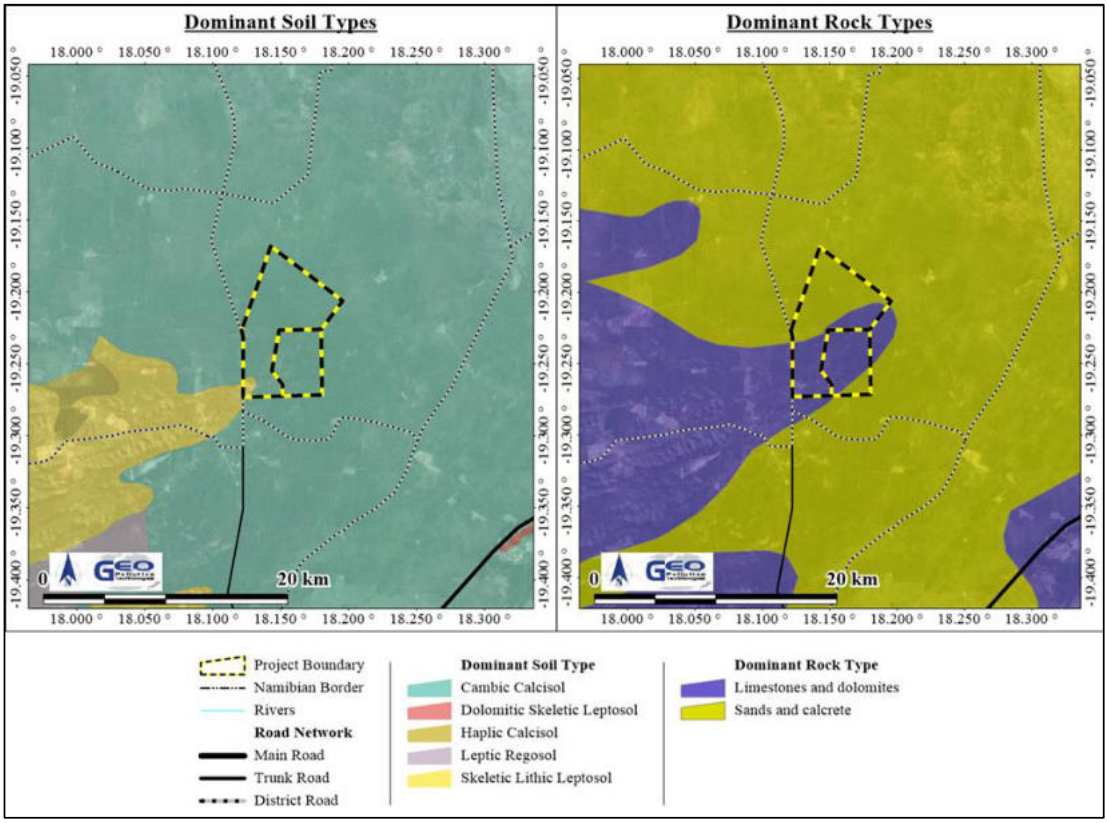


Figure 5-4 Dominant soil and rock types

The geology underlaying the project area formed during the Namibian, Quaternary and Tertiary Age. Locally the geology from the Quaternary and Tertiary Age comprises of the Kalahari Group deposits which consists of sand, calcrete and gravel (Figure 5-5). The Kalahari Group sediments originate mainly from fluvial deposition with some reworking through aeolian processes. Kalahari sediments at the project area form only a surface cover. The Kalahari Group sediments here commonly overlie pre-Kalahari rocks of the Damara Sequence (Namibian Age).

At the project area the Damara Sequence consists of dolostone (bedded and massive) and limestones of the Elandshoek (NEl) and Maieberg (NMa) Formations respectively (Figure 5-6), which belongs to the Tsumeb Subgroup, Otavi Group. Some small outcrops of laminated dolostone from the Berg Aukas Formation, Abenab Subgroup, Otavi Group is also present on Farm Karuchas. The project area falls within the Northern Platform Zone of the Damara Sequence. A tectonostratigraphic zone in which the carbonate-dominated Otavi Group was deposited in a lagoon like environment. Predominant east-west-trending anticlinal structures are common.

Moderate folding of the strata occurred during the Pan African Orogeny (680 - 450 Ma) and resulted in the formation of synclines and anticlines, generally trending east - west. The

development of joints and fractures in the rocks are associated with the folding, which have an impact on the hydrogeological characterization of the area. Major faults and geological structures can be found in the region with the Adelaide Syncline transecting the project area.

Various northeast striking magnetic dykes (subsurface) are known to be present in the area surrounding the project location, as inferred from aeromagnetic data. These dykes seem to be related to the Paresis intrusion which are situated just south of Otjiwarongo, with dykes radiating from this intrusion. Geophysical-interpreted dykes can also occur in the area and strike towards the northeast. The nature of these dykes tend to be mineralised faults with high hydraulic conductivity values. Both the Remnant dykes (8 km to the west) and Tsumeb (further to the west) represented a major exploration target for the NamWater exploration water supply programme to Windhoek. The dykes are thought to have shattered the host rocks during its formation (Hoad, 1992). Where dolomite is the host rock, it forms a zone favourable for the development of karst features and groundwater accumulation.

Several known karst features are present in the region. The mineralised karst chimneys of the Abenab – and Abenab West Mine (Bäumle, 2003) is approximately 3.5 km to the southwest of the project area and are hydrothermal deposit that represents a highly mineralized zone of which metals like vanadium as well as lead, copper and zinc were mined until 1958 (von Bezing *et. al.*, 2014). No sinkholes or caves have been documented near the project area (<30 km).

A number of springs are present in the Otavi Mountainland (OML) and most of these springs are related to the contact zones between relatively impermeable formations of the Grootfontein Metamorphic Complex and more permeable formations of the Damara Sequence. The Karuchas spring has been documented on Farm Karuchas (Figure 5-5), with several other documented springs (i.e. Auritsab) to the south of the project area. Based on the interpretation of the structural geology at the project area, it is assumed that these springs are a product of the inferred groundwater level, the local anticline and syncline structures and the topography.

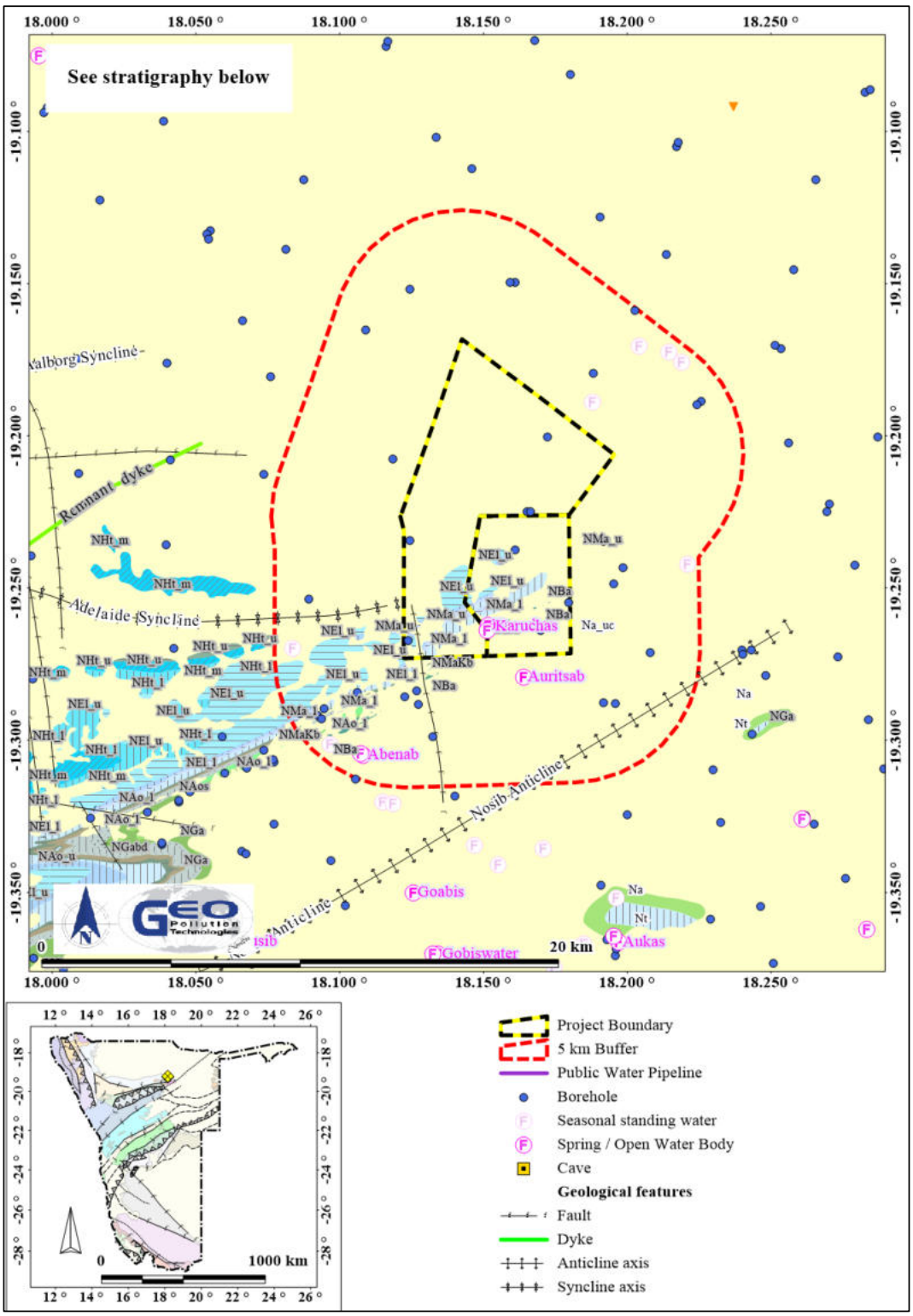


Figure 5-5 Hydrogeological map

Age	Lithcode	Supergroup	Group	Subgroup	Formation	Member	Main Litho	Other Rock
Quaternary	Qs						sand; gravel; calcrete	
Namibian	NHt_u	Damara	Otavi	Tsumeb	Huttenberg		dolostone (bedded)	
	NHt_m						dolostone (bedded)	phyllite
	NHt_l						dolostone (bedded)	chert (algal)
	NEl_u				Elandshoek		dolostone (bedded)	
	NEl_l						dolostone (massive)	
	NMa_u				Maieberg		dolostone (bedded)	
	NMa_l						limestone/marl (bedded)	
	NMaKb					Keilberg	dolostone	
	NAo_u			Abenab	Auros		dolostone	
	NAos						shale	limestone
	NAo_m						dolostone	
	NAo_l						dolostone (cherty)	
	NAo_b						shale	
	NGu				Gauss	Gruis	dolostone (bedded)	
	NGa						dolostone (massive)	
	NGabd						dolostone (bedded)	
	NBa				Berg Aukas		dolostone (laminated; light/dark)	

Figure 5-6 Stratigraphy

5.5 HYDROGEOLOGY

The project area is located inside of the Tsumeb-Otavi-Grootfontein subterranean groundwater control area. Farm Starnberg is located in the Tsumeb (B2) sub-division of water control area while the Karuchas is located in Nosib (C) sub-division (MAWLR, 2013). This is set forth in the Government Notice 1969 of 13 November 1970 and Proclamation 278 of 31 December 1976 (Extension).

The project area is situated in the Owambo Groundwater Basin. Localised groundwater flow may take place along preferred flow paths in different directions, but the larger scale groundwater flow is expected to be in a northern direction (Figure 3-1). Local flow patterns may vary due to groundwater abstraction. Groundwater flow is expected to take place through primary porosity in the surface cover, while it is expected to flow along fractures, faults, dykes/mineralised faults or along contact zones (secondary porosity) and other geological structures present within the underlaying formations (hard rock formations).

The aquifer associated with the project area falls within the Karst Area IV aquifer zoning. Bäumle (2003) described the Elandshoek Formations as the productive aquifer. Pumping test analysis yielded an average transmissivity of 300 m^2/d and typical storage coefficients in the order of 7×10^{-4} for the Elandshoek Formation. The Maieberg Formation presents as a less favourable aquifer and is consider more of an aquitard by Bäumle (2003).

Groundwater quality data is presented in Figure 5-7 as Maucha plots. It is clear that the groundwater of the project area is mostly of a calcium-magnesium-bicarbonate type which suggest the water is recently recharged. Groundwater quality from the project area reflects an aquifer that is typical of a dolomitic hard rock formation host where rapid groundwater recharge takes place.

Table 5-3 presents groundwater statistics for 37 boreholes in a 5 km radius around the project area. The groundwater information was obtained from Department of Water Affairs (DWA) borehole database. This database is generally outdated and more boreholes might be present. The average depth of 16 of the boreholes are 82.59 m below surface and the average yield of 17 of the boreholes is 19.37 m^3/h. The average groundwater level of 29 of the known boreholes is 28.86 m below surface, ranging between 1.2 and 75 m below surface. Groundwater quality falls mostly under Group A category, however some samples triggered Group B and C analysis on Nitrate.

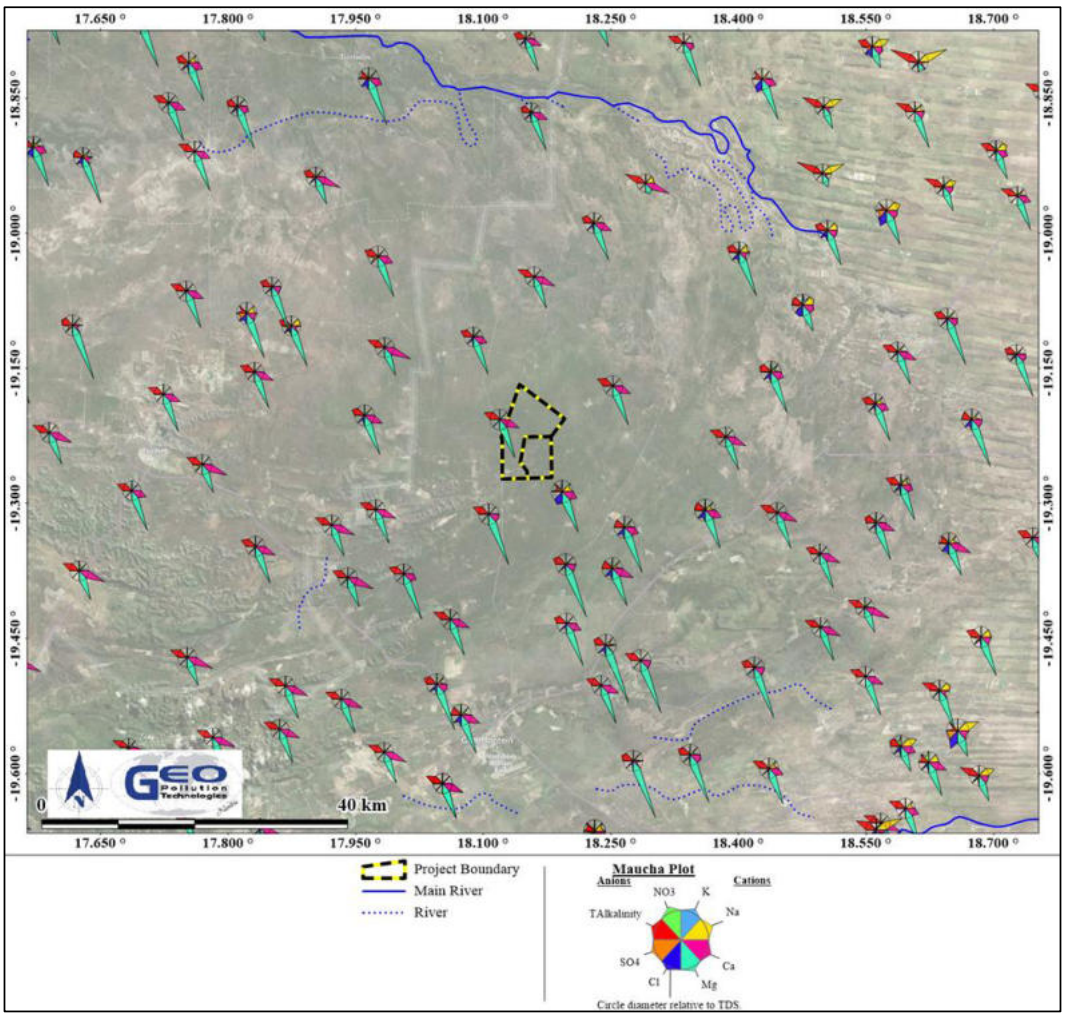


Figure 5-7 Groundwater quality

Table 5-3 Groundwater statistics

	DEPTH (mbs)	YIELD (m^3/h)	WATER LEVEL (mbs)	TDS (ppm)	SULPHATE (ppm)	NITRATE (ppm)	FLUORIDE (ppm)
Data points	16	17	29	25	25	17	25
Minimum	37.00	1.80	1.20	490.00	2.00	0.60	0.10
Average	82.59	19.37	28.86	682.76	14.64	8.85	0.37
Maximum	150.00	55.00	75.00	2,499.00	50.00	30.00	1.00
Group A	18.75%	47.06%	10.34%	96.00%	100.00%	58.82%	100.00%
Limit	50	>10	10	1000	200	10	1.5
Group B	37.50%	11.76%	72.41%	0.00%	0.00%	23.53%	0.00%
Limit	100	>5	50	1500	600	20	2.0
Group C	43.75%	29.41%	17.24%	0.00%	0.00%	17.65%	0.00%
Limit	200	>0.5	100	2000	1200	40	3.0
Group D	0.00%	11.76%	0.00%	4.00%	0.00%	0.00%	0.00%
Limit	>200	<0.5	>100	>2000	>1200	>40	>3
37 known boreholes within the project area and a 5 km buffer around the area							

Statistical grouping of parameters is for ease of interpretation, except for the grouping used for sulphate, nitrate and fluoride, which follow the Namibian guidelines for the evaluation of drinking-water quality for human consumption, with regard to chemical, physical and bacteriological quality. In this case the groupings has the following meaning:

Group A: Water with an excellent quality
Group B: Water with acceptable quality
Group C: Water with low health risk
Group D: Water with a high health risk, or water unsuitable for human consumption

Implications and Impacts

Local groundwater recharge is influenced by a thin veneer of Kalahari deposit, which might influence the sustainability over time. Recharge from the Otavi Mountainland further to the south is likely the main source of groundwater recharge.

It is apparent that the geology and anthropogenic activities in the area has an influence on the quality of the groundwater.

6 ASSESSMENT OF WATER LEVEL MONITORING DATA

Monitoring borehole related water level monitoring data was sourced from the Ministry of Agriculture, Water and Land Reform (MAWLR) in order to construct a hydrological cross-section of the study area. Figure 6-1 was used to identify the inferred flow direction of the groundwater in the area, which flows in a northerly direction. Appropriate boreholes were selected along this flow path to showcase the current level and historic behaviour of the groundwater table. The following boreholes were identified:

- WW27955,
- WW27068,
- WW27221,
- WW27815,
- WW200212,
- WW200215 and
- WW200217

In Figure 6-1, the cross-sectional of the inferred groundwater flow path can be perceived crossing the Omatako and Owambo groundwater basins, as well as the different geological units. The project area is located in the Owambo Groundwater Basin and underlain by geological formations of Namibian and Quaternary Ages (Figure 6-1). The aquifer in the area consists a primary aquifer (Kalahari sediments) and a fractured dolostone aquifer (Otavi Group). It is presumed that these aquifer systems are underlain by a confining layer, the Grootfontein Metamorphic Body/Complex. This basement layer would to a large degree dictates the inferred flow path of the groundwater to the north. Figure 6-2 illustrates the

groundwater table data in comparison with the elevation profile of the cross-section of the inferred flow path. The average, minimum and maximum values can be seen for each of the monitoring wells that were selected along the flow path.

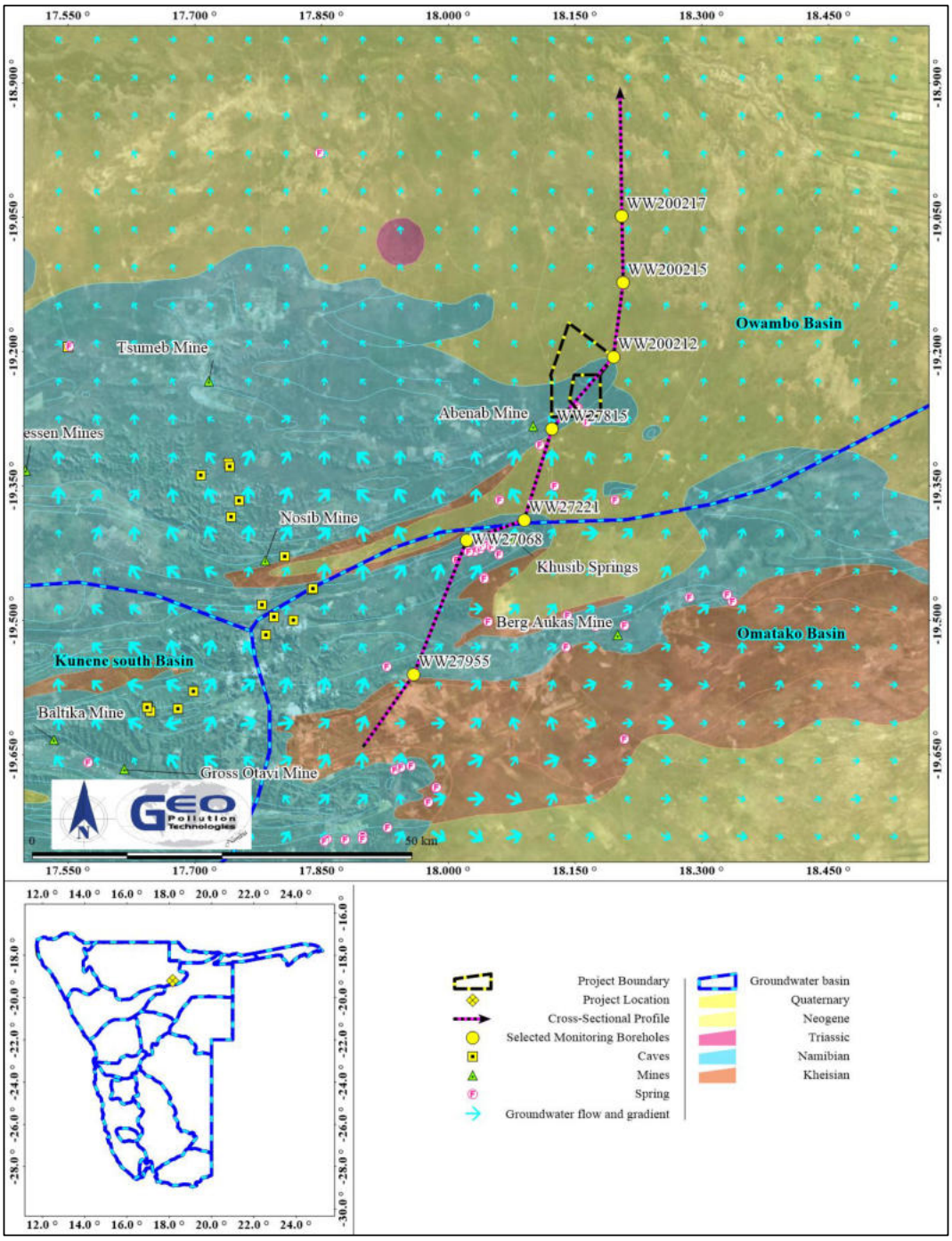


Figure 6-1 Monitor borehole locations, caves, sinkholes and springs

The historical data of these boreholes will be discussed as the cross-section profile migrates in the direction of the groundwater flow (i.e. from south to north).

The monitoring boreholes (WW27955 and WW27068) are located to the south of the project location have recorded groundwater levels from 1987 until 2016. Over this period the water remained relatively stable with some fluctuations. These fluctuation correlates well with recorded above normal rainfall events. Borehole WW27068 is in close proximity to a number of local springs and this is also reflected in its more stable groundwater level profile.

Monitoring data for borehole WW27221 has also been recorded from 1987 until 2016. This borehole responded more to the region groundwater levels. A number of springs are also present near WW27221 and this close proximity to local springs, is also reflected in a more stable groundwater level profile.

Monitoring boreholes (WW27815 and WW200212) are respectively located on the southern and north-eastern boundaries of the project area. The groundwater levels of these two boreholes follows a very similar trend, but with a slight height offset. Good responses associated with above average rainfall events have been recorded.

The last two monitoring boreholes (WW200215 and WW200217) are downstream from the project area. The groundwater levels of these two boreholes also follows a very similar trend, but with a slight height offset. Good responses associated with above average rainfall events have been recorded.

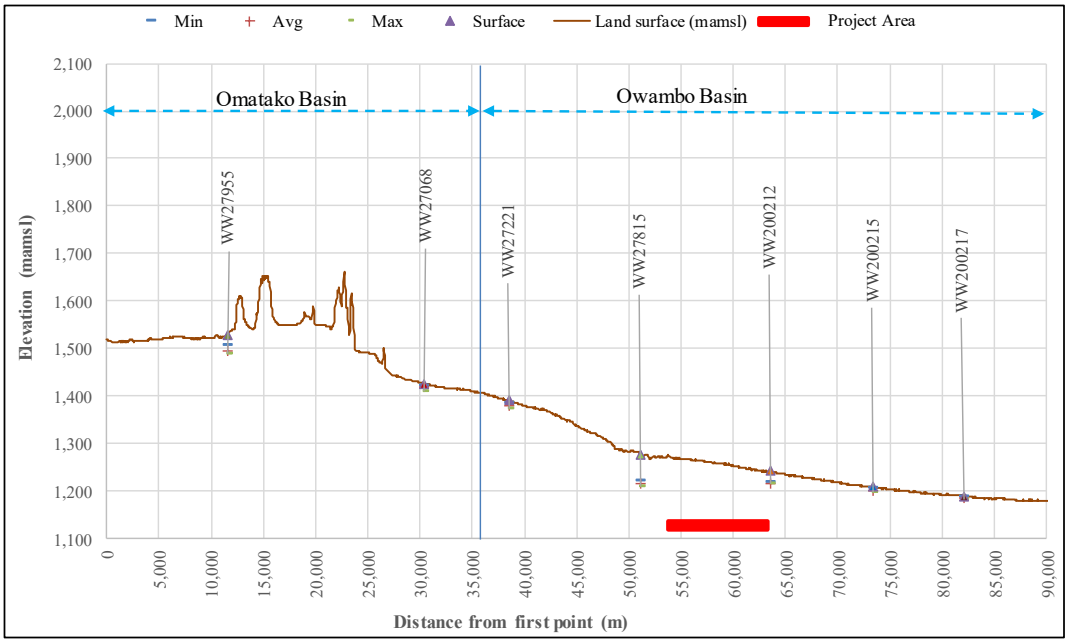


Figure 6-2 Regional water level profile and conceptual geological profile

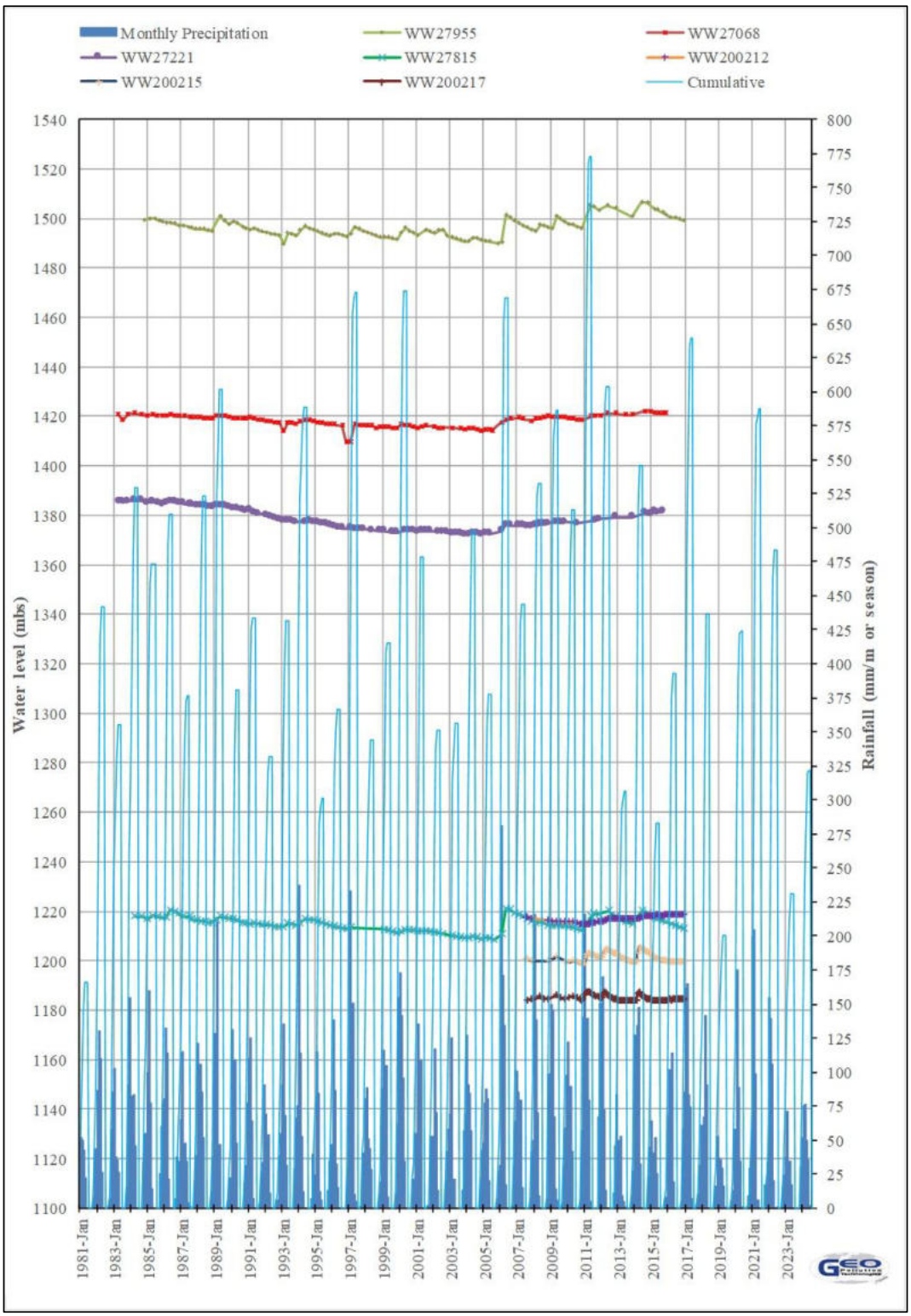


Figure 6-3 Regional water level changes and monthly rainfall

7 WATER SUPPLY AND QUALITY

7.1 GROUNDWATER USAGE

The only available source of water on or near the project area is the local aquifer. The Proponent has drilled several boreholes on different parts of the project area, in order to utilise the groundwater for irrigation, stock watering and domestic uses.

During a hydrocensus survey conducted on 05 March 2024 on the farms (Starnberg and Karuchas) thirteen boreholes and one spring (Karuchas) was visited. Information regarding their use, status and physical description was collected. Seven borehole were identified on the farm Starnberg, while six boreholes and the Karuchas spring was identified on the farm Karuchas. Figure 7-1 illustrates the locations of the thirteen boreholes. Eleven of the thirteen boreholes are equipped with either a submersible pump or a windmill for water extraction. Three boreholes are equipped and used for irrigation. The other remaining boreholes are used for domestic and stock watering purposes.

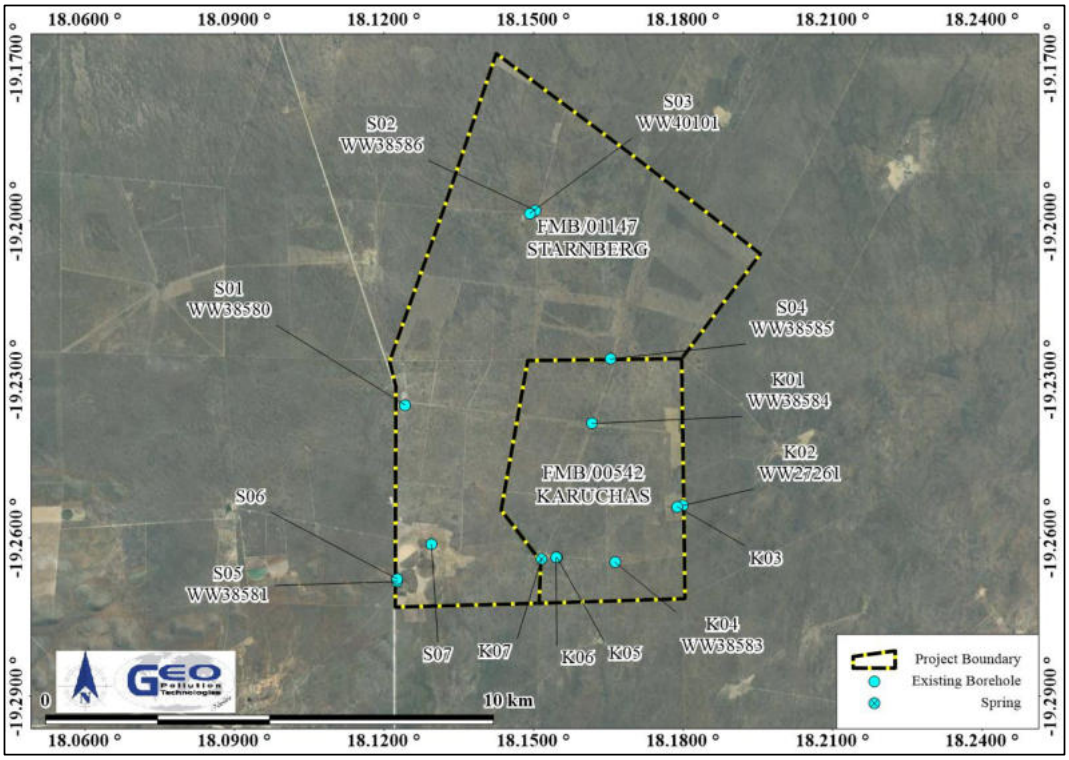


Figure 7-1 Borehole locality map

It was possible to measure or obtain information on all of the boreholes. The resting groundwater levels range between 12 to 56 m below surface. While most of the water levels can be found between 40 and 50 m below surface. The collected borehole data is summarised in Table 7-1.

Table 7-1 Summary of groundwater information obtained from field investigations

Map Ref	Borehole Name	Farm portion	Use	Borehole Depth (m)	Yield (m^3/h)	Water Level (mbs)
S01	WW38580	Starnberg FMB/01147	Stock watering	65	5.00	56
S02	WW38586	Starnberg FMB/01147	Not Used	65	1.50	45
S03	WW40101	Starnberg FMB/01147	Domestic/Stock watering	140	1.50	45

Map Ref	Borehole Name	Farm portion	Use	Borehole Depth (m)	Yield (m^3/h)	Water Level (mbs)
S04	WW38585	Starnberg FMB/01147	Stock watering	65	3.50	51
S05	WW38581	Starnberg FMB/01147	Irrigation	120	60.00	44
S06		Starnberg FMB/01147	Irrigation/Domestic	84	120.00	44
S07		Starnberg FMB/01147	Stock watering	120	5.00	39
K01	WW38584	Karuchas FMB/00542	Stock watering	65	4.00	44
K02	WW27261	Karuchas FMB/00542	Irrigation	100	150.00	30
K030		Karuchas FMB/00542	Monitoring	100		51
K04	WW38583	Karuchas FMB/00542	Stock watering	65	3.00	12
K05		Karuchas FMB/00542	Not Used	100		
K06		Karuchas FMB/00542	Monitoring	100		12
K07	Spring (Karuchas)	Karuchas FMB/00542	Stock	Surface water		

Photo 7-1 S01 Liefling, stock watering

Photo 7-2 S03 Dublin Solar, stock watering

Photo 7-3 S04 Maria Pos, stock watering

Photo 7-4 S05 Huis Pos, domestic watering

Photo 7-5 S07 Kruis Pos, stock watering

Photo 7-6 K03 Solar Pos, irrigation

Photo 7-7 K04 Oos Pos, stock watering

Photo 7-8 K07 Surface Spring (Karuchas), stock watering

7.2 WATER QUALITY ANALYSIS

The Proponent collected two water samples, one on each of the farms. The first sample was taken from S05 (Figure 7-1), a borehole situated near the main farmstead (Farm Starnberg). The second water sample was taken from K04, a stock watering borehole on the Farm Karuchas. The location of these water samples are indicated on Figure 7-1. The water samples were taken 31st of August 2022 and were received on the 6th of September 2022 for analysis (Table 7-2). Original quality reports for these two water samples are attached in Appendix A.

Table 7-2 Analysis of groundwater samples

Chemical parameter	Units	Water quality guidelines and standards (Act No. 11 of 2013, Government Notice No. 268 of 2023)		Sample	
		Ideal Guidelines	Acceptable Standards	I221411/1 (S05)	I221411/2 (K04)
pH		6.0 to 8.5	6.0 to 9.0	7.2	7.2
Electrical conductivity	mS/m	80	300	111.1	105.3
Turbilinity	NTU	0.5	2	0.25	
Total Disolved Soids	mg/l	1000	2000	618	706
P-Alkalinity $CaCO_3$	mg/l	No Value	No Value	0	0
Total alkalinity $CaCO_3$	mg/l	No Value	No Value	545	575
Bicarbonate HCO_3^-	mg/l	No Value	No Value		702
Total hardness $CaCO_3$	mg/l	400	1000	607	586
Ca- Hardness as CaCO3	mg/l	No Value	No Value	277	
Mg Hardness as CaCO3	mg/l	No Value	No Value	329	
Chloride Cl^-	mg/l	100	300	18	13
Fluoride F^-	mg/l	0.7	1.5	0.2	0.2
Sulphite SO_4^{2-}	mg/l	100	300	14	10
Nitrate N	mg/l	6	11	12	0.7
Nitrite N	mg/l	0.1	0.15	0.01	
Sodium Na	mg/l	100	300	13	10
Potassium K	mg/l	25	100	1.2	0.3
Magnesium Mg	mg/l	30	70	80	98
Calcium Ca	mg/l	80	150	111	73
Iron Fe	mg/l	0.2	0.3	<0.01	0.02

Note:
Ideal Guidelines
Acceptable Standards
Exceeding Acceptable guidelines
Exceeding Acceptable guidelines *100

The water analysis provides us an insight on the chemical profile of the groundwater and related aquifer. The water has a very neutral pH of 7.2, with a slightly elevated alkalinity content. This is because of the local geology (dolostone). Similar observations can be made in the Maucha plots (Figure 5-7). Water samples were screened against the water quality standards and guidelines of the Water Resource Management act of 2013, (Act No. 11 of 2013, Government notice No. 268 of 2023).

The screening of groundwater samples revealed several noteworthy findings regarding water quality on the farm. Nitrate concentrations in S05 were found to be slightly elevated above the recommended guidelines. This increase in Nitrate might be attributable to runoff from nearby irrigation fields and /or for a cattle kraal, a phenomenon commonly associated with the process of nitrification. Elevated levels of nitrate in groundwater pose a risk, particularly due to their potential to affect both human and animal health.

Magnesium (Mg) concentrations were elevated in both analysed samples. Excessive Magnesium in soils, especially those with high clay content, can negatively impact soil health and structure. Specifically, high Magnesium can cause soil compaction, where pore spaces become filled with fine clay particles, leading to reduced water infiltration rates. In addition, water with high Magnesium content—referred to as hard water—can result in scale build-up within irrigation systems. As water evaporates and / or pressure changes occur, mineral deposits accumulate, potentially causing blockages in pipes and emitters.

Given the agricultural activities conducted on the farm, the water analysis results fall within the expected range as noted in previous studies (Stein et al., 1995). However, the Proponent has indicated that one borehole (S02) is currently not in use due to excessive Nitrate levels found in its water. High Nitrate concentrations can be particularly hazardous, causing acute health problems such as methemoglobinemia (commonly known as "blue baby syndrome") in infants. This condition impairs the blood's ability to transport oxygen and can be fatal if not addressed promptly (Skipton et al., 1998). Similar adverse health effects have been observed in game and farm animals consuming water with elevated Nitrate levels.

Implications and Impacts

Groundwater is a valuable resource at the project area and is regulated by the Ministry of Agriculture, Water and Land Reform. Groundwater contamination may negatively impact surrounding boreholes and groundwater is widely utilised for public water supply. No alternative water supply options exist if contamination or deterioration of groundwater occur.

8 SOIL ANALYSIS

Soil analysis of four agricultural areas were conducted in March and May 2022 at Analytical Laboratory Services cc. The soil analysis reports will be attached in Appendix B. The samples were all composites that was taken over an area, consisting of 10 samples. The locations of the samples are present in Figure 8-2. The soils were tested for several parameters, including pH, organic content, micro - and macro elements, particle and texture classes. A summary of the chemical analysis can be seen in Table 8-1 below. The pH of the soil samples range from 7.5 - 8.4, making the soils slightly alkaline to medium alkaline as indicated by the red box in Figure 8-1. As the pH of the soil increases (become more alkaline) it could lead to further deficiencies in Nitrogen, Phosphorus, and / or Calcium. Figure 8-1 indicates the solubility of different nutrients present in the soil at different pH levels.

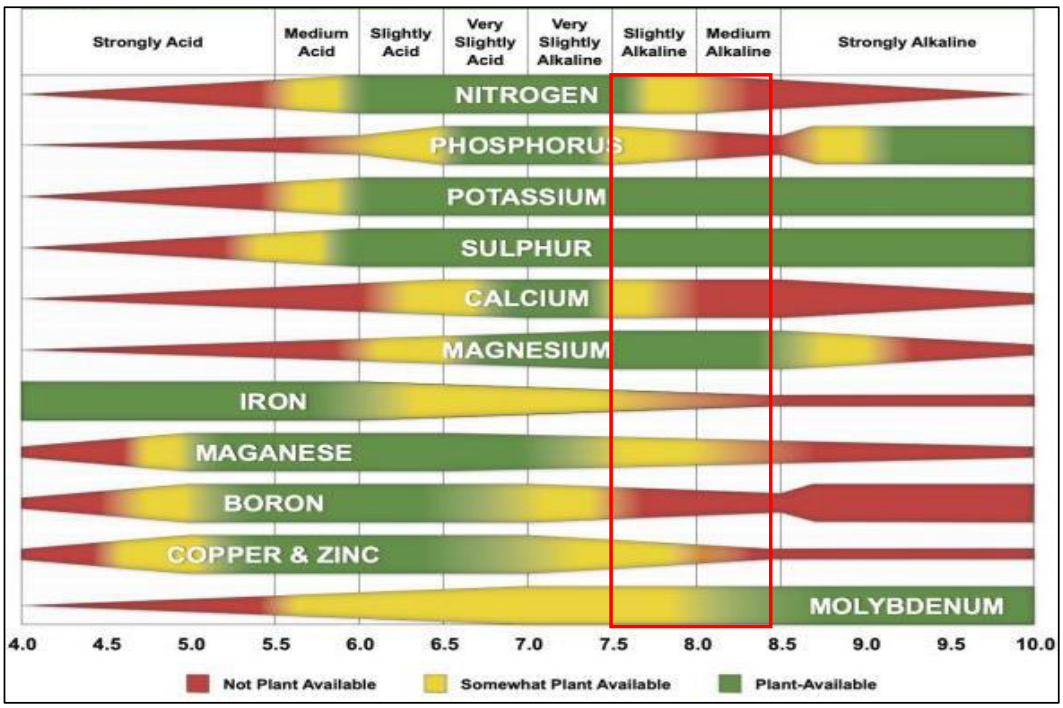


Figure 8-1 Soil pH effects on availability of elements (after University of California, 2019)

A summary of the soil sample results is depicted in Table 8-1 below with the relative sample locations given in the Figure 8-2 below. All elements highlighted in blue have low concentrations of the elements as required by plants. All highlighted in orange have high concentrations of the elements that can be harmful to plants. All the elements not highlighted (white) are in the most efficient range as required by plants. The first three composite samples are from the canter pivot irrigation systems on the Farm Starnberg, while the remaining samples were taken at different depths from the dry faming land area on the Farm Karuchas. In the majority of the samples pH, Magnesium and Calcium exceeded the concentration for efficient plant growth. This could be attributed to the local geology and soil conditions (Cambic Calcisol). Phosphorus is slightly elevated in two and depleted in seven of the samples. While the organic carbon is depleted in the majority of the samples. The remaining soil parameters are all within acceptable concentration levels to promote efficient growth and nutrient exchange.

Fertilizer application should be tailored to the soil's characteristics to prevent over application of fertilizer. The application of an excess of fertilizer to the cultivation soil can lead to groundwater contamination. Nitrate is of particular concern because it leaches easily and causes contamination at low concentrations in the groundwater (Stevens *et al.*, 1993).

Table 8-1 Summary of the soil analysis results

Chemical Analysis														
Parameters	Unit	Acceptable guideline	Sample											
			Starnberg FMB/01147 Sample area			Karuchas FMB/00542 Sample area								
			14 ha Comp	18 ha Comp	DL1.1 Comp	1 Soil 1 20cm	2 Soil 1 40 cm	3 Soil 1 60 cm	4 Soil 2 20cm	5 Soil 2 40cm	6 Soil 2 60cm	7 Soil 3 20cm	8 Soil 3 40cm	9 Soil 3 80cm
pH		5.5 to 6.7	8.2	8.4	8.4	7.7	7.6	7.8	7.6	7.5	7.5	7.5	7.5	7.6
Conductivity	(mS/m)		37.3	35.2	39.9	29.3	30.3	29.2	24.1	30.3	29.2	30.4	33.8	37
Carbonate	(%$CaCO^3$)		1.8	3	2.3	0.9	2.4	3.5	0.5	0.3	0.2	2.2	4	4
Organic Carbon	(%m/mC)	0.9 to 1.3%	0.9	0.7	0.8	0.9	0.5	0.5	0.8	0.7	0.7	0.7	0.5	0.5
Organic Matter	(%m/m OM)		1.6	1.2	1.4	1.6	0.9	0.8	1.3	1.2	1.1	1.2	0.9	0.8
Phosphorus (Ohlsen)	(mg P/kg)	10 to 20	24	22	14	4	3	2	20	8	15	8	2	2
Sodium Na	(mg/kg)		13	11	13	3	5	4	3	2	5	3	4	9
Potassium K	(mg/kg)	150 to 250	220	142	141	95	76	50	64	46	52	131	53	73
Magnesium Mg	(mg/kg)	60 to 180	1060	1005	1356	405	391	501	224	293	434	216	228	409
Calcium Ca	(mg/kg)	1000 to 2000	5170	5045	4816	5830	5537	5372	4625	4748	5109	5833	5587	6081
Particle size														
Sand	(>53 µm%)		65.8	59.7	63.3	73.4	68.5	63.9	79.1	73.4	70.7	68	53	52.9
Silt	(53-2 µm%)		9.2	13.7	10.1	9.7	8.5	11.7	10.7	6.8	7.1	12.5	20.7	15.9
Clay	(<2 µm%)		25	26.6	26.5	16.9	23	24.4	10.2	19.8	22.3	19.5	26.2	31.2

Note:
High
Optimal
Low

Figure 8-2 Approximate locations of soil samples

9 ASSESSMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts and provides possible mitigation measures that are expected from the project. The Rapid Impact Assessment Method (Pastakia, 1998) will be used during the assessment. Impacts are assessed according to the following categories: Importance of condition (A1); Magnitude of Change (A2); Permanence (B1); Reversibility (B2); and Cumulative Nature (B3) (see Table 9-1).

The Environmental Classification = A1 x A2 x (B1 + B2 + B3), see Table 9-2.

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures).

Table 9-1 Assessment criteria

Criteria	Score
Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect	
Importance to national/international interest	4
Important to regional/national interest	3
Important to areas immediately outside the local condition	2
Important only to the local condition	1
No importance	0
Magnitude of change/effect (A2) – measure of scale in terms of benefit / detriment of an impact or condition	
Major positive benefit	3
Significant improvement in status quo	2
Improvement in status quo	1
No change in status quo	0
Negative change in status quo	-1
Significant negative detriment or change	-2
Major detriment or change	-3
Permanence (B1) – defines whether the condition is permanent or temporary	
No change/Not applicable	1
Temporary	2
Permanent	3
Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition	
No change/Not applicable	1
Reversible	2
Irreversible	3
Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.	
Light or No Cumulative Character/Not applicable	1
Moderate Cumulative Character	2
Strong Cumulative Character	3

Table 9-2 Environmental classification of impacts (Pastakia 1998).

Environmental Classification (ES)	Class Value	Description of Class
72 to 108	5	Extremely positive impact
36 to 71	4	Significantly positive impact
19 to 35	3	Moderately positive impact
10 to 18	2	Less positive impact
1 to 9	1	Reduced positive impact
0	-0	No alteration
-1 to -9	-1	Reduced negative impact
-10 to -18	-2	Less negative impact
-19 to -35	-3	Moderately negative impact
-36 to -71	-4	Significantly negative impact
-72 to -108	-5	Extremely Negative Impact

9.1 GROUNDWATER ABSTRACTION

Groundwater abstraction is a very sensitive topic in a dry country where the value of land is drastically reduced if no or poor-quality groundwater is present on the land. Abstraction of groundwater must be done in a sensible way not to impact on other groundwater users that depend on such groundwater. This includes water abstracted for human and animal use, irrigation, and also ecosystems that depend on groundwater. A typical groundwater balance was compiled to illustrate the potential consequences of over abstraction of groundwater, see Figure 9-1. Recharge to the area is considered to be high. It is considered that recharge can vary from 0 % to 4 % of rainfall with an average of 2 % of the rainfall. In periods of drought there may be no recharge while in above average rainfall recharge could be above 4 % (Hoad, 1992)

In a typical groundwater environment, a water balance would consist of inflow and outflow of the groundwater system. Over time an equilibrium (or steady state) is normally reached with rising water tables following good recharge events and declining water tables when recharge is below average.

Inflow into the system would typically be from infiltration following rainfall in the area and in upstream areas. The inflow component will further be enhanced by the high secondary porosity nature of the karst aquifer.

Outflow would be comprised of water leaving the system through springs and as outflow over the lower boundary of the groundwater system as well as evapotranspiration losses. Groundwater abstraction from boreholes is important as this is normally necessary to sustain human and animal demands where such users became essentially dependant on the abstracted groundwater as a reliable and sustainable source.

Typical consequences of over abstraction will include a lowering in the water table. This may lead to the collapse of underground cave roofs where the hydrostatic pressure, used to support the roof of a cave, decrease. The increased flow of water may enhance the dissolution of dolomitic rock, leading to an increase in karst structures. Lowering of water tables may further lead to the drying up of boreholes, springs, underground caves and the subsequent loss of organisms that lives in the subsurface and surface water. Vegetation will also be impacted where such vegetation has access to groundwater.

Based on current water level fluctuations in the area, a short-term threshold of 5 m below the long term average water level is set from where abstraction rates should be reduced. Note that this level refers to rest water levels and not pump water levels.

All boreholes should be equipped with a dipper pipe to enable safe water level measurements.

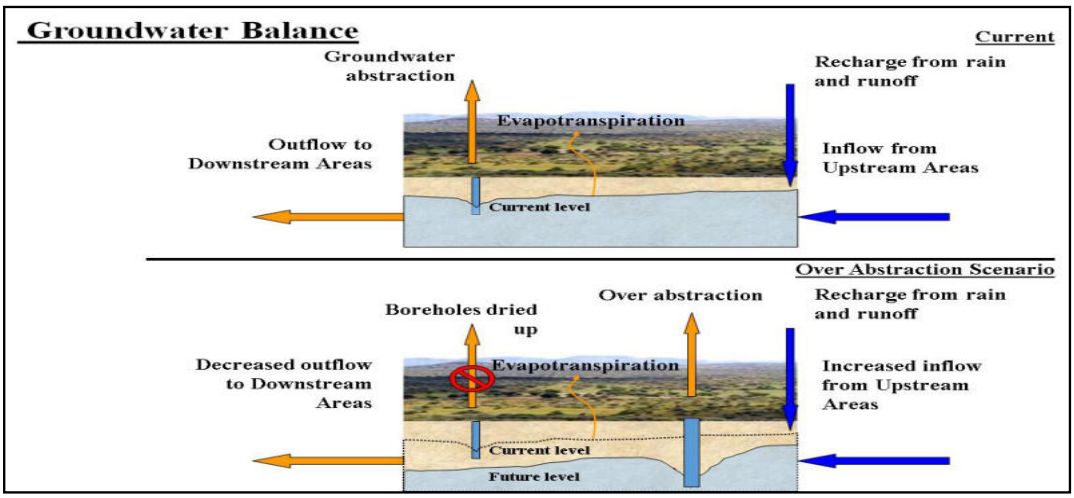


Figure 9-1 Conceptual groundwater balance with over abstraction scenario

Table 9-3 Assessment – Groundwater abstraction

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Over-abstraction of the local aquifer, decrease in the local hydraulic head.	2	-2	2	2	2	-24	-3	Probable

Desired Outcome: To utilise the groundwater sustainably.

Actions

Prevention:

- Spread the water abstraction points over a larger area to diffuse the impact.
- Monthly water level monitoring.
- Maintain safe abstraction rates prescribed by test pump evaluations (an abstraction permit with prescribed rates from the MAWLR is a requirement for this project).

Mitigation:

- Reduce abstraction when the water levels nears 5 m below the average rest water level of each borehole.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Monthly boreholes rest water level monitoring.
- Baseline values should be reviewed every three years based on all historic water level data.
- A summary report on all monitoring results must be prepared.
- The Proponent supply monitoring returns to the MAWLR, as required by the permit.

9.2 GROUNDWATER, SURFACE WATER AND SOIL CONTAMINATION

Leakages and spillages of hazardous substances from vehicles, waste oil handling and accidental fuel, oil or hydraulic fluid spills during the operational phase may contaminate the environment. Increase of nutrient levels (from over application of fertilizers or pesticides) in the soil that can leach to the groundwater. Pollution due to sewerage system overflow or leakage may further put the groundwater at risk.

Table 9-4 Assessment – Groundwater, surface water and soil contamination

Project Activity/Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery.	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Over application of fertilizer, pesticides, herbicides, etc. Sewerage system malfunction.	2	-1	2	2	1	-10	-2	Improbable

Desired Outcome: To prevent the contamination of groundwater, surface water and soil.

Actions

Prevention:

- Appoint reputable contractors.
- Vehicles may only be serviced on a suitable spill control structure.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- All hazardous chemicals and fuel should be stored in a sufficiently bunded area, as per MSDS requirements.
- Ensure all waste oil handling is conducted on impermeable or bunded areas.
- Follow prescribed dosage of fertilizers and pesticides / herbicides and to avoid over application.
- Maintain sewerage systems and conduct regular monitoring.
- All hazardous waste must be removed from the site and disposed of timeously at a recognised hazardous waste disposal facility, including any polluted soil or water.
- Avoid placing animal kraals near boreholes.

Mitigation:

- All spills must be cleaned up immediately.
- Consult relevant Material Safety Data Sheet (MSDS) information and a suitably qualified specialist where needed.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Maintain Material Safety Data Sheets for hazardous chemicals.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained.
- Groundwater should be sampled and analysed to test for nitrate concentrations from the fertilizer and for traces of chemicals used in pesticides and herbicides.
- Registers be kept by the Proponent on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.

- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- All spills or leaks must be reported on and cleaned up immediately.

10 CONCLUSION

Groundwater at the project area is high yielding and of acceptable quality for human consumption. Three of the thirteen boreholes are utilisation for irrigation purposes. Care must be exercised when long-term irrigation takes place and Nitrate values should be monitored regularly.

Based on current water level fluctuations in the area, as presented in Figure 6-3 a short-term threshold of 5 m below the long-term average groundwater level is set from where abstraction rates should be reduced. This threshold may require adjustment during drought periods as abstraction from neighbouring farms may also influence the regional water levels. Careful cooperation between neighbouring farms is required to optimally utilize the groundwater resource without depleting it as depletion will be detrimental to all. This should include self-monitoring and assessment of local water levels, as data obtained from DWA indicates a lack of sufficient monitoring in the recent years. Proper monitoring data will provide the required information to make informed decisions and will assist to obtain increased abstraction permits when needed and if justified.

Groundwater vulnerability to contamination would be the highest around boreholes, around geological structures as well as where shallow groundwater is present (i.e. springs). Contaminated surface runoff can create a pathway to the groundwater, putting the groundwater at risk. Potential sources of groundwater pollution include normal runoff from roofs, properties and surfaced areas, e.g. roads. These impacts are normally of a low magnitude and can be managed through proper housekeeping.

Based on the current groundwater level and abstraction volumes, continuous monitoring is recommended to determine if higher abstraction volumes may be considered.

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Appendix A: Irrigation water analysis Report

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TEST REPORT I221411/2

To: **Andreas Blume**
P.O.Box 26

e-mail: andreas@damarandi.com
Tel: 081-733 5448

Date received: 06/Sep/22
Date analysed: 7 - 13 September 2022
Date reported: 15/Sep/22

Client Reference no.: verbal
Quotation no.: QU-8297
Lab Reference: I221411
Enquiries: Ms Manuela Mayer

Sample details	water sample
Location of sampling point	Farm Starnberg & Farm Karuchas 2
Description of sampling point	Ostposten
Date of sampling	2022/08/31
Test item number	I221411/2

Parameter	Value	Units	me	Salinity/Chloride/RSC Hazard Low	Medium	High	Very High
p H	7.2			Acceptable pH range: 6.5-8.4			
Electrical Conductivity	105.3	mS/m		<25	25-75	75-225	>225
Total dissolved solids (calc.)	706	mg/l					
P-Alkalinity as $CaCO_3$	0	mg/l					
Total Alkalinity as $CaCO_3$	575	mg/l					
Bicarbonate as HCO_3^-	702	mg/l	11.5				
Carbonate as CO_3^{2-}	0	mg/l	0				
Total Hardness as $CaCO_3$	586	mg/l					
Chloride as Cl^-	13	mg/l		0-105	105-140	140-350	>350
Fluoride as F^-	0.2	mg/l					
Sulphate as SO_4^{2-}	10	mg/l					
Nitrate as N	0.7	mg/l					
Sodium as Na	10	mg/l	0.44				
Potassium as K	0.3	mg/l					
Magnesium as Mg	98	mg/l	8.06				
Calcium as Ca	73	mg/l	3.64				
Manganese as Mn	<0.01	mg/l					
Iron as Fe	0.02	mg/l					
Copper as Cu	0.01	mg/l					
Zinc as Zn	0.01	mg/l					
Molybdenum as Mo	<0.01	mg/l					
Boron as B	0.02	mg/l		0.3-1.0	1.0-2.0	2.0-4.0	>4.0
Quality Indices:							
Electrical Conductivity	1.05	mS/cm					
HCO_3:Ca	3.16	me/l					
Modified calcium value	0.90	me/l					
Adj. Sodium Adsorption Ratio	0.29	me/l					
Residual Sodium Carbonate	-0.21	me/l		<1.25	1.25-2.50	>2.50	
Magnesium Ratio	68.9	me/l			Acceptable ratio: <50		
Stability pH, at 25°C	6.86						
Ryznar Index	6.53	stable		<6.5=scaling, >7,5=corrosive, ≥6.5 and ≤7.5=stable			
Corrosivity ratio	0.05	no corrosive properties		Applies to water in the pH range 7-8 which also contains dissolved oxygen ratios <0.2 no corrosive properties ratios >0.2 increasing corrosive tendency			

I. Carew
Deputy Section Head

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Unit 16, Ben Amathila Ave.

PO Box 86782, Windhoek, Namibia

TEST REPORT I221411/1

To: **Andreas Blume**
P.O.Box 26

e-mail: andreas@damarandi.com
Tel: 081-733 5448

Date received: 06/Sep/22
Date analysed: 7 - 13 September 2022
Date reported: 15/Sep/22

Client Reference no.: verbal
Quotation no.: QU-8297
Lab Reference: I221411
Enquiries: Ms Manuela Mayer

Sample details	water sample
Location of sampling point	Farm Starnberg & Farm Karuchas 2
Description of sampling point	Haus
Date of sampling	2022/09/01
Test item number	I221411/1

				Recommended maximum limits			
				Human consumption			Livestock
Parameter	**Value**	**Units**	**Classification**	**Group A**	**Group B**	**Group C**	**watering**
p H	**7.2**		A	6-9	5.5-9.5	4-11	
Electrical Conductivity	**111.1**	**mS/m**	A	150	300	400	
Turbidity	**0.25**	**NTU**	A	1	5	10	
Total Dissolved Solids (calc.)	**618**	**mg/l**					6000
P-Alkalinity as $CaCO_3$	**0**	**mg/l**					
Total Alkalinity as $CaCO_3$	**545**	**mg/l**					
Total Hardness as $CaCO_3$	**607**	**mg/l**	B	300	650	1300	
Ca-Hardness as $CaCO_3$	**277**	**mg/l**	A	375	500	1000	2500
Mg-Hardness as $CaCO_3$	**329**	**mg/l**	B	290	420	840	2057
Chloride as Cl^-	**18**	**mg/l**	A	250	600	1200	1500-3000
Fluoride as F^-	**0.2**	**mg/l**	A	1.5	2.0	3.0	2.0-6.0
Sulphate as SO_4^{2-}	**14**	**mg/l**	A	200	600	1200	1000
Nitrate as N	**12**	**mg/l**	B	10	20	40	100
Nitrite as N	**0.01**	**mg/l**					10
Sodium as Na	**13**	**mg/l**	A	100	400	800	2000
Potassium as K	**1.2**	**mg/l**	A	200	400	800	
Magnesium as Mg	**80**	**mg/l**	B	70	100	200	500
Calcium as Ca	**111**	**mg/l**	A	150	200	400	1000
Manganese as Mn	**<0.01**	**mg/l**	A	0.05	1.0	2.0	10
Iron as Fe	**<0.01**	**mg/l**	A	0.1	1.0	2.0	10
Stability pH, at 25°C	**6.7**						
Langelier Index	**0.5**	scaling		>0=scaling, <0=corrosive, 0=stable			
Ryznar Index	**6.2**	scaling		<6.5=scaling, >7,5=corrosive, ≥6.5 and ≤7.5=stable			
Corrosivity ratio	**0.1**	no corrosive properties		Applies to water in the pH range 7-8 which also contains dissolved oxygen ratios <0.2 no corrosive properties ratios >0.2 increasing corrosive tendency			

I. Carew
Deputy Section Head

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TEST REPORT I221411/2

Assessment of water quality and its subsequent effect on soils

pH value	:	**suitable**, even when crop foliage is wetted, this should not casue foliar damage
Salinity hazard	:	**high**, water cannot be used on soils with restricted drainage, special management for salinity control may be required. A 90% relative yield of moderately salt tolerant crops can be maintained by using a low frequency irrigation system
Chloride hazard	:	**low,** should prevent the accumulation of chloride to toxic levels in all but the most sensitive plants, even when chloride uptake is through foliar absorption
Boron hazard	:	Boron, though a plant nutrient, becomes toxic if present in water beyond a particular level. **Safe**
Sodium hazard	:	**low**, water can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium Should prevent the accumulation of sodium to toxic levels in all but the most sensitive plants, even when crop foliage is wet.
RSC hazard	:	This index indicates the tendency of carbonate and bicarbonates to precipitate calcium as calcium carbonate. **Safe**
Magnesium ratio	:	Magnesium deteriorates soil structure particularly when waters are sodium-dominated and highly saline. Higher level of Mg usually promotes higher development of exchangeable Na in irrigated soils. **Unsafe**
Fluoride	:	Its contents beyond 1 mg/l in drinking water and 10ppm in irrigation water is harmful. It is not directly toxic to the plant but to animals feeding on plants which have been irrigated with high fluoride waters.
Nitrate	:	Nitrate generally occurs in trace quantities in surface water but can be present in higher concentrations in some groundwaters. Beneficial effect of nitrates on crop production has been widely reported. The presence of potassium and nitrate in appreciable amounts in irrigation water has been found to partially counteract the adverse effect of salinity and sodicity on plant growth.
Potassium	:	Being a plant nutrient, its presence in saline water counteracts the adverse effect of sodium on crop growth.
Manganese	:	**Safe**
Iron	:	**Safe**
Copper	:	**Safe**
Zinc	:	**Safe**
Molybdenum	:	**Safe**

I. Carew
Deputy Section Head

Appendix B: Soil Analysis Report

Grondontledingsverslag:
Order: N080 - BLUME_F
Date: 20-10-2022

Verwysings no	pH (KCl)	P (Bray1)	P Mehlich	K	Na	Ca	Mg	UIT H+	%Ca	%Mg	%K	%Na	SUUR.V	Ca:Mg	(Ca+Mg)/K	Mg:K	Na:K	CEC	Fe	Mn	Cu	Zn	S	B
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	%	%	%	%	%	1.5 - 4.5	10.0 - 20.0	3.0 - 4.0			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
14.1	7.7	32	69	202	30	4525	987	0.00	72.1	25.8	1.6	0.4	0.0	2.8	56.6	15.7	0.3	31.36	25.0	64.2	1.10	4.07	11.1	1.20
14.2	7.6	38	72	144	35	5270	1007	0.00	75.0	23.5	1.0	0.4	0.0	3.2	64.1	22.4	0.4	35.12	23.8	78.4	1.06	4.31	12.4	1.33
14.3	7.7	25	48	148	33	5057	1024	0.00	73.9	24.5	1.1	0.4	0.0	3.0	69.2	22.2	0.4	34.20	21.1	90.5	0.98	3.49	11.0	1.29
14.4	7.7	18	38	146	30	4734	1163	0.00	69.9	28.6	1.1	0.4	0.0	2.4	69.2	25.9	0.3	33.67	20.0	67.4	1.20	3.52	10.9	1.44
18.1	7.2	21	48	176	15	4379	830	0.00	74.9	23.3	1.5	0.2	0.0	3.2	63.6	15.1	0.1	29.22	21.9	74.2	1.16	4.38	12.3	1.46
18.2	7.7	18	41	147	23	4399	907	0.00	73.5	24.9	1.3	0.3	0.0	3.0	78.1	19.7	0.3	29.91	23.5	84.9	0.95	3.92	11.8	1.43
18.3	7.8	33	67	233	32	4850	1012	0.00	72.9	24.9	1.8	0.4	0.0	2.9	54.5	13.9	0.2	33.29	27.0	111.5	1.74	5.85	11.4	1.52
18.4	7.6	48	89	222	29	5295	1110	0.00	73.0	25.1	1.6	0.4	0.0	2.9	62.7	16.0	0.2	36.27	30.2	104.4	1.80	6.45	11.7	1.60
DL1.1	7.2	5	13	165	11	4213	491	0.00	62.4	15.7	1.7	0.2	0.0	5.2	59.4	9.5	0.1	25.56	22.0	96.2	0.84	0.80	5.2	0.52
DL1.2	6.9	5	12	174	11	4214	374	0.00	65.6	12.4	1.8	0.2	0.0	6.9	54.1	6.9	0.1	24.63	20.8	100.1	0.87	0.72	4.5	0.53
DL1.3	6.9	4	10	165	10	4314	533	0.00	61.7	16.6	1.6	0.2	0.0	4.9	61.5	10.4	0.1	26.41	20.4	90.5	1.11	0.63	4.3	0.56
DROELAND 2	6.8	6	14	176	11	4139	270	0.00	68.4	9.5	1.9	0.2	0.0	9.4	50.9	4.9	0.1	23.41	15.7	98.2	1.00	0.54	20.4	0.61

OPMERKINGS

pH is oor die algemeen hoog weens vry Karbonate in die grond. Dit sal veroorsaak dat Fosfaat vasgele word (bv. DL1.1, 1.2, 1,3 en Droeland2).
Die hoe Kalsium% onderdruk Kalium%, en hoewel Kalium in d.p.m. nie te sleg ontleed nie, is Kalium geweldig onder druk. Goeie praktyk sal wees om voor plant Kalium 20cm diep in 'strepe' te pre-plant
Gelukkig is Natrium nie baie hoog nie. Kalium moet egter bo onttrekking bemes word om te kompeteer met Kalsium en Natrium.
Spoorelemente sal oor die algemeen onder druk wees weens die hoe pH, en kan tesame met die kunsmis, of as blaarvoeding aangespreek word.
Geen Kalk of Gips word benodig nie.
Geen Fosfaat 'regstelling' met kunsmis word aanbeveel nie, weens die oneffektiwiteit in die hoe pH. 5Ton/Ha Hoendermis in die lae P gedeeltes sal egter die Fosfaat help bou. (DL1.1, 1.2, 1.3, Droeland2)

Hoog bo norm
Neig hoog
Norm
Neig laag
Tekort

WARNING: The sample(s) to which the findings recorded herein (the "Findings") relate was(were) drawn and / or provided by the Client or by a third party acting at the Client's direction. The Findings constitute no warranty of the sample's repr

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TEST REPORT

Client: **Blume Farming**
Address: **P O Box 26**
Grootfontein
Namibia
Attn: **Mr Andreas Blume**
email: **andreas@damaranti.com**
Tel: 081-7335448

Date received: **9-May-22**
Date analysed: **11-17-May-22**
Date reported: **18-May-22**
Client Reference: verbal
Quotation: QU 7706
Lab Reference: I220787
Enquiries: Ms Silke Rugheimer

Lab No.	Test:	pH (H_2O)	Conductivity	Calcium carbonate equivalent	Organic carbon	Organic matter	Phosphorus	Sodium	Potassium	Magnesium	Calcium
	Method Description:	2:5 electrometric	2:5 electrometric	acid neutralisation	Walkey Black	calculated factor = 1.724	extractable Ohlsen	extractable/exchangeable 1M ammonium acetate (pH 7.0) followed by ICP-OES			
	Unit:		mS/m	% $CaCO_3$ equivalent	% m/m C	% m/m OM	mg P /kg	mg Na/kg	mg K/kg	mg Mg/kg	mg Ca/kg
	Sample ID										
1	01 composite sample 7ha	8.2	37.3	1.8	0.9	1.6	24	13	220	1060	5170
2	02 composite sample 7ha	8.4	35.2	3.0	0.7	1.2	22	11	142	1005	5045
3	03 composite sample 7ha	8.4	39.9	2.3	0.8	1.4	14	13	141	1356	4816

Lab No.	Test:	Particle Size Analysis			Textural class
	Method Description:	Pipette method			
		Sand (2mm - 53 µm)	Silt (53-2 µm)	Clay (<2 µm)	
	Units:	%	%	%	
1	01 composite sample 7ha	65.8	9.2	25.0	sandy clay loam
2	02 composite sample 7ha	59.7	13.7	26.6	sandy clay loam
3	03 composite sample 7ha	63.3	10.1	26.5	sandy clay loam

Since Ca and Mg carbonates dissolve to a large extent in ammonium acetate at pH7 the concentrations of these cations are over-estimated in calcareous soils

Page 1 of 1

Silke Rügheimer
Laboratory Manager

Appendix B: Tree Information

Trees recorded in quarter degree squares 1918AA and 1918AC (Curtis & Mannheimer, 2005)

Name	Common_Name	Notes
Acacia ataxacantha	Flame-thorn	None
Acacia erioloba	Camel-thorn	Protected by forestry legislation
Acacia fleckii	Sand-veld Acacia	None
Acacia hebeclada subsp hebeclada	Candle-pod Acacia	None
Acacia hereroensis	Mountain-thorn	None
Acacia karroo	Sweet-thorn	None
Acacia kirkii subsp kirkii var kirkii	Floodplain Acacia	May be declining in Etosha and North-west
Acacia luederitzii var luederitzii	Kalahari Acacia	None
Acacia mellifera subsp detinens	Blue-thorn Acacia	Aggressive invasive
Acacia nilotica subsp kraussiana	Scented-pod Acacia	None
Acacia reficiens subsp reficiens	Red-thorn	Very aggressive invader
Acacia tortilis	Umbrella Thorn	None
Acacia tortilis subsp spirocarpa	Umbrella-thorn	None
Albizia anthelmintica	Worm-cure Albizia; Aru	The low numbers of young trees recorded are a concern, as is the number of dead trees in some areas. It is Protected by forestry legislation.
Aloe littoralis	Windhoek Aloe	Potentially threatened by pachycaul trade. Protected by the Nature Conservation Ordinance and listed in CITES Appendix II.
Artemisia afra	Wild wormwood; African wormwood	None
Berchemia discolor	Bird Plum	Protected by forestry legislation, as well as by traditional Owambo cultures for its fruit and shade. The population does not appear to be in any real danger at the moment, but communities could be encouraged to plant this species.
Boscia albitrunca	Shepherd's Tree	Although widespread and hardy, it is heavily utilised by people and animals. The difficulty that young plants have in becoming established is a concern, but fortunately there appears to be a healthy and widespread population of young plants. Protected by forestry legislation.
Boscia foetida subsp foetida	Smelly Shepherd's-bush	None
Caesalpinia rubra	Purple Caesalpinia	None

Carissa bispinosa subsp bispinosa	Y-thorn Carissa; Common Num-num	Rare in Namibia, but probably not threatened. Widespread in South Africa.
Carissa edulis	Simple-spined Carissa; Climbing Num-num	None
Catophractes alexandri	Trumpet-thorn; Rattlepod	Invasive in some areas
Cissus nymphaeifolia	Wild Grape	None
Combretum apiculatum subsp apiculatum	Kudu-bush	None
Combretum hereroense subsp hereroense	Mouse-eared Combretum	None
Combretum imberbe	Leadwood	Although heavily utilized by people, regrowth is good and growth of young trees is vigorous. Because of its religious importance and many uses, it is protected locally. Old specimens warrant protection as monuments. Protected by forestry legislation.
Commiphora africana	Hairy Corkwood; Poison-grub Commiphora	None
Commiphora angolensis	Sand Corkwood	None
Commiphora glandulosa	Tall Common Corkwood; Tall firethorn Corkwood	None
Commiphora glaucescens	Blue-leaved Corkwood	None
Commiphora mollis	Velvet Corkwood	None
Commiphora pyracanthoides	Fire Thorn Corkwood; Small Common Corkwood	None
Commiphora tenuipetiolata	Satin-bark Corkwood	None
Croton gratissimus	Lavender Croton; Lavender fever berry	None
Croton gratissimus var gratissimus	Lavender Croton	None
Croton gratissimus var subgratissimus	None	None
Croton menyhartii	Rough-leaved Croton	None
Cyphostemma juttae	Blue Kobas, Namibian grape, Wild grape	Endemic with very small population and threatened with pachycaul trade. Least concern according to IUCN criteria. Protected by Nature Conservation Ordinance. Protected by forestry legislation.
Datura ferox	Thorn Apple	Alien species. Not a threat in Namibia
Datura innoxia	Thorn Apple	Alien species. Not a threat in Namibia

Datura spp	Thorn Apple	None
Dichrostachys cinerea subsp africana	Kalahari Christmas Tree; Sickle-bush	Of concern because of its effects on other species (invasive)
Dombeya rotundifolia	Wild Pear	Two varieties rotundifolia and velutina. Velutina is endemic and classified as least concern.
Ehretia alba	White-puzzle Bush	None
Elaeodendron transvaalense	Transvaal Saffron; Bushveld Saffron	None
Elephantorrhiza suffruticosa	Skew-leaved Elephant Root	None
Erythrina decora	Namib Coral-tree	Endemic to Namibia and very uncommon throughout its range. Worthy of Protection. Very few young trees. Protected by forestry legislation.
Erythrococca menyharthii	Northern Red-berry	Population could be declining.
Euclea divinorum	Magic Guarri	None
Euclea undulata var myrtina	Common Guarri; Mountain Ebony	None
Euphorbia guerichiana	Paper-bark Euphorbia	CITES Appendix II
Ficus cordata subsp cordata	Namaqua Rock-fig	Protected by forestry legislation
Ficus thonningii	Common wild Fig; Stranglerfig	None
Flueggea virosa subsp virosa	White-berry Bush	None
Gomphocarpus fruticosus	Milkweed; Wild Cotton	None
Grewia bicolor var bicolor	Two-coloured Raisin-bush	None
Grewia flava	Velvet Raisin	None
Grewia flavescens	Sandpaper Raisin	None
Grewia villosa var villosa	Mallow Raisin	None
Gymnosporia buxifolia	Common Spikethorn	None
Gymnosporia senegalensis	Confetti Spikethorn	None
Gyrocarpus americanus	Propeller Tree	None
Helinus integrifolius	Soap creeper	None
Hyphaene petersiana	Makalani Palm	Should be monitored due to extensive harvesting. Protected by forestry legislation
Ipomoea adenioides	None	None

Kirkia acuminata	Common Kirkia	None
Lannea discolor	Live-long	Protected by forestry legislation
Lantana angolensis	None	None
Lantana camara	Lantana	Alien. Should be controlled in wetter areas. Not a threat in Namibia
Maerua schinzii	Ringwood Tree	Increasingly impacted by humans and giraffes. Protected by forestry legislation.
Montinia caryophyllacea	Wild Clove-bush	None
Mundulea sericea	Silverbush	None
Nicotiana glauca	Wild Tobacco	Alien. Not a major threat in Namibia, but should be monitored.
Olea europaea subsp cuspidata	Wild Olive	None
Opilia campestris var campestris	None	None
Opuntia spp	Spiny Cactus; Prickly-pear	Alien. Some species are problematic.
Ozoroa insignis	Africa Resin-tree	None
Ozoroa paniculosa	Common Resin-bush	None
Pavetta zeyheri	Small-leaved Bride's-bush	May be declining
Pechuel-Loeschea leubnitziae	Wild sage; Sweat bush; Stink bush	None
Peltophorum africanum	Muparara	None
Philenoptera nelsii subsp nelsii	Kalahari Omupanda; Kalahari Apple-leaf	None
Prosopis spp	Mesquite	None
Rhigozum brevispinosum	Simple-leaved Rhigozum	None
Ricinus communis	Castor-oil Bush	Alien. Should be controlled.
Schinziophyton rautanenii	Manketti; Mongongo nut; False balsa	Increased use for carving might be a concern. Great food value. Greatly damaged by veld fires. Protected by forestry legislation.
Sclerocarya birrea	Marula	Protected locally by communities that use them. Protected by forestry legislation.
Searsia ciliata	Sour Karee	None

Searsia lancea	Willow Rhus	May be affected by a disease. Protected by forestry legislation. Previously Rhus lancea.
Searsia marlothii	Bitter Karee	None
Searsia tenuinervis var tenuinervis	Kalahari Currant	None
Securidaca longepedunculata	Violet-tree	None
Spirostachys africana	Tamboti	Protected by forestry legislation
Steganotaenia araliacea var araliacea	Carrot-tree	None
Tarchonanthus camphoratus	Camphor Bush	None
Terminalia prunioides	Purple-pod Terminalia	None
Terminalia sericea	Silver Cluster-leave	None
Tinnea rhodesiana	Maroon Bells	May be overlooked.
Triaspis hypericoides subsp nelsonii	None	None
Ximenia americana var americana	Blue Sourplum	None
Ximenia americana var microphylla	Blue Sourplum	None
Ximenia caffra var caffra	Large Sourplum	None
Ziziphus mucronata	Buffalo-thorn	Protected by forestry legislation

Appendix C: Proof of Public Consultation

Notified IAPs

Name	Organisation
A Mweti	Otjozondjupa Regional Council
M Garonga	Otjozondjupa Regional Council
J Murangi	Namwater
Mr Vitals	Calais FMB/00833 & Dover FMB/00701
Mr Shimana	Drontheim FMB/00703
S Fourie	Cleveland FMB/00706
L Mbwale	Abenab FMB/00707
O Mouton	Auritsab FMB/00708
D Kaiser	Duluth FMB/00714
G Kondja	Swerwerstroom FMB/00831
A Heimbodi	Aandrus FMB/00832/00REM
Mr Shali	Aandrus FMB/00832/00001
R Johannes	Namibian Organic Association (NOA)
M Aufderheide-Voigts	
E Förtsch	
V Corry	

Notification Letter

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E-MAIL: gpt@thenamib.com

To: **Interested and / or Affected Party** **28 February 2024**

Re: **Environmental Scoping Assessment and Environmental Management Plan for Agricultural Activities and the Environmental Release of Genetically Modified Maize on Farms Karuchas and Starnberg, Otjozondjupa Region**

Dear Sir/Madam

Geo Pollution Technologies (Pty) Ltd was appointed by F Blume to undertake an environmental assessment for agricultural activities and the environmental release of genetically modified (GM) maize on farms Karuchas FMB/00542 and Starnberg FMB/01147 in the Otjozondjupa Region (see location map on page 2). The assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

Project: Environmental Scoping Assessment and Environmental Management Plan for Agricultural Activities and the Environmental Release of Genetically Modified Maize on Farms Karuchas and Starnberg, Otjozondjupa Region

Proponent: F Blume

Environmental Assessment Practitioner: Geo Pollution Technologies (Pty) Ltd

The Proponent has a total area of 102.2 ha under cultivation, while an additional 55 ha is planned to be cultivated. Of the current area cultivated, 32.2 ha is irrigated by means of centre pivot, drip and micro sprayer irrigation and 70 ha is used for dry land cropping. The main crops cultivated are tomatoes, cabbage, maize, wheat, sorghum and lablab legume. In order to improve productivity, the Proponent wishes to replace the traditional maize cultivars with insect and/or roundup resistant GM strains. The Proponent is also in the process of clearing additional land for dry land cropping.

The environmental scoping assessment will include all pertaining to the transport, storage and planting of GM maize seeds, the management of the crops during the growing period, the application of pesticides to the crops, harvesting of the crops, and the handling and transport of the harvested maize to the markets. Fuel for farm vehicles is stored in aboveground diesel tanks. Bush clearing of approximately 10 ha per year is conducted to create additional dry land cropping areas. General operations also include activities such as water abstraction, electricity supply, waste handling and sewage disposal.

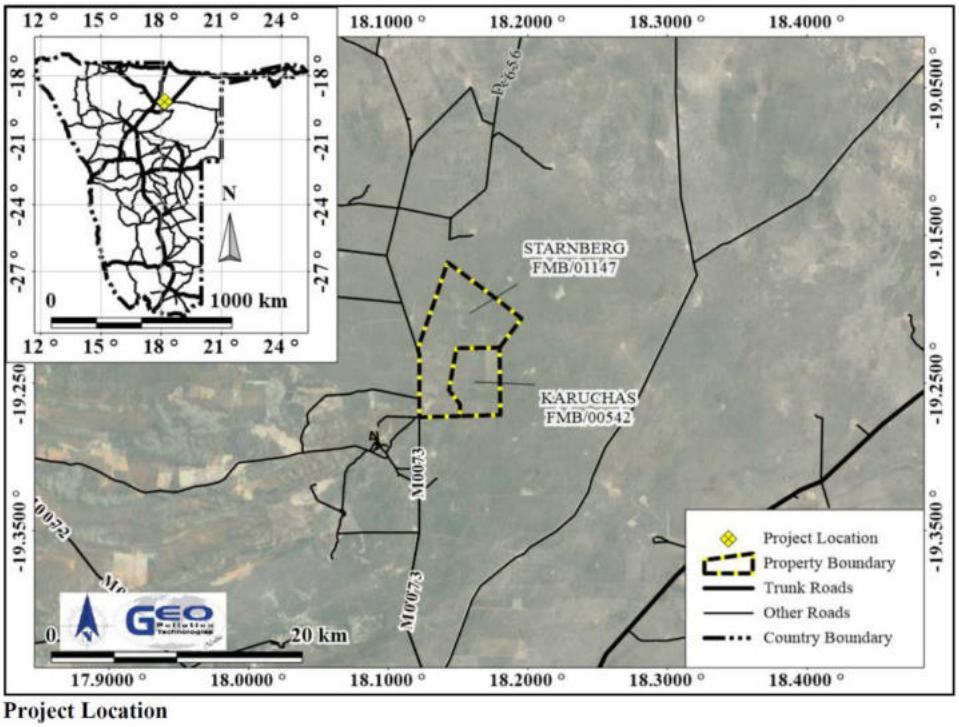
Interested and affected parties or neighbours are invited to register with the environmental consultant, to receive further documentation and communication regarding the project, or to provide comments related to the project, for inclusion in the assessment. Please register or submit comments at:

Fax: 088-62-6368 or **E-Mail:** karuchas@thenamib.com

Should you require any additional information please contact Geo Pollution Technologies at telephone 061-257411.

Sincerely,
Geo Pollution Technologies

Quzette Bosman
Social and Environmental Assessment Practitioner



Project Location

Background Information Document

ENVIRONMENTAL SCOPING ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN FOR AGRICULTURAL ACTIVITIES AND THE ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE ON FARMS KARUCHAS AND STARNBERG, OTJOZONDJUPA REGION

BACKGROUND INFORMATION DOCUMENT

Prepared by:

Prepared for:

F Blume

November 2023

1 INTRODUCTION

Geo Pollution Technologies (Pty) Ltd was appointed by F Blume (the Proponent) to undertake an environmental assessment for the environmental release of genetically modified (GM) maize on farm Karuchas (FMB/00542) and Starnberg (FMB/1147) in the Ojozondjupa Region (Figure 1-1). The total area currently under cultivation by the Proponent is 102.2 ha, while an additional 55 ha is planned to be cultivated. Of the current area cultivated, 32.2 ha is irrigated by means of centre pivot, drip and micro sprayer irrigation and 70 ha is used for dry land cropping. The main crops cultivated are tomatoes, cabbage, maize, wheat, sorghum and lablab legume. In order to improve productivity, the Proponent wishes to replace the traditional maize cultivars with insect and/or roundup resistant GM strains. The Proponent is also in the process of clearing additional land for dry land cropping.

An environmental clearance certificate (ECC) for the environmental release (cultivation) of genetically modified organisms (GMO) is required as per the Environmental Management Act No. 7 of 2007 (EMA). A scoping environmental assessment report (SR) and an environmental management plan (EMP) are proposed to be submitted to the Ministry of Environment, Forestry and Tourism's (MEFT) Department of Environmental Affairs (DEA) in consideration of an application for an ECC. The environmental assessment will include all operational aspects related to the cultivation of GM maize by the Proponent and will also include additional farming related activities such as water abstraction, bush harvesting for charcoal and wood production and fuel storage.

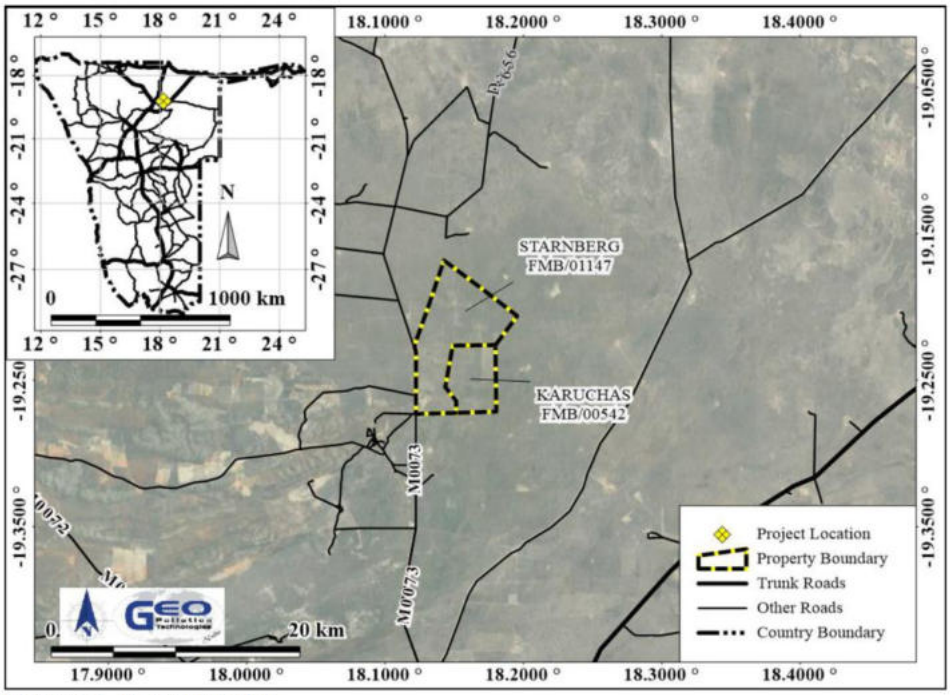


Figure 1-1 Project location

2 PURPOSE OF THE BID

With this background information document (BID), GPT aims to provide interested and affected parties (IAPs) with information about the project and interact with them regarding it. All IAPs are therefore invited to register with GPT for the project in order to:

- Provide GPT with additional information which should be taken into account in the assessment of impacts;

- Share any comments, issues or concerns related to the project; and
- Review and comment on the reports (SR and EMP).

3 PROJECT DESCRIPTION

The Proponent owns the farms with all infrastructure required for the cultivation of GM maize already in place, since the farm has traditionally been a crop cultivation unit for many years. Activities associated with the project have been divided into the following phases: planning, operational and the decommissioning phase. A brief outline of expected activities for each phase is detailed below.

3.1 PLANNING PHASE

Planning is an ongoing process in preparation of the planting of GM maize as well as during and after the planting of such crops. As part of planning, it is the responsibility of the Proponent to ensure they are and remain compliant with all legal requirements. The Proponent must also ensure that all required management measures are in place prior to and during all phases, to ensure potential impacts and risks are minimised. Typical planning activities include:

- Obtain permits and approvals from local and national authorities including approval for environmental release of GMOs from the National Commission on Research, Science and Technology, water permits from the Ministry of Agriculture, Water and Land Reform, and a consumer installation certificate from the Ministry of Mines and Energy.
- Make provisions to have a health, safety and environmental coordinator to implement the EMP.
- Ensure provisions for a fund to cater for environmental incidents if ever required.
- Ensure all appointed contractors and employees enter into agreements which include the EMP.
- Establish and/or maintain a reporting system to report on aspects of operations and decommissioning as outlined in the EMP.

3.2 OPERATIONAL PHASE

Genetically modified crops have the potential to increase profitability by mainly reducing input costs related to pest control. The two main traits in the GM maize cultivars proposed to be planted are insect and RoundUp resistance.

Insect resistance is achieved by the insertion of certain gene segments of the *Bacillus thuringiensis* bacterium which produces a protein that is toxic to target pests of the insect order Lepidoptera (moths and butterflies). Specifically the larvae stages (caterpillars) are targeted as they die when eating the crops, therefore breaking the life cycle of the pest species.

RoundUp is the trade name of a systemic herbicide containing the active ingredient glyphosate. RoundUp resistance in crops has, among others, the advantage of a reduced need for mechanical weeding of fields. Also, often fields are prepared for planting by first allowing the weeds to germinate and grow, then spraying such weeds with herbicides, and once dead, planting of crops can commence. During short growing seasons, this is not always possible and by planting RoundUp resistant crops, you can immediately start planting and then spray while both the weeds and crops are on the field. RoundUp resistance is achieved by inserting gene segments from the bacteria *Agrobacterium* sp. strain CP4. It produces an enzyme that is tolerant to glyphosate, thus allowing the GM crop to grow in the presence of glyphosate.

The following is a list of the GM maize cultivars (or events) proposed for environmental release.

GM Event	Crop Type	Trait
MON 810	Maize	Insect Resistance
MON 89034	Maize	Insect Resistance
NK 603	Maize	RoundUp Resistance
MON 89034 × NK 603	Maize	Insect Resistance and RoundUp Resistance
NK 603 × MON 810	Maize	Insect Resistance and RoundUp Resistance

The main operational activities that will be addressed in the SR pertain to the transport, storage and planting of GM maize seeds, the management of the crops during the growing period, the application of pesticides to the crops, harvesting of the crops, and the handling and transport of the harvested maize to the markets. Fuel for farm vehicles is stored in aboveground diesel tanks. Bush clearing of approximately 10 ha per year is conducted to create additional dry land cropping areas. General operations also include activities such as water abstraction, electricity supply, waste handling and sewage disposal.

3.3 Decommissioning Phase

In the context of GM crop cultivation, decommissioning refers to the termination of cultivation of any GM crop. Such decommissioning is not foreseen during the validity of the ECC. Decommissioning will however be assessed. Should decommissioning occur at any stage, aftercare will be required to ensure no GM maize remain on the cultivated fields and that regrowth be controlled by chemical and/or mechanical means.

Decommissioning of selected infrastructure may occur and will also be assessed. Should decommissioning occur at any stage, rehabilitation of the area may be required. Decommissioning will entail the complete removal of all infrastructure including buildings and underground infrastructure. Pollution present on the site, if any, must then be remediated.

3.4 Preliminary Identified Impacts

During the environmental assessment all components of the environment will be considered, however only those components which are being impacted on significantly, or are deemed to be sensitive, will be assessed. These include the following:

- Socio-economic contributions
- Health and safety risks
- Ecosystem and biodiversity impacts
- Cross pollination of GM and non-GM crops
- Soil and groundwater pollution
- Groundwater over-abstraction
- Fire risks
- Waste and effluent generation and disposal
- Traffic
- Noise

4 PUBLIC CONSULTATION

GPT invites all IAPs to provide in writing, any issues and suggestions regarding the project. This correspondence must include:

- Name and surname
- Organization represented or private interest
- Position in the organization
- Contact details
- Any direct business, financial, personal or other interest which you may have in the approval or refusal of the application.

All contributions become public knowledge and will be circulated along with the reports as per the EMA requirements. The comments, inputs and suggestions will also be submitted to the DEA along with how any issues have been addressed in the SR. The public participation process will remain ongoing during the environmental assessment.

The project team may be contacted on the contact details below

Geo Pollution Technologies (Pty) Ltd.
Telephone: (+264-61) 257411
Fax: (+264) 88626368
E-mail: karuchas@thenamib.com

Your Rights as an IAP according to the Environmental Management Act, No7 of 2007, Government Notice No 30 (Environmental Impact Assessment Regulations)

Section 23. (1) A registered interested or affected party is entitled to comment in writing, on all written submissions made to the Environmental Commissioner by the applicant responsible for the application, and to bring to the attention of the Environmental Commissioner any issues which that party, believes may be of significance to the consideration of the application, as long as -

(a) comments are submitted within 7 days of notification of an application or receiving access to a scoping report or an assessment report;
(b) the interested and affected party discloses any direct business, financial, personal or other interest which that party may have in the approval or refusal of the application.

(2) Before the applicant submits a report compiled in terms of these regulations to the Environmental Commissioner, the applicant must give registered interested and affected parties access to, and an opportunity to comment in writing on the report.

(3) Reports referred to in sub regulation (2) include (a) scoping reports; (b) scoping reports amended and resubmitted; (c) assessment reports; and (d) assessment reports amended and resubmitted.

(4) Any written comments received by the applicant from a registered interested or affected party must accompany the report when the report is submitted to the Environmental Commissioner.

(5) A registered interested or affected party may comment on any final report that is submitted by a specialist reviewer for the purposes of these regulations where the report contains substantive information which has not previously been made available to a registered interested or affected party.

Section 24: The applicant responsible for an application must ensure that the comments of interested and affected parties are recorded in reports submitted to the Environmental Commissioner in terms of these regulations, and comments by interested and affected parties on a report which is to be submitted to the Environmental Commissioner may be attached to the report without recording those comments in the report itself.

Press Notice: The Namibian Sun 22 and 29 February 2024

• AUTHORITIES TAKE URGENT STEPS TO PROTECT POPULATION

Oshikoto battles steep rise in malaria cases

More than 250 cases of malaria have been reported in the Oshikoto Region between January and 18 February this year.

CLAUDIA REITER
WINDHOEK

Oshikoto regional health director Joshua Nghipangelwa has urged community members to seek early treatment following an outbreak of malaria in the region.

According to Nghipangelwa, 256 cases of malaria were reported between January and 18 February this year.

"The regional crisis response team and the district response team have started responding to the outbreak," he said.

He added that the team has investigated a majority of cases and visited the most-affected areas to educate the population about the risks and to distribute long-lasting insecticidal mosquito nets.

"We have also introduced new methods to contain the increasing malaria cases in the region by combatting breeding sites with larvae and spraying houses that have reported cases," Nghipangelwa said.

On the ground

He said health authorities are testing and treating cases both at health facilities and within the community, conducted by community health workers.

"These cases are sporadic. The entire region is affected, but the most-affected constituency is Okankolo."

Nghipangelwa said Onandjokwe District Hospital has recorded the highest number of cases with 92, and most of these cases originated from the Okankolo constituency.

Tsumeb Hospital has recorded 84 cases and Omuthiya District Hospital recorded 80 cases from January to 18 February.

"Everyone is at risk of contracting malaria, so no one is safe," he warned.

He urged residents of the region to protect themselves from mosquito bites both outdoors and in their homes.

Ohangwena outbreak

In late January, Namibia Media Holdings reported that the Ohangwena Region had recorded a total of 392 cases of malaria.

Of these, 154 cases were documented locally in Ohangwena, while 238 cases originated elsewhere.

George Jeremiah, the acting regional health director, said at the time that there has been a shortage of testing materials over the past two months, and they now rely exclusively on microscopic tests conducted in laboratories in the region.

"Looking at the statistics for 2023, malaria cases have slightly increased. The local cases are very dangerous, indicating that the vector is within Namibia and not outside," he said in January.

In their efforts to contain the further spread of malaria, the region deployed a team of 241 sprayers to the three districts last year.

Justine Haikali, the senior environmental and health practitioner in Ohangwena and coordinator of the malaria spraying programme, said the teams had covered 35% of at-risk villages.

She added that only a few households still refused to have their houses sprayed – unlike in the past when many resisted.

Health authorities also reported that in 2023 four people in the region died from malaria.

AT RISK: Health authorities are taking steps to counter rising malaria cases in the Oshikoto Region. PHOTO: FILE

//Karas governor optimistic about regional development

ELIZABETH KHEIBES
WINDHOEK

//Karas regional governor Aletha Frederick says Namibia's oil and gas discoveries present unprecedented opportunities for the region's economic growth and prosperity.

"The potential for massive new green hydrogen development further solidifies our region's position as a key player in Namibia's sustainable energy future," she said during a recent regional consultative meeting for the National Development Plan 6 (NDP6).

The governor said she envisions the region becoming not only "a hub of economic activity but also a beacon of sustainable development in Namibia. With the right support and financing from the national government we have the power to eradicate poverty, hunger and unemployment in our region."

In addition, Frederick highlighted the importance of local community participation in the vast opportunities presented by regional development.

"As we embark on this journey of envisioning the future of our region, it is imperative that we recognise the immense potential that lies within //Karas – a region blessed with abundant mineral and natural resources, a thriving fishing industry, significant mining activities and an expanding tourism sector," she said.

Frederick also called for the full development of the region's agricultural sector, which is currently "underutilised".

POTENTIAL: //Karas regional governor, Aletha Frederick. PHOTO: FILE

POLICE OFFICER'S FRAUD CASE CONTINUES

KRISTIEN KRUGER
WINDHOEK

The trial of the former police officer Ricardo Nestor, who was initially charged with fraud amounting to more than N$10 million, continued in court this week.

However, Nestor is now only facing three charges of fraud related to N$720 000 after the court acquitted him of six charges.

He has already taken the stand and testified in his own defence. The case has been postponed to 19 April for final submissions before conviction.

Nestor further filed an application under Section 174 of the Criminal Procedure Act, arguing that the State had not presented enough evidence for the court to find him guilty.

Direct evidence lacking

Judge Philanda Christiaan acquitted Nestor of six out of the nine charges he faced in November. She found that they had not succeeded in proving a case beyond a reasonable doubt against Nestor.

Christiaan further stated that the State's case is primarily based on circumstantial evidence, with no direct evidence linking Nestor to the crimes committed.

"There are no facts presented that prove that the accused had access to the computers, the login credentials or the internet banking profiles of any of the complainants," Christiaan said in her judgment.

STILL IN COURT: Fraud accused Ricardo Nestor and his legal representative, Albert Titus. PHOTO: FILE

She further said there is no evidence that Nestor received or drew on the funds transferred from these accounts.

The charges on which he was acquitted relate to allegations that Nestor defrauded Namibia Marble and Granite near Karibib and/or Carmen Bianca Wittreich of an amount of N$10 million. Additionally, there is a further charge that he defrauded, among others, Spot-On Discount Liquor and Meransha Properties.

Additional charges

The charges that Nestor still faces pertain to Tayo Namibia. It is alleged that Nestor falsely represented to Tayo Namibia that the bank account of Walcon Construction had been changed from Bank Windhoek to Standard Bank and that Tayo Namibia should pay an amount of N$720 000 into the Standard Bank account for work that was purportedly done by Walcon Construction.

Nestor is currently in custody at Windhoek Central Prison.

kristien@nnh-hub.com.na

City acts swiftly against illegal paper dump

ELIZABETH KHEIBES
WINDHOEK

On Monday, a pedestrian in Windhoek's Agste Laan witnessed unidentified individuals dumping thousands of documents from the education ministry at an unauthorised location.

The documents included old question papers and curriculum vitae. The ministry's executive director, Sanet Steenkamp, confirmed that the photos and videos sent to her by Namibian Sun displayed several personal and public documents from the ministry being discarded unlawfully.

"These are indeed from the ministry, from the examination directorate. I have since given clear instructions that they need to retrieve these documents and correctly dispose of them," Steenkamp said.

"Some things are usually kept for archival purposes, and in this case, I believe that someone did not do what was expected of them. We apologise for this," she added.

Aggressive

According to the witness to the unlawful document dump, the culprits passed a designated dumpsite in the Kupferberg area and "carelessly" got rid of the documents at a random place.

"I approached the private vehicle and tried to question the men about the dumping, but that led to aggressive responses instead," the bystander said.

"I started taking photos and videos that I planned to share to get help clearing up the area," the source, only known as Ruben, explained.

City acts promptly

City of Windhoek officials, who were given access to the photos and video, later tracked down the driver from a licence plate that was shown in the images and resolved the matter.

"We managed to locate the illegally dumped waste alongside Sam Nujoma Road on the way to Daan Viljoen. Due to the nature of the waste, which is paper that can easily blow away, our team cleaned up," the City said.

"We also managed to locate the culprit through the vehicle registration number and he will be fined an amount of N$1 608 for illegal dumping. This will be billed on his municipal account," city spokesperson Lydia Amutenya said.

Amutenya highlighted continuous efforts by the municipality to keep the streets of Windhoek clean and said they cannot tolerate illegal dumping of waste.

"Waste must be disposed of properly at our respective landfill. We also have waste recycling initiatives where this type of waste can be recycled," she said.

Ondangwa electrification project advances

• LIGHTS ON

The Ondangwa council has provided 300 electrical connections **and is working on connecting around 153 households at the moment.**

TUYEIMO HAIDULA
ONDANGWA

As the Omahenene electrification project in Ondangwa advances, the council hosted a community meeting on Tuesday to inform affected residents of the procedures that will be used to connect their houses.

The project, funded by the mines and energy ministry and executed by Nored, was initially scheduled to be implemented in the 2020-21 financial year, but due to Covid-19, it was rescheduled to take place between September 2023 and January this year.

Ondangwa town spokesperson Petrina Shitalangaho-Mutikisha said council provided 300 electrical connections and is currently working on connecting around 153 households.

"We would like to extend our heartfelt thanks to the residents of Uuskopa, Omahenene and Epya for their patience and cooperation during the construction work in Omahenene. Their understanding and support have allowed this project to be carried out as planned without any interruption or delay from their side," Shitalangaho-Mutikisha said.

Omahenene is one of the oldest informal settlements in Ondangwa and is classified as a low-income area.

Quality of life

Shitalangaho-Mutikisha added that the process of household connections has started, and homeowners who qualify for household connections will get connected.

"They will be required to have a letter of recommendation from the council with matching details of what is on their certified copy of the Namibian identification document," she explained.

"Overall, the importance of house electrical connections cannot be overstated, as they are integral to the safety, functionality and comfort of modern homes," Shitalangaho-Mutikisha added.

She said although in the past there were a number of challenges associated with an area without electricity, this will now be a thing of the past with streets, dark areas and homes being electrified.

She urged residents to look after their property, saying the council will focus on electrifying other areas and not repairing vandalised items.

PROGRESS: The Ondangwa electrification project is advancing. PHOTO: TUYEIMO HAIDULA

Press Notice: Die Republikein 22 and 29 February 2024

PUBLIC PARTICIPATION NOTICE

ENVIRONMENTAL IMPACT ASSESSMENTS FOR AGRICULTURE AND ENVIRONMENTAL RELEASE OF GENETICALLY MODIFIED MAIZE AND COTTON FOR CULTIVATION

Geo Pollution Technologies (Pty) Ltd (GPT) was appointed by the Proponents: A Coetzee, F Blume, H van Eeden, HB Eggert, JN Malan, JW Brandt, KI Günzel, NJ Jacobsz, RH van Eeden, RP Menne and WF Lubbe, to undertake environmental assessments for agricultural activities and the environmental release of genetically modified (GM) maize and cotton for cultivation on their respective farms in the Otjozondjupa and Oshikoto Regions, as indicated in the below map. Additional information about the respective Proponents' farms and farming activities can be obtained from GPT or viewed at: http://www.thenamib.com/projects/projects.html

The environmental assessments will be conducted according to the Environmental Management Act of 2007 and its regulations published in 2012. Depending on the respective Proponents' individual farming activities, aspects related to cultivation of GM maize and cotton, water abstraction, fuel storage and hospitality and tourism facilities, will be included.

All interested and affected parties are invited to register with GPT. By registering you are provided with the opportunity to share any comments, issues or concerns related to the projects, for consideration in the environmental assessments. Additional information can be requested from GPT: Tel: +264-61-257411; Fax: +264-88626368; E-Mail: gmo@thenamib.com

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GEO Pollution Technologies

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Site Notice


PUBLIC NOTICE
Environmental Scoping Assessment and Environmental Management Plan for Agriculture Activities and the Environmental Release of Genetically Modified Maize on Farms Karuchas and Starnberg, Otjozondjupa Region

Appendix D: Consultants' Curriculum Vitae

ENVIRONMENTAL ASSESSMENT PRACTITIONER **Quzette Bosman**

Quzette Bosman has 19 years' experience in the Impact Assessment Industry, working as an Environmental Assessment Practitioner and Social Assessment practitioner mainly as per the National Environmental Legislation sets for South Africa and Namibia. Larger projects have been completed in terms of World Bank and IFC requirements. She studied Environmental Management at the Rand Afrikaans University (RAU) and University of Johannesburg (UJ), including various Energy Technology Courses. This has fuelled a passion towards the Energy and Mining Industry with various projects being undertaken for these industries. Courses in Sociology has further enabled her to specialize in Social Impact Assessments and Public Participation. Social Assessments are conducted according to international best practise and guidelines. Work has been conducted in South Africa, Swaziland and Namibia.

CURRICULUM VITAE QUZETTE BOSMAN

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	QUZETTE BOSMAN
Profession	:	Social Impact Assessor / Environmental Assessment Practitioner
Years' Experience	:	19
Nationality	:	South African
Position	:	Senior Environmental Consultant
Specialisation	:	ESIA & ESMP; SIA
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent German –speaking, reading - fair
First Aid Class A		EMTSS, 2017
First Aid LSM		OSH-Med International 2022
Basic Fire Fighting		EMTSS, 2017
Basic Industrial Fire Fighting		OSH-Med International 2022

EDUCATION AND PROFESSIONAL STATUS:

BA	Geography & Sociology	:	Rand Afrikaans University, 2003
BA	(Hons.) Environmental Management	:	University of Johannesburg, 2004

PROFESSIONAL SOCIETY AFFILIATION:

Namibian Environment and Wildlife Society
International Association of Impact Assessors South Africa (IAIA SA)
Member 2007 - 2012
Mpumalanga Branch Treasurer 2008/2009

OTHER AFFILIATIONS
Mkhondo Catchment Management Forum (DWAF): Chairperson 2008-2010
Mkhondo Water Management Task Team (DWAF): Member 2009

AREAS OF EXPERTISE:

Knowledge and expertise in:

- environmental impact assessments, social impact assessment and social management planning
- project management
- community liaison and social monitoring
- public participation / consultation, social risk management
- water use licensing
- environmental auditing and compliance
- environmental monitoring
- strategic environmental planning

EMPLOYMENT:

2015 - Present	:	Geo Pollution Technologies – Senior Environmental Practitioner
2014-2015	:	Enviro Dynamics – Senior Environmental Manager
2010 - 2012	:	GCS – Environmental Manager (Mpumalanga Office Manager)
2007 - 2009	:	KSE-uKhozi - Technical Manager: Environmental
2006 -2007	:	SEF – Environmental Manager
2004 - 2005	:	Ecosat – Environmental Manager

PUBLICATIONS:

Contract reports	: +230
Publications	: 1