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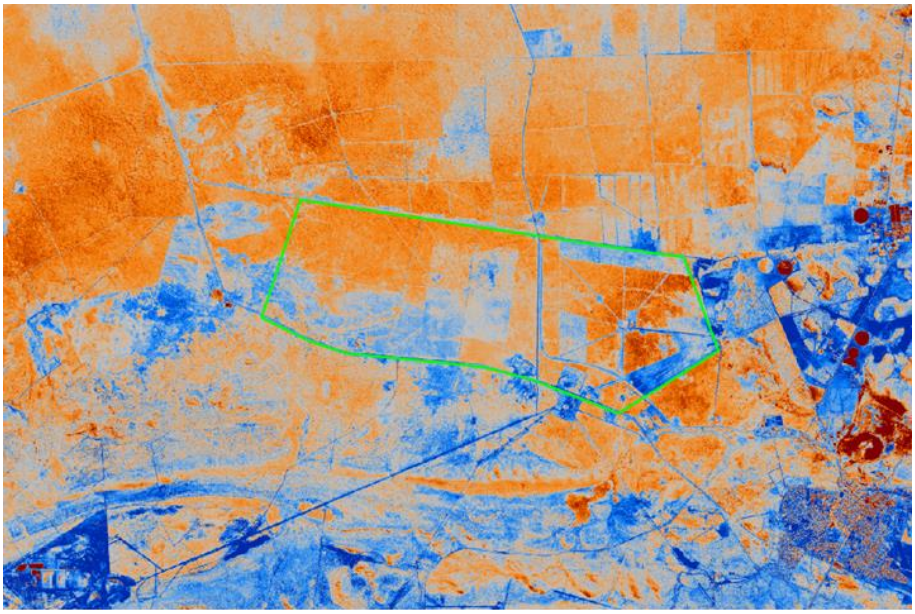
PROPOSED IRRIGATION ACTIVITIES OF HENNING CRUSHER ON STEINQUELLE, OSHIKOTO REGION

ENVIRONMENTAL ASSESSMENT SCOPING REPORT



Assessed by:

Assessed for:

Henning Crusher (Pty) Ltd

December 2019

Project:	**PROPOSED IRRIGATION ACTIVITIES OF HENNING CRUSHER ON STEINQUELLE, OSHIKOTO REGION: ENVIRONMENTAL ASSESSMENT SCOPING REPORT**	
Report: Version/Date:	Final December 2019	
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Cite this document as:	Botha P, Bosman Q, Coetzer W, van der Merwe J, Faul A.; 2019 December; Proposed Irrigation Activities of Henning Crusher on Steinquelle, Oshikoto Region: Environmental Assessment Scoping Report	
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Report Approval	20/02/19 Henning Crusher Steinquelle EIA & EMP **André Faul** **Conservation Ecologist**	

I Schalk Henning acting as representative of Henning Crusher (Pty) Ltd hereby confirm that the project description contained in this report is a true reflection of the information which the Proponent provided to Geo Pollution Technologies. All material information in the possession of the proponent that reasonably has or may have the potential of influencing any decision or the objectivity of this assessment is fairly represented in this report and the report is hereby approved.

Signed at Tsumeb on the 17th day of February 20~~19~~20.

Henning Crusher (Pty) Ltd

EXECUTIVE SUMMARY

Henning Crusher (Pty) Ltd requested Geo Pollution Technologies (Pty) Ltd to undertake an environmental assessment for their proposed irrigation activities on Portion 23 (Steinquelle) of Consolidated Farm Tsumore No. 761 in the Tsumeb District, Oshikoto Region. It is the intention of Henning Crusher to conduct pivot based irrigation on an area of approximately 180 ha. The main focus will be on maize and sorghum production while lucerne and cowpeas may also be considered.

The environmental assessment is conducted to determine all environmental, safety, health and socio-economic impacts associated with the development and future operations of the irrigation area on the farm. Relevant environmental data was compiled from a specialist hydrogeological 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 proposed irrigation area is mainly surrounded by open farmland except for Henning Crusher's own sand mining and quarrying operations, also on Steinquelle, east of the proposed operations. Due to the nature and location of the proposed irrigation development, some impacts can be expected on the surrounding environment, see summary impacts table below. Regular environmental performance monitoring is thus recommended to ensure regulatory compliance and the implementation of corrective measures when necessary. The proposed activities will play a role in contributing to the Namibian agricultural sector.

The main concerns related to the intended operations are potential groundwater, surface water and soil contamination, decreased groundwater availability, ecological and social impacts. Implementing a safety, health, environment and quality (SHEQ) policy will contribute to effective management procedures, to prevent and mitigate impacts. All regulations relating to agriculture, labour and health and safety 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 obtained and strictly adhered to. Any waste produced must be 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 mitigating any negative impacts.

The environmental management plan included in Section 10 of this document should be used as an on-site reference document during all phases (planning, construction, operations 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. Parties responsible for transgression of the environmental management plan should be held responsible for any rehabilitation that may need to be undertaken. A Health, Safety, Environment 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.

Impact Summary Class Values

Impact Category	Impact Type	Construction	Operations
	Positive Rating Scale: Maximum Value	5	5
	Negative Rating Scale: Maximum Value	-5	-5
EO	Skills and Development	2	2
EO	Revenue Generation and Employment	2	2
SC	Demographic Profile and Community Health	-1	-2
EO	Agricultural Produce and Economic Diversification		3
SC	Traffic	-2	-2
SC	Health, Safety and Security	-2	-2
PC	Fire	-3	-3
PC	Noise	-2	-1
PC	Waste Production	-2	-2
BE	Ecosystem and Biodiversity Impact	-2	-2
PC	Groundwater, Surface Water and Soil Contamination	-2	-3
BE/EO	Groundwater Abstraction	-1	-3
PC	Air Pollution	-2	-2
SC	Visual Impact	-1	-1
EO	Impacts on Utilities and Infrastructure	-2	-2
SC	Heritage	-3	-3
	Cumulative Impact	-2	-2

BE = Biological/Ecological *EO = Economical/Operational* *PC = Physical/Chemical* *SC = Sociological/Cultural*

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LIST OF ABBREVIATIONS

AEZ	Agro-Ecological Zone
AIDS	Acquired Immune Deficiency Syndrome
BE	Biological/Ecological
DWA	Department of Water Affairs
EA	Environmental Assessment
EIA	Environmental Impact Assessment
EMA	Environmental Management Act No 7 of 2007
EMP	Environmental Management Plan
EMS	Environmental Management System
EO	Economic/Operational
ES	Environmental Classification
GPT	Geo Pollution Technologies
HIV	Human Immunodeficiency Virus
IAPs	Interested and Affected Parties
IUCN	International Union for Conservation of Nature
LNAPL	Light Non-Aqueous Phase Liquids
mamsl	Meters Above Mean Sea Level
m/s	Metre per second
mbs	Metres below surface
MET	Ministry of Environment and Tourism
mm/a	Millimetres per annum
MSDS	Material Safety Data Sheet
PC	Physical/Chemical
PPE	Personal Protective Equipment
ppm	Parts per million
SANS	South African National Standards
SC	Sociological/Cultural
SHEQ	Safety, Health, Environment and Quality
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization

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 - means a body or person empowered under the local authorities act or Environmental Management Act to enforce the rule of law.

Construction - means 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 – means 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.

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 & 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 - means an 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 Henning Crusher (Pty) Ltd to undertake an environmental assessment for their proposed irrigation activities on Portion 23 (Steinquelle) of Consolidated Farm Tsumore No. 761 (Figure 1). Irrigation is planned for an area of approximately 180 ha. The main activities for the development and operations of the irrigation area include:

- Installation of centre pivot irrigation systems;
- Soil preparation;
- Planting;
- Water abstraction and irrigation;
- Fertilizer application and pest control;
- Harvesting; and
- Processing / storage.

A risk assessment was undertaken to determine the potential impact of the construction, operations and possible decommissioning phases of the proposed activities on the environment. The environment being defined in the Environmental Assessment Policy and 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 – Intensive commercial agriculture has long been practiced in Namibia in areas with reliable water sources. It is a very important sector in Namibia in terms of feed and food production, employment and livelihoods, and revenue generation. Agriculture contributes 3.8% to gross domestic product of Namibia, but it supports 70% of the Namibian population and employs a third of the work force. One of the key strategies of the NDP5 is to increase agricultural production of cereals and horticulture. Henning Crusher's planned irrigation development will contribute to feed and food production in Namibia.

Benefits of proposed irrigation activities include:

- Feed and food production for local markets and contribution to food security in Namibia,
- Employment and skills development,
- Generation of income contributing to the national treasury,
- Support for economic resilience in the area through diversified business activities and opportunities.

2 SCOPE

The scope of the environmental assessment is to:

1. Determine the potential environmental impacts emanating from the proposed development and operations of the irrigation project.
2. Identify a range of management actions which could mitigate the potential adverse impacts to acceptable levels.
3. Comply with the requirements of EMA.
4. Provide sufficient information to the relevant competent authority and MET to make an informed decision regarding the project.

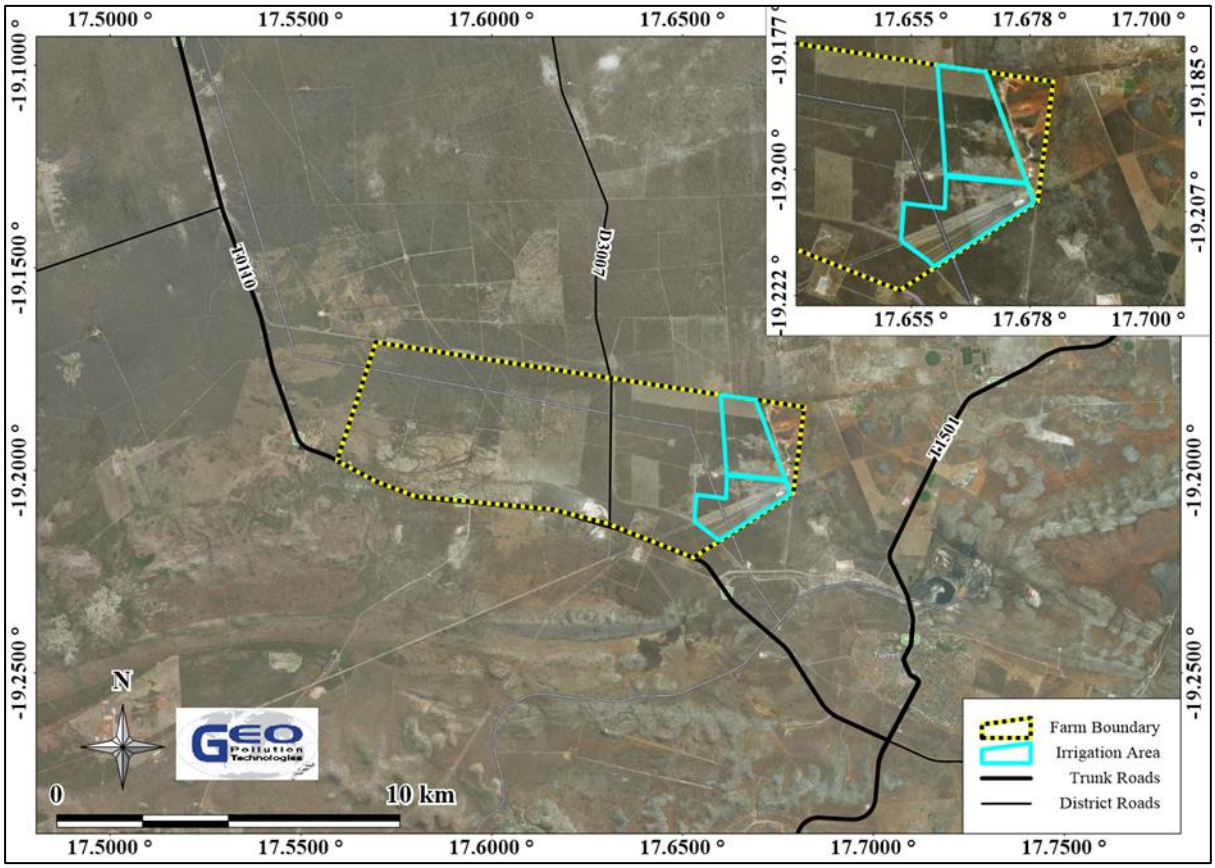


Figure 1. Project location

3 METHODOLOGY

The following methods were used to investigate and report on the potential impacts of the proposed irrigation development, and it subsequent operations, on the social and natural environment:

1. Baseline information about the site and its surroundings was obtained from a hydrogeology specialist study, existing secondary information, as well as from a reconnaissance site visit.
2. 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.
3. Potential impacts were identified and preventative and mitigating measures proposed. A scoping report was drafted and an environmental management plan (EMP) was incorporated into this report.
4. The scoping report and EMP will be submitted to the Ministry of Environment and Tourism (MET) together with an application for an ECC.

4 OPERATIONS AND RELATED ACTIVITIES

Steinquelle has been under ownership of Henning Crusher for more than 20 years. During this period the area was used for livestock grazing as well as for sand mining and quarrying operations. A separate environmental assessment is conducted for the sand mining and quarrying operations.

Bush encroachment is a problem over large parts of Namibian agricultural land. On Steinquelle bush encroachment has converted the vegetation into very densely populated shrub and woodland. As such, two de-bushing projects were initiated. The first was chemical invader bush control many years ago while the second one was physical bush removal for which an environmental assessment was conducted. The second de-bushing project and its environmental assessment were conducted as part of the NamPower initiative to provide fuel (biomass) for their NamPower Encroacher Bush to Power Plan (Otjikoto Substation).

As a result of the bush control projects, the areas now identified for irrigation purposes are already cleared to some extent. This presented the proponent with an opportunity to conduct irrigation activities on Steinquelle, in order to augment the sand mining and quarrying activities on the farm. As mentioned, the sand mining and quarrying activities are dealt with in a separate environmental assessment, as directed by the Department of Environmental Affairs, even though water and electricity resources will be shared by the projects. The following section provides a description of the planned irrigation activities.

4.1 DEVELOPMENT

Clearing of land for cultivation and infrastructure purposes will be done mechanically. This will involve removing a number of dead and live trees. Large protected species will be identified and retained as far as is practically possible. Where protected species have to be removed, the necessary permits will be obtained prior to removal. The natural environment surrounding the irrigated areas will be maintained as far as practically possible.

Centre pivot irrigation systems will be erected and underground water pipelines will be installed from nearby boreholes to the centre pivot systems. The entire development will be phased. Phase one will aim at installing up to three centre pivots near the boreholes. The second phase will involve the addition of another three centre pivots. Each centre pivot will cover about 30 ha for a total of approximately 180 ha under all six pivots. Three existing boreholes will be used for water abstraction purposes.

During the first phase, the area earmarked for phase two will be used for grass harvesting for livestock feed. The area was previously cleared of shrubs and trees which makes it suitable for this purpose.

4.2 CROP PRODUCTION

Maize and sorghum are the main produce planned, with the possibility of cowpeas and the perennial legume, lucerne, as feed. Sorghum is considered a draught resistant crop and thus minimises the amount of water required for its cultivation. Sorghum also acts as a good source of feed for livestock due to its high nutritional value.

Preparation of the land and planting will entail mechanical activities like ripping, tilling and seeding of the soil with tractors and specialised implements. Fertilizers and pesticides will be applied to crops as required and according to the specifications for application. Fertilizer and pesticide requirements will be determined by a specialist, based on soil and environmental conditions. To ensure correct and safe application of pesticides, a pesticide plan will be drawn up by a specialist and updated as required. Fertilizers will typically be applied by mixing into water tanks and then applying via the centre pivot irrigation systems. Harvesting will be conducted with combine harvesters and tractors with specialised implements like disc mowers and balers.

After harvesting, crops will either be stored in a dedicated area on the farm for own use, or transported to local markets as required. The transportation of produce may be outsourced to external contractors.

4.3 UNDERSTANDING THE PIVOT-IRRIGATION SYSTEM

Phocaides (2007) provides a concise description of the center pivot, being a low to medium pressure fully mechanised, automated irrigation system of permanent assembly. It basically comprise a sprinkler pipeline (usually of high tensile galvanized light steel or aluminium pipes) supported aboveground by mobile A-frame towers, long spans, steel trusses and/or cables. The pipeline is connected to a central tower with the “pivot mechanism” and main control panel. The central tower is a fixed structure with a concrete base secured at a fixed water supply point, in the centre of the pivot (field). The entire system is self-propelled to slowly rotate around the central tower while dispensing water through sprinklers (emitters) connected to the pipeline. An automatic alignment system ensures the irrigation pipeline remains straight while a drive system enables system movement.

Mobile towers are typically approximately 3 m in height and spaced about 30 m apart. The entire length of the system may vary from design to design and therefore the size of the irrigated area will also vary. Longer systems will have a greater circumference and larger range. Photo 1 depicts a typical centre pivot system while Photo 2 and Photo 3 presents some of the pivots systems which are being employed in the region. The system depicted in Photo 2 and Photo 3 has a system length of 300 m with spans at a width of 50 m. The irrigated area therefore covered by these systems are 30 ha.

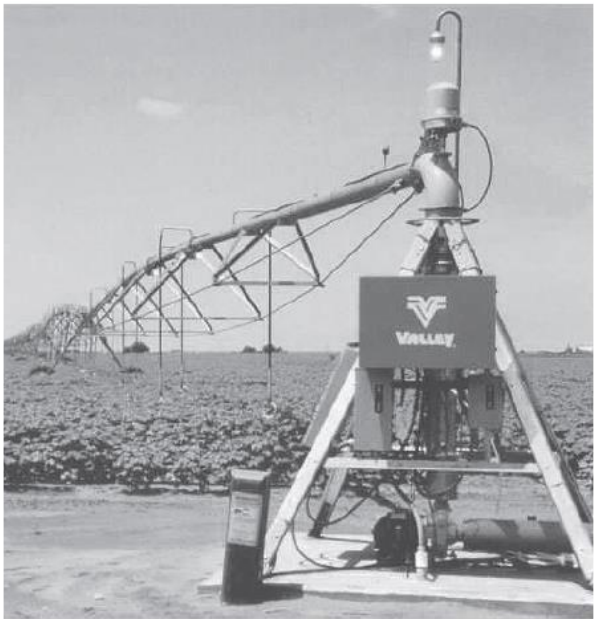


Photo 1. Typical centre pivot system with fixed central tower (Phocaides (2007)

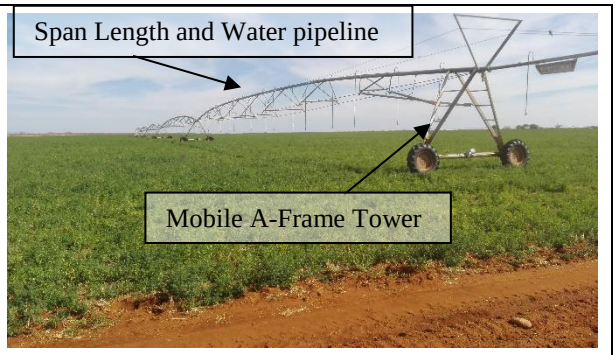


Photo 2. Central pivot system pipeline

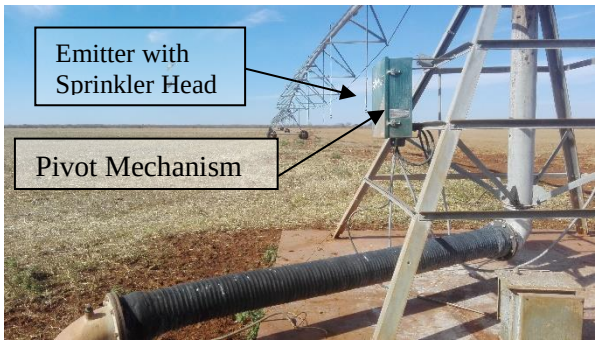


Photo 3. Central pivot system employed in the region

4.4 WATER SUPPLY

Water supply for irrigation will be shared with existing sand mining and quarrying activities from three existing boreholes located on the eastern boundary of the irrigation area. If required, water may also be sourced from an additional borehole located to the west of the irrigation area (Figure 2). All boreholes were test pumped with results indicating a yield of 100 m^3/h or more since the pump tests could only measure up to this level. Irrigation is expected to require around 900,000 m^3 per annum (average of 2,465 m^3 / day) for the first phase, and an additional 900,000 m^3 per annum for the second phase of irrigation. Henning Crushers is in the process of applying for groundwater abstraction permits from the Department of Water Affairs and Forestry.

4.5 SUPPORT INFRASTRUCTURE

Electricity supply is provided by NamPower through Central North Regional Electricity Distributor (CENORED). The mining operations on the farm have a 1 MW installed power supply. Only around 0.7 MW of the installed capacity is used for mining and related operations, therefore power supply for irrigation activities will be sourced from the excess power supply available from the mining activities. Fuel required for tractors and other vehicles will be sourced from a consumer fuel installation located outside of the project area.

All maintenance of vehicles will be done at the mining operations maintenance yard, adjacent to the proposed irrigation site. All chemicals related to the project, such as pesticides, will be stored in a dedicated chemical store. The store will have appropriate spill containment infrastructure (bunding / drip trays), health and safety warnings, and will be kept locked.

General waste generated from the proposed irrigation activities will be minimal, and will be handled along with the waste from the mining operations. All empty chemical containers will be handled as hazardous waste, and appropriate disposal procedures will be followed.

4.6 EMPLOYMENT

The proposed farm activities will be performed by an estimated 10 permanent employees and between 20 to 30 seasonal employees. Employees will be transported from town to the farm on a daily basis when required. The operations will aim at employing local Namibians only. Employees will use the ablution facilities of the mining operations adjacent to the site. Ablution facilities have sufficient change rooms and toilets connected to a French drain system to accommodate all proposed employees.

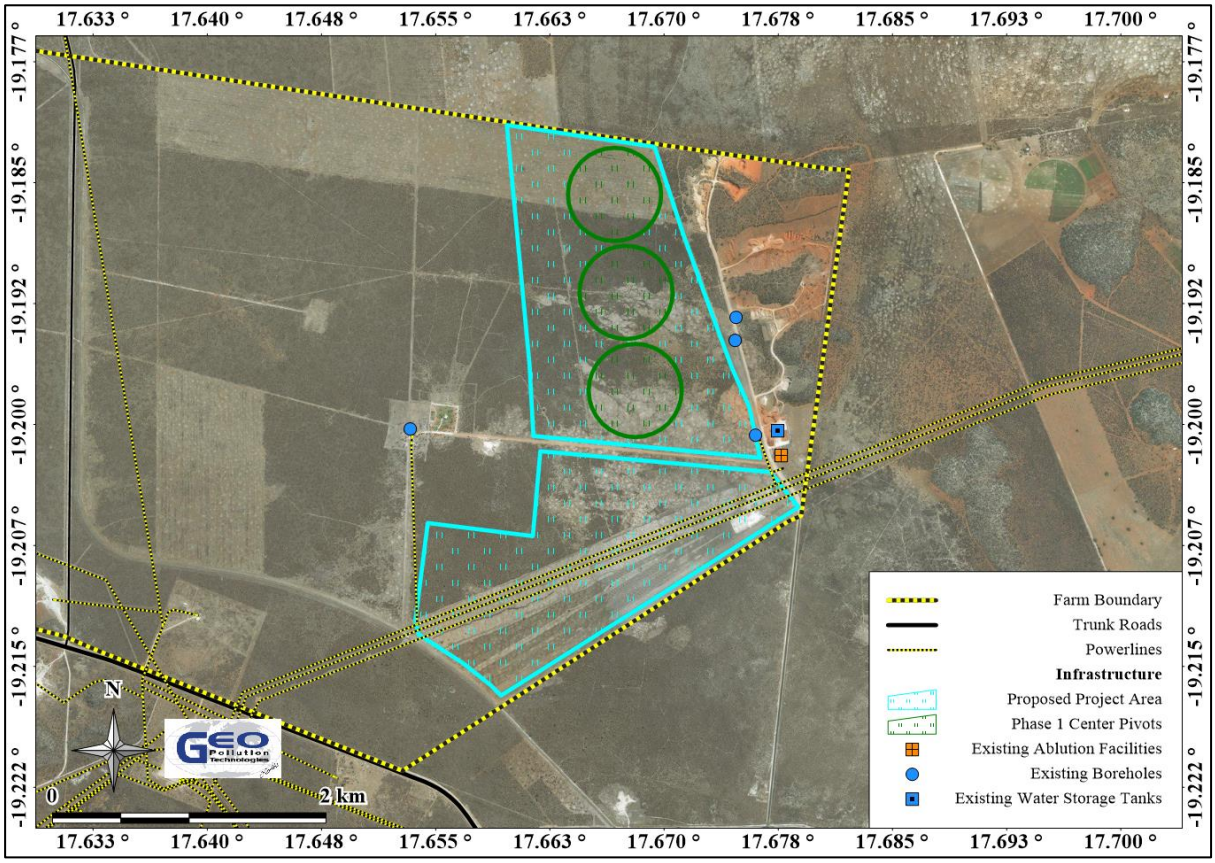


Figure 2. Farm layout

Photo 4. Grassland used for grass harvesting (proposed phase 2 area)

Photo 5. Proposed phase 1 irrigation area

Photo 6. Dead trees and shrubs on proposed irrigation areas

Photo 7. Proposed phase 1 irrigation area (few large remaining trees)

Photo 8. Borehole and pump house in background

Photo 9. Site access road

Photo 10. Veld condition (dead shrubs)

Photo 11. Power supply of mining and proposed irrigation activities

5 ALTERNATIVES

Various alternatives related to the project are considered and each of these are briefly discussed. The alternatives can roughly be grouped into three main groups namely:

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

5.1 LOCATION ALTERNATIVES

The proposed location for irrigation is well suited for crop production due to the availability of water and suitability of soils. Boreholes have been established and some degree of land clearing has already been completed. Obtaining additional or alternative property for the project may require bush clearing, and its associated impacts, in another location. No location alternatives are therefore considered feasible, as the proponent owns the property on which operations are conducted.

5.2 PROJECT IMPLEMENTATION AND DESIGN ALTERNATIVES

Various alternatives are continually considered to optimise crop production. Boreholes are established and no surface water is available. Therefore, there are no alternative water sources for the proposed irrigation operations. However, there are a number of alternatives with regards to the application of the water used. The most pertinent relates to crop irrigation methods.

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 (such as drip irrigation) for crops with lower economic yields. The high value of horticulture crops can however accommodate such systems. In turn, some crops will not produce such high yields when cultivated under less efficient systems. Table 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. Although flood systems are not viable irrigation methods, these have been included for comparison with regards to capital cost and design efficiency.

Table 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 Tsumeb area, climatic and soil conditions necessitate an irrigation system with a high rate of water deposition (due to evaporation and soil salinization). For purposes of irrigation of maize, sorghum and lucerne, sprinkler systems are most suitable. Of the various sprinkler systems, centre pivot systems have high efficiency and are suitable for these crop types. For phase 2 development the powerline and its reserve needs to be taken into consideration and alternative irrigation methods might be more efficient / suitable for the space available.

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 currently however a shift in the approach to soil preparation. Conservation tillage practises aims at less disturbance of the soil and has advantages of less erosion and evaporation, as well as time and cost savings when compared with 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 seeds are planted. 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. Henning Crusher should investigate the applicability and potential advantages of conservation tillage on Steinquelle.

5.3 NO GO ALTERNATIVE

Crop cultivation has been a core activity in the Tsumeb area for years. Crops are supplied to local markets as well as used for fodder, therefore reducing the import of crops and fodder. Should the project not receive an environmental clearance certificate, there would be a loss in capital investment and no additional employment opportunities will realise. Thus, the spending power of the local community will not increase and less revenue will be generated for Namibia. Furthermore, the gap between volumes of locally produced crops and imported crops will not be reduced.

6 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 assessment, as per the Namibian legislation. The legislation and standards provided in Table 2 to Table 4 govern the environmental assessment process in Namibia and/or are relevant to the activities on the farm.

Table 2. Namibian law applicable to the development

Law	Key Aspects
The Namibian Constitution	♦ Promote 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 ♦ Promote sustainable management of the environment and the use of natural resources ♦ Provide a process of assessment and control of activities with possible significant effects on the environment
Environmental Management Act Regulations Government Notice No. 28-30 of 2012	♦ Commencement of the Environmental Management Act ♦ List activities that requires an environmental clearance certificate ♦ Provide Environmental Impact Assessment Regulations
Nature Conservation Ordinance 4 of 1975 Including all amendments: Government Notice: 117 of 1976; 115 of 1978 77 of 1985; 75 of 1987; 90 of 1988; 131 of 1996 Nature Conservation Amendment Ordinance 4 of 1977; 16 of 1980; 27 of 1986 Nature Conservation Amendment Act: 6 of 1988; 17 of 1988; 31 of 1990; Act 5 of 1996	♦ To consolidate and amend the laws relating to the conservation of nature; the establishment of game parks and nature reserves; the control of problem animals; and to provide for matters incidental thereto ♦ Provides list of specially protected game, protected game (including birds) and huntable game (including birds) ♦ Provides a list protected species in annex 243
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

Law	Key Aspects
The Water Act Act No. 54 of 1956	♦ Remains in force until the new Water Resources Management Act comes into force ♦ Defines the interests of the state in protecting water resources ♦ Controls water abstraction and the disposal of effluent ♦ Numerous amendments
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 ♦ Not in force yet
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 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 Government Notice No. 170 of 2015	♦ Declares protected trees or plants ♦ Issuing of permits to remove protected tree and plant species
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 in Namibia
Biosafety Act **Act No. 7 of 2006**	♦ Regulate 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
Local Authorities Act Act No. 23 of 1992, Government Notice No. 116 of 1992	♦ Define the powers, duties and functions of local authority councils
Public Health Act Act No. 36 of 1919	♦ Provides for the protection of health of all people
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
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)

Law	Key Aspects
Atmospheric Pollution Prevention Ordinance Ordinance No. 11 of 1976	♦ Governs the control of noxious or offensive gases ♦ Prohibits scheduled process without a registration certificate in a controlled area ♦ Requires best practical means for preventing or reducing the escape into the atmosphere of noxious or offensive gases produced by the scheduled process
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 3. Relevant multilateral environmental agreements for Namibia and the development

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	♦ Promote 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 4. Standards or codes of practise

Standard or Code	Key Aspects
National Climate Change Strategy & Action Plan, 2013 – 2020 Republic of Namibia, Ministry of Environment and Tourism	♦ The strategy aims to develop, identify and disseminate climate resilient crop farming practices ♦ Aims to ensure water resources are sustained and to ensure monitoring and data collecting technologies of surface and underground water are developed and implemented at basin/watershed level ♦ Promote conservation and sustainable utilisation of water resources

The agricultural and related activities that are listed as activities requiring an environmental clearance certificate are (Government Notice No. 29 of 2012):

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 proponent has already conducted an environmental assessment for bush clearing activities. The listed activity therefore does not pertain to this environmental assessment.

7. Agriculture and Aquaculture Activities

- 7.5 Pest control (Crop cultivation will require a pest control through the application of approved Namibian pesticides. A pesticide management plan will be established by a related specialist and details annual pesticide requirements)

8. Water Resource Developments

- 8.1 The abstraction of ground or surface water for industrial or commercial purposes. (Abstraction of groundwater for the commercial production of crops.)
- 8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems. (French drains for domestic use)
- 8.7 Irrigation schemes for agriculture excluding domestic irrigation. (No *irrigation scheme* will be 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.)

Additional national planning legislation considered include:

- 5th National Development Plan (NDP5),
- Harambee Prosperity Plan.

The Harambee Prosperity Plan (HPP) is a targeted action plan to accelerate development in clearly defined priority areas, which lay the basis for attaining prosperity in Namibia. The Plan does not replace, but rather complements the long-term goal of the National Development Plans (NDPs) and Vision 2030. The rationale behind the HPP is to introduce an element of flexibility in the Namibian 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 NDPs. It is the purpose of NDP5 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 proposed by Henning Crusher will 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 NDP5 is agriculture and food security. The NDP5 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 farm Steinquelle are in line with all of these strategies as identified in the NDP5. The project will increase the amount of irrigated land in Namibia, will provide employment, produce crops for local markets, as well as produce fodder for livestock farming.

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

Farm Steinquelle FMB/00761/00023 (19.2008 °S; 17.6530 °E) is located approximately five kilometres northwest of Tsumeb along the B1 trunk road leading to Ondangwa. Henning Crusher (Pty) Ltd also conducts sand and dolomite mining activities on farm Steinquelle, adjacent to the proposed irrigation areas. All adjacent properties are farms mainly used for agriculture. A NamPower substation is also situated opposite the B1 trunk road. The adjacent farms can be seen in Table 5 and Figure 3.

Table 5. Adjacent farms

Number on Map	Direction from Steinquelle FMB/00761/00023	Farm Name and Number
1	North	Pasadena FMB/00477
2	Northeast	Dannenberg FMB/00478
3	East	Skadu FMB/00761/00020
4	East	Tsumore FMB/00761/00REM
5	Southeast	Steinquelle FMB/00761/00024
6	South to West	Tsumore FMB/00761
7	South	Tsumore FMB/00761/00005
8	Northwest	Riepe Plot FMB/00476/00REM

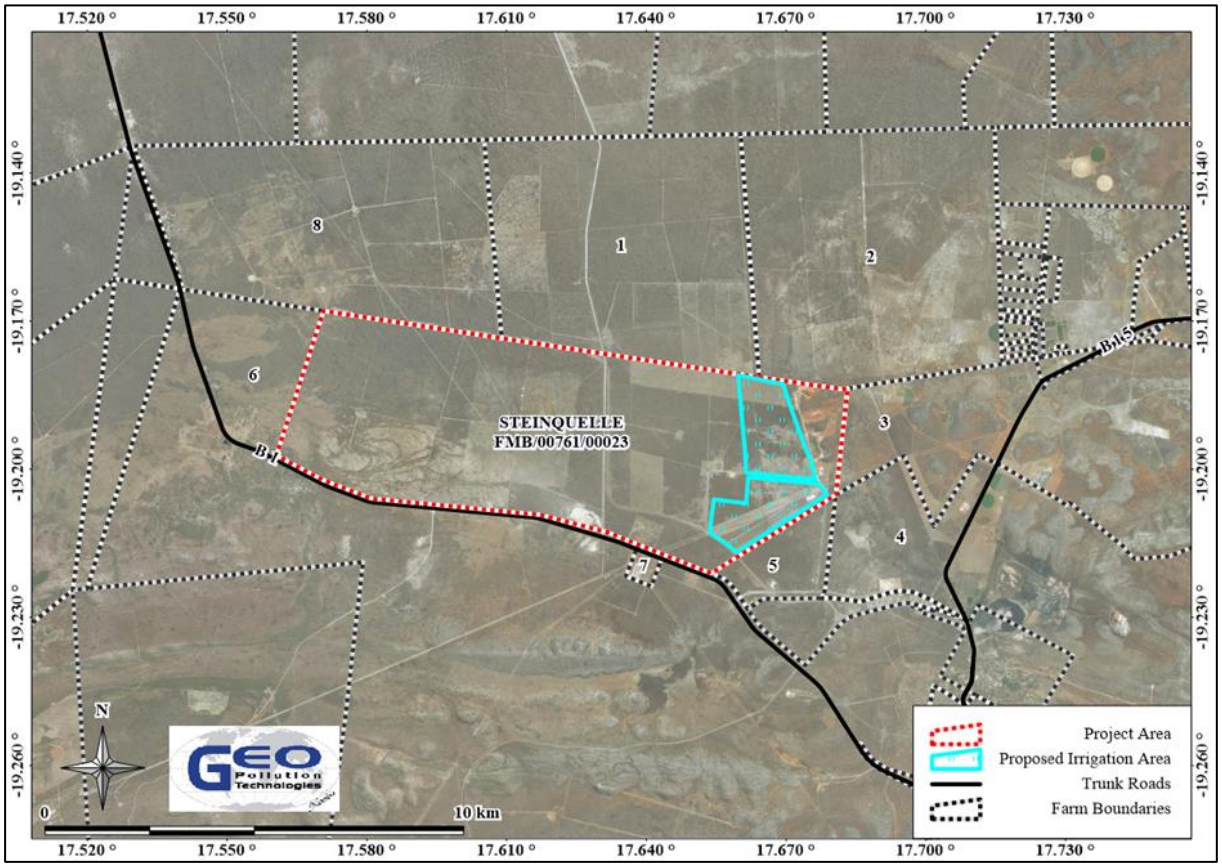


Figure 3. Properties adjacent to the project area

Implications and Impacts

The location is well suited for the agricultural activities. It is already zoned for agricultural use and is situated in an area suitable for irrigation. The farm is further surrounded by activities of similar nature. The farm will follow sustainable agricultural practices ensuring impacts on the surrounding land-users are minimised.

7.2 CLIMATE

The Tsumeb area is situated in a semi-arid climatic region. Days are mostly warm with very hot days during the summer months, while nights are generally cool. Rainfall occurs from October to April. The highest rainfall is normally received during the months of January, February and March, whilst July and August are generally dry. Average annual rainfall received in Tsumeb are high compared to the most of Namibia and it ranges between 450 and 500 mm/a, with a rainfall variability of 30%. The average annual evaporation exceeds 2,800 mm/a. Table 6 below contain a summary of climate conditions for the area. As seen in Figure 5, the dominant wind direction is

from the east while average wind speed is around 4.8 km/h. Wind speeds measured at the Tsumeb airport rarely exceeds 16 km/h.

Table 6. Summary climate data

Precipitation	450-500
Variation in annual rainfall (%)	< 30
Average annual evaporation (mm/a)	2,800-3,000
Water deficit (mm/a)	1,501-1,700
Temperature (°C)	20-21

Average Monthly Rainfall (mm)											
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
0.0	**0.5**	**3.2**	**16.7**	**53.1**	**62.4**	**127.8**	**120.2**	**84.9**	**35.2**	**2.8**	**1.1**

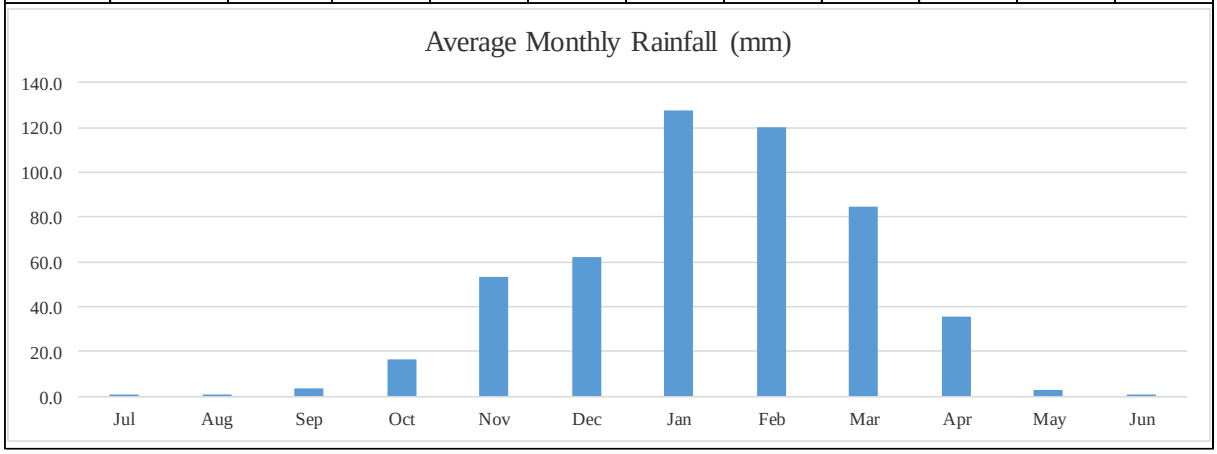


Figure 4. Rainfall information for the Steinquelle area (Atlas of Namibia)

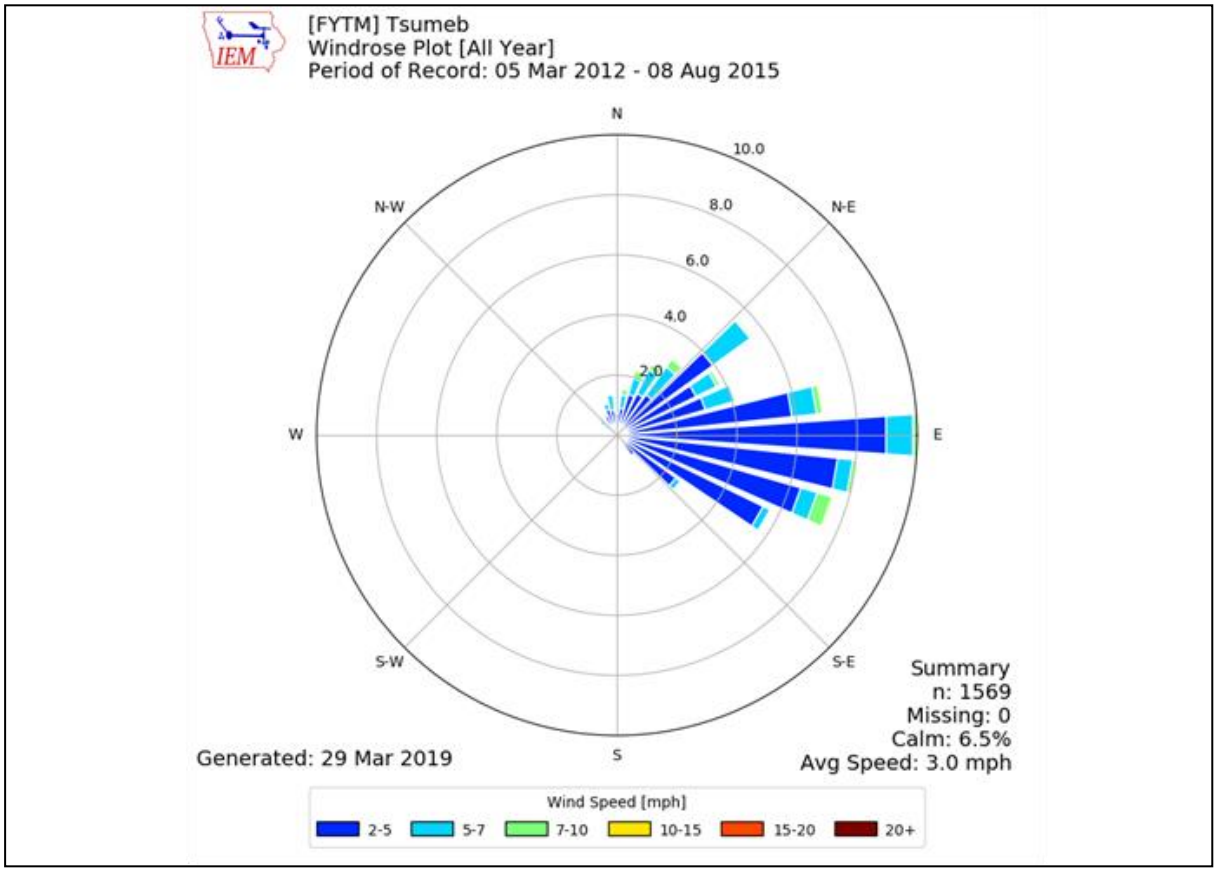


Figure 5. Wind rose: Tsumeb Airport (Mesonet, 2019)

Several models were run in an attempt to predict the effects that possible climate change will have on Namibia. Based on these models it was predicted that soil moisture levels will decline as temperatures rise and evaporation rates increase. Besides the temperature changes, rainfall

changes are expected to become more unpredictable which will decrease dry land cropping potential.

Climate change impacts for most of Namibia, including the Oshikoto Region, are further predicted to negatively affect groundwater availability. Most of the crop production on commercial farms takes place under irrigation, particularly in the Oshikoto Region. Climate change impacts are likely to increase water demand through increased evaporation rates, as wells as a reduction in rainfall. Higher evaporation rates, over irrigation or improper irrigation practices may in turn lead to reduced soil quality due to leaching of minerals and potential soil salinification on the surface.

Certain long term procedures may mitigate the impacts expected from climate change in the agricultural sector. These include the production of drought resistant crops when low rainfall seasons are expected and practicing sustainable agricultural methods such as conservation tillage to reduce evaporation rates. Implementing large scale management on groundwater usage and availability, as well as proper monitoring, not only for agricultural use, but also for residential and industrial use at regional level (towns and villages), will play an important role in ensuring the sustainable utilization of water sources.

Implications and Impacts

Water is a scarce and valuable resource in Namibia and in the project area. Rainfall events are typically thunderstorms with heavy rainfall that can occur in short periods of time (cloud bursts). Rainfall in the area is above the Namibian average. Heavy rainfall can lead to soil erosion where vegetation is removed. Dust carried by wind from nearby mining activities may negatively impact employees and crop production. The project should not pose any environmental threat in relation to Namibia's climatic conditions

Expected climate changes that may occur are called climate change 'risks'. Higher temperatures, which lead to increased evaporation, will lead to an overall reduction of water availability due to less replenishment of surface and groundwater resources (even if there is higher rainfall). Increased evaporation may further lead to salinization of soil. The increase in sporadic rainfall events and shortening of the rainfall season, expected from climate change, may further lead to shorter growing periods, negatively impacting crop production.

7.3 TOPOGRAPHY AND DRAINAGE

The project area forms part of the Karstveld Landscape, with Kalahari surface deposits in the form of pan deposits. The farm form part of the Otavi Mountain Land which is dominated by hills rising up to 500 m above the surrounding plains, with major east-west trending valleys with relatively flat valley bases. This is evident mostly to the east of the farm. Drainage is poorly developed in the area. The site falls within the catchment of the Etosha Pan. The development of sinkholes, dolines and caves are common in the region. The sinkhole, Lake Otjikoto, occurs approximately 1 km west of the farm. A map showing slope and surface drainage directions, as generated from SRTM 30 m data, can be seen in Figure 6. It should be noted that drainage lines are not as well developed as what the figure might present due to high infiltration rates. The slope of the project area is mainly less than 5° with some steeper slopes near the eastern farm border.

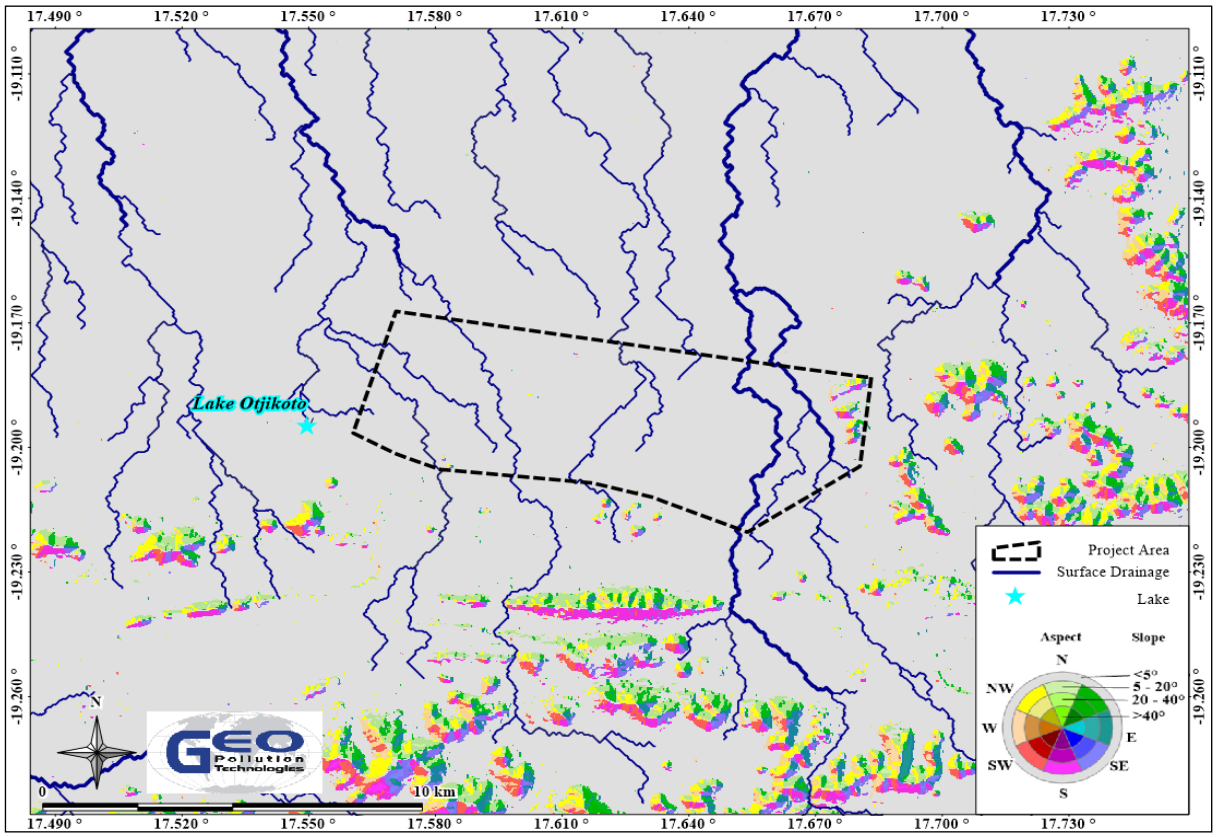


Figure 6. Slope and aspect on site

Implications and Impacts

The lack of major surface runoff and drainage may lead to ponding and even flooding of plains during heavy rainfall events which may negatively impact soil quality and crop production. Runoff from areas where vegetation has been removed may lead to increased soil erosion.

7.4 SOIL

The farm is dominantly underlain by limestone and dolomite rock types (Figure 7). The farm is characterised by a superficial cover of mollic Leptosols, with only a small portion near the southeastern corner comprising of rocky outcrop. Mollic Leptosols has a slight increased thickness compared to some other Leptosols and has a somewhat higher organic content suitable for cropping.

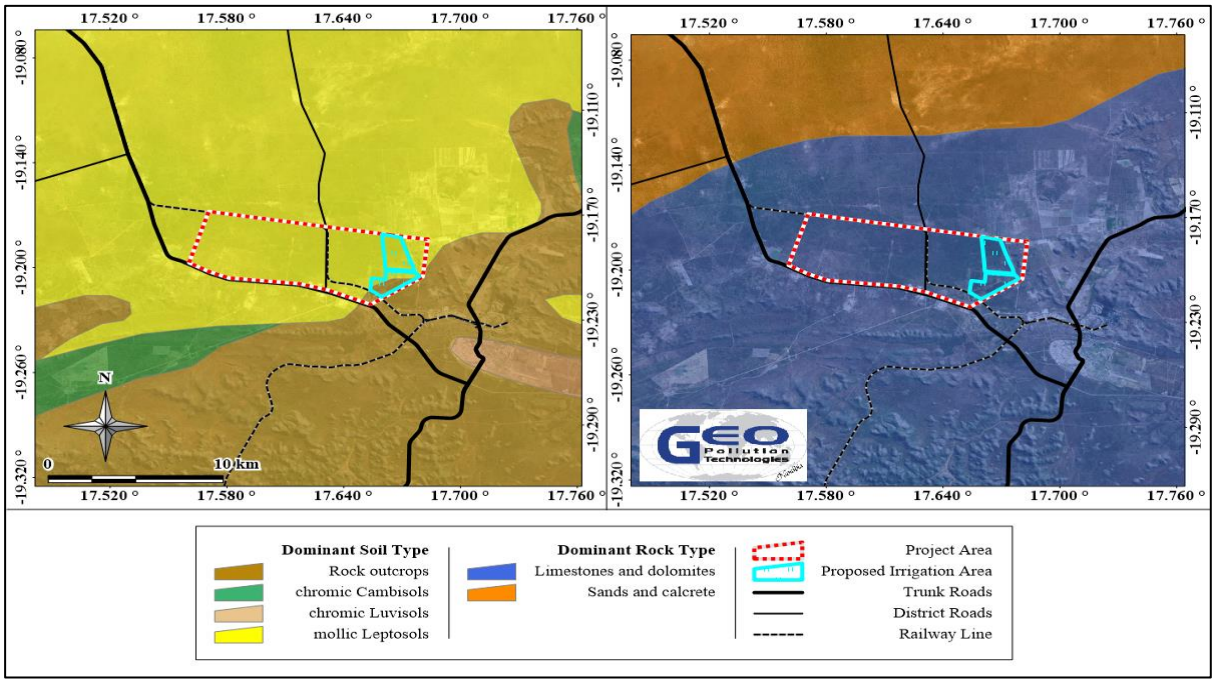


Figure 7. Dominant soil and rock types

Implications and Impacts

Although soil depth of mollic Leptosols in some cases may not be favourable for crop production, soil depth at the proposed irrigation areas are expected to be suitable.

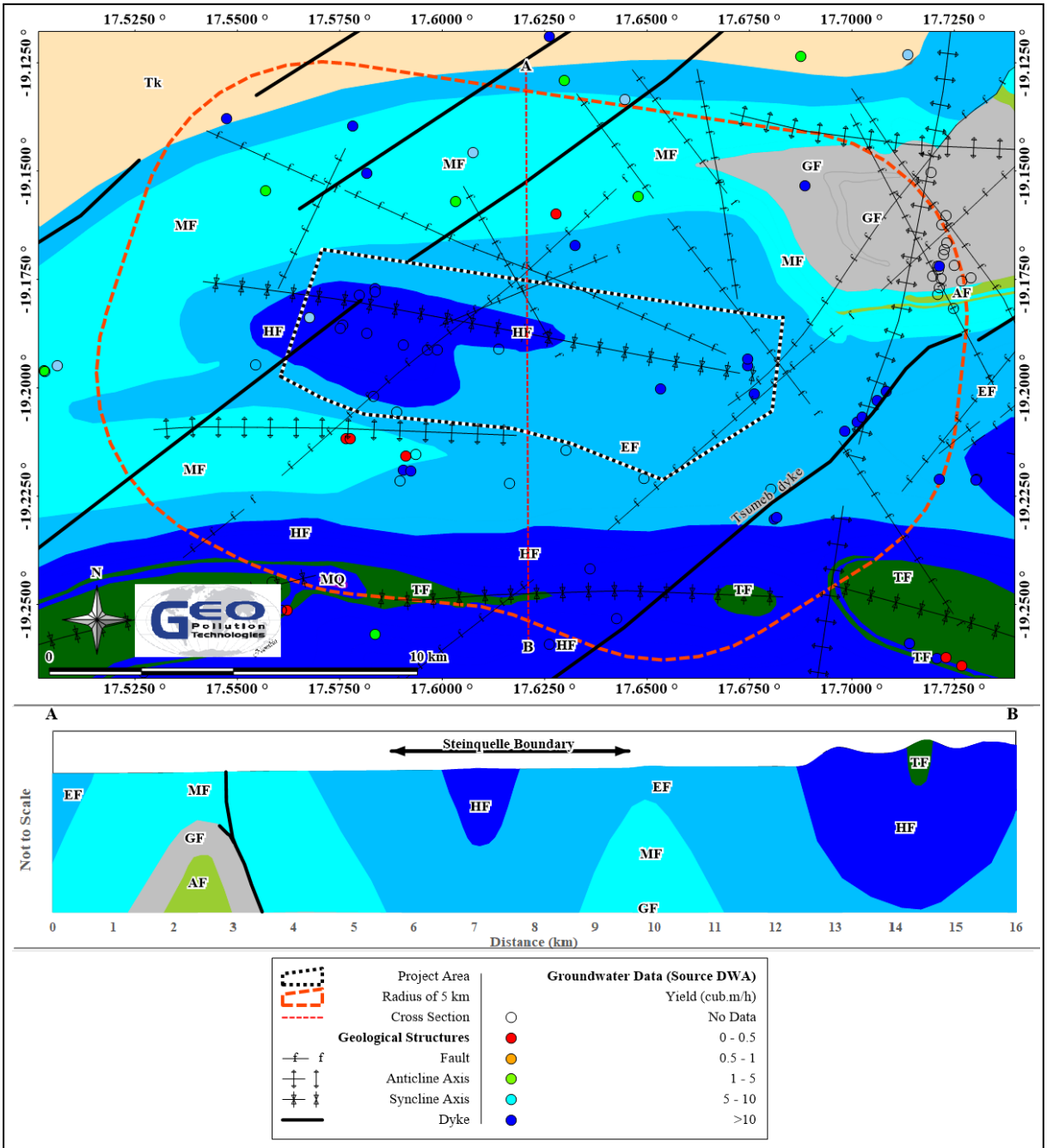
7.5 GEOLOGY AND HYDROGEOLOGY

The geology underlying the farm formed during the Quaternary-, Tertiary- and Namibian Age. Geology from the Quaternary and Tertiary Ages consist of the Kalahari Group deposits which typically is sand, calcrete and gravel. Sediments from the Kalahari Group originate mainly from fluvial deposition with some reworking of aeolian processes. The Kalahari Group sediments overlie pre-Kalahari rocks, in this case rocks belonging to the Namibian Age. Damara Sequence rocks consists locally of the Mulden- and Otavi Groups. Subsurface geology of the farm consist of dolomite, chert and breccia from the Huettenberg- and Elandshoek Formation.

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. It should be noted that a thin veneer of Quaternary and Tertiary Age Kalahari Group deposits are present further south than what is indicated in Figure 8. The thin veneer was not showed to better present the more important underlying formations.

The main fault orientation is roughly northeast to southwest and northwest to southeast. Geophysical-interpreted dykes occur in the area and strike towards the northeast. Figure 8 depicts geological structures interpreted from geophysical data for the farm and the surrounding area. The Tsumeb dyke is located about 2 km southeast of the farm and another dyke intersects western portion of the farm. Groundwater flow is expected to take place through primary porosity in the surface cover, while it is expected to flow along fractures, faults, dykes or along contact zones and other geological structures present within the underlying hard rock formations. Groundwater flow from the site can be expected in a north to north-western direction. Local flow patterns may vary due to groundwater abstraction (Figure 9).

For more detail on the geology refer to the hydrogeology specialist study conducted for this project.



Lithcode	Age	Sequence	Group	Subgroup	Formation	Lithology
Tk	Quaternary & Tertiary		Kalahari			Sand, calcrete, gravel
TF	Namibian	Damara	Mulden	Otavi-Mulden	Tschudi	Arenite, subgreywacke, conglomerate
HF			Otavi	Tsumeb	Huettenberg	Dolomite, oolite, chert, shale, stromatolite, breccia
EF					Elandshoek	Dolomite, chert, breccia
MF					Maieberg	Dolomite, limestone
GF				Abenab	Auros	Stromatolite, chert, limestone
AF					Gauss	Breccia, oolite, dolostone, chert

Figure 8. Hydrogeology map

Table 7 indicates the groundwater statistics for a radius of 5 km around the project area (Figure 8). The groundwater information was obtained from Department of Water Affairs (DWA) borehole database and from the proponent. The DWA database is generally outdated and more boreholes might be present. Groundwater is widely utilised in the study area, with a total of 187 boreholes within a 5 km radius. The groundwater quality falls under the Group A category which means it excellent quality.

According to the Ministry of Agriculture, Water and Forestry (MAWF, 2006) the farm is located inside the Tsumeb-Otavi-Grootfontein Subterranean Water Control Area, Government Notice

1969 of 13 November 1970 and Proclamation 278 of 31 December 1976 (Extension). The farm also falls under a sub-division of the water control area (Guinas - B1), known as the western half of the Tsumeb-Abenab Synclinorium sub-catchment (Bäumle, 2004). Government regulates groundwater usage in this area and all other groundwater related activities like drilling, cleaning or deepening of boreholes and rates of water abstraction. See Figure 9 for a map indicating the water control area, groundwater basin and inferred groundwater flow.

Groundwater quality data is presented in Figure 10 as a Maucha Plot. From the figure it is clear that the groundwater of the project location is mostly of a calcium-magnesium-bicarbonate water type 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 take place (Te Chow, 1964).

Table 7. Groundwater statistics

Area of Interest:	Groundwater Quality: STEINQUELLE					Query Radius:		5 km
	Number of Known Boreholes	DEPTH (mbs)	YIELD (m^3/h)	WATER LEVEL (mbs)	TDS (ppm)	SULPHATE (ppm)	NITRATE (ppm)	FLUORIDE (ppm)
Data points	**187**	35	36	31	10	10	5	10
Minimum		18.30	2.70	6.00	392.00	10.00	0.20	0.10
Average		92.01	31.88	30.17	521.70	32.70	7.42	0.25
Maximum		235.30	100.00	108.00	856.00	73.00	28.40	0.30
Group A		25.71%	75.00%	12.90%	100.00%	100.00%	80.00%	100.00%
Limit		50	>10	10	1000	200	10	1.5
Group B		22.86%	2.78%	64.52%	0.00%	0.00%	0.00%	0.00%
Limit		100	>5	50	1500	600	20	2.0
Group C		48.57%	11.11%	9.68%	0.00%	0.00%	20.00%	0.00%
Limit		200	>0.5	100	2000	1200	40	3.0
Group D		2.86%	11.11%	3.23%	0.00%	0.00%	0.00%	0.00%
Limit		>200	<0.5	>100	>2000	>1200	>40	>3

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.

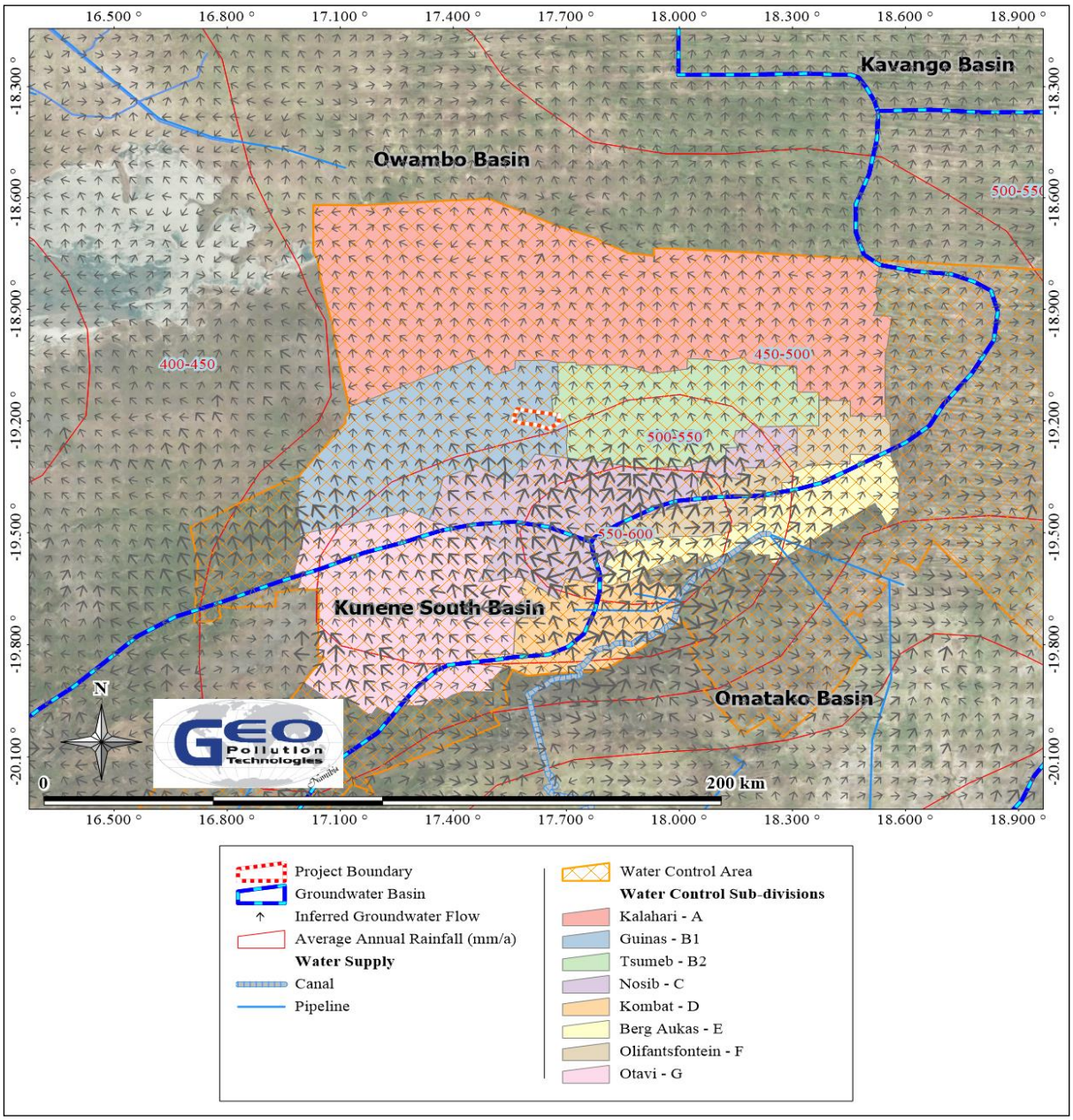


Figure 9. Water control area, groundwater basin and inferred groundwater flow

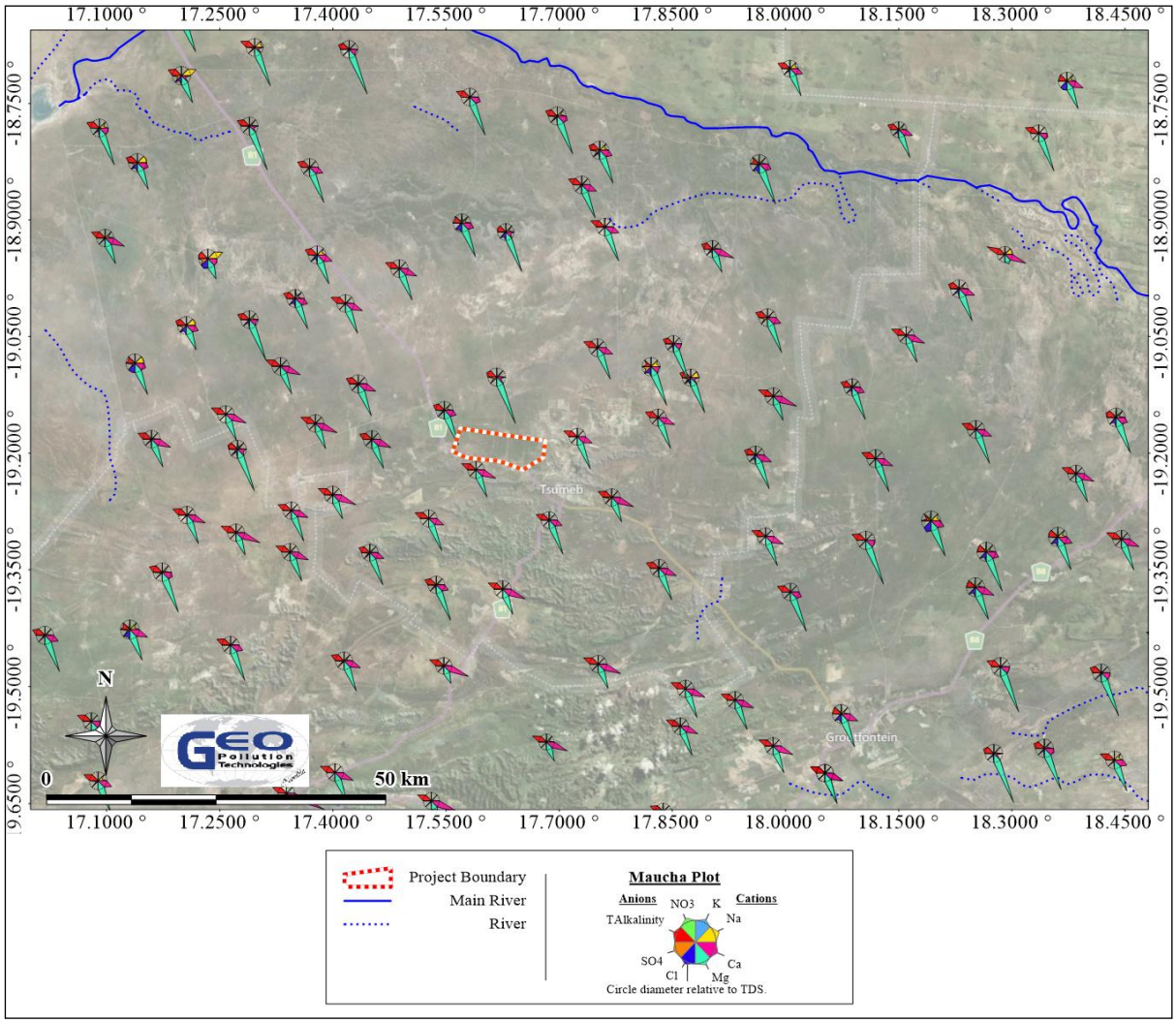


Figure 10. Groundwater quality

Implications and Impacts

A risk to groundwater pollution is expected due to the geological sensitivity of the area. Kartsic aquifers is very susceptible to pollution due to rapid infiltration through formation fractures in the hard rock formations. 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, herbicides and pesticides, which in turn will increase nitrates, herbicide and pesticide concentration in the Karst Aquifer.

7.6 PUBLIC WATER SUPPLY

The only available water supply is groundwater. Water is supplied to Tsumeb by the municipality from boreholes roughly grouped in 3 areas: Extension 8, Nomtsoub and Extensions 6 and 7. The boreholes in the Nomtsoub Group have the highest yields. The majority of farms surrounding the projects area rely on boreholes installed on the farms as well as Lake Otjikoto for water supply.

Implications and Impacts

Groundwater is a valuable resource in the area. Groundwater contamination may negatively impact surrounding boreholes, widely utilised for public water supply. Water abstraction should not affect surrounding / up or downstream groundwater availability.

7.7 AGRO ECOLOGICAL ZONE

The majority of the farm falls within the Kalk-2 agro-ecological zone (AEZ) with an average growing period of 91 to 120 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. However, it is generally not regarded as ideally suited for cropping due to soil depth, and this is true for most of it. The areas under irrigation around Tsumeb are however located in patches where sufficiently deep, quality soil is present for crop cultivation. On Farm Steinquelle, the proposed irrigation area, as seen in Figure 11 is expected to have sufficient soil depth for crop production.

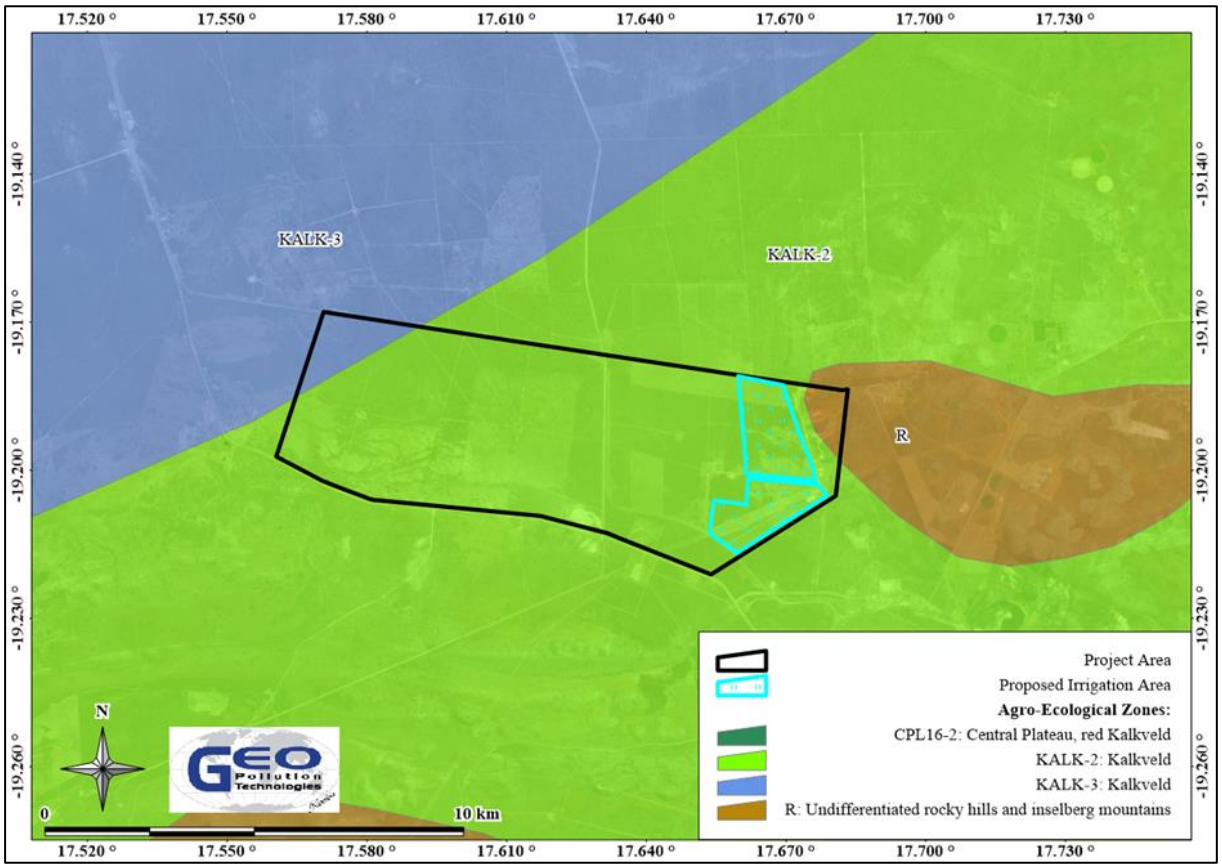


Figure 11. Agro ecological zone

Implications and Impacts

Irrigation attempts outside of suitable areas may be less productive than other types of farming such as livestock farming. This may lead to debushing and habitat destruction with no real positive advantage.

7.8 ECOLOGY

The farm falls within the Savanna Biome with a Karstveld vegetation and Woodland structure. Namibia's biodiversity pattern is characterised by low species diversity, but high endemism, in the west while high species diversity, but low levels of endemism, is present towards the northeast. Plant and animal diversity on Farm Steinquelle would thus be expected to be relatively high in undisturbed areas, but with low endemism.

Plant diversity in the area is high and trees such as *Colophospermum mopane, Terminalia prunioides, Commiphora* species, *Combretum apiculatum, Acacia reficiens, Dichrostachys cinerea* and a variety of other trees are characteristic of this vegetation type. Table 8 and Table 9 present a summary of the general plant and animal diversity of the broader area.

Farm Steinquelle falls within quarter degree square 1917BA. According to the Tree Atlas Project, 73 different tree species occur in this quarter degrees (Curtis & Mannheimer 2005). A summary of those trees protected by legislation in Namibia is presented in Table 10, together with notes on abundance and conservation status / concerns. Not all the trees listed are expected to occur within the vicinity of the farm. Henning crushers proposes to clear an estimated 180 ha or less of land for irrigation purposes. The proposed irrigation areas were previously used for large livestock

grazing, however, bush encroachment has converted the area into a dense shrub and woodland area. As such an de-bushing activities were undertaken as part of the NamPower Encroacher Bush to Power Plan as well as by the proponent in the past. As a result, the areas now identified for irrigation purposes are either devoid of bush vegetation by either being cleared, or being dead, with some larger tress remaining.

Animal diversity in the undisturbed areas of the kartstveld (Tsumeb-Otavi Area) is expected to be relatively high, but with low endemism. Birds like the Lilac-breasted Roller, Purple Roller, Crimson-breasted Shrike, Violet-eared Waxbill, etc., as well as birds of prey such as the near threatened Red-footed Falcon (*Falco vespertinus*) is expected to be found here. Of the vultures, the critically endangered White-backed Vulture (*Gyps africanus*) and the endangered Lappet-faced Vulture (*Torgos tracheliotos*) have been recorded in the area (BirdLife International 2018a). Although, the larger area east of Tsumeb is impacted by anthropogenic activity, animals protected under the Nature Conservation Ordinance of 1975, like the duiker, scaly anteaters, monitor lizards, pythons, tortoises, honey badgers and steenbok, are still expected to be found in fragmented patches of natural habitat.

Of unique importance is the xeric freshwater ecosystems of the karstic aquifers in the area. The lakes and caves within the aquifer support a range of endemic species such as the critically endangered blind cave catfish (*Clarias cavernicola*) and Guinas Tilapia (*Tilapia guinasana*) (IUCN, 2019). The Guinas Tilapia was originally found in Lake Guinas alone, but have been released in the nearby Lake Othikoto for breeding purposes by anthropogenic activities (Irish, 1990). A wide range of groundwater amphipods can also be found in these caves and lakes.

Table 8. General plant data (Digital Atlas of Namibia)

Biome	Savanna
Vegetation type	Karstveld
Vegetation structure type	Woodland
Diversity of higher plants	High (Diversity rank = 2 [1 to 7 representing highest to lowest diversity])
Number of plant species	400-500
Percentage tree cover	11 - 25
Tree height (m)	2 – 5
Percentage shrub cover	51 – 75
Shrub height (m)	1 – 2
Percentage dwarf shrub cover	2 – 10
Dwarf shrub height (m)	< 0.5
Percentage grass cover	26 – 50
Grass height (m)	< 0.5
Dominant plant species	*Colophospermum mopane; Terminalia prunioides; Commiphora* species*; Combretum apiculatum; Acacia reficiens; Dichrostachys cinerea*

Table 9. General animal data (Digital Atlas of Namibia)

Mammal Diversity	76 - 90 Species
Rodent Diversity	24 - 27 Species
Bird Diversity	201 - 230 Species
Reptile Diversity	71 - 80 Species
Snake Diversity	35 - 39 Species
Lizard Diversity	28 - 31 Species
Frog Diversity	12 - 15 Species
Termite Diversity	7 - 9 Genera

Scorpion Diversity	10 - 11 Species

Table 10. Trees with conservation concerns in Quarter Degree Square 1917BA (Curtis & Mannheimer 2005)

Name	Common Name	Conservation Concerns
Acacia erioloba	Camel-thorn	Protected by Forestry Legislation
Albizia anthelmintica	Worm-cure Albizia;Aru	Protected by Forestry Legislation
Aloe littoralis	Windhoek Aloe	Protected by the Nature Conservation Ordinance and listed in CITES Appendix II.
Berchemia discolor	Bird Plum	Protected by Forestry Legislation
Boscia albitrunca	Shepherd's Tree	Protected by Forestry Legislation.
Combretum imberbe	Leadwood	Protected by Forestry Legislation
Erythrina decora	Namib Coral-tree	Endemic to Namibia and very uncommon throughout its range. Protected by Forestry Legislation.
Ficus cordata subsp *cordata*	Namaqua Rock-fig	Protected by Forestry Legislation
Ficus sycomorus	Sycamore Fig	Protected by Forestry Legislation.
Hyphaene petersiana	Makalani Palm	Protected by Forestry Legislation
Maerua schinzii	Ringwood Tree	Protected by Forestry Legislation
Pachypodium lealii	Bottle Tree	Protected by nature conservation ordinance. Listed on CITES Appendix II. Near-endemic extending into extreme southern areas of Angola. Protected by Forestry Legislation
Sclerocarya birrea	Marula	Protected by Forestry Legislation
Spirostachys africana	Tamboti	Protected by Forestry Legislation
Ziziphus mucronata	Buffalo-thorn	Protected by Forestry Legislation

Implications and Impacts

The proposed irrigation area on farm Steinquelle has previously been disturbed by debushing activities. As a result, only a few larger live trees remain, and the majority of trees and shrubs have either been removed or are dead. Clearing of the dead vegetation, and removal of live trees where required may however still lead to small scale habitat destruction or biodiversity impacts. Poaching and illegal collection of plant and animal material may impact on the local environment. Over abstraction of groundwater and pollution of the soil and groundwater by hazardous chemicals and / or the excessive use of fertilizers and pesticides may negatively impact the local ecology.

Over-abstraction of groundwater may lead to ecosystem changes as groundwater levels decrease. Deep rooted terrestrial plants dependent on groundwater will dry out and eventually die and animals dependent on springs will migrate or die. The impact of possible decreases in groundwater level may impact on aquatic organisms in lakes, caves and groundwater. The possible extent of impact is uncertain due to a lack of scientific information on these organisms' ecology and habitat

7.9 DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

The project area falls within the Oshikoto Region with a population of 181,973 and a density of approximately 4.7 people per km^2 (National Planning Commission, 2012). Table 11 provides demographic information for the Tsumeb Constituency, the region and nationally.

The economy of the area relies largely on farming which comprise mainly of crop cultivation and livestock farming. With the growing tourism industry, many cattle farms have been converted into game and hunting farms or lodges. The farming sector made up 33% of salaries in the

Oshikoto Region as per a census conducted in 2011. This is a decrease from 56% in 2001 (Namibia Statistics Agency, 2014) and indicates the need to maintain and develop the agricultural sector.

Table 11. Demographic characteristics of the Tsumeb Constituency, the Oshikoto Region and Nationally (Namibia Statistics Agency, 2011)

	Tsumeb Constituency	Oshikoto Region	Namibia
Population (Males)	9,800	87,066	1,021,912
Population (Females)	9,900	94,907	1,091,165
Population (Total)	19,700	181,973	2,113,077
Unemployment (15+ years)	N/A	40%	33.8%
Literacy (15+ years)	N/A	88%	87.7%

Implications and Impacts

The development will provide permanent as well as seasonal employment to people from the area. Some skills development and training will also benefit employees during the operational phase.

7.10 CULTURAL, HERITAGE AND ARCHAEOLOGICAL ASPECTS

Lake Otjikoto, situated on farm Tsumore FMB/761 adjacent to farm Steinquelle has been declared a national heritage site. The lake has a rich history filled with superstitions. The earliest known one being the San, who had settlements in the area, and believed the lakes are bottomless and any person entering them would simply disappear.

Lake Otjikoto, as well as Lake Guinas further west are at times visited by recreational divers and various First World War German military objects have been retrieved from Lake Otjikoto. These are now in a museum in Tsumeb.

The Otavi Mountains, south of farm Steinquelle, have delivered various fossils during palaeontological excursions (Pickford & Senut, 2010). Among them was a Miocene hominoid, *Otavipithecus namibiensis*, discovered in 1991, the first of its kind in the southern hemisphere at that stage

Implications and Impacts

Artefacts from early settlements may be present on undisturbed areas of the farm. These may be impacted on by human activity.

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 the activities and to identify additional issues which they feel should be addressed in the environmental assessment. During the initiation phase of the public consultation process, IAPs were made aware of their rights to provide input into the assessment process through registering for the project and providing comments and concerns. This invitation appeared on all the notices as mentioned below as well as the notification letters.

Public participation notices were advertised twice in two weeks in the national papers: The Republikein and Namibian Sun on 25 June 2019 and 2 July 2019. A site notice was placed at the site entrance and notification letters delivered via email or hand delivery to neighbours. Neighbours indicated their preferred method of communication and information receipt. As such, some IAPs requested to be sent the information by email, while others were engaged with in a brief meeting. A background information document was loaded onto the MET electronic system as well as made available to commenting authorities and IAPs.

The Tsumeb Town Council was notified and acknowledged the notification. See Appendix A for proof of the public participation processes and registered IAPs along with a comments and responses table.

8.1 COMMENTS AND CONCERNS

Comments and concerns received during the notification process of the project were mostly related to the mining activities of Henning Crusher. Comments received regarding the proposed irrigation activities were minimal, and mostly related to groundwater abstraction impacts.

Written comments have been recorded and included in the comments and responses table as per Appendix A. The comments and responses table also indicates how concerns have been addressed in this assessment.

9 MAJOR IDENTIFIED IMPACTS

During the scoping exercise a number of potential environmental impacts have been identified. The following section provides a brief description of the most important of these impacts.

9.1 SOIL AND GROUNDWATER CONTAMINATION

Soil and groundwater contamination are possible when large quantities of fertilizers or pesticides are applied. Excessive fertilizer use may result in increased soil nutrient levels (i.e. nitrogen, phosphorus and potassium), to a point that soil is regarded as contaminated. Similarly, pesticides can accumulate in soil at levels detrimental to biota. Fertilizers and pesticides can leach deeper into the ground and eventually reach and contaminate groundwater. Chemical spills, inclusive of fertilizers and pesticides, may result in very high but localised contamination of soil, increasing the risk of groundwater if spill clean-up is not performed.

Hydrocarbon pollution resulting from the spilling of fuel, oil or hydraulic fluids is possible. Tractor and other vehicle breakdowns or incorrect refuelling and storage of fuel are the most likely causes of hydrocarbon pollution. Contamination of the environment may also occur if hazardous substances such as pesticides are stored or handled incorrectly and a spill occur, or if pesticides are applied excessively.

9.2 GROUNDWATER ABSTRACTION

Groundwater will be abstracted for irrigation and related activities. The over abstraction of groundwater can impact on the farm and surrounding users that depend on groundwater as a water source.

9.3 FIRE

A risks of veld fires exist. Open fires in areas not designated for this purpose may spread to nearby veld. Machinery used near vegetation may cause sufficient heat (e.g. exhaust pipes) or sparks that can ignite dry vegetation. Chemicals and fuels stored and used for general activities may be flammable. Electrical shorts on the electricity supply network can cause fires in buildings. Lightning can be a natural ignition source for veld fires which in turn can spread and damage infrastructure and crops, or pose health impacts.

9.4 DUST

Dust may become a nuisance and health risk during construction activities and when land is cleared, ploughed, tilled or prepared for planting, or when strong winds are present while there is dry, barren land in between planting cycles.

9.5 TRAFFIC

Construction and operational activities may add to the traffic present on the B1 main road and the turnoff to the farm as a result of the proposed irrigation activities on the farm. This include the delivery of equipment and construction material, transport of staff, the delivery of fertilizers, seed, etc., as well as the transport of crops to markets.

9.6 HEALTH AND SAFETY

Injuries related to working with machinery, chemicals, pesticides, etc. Inhalation and dermal contact with pesticides are possible where pesticides are for example applied by means of tractor mounted sprayers or via the irrigation system. Vehicle accidents involving staff when transported to and from work, or during movement of machinery like tractors on the farm may occur. Venomous animals like snakes, scorpions and spiders may be present. The project area falls within a malaria risk area with an estimated 100 to 300 malaria cases for every 1,000 people in the area (Digital Atlas of Namibia).

9.7 ECOSYSTEM AND BIODIVERSITY IMPACT

Poaching and illegal collection of plant and animal material by staff and / or non-staff members is possible. Pollution of the environment and groundwater, especially by fuel, pesticides and fertilizers, can deteriorate or alter the ecosystem structure and function. Over-abstraction of groundwater can impact on aquatic organisms living in the groundwater. Due to the endemic nature of such aquatic organisms, the continued pumping of water that results in the extraction of for example amphipods, may detrimentally affect population sizes and viability.

9.8 SOCIO-ECONOMIC IMPACTS

The project will contribute to the supply of food on national level. Employment will be provided to an estimated 10 full time employees and 20 to 30 seasonal employees. Increased spread of HIV/AIDS and other diseases due to an influx of people for seasonal and full time employment may take place.

10 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 construction, operational and potential decommissioning activities of the project (proposed irrigation and related activities on farm Steinquelle). An EMP based on these identified impacts are also incorporated into this section.

For each impact an environmental classification was determined based on an adapted version of the Rapid Impact Assessment Method (Pastakia, 1998). 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 12)

Ranking formulas are then calculated as follow:

Environmental Classification = A1 x A2 x (B1 + B2 + B3)

The environmental classification of impacts is provided in Table 13.

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 12. 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 13. 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

10.1 RISK ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

The EMP provides management options to ensure impacts of the irrigation and related activities are minimised. An EMP is a tool used to take pro-active action by addressing potential problems before they occur. This should limit the 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 various phases of the operation and maintenance / construction of the project. This section of the report can act as a stand-alone document. All personnel taking part in the operations of the farm should be made aware of the contents in 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 construction activities of the farm;
- to prescribe the best practicable control methods to lessen the environmental impacts associated with the farming operation;

- 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 construction, operations 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 mostly be mitigated to have a low significance. The extent of impacts are mostly 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 impacts.

10.1.1 Planning

During the phases of planning for the construction, operations and decommissioning phases of the project, it is the responsibility of 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 various other phases of the project:

- Ensure that all necessary permits from the various ministries, local authorities and any other bodies that governs the construction operations and decommissioning activities of the project are and remain valid. This includes the groundwater abstraction permits.
- Ensure all appointed contractors and employees enter into an agreement which includes the EMP. Ensure that the contents of the EMP are understood by the contractors, sub-contractors, employees and all personnel present or who will be present on site.
- Make provisions to have a Health, Safety and Environmental Coordinator to implement the EMP and oversee occupational health and safety as well as general environmental related compliance at the site.
- 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 / mitigation / emergency response plan and health safety and environment (HSE) manuals;
    - Adequate protection and indemnity insurance cover for incidents;
    - Comply with the provisions of all relevant labour and safety standards;
    - Procedures, equipment and materials required for emergencies.
- Establish and maintain a fund for future ecological restoration of the project site should project activities cease and the site is decommissioned and environmental restoration or pollution remediation is required.
- Establish and maintain a reporting system to report on aspects of operations, maintenance / construction, and decommissioning as outlined in the EMP.
- Submit monitoring reports to MET every six months to allow for environmental clearance certificate renewal when needed. This is a requirement by MET.
- Appoint a specialist environmental consultant to update the EA and EMP and apply for renewal of the environmental clearance certificate prior to expiry.

10.1.2 Skills and Development

The development of infrastructure for crop production will contribute to technology advancement and skill transfer in the area. Development in the agricultural field may lead to higher crop yields, thus increasing the food security in Namibia, thereby promoting and sustaining the agricultural industry. During the construction and operational phases some training will be provided to a portion of the workforce to be able to conduct certain tasks according to the required standards. Skills will be periodically transferred to an unskilled workforce for general tasks. Development of people and technology are key to economic development.

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	Probable
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

Mitigation:

- If the skills exist locally, employees and contractors must first be sourced from the region, and then nationally. Deviations from this practice must be justified.
- Skills development and improvement programs to be made available as identified during performance assessments.
- Employees to be informed about parameters and requirements for references upon employment.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Bi-annual record should be kept of training provided.
- Ensure that all training is certified or managerial references provided (proof provided to the employees) inclusive of training attendance, completion and implementation.

10.1.3 Revenue Generation and Employment

Skilled and unskilled labour will be required for the construction and operational activities associated with the project. Revenue will be generated through the sale of agricultural products on national markets. An increase in food security in Namibia will take place

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 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

Mitigation:

- The proponent must employ local Namibians where possible.
- If the skills exist locally, employees must first be sourced from the town, 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.

10.1.4 Demographic Profile and Community Health

The project will rely on labour during the construction and operational phase. The scale of the project is limited and employees will not reside at the farm, thus the activities are not expected to create change in the demographic profile of the local community. Community health may be exposed to factors such as communicable disease like HIV/AIDS as well as alcoholism/drug abuse. These are typically aggravated during the presence of seasonal employees, and possible foreign construction teams and contractors. An increase in foreign people in the area may potentially increase the risk of criminal and socially/culturally deviant behaviour. However, such trends are considered unlikely.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	In-migration and social ills related to foreign contractors temporarily on site	2	-1	1	1	2	-8	-1	Probable
Daily Operations	Social ills possibly associated with staff	2	-1	1	2	2	-10	-2	Probable
Indirect Impacts	The spread of disease	2	-1	2	2	2	-12	-2	Improbable

Desired Outcome: To prevent the occurrence of social ills and prevent the spread of diseases such as HIV/AIDS.

Actions:

Prevention:

- Employ only local people from the area, deviations from this practice should be justified appropriately.
- Adhere to all local authority by-laws relating to environmental health which includes, but is not limited to, sanitation requirements.

Mitigation:

- Educational programmes for employees on various topics of social behaviour and HIV/AIDs and general upliftment of employees' social status.
- Appointment of reputable contractors.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Summary report based on educational programmes and training conducted.
- Bi-annual reporting and review of employee demographics.

10.1.5 Agricultural Produce and Economic Diversification

The project is in line with Namibia's NDP 5, and will contribute to the development of crop production under irrigation, the economy and food security in Namibia. The project will increases the amount of crops and fodder produced locally, thereby decreasing the need to import crops and adding to the trade balance.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Daily Operations	Contribution to economy, contribution to food security in Namibia	3	1	3	3	2	21	3	Definite
Indirect Impacts	Reduced import needs, increase in trade balance. Spread of knowledge and skill, increased crop productivity	3	1	3	3	3	27	3	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 produce that needs to be imported.

Actions:

Enhancement:

- Local employees should be coached on sustainable farming practices to enable the spread of knowledge and skills and thereby increasing the productivity of small-scale farming as well.
- Sustainability of the farm must be studied through careful monitoring of conditions to optimise the system.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Record should be kept of educational programmes and training conducted.
- Records to be kept in a bi-annual report.

10.1.6 Traffic

Potential traffic impacts will mostly be limited to the turnoff from the main road to the farm. The increase traffic is mostly related to the transport of staff, the delivery of fertilizers, seed, etc., as well as the transport of crops to markets. As traffic during the operational phase will mostly be during harvesting season for a short period, traffic impacts are expected to be minor.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Delivery of equipment and building supplies	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	Increased traffic, road wear and tear and accidents	2	-1	2	2	1	-10	-2	Improbable

Desired Outcome: Minimum impact on traffic and no transport or traffic related incidents.

Actions

Prevention:

- Erect clear signage regarding access and exit points at the farm as well as speed limits on the gravel roads within the farm where required.

Mitigation:

- If any traffic impacts are expected, possibly as a result of delivery of equipment or construction material, traffic management should be performed to prevent these.
- The placement of signs to warn and direct traffic will mitigate traffic impacts.

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Any complaints received regarding traffic issues should be recorded together with action taken to prevent impacts from repeating itself.
- A bi-annual report should be compiled of all incidents reported, complaints received, and action taken.

10.1.7 Health, Safety and Security

Activities associated with construction and operations will rely on human labour and therefore health and safety risks exist. Activities such as the operation of vehicles and machinery as well as handling of hazardous chemicals with inherent health risks pose risks to employees. Encounters with wild animals and especially venomous species like snakes may pose risks to personnel on site. Security risks will be related to unauthorized entry, 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.
- Educate staff on the symptoms of malaria and encourage them to report such symptoms.
- All health and safety standards specified in the Labour Act should be complied with.
- Clearly label dangerous and restricted areas as well as dangerous equipment and products.
- Equipment and goods locked away on site must be placed in a way that does not encourage 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 operation of equipment and machinery / handling of hazardous substances.
- Personnel should be encouraged to, during times of mosquito activity, take measures to prevent mosquito bites including wearing long sleeved clothing, applying insect repellents and sleeping under mosquito nets.
- Implementation of maintenance register for all equipment and hazardous substance storage areas.
- All industry specific health and safety procedures and regulations applicable to the handling of produce for markets should be in place and adhered to.

Mitigation:

- Selected personnel should be trained in first aid and first aid kits must be available on site. The contact details of all emergency services must be readily available.
- Educate staff on the symptoms of malaria and encourage them to report such symptoms.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Any incidents must be recorded with action taken to prevent future occurrences.
- A bi-annual report should be compiled of all incidents reported. The report should contain dates when training were conducted and when safety equipment and structures were inspected and maintained.

10.1.8 Fire

Construction activities, failing electrical infrastructure and fires outside of designated areas may increase the risk of the occurrence of uncontrolled fires which may spread to nearby operations and surrounding farms.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Fire risk	2	-2	2	2	1	-20	-3	Probable
Daily Operations	Fire risk	2	-2	2	2	1	-20	-3	Probable

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

Actions:

Prevention:

- Ensure all chemicals are stored according to MSDS and SANS instructions and all spills / leaks are cleaned.
- Maintain regular site, mechanical and electrical inspections and maintenance.
- Clean and maintain fire breaks at strategic locations around the property.
- Should firebreaks be made, the farmers' association, fire brigade as well as all surrounding farmers should be notified prior to commencement.
- Fire used for purposes such as cooking (by staff) must only be allowed within designated areas.
- Follow SANS standards for the operations and maintenance of the consumer fuel installation.

Mitigation:

- A holistic fire protection and prevention plan is needed. This plan must include evacuation plans and signage, an emergency response plan and a firefighting plan.
- Maintain firefighting equipment and promote good housekeeping.
- Personnel training (firefighting, fire prevention and responsible housekeeping practices).

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- 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.
- A bi-annual report should be compiled of all incidents reported. The report should contain dates when fire drills were conducted and when fire equipment was tested and training given.

10.1.9 Noise

Noise will be generated due to the operation of machinery, and vehicles accessing the site. Construction and maintenance activities may increase the amount of noise generating activities which may lead to hearing loss in workers. It is however not expected that surrounding farms will be impacted by noise generated from the operations and construction activities of the project.

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	-2	2	2	1	-10	-2	Probable
Daily Operations	Noise generated from the operational activities – nuisance and hearing loss	1	-1	2	2	1	-5	-1	Improbable

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

Actions

Prevention:

- Follow World Health Organization (WHO) guidelines on maximum noise levels (Guidelines for Community Noise, 1999) to prevent hearing impairment.
- All machinery must be regularly serviced 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:

- WHO Guidelines.
- Maintain a complaints register.
- Bi-annual reports on complaints and actions taken to address complaints and prevent future occurrences.

10.1.10 Waste Production

Various waste streams are produced during the operational and construction / maintenance phases. Waste may include hazardous waste associated with hydrocarbon products and chemicals and soil and water contaminated with such products. Construction waste may include building rubble and discarded equipment. Domestic waste will be generated by the farm and related operations. Waste presents a contamination risk and when not removed regularly may become a health and / or fire hazard.

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:

- Waste reduction measures should be implemented and all waste that can be re-used / recycled must be kept separate.
- Ensure adequate disposal storage facilities are available, which prevents contaminants potentially leaching from the waste entering the environment.
- Ensure waste cannot be blown away by wind.
- Prevent scavenging (human and non-human) of waste at the storage facilities.

Mitigation:

- Waste should be disposed of regularly and at appropriately classified disposal facilities, this includes hazardous material (empty chemical containers, contaminated materials, soil and water).
- Empty pesticide / herbicide containers that may present a contamination / health risks must rinsed (approved triple rinsing procedure) prior to disposal at a classified facility.
- Liaise with the applicable municipality regarding waste and handling of hazardous waste.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- A register of hazardous waste disposal should be kept. This should include type of waste, volume as well as disposal method/facility.
- Any complaints received regarding waste should be recorded with notes on action taken.
- All information and reporting to be included in a bi-annual report.

10.1.11 Ecosystem and Biodiversity Impact

Land clearing for infrastructure and agricultural development will lead to vegetation and habitat loss, this is however expected to be minimal as the majority of the proposed area was previously impacted by debushing activities. Pollution of the environment and the overutilization of water sources may impact on the ecosystem and biodiversity. Poaching and illegal collection of plant and animal materials may occur.

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	Improbable
Daily Operations	Impact on fauna and flora. Loss of biodiversity - poaching	2	-1	2	2	2	-12	-2	Improbable

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

Actions.

Prevention:

- The necessary permits from the Directorate of Forestry, Ministry of Agriculture, Water and Forestry, must be obtained for removal of all protected species.
- Where possible, removal of protected species and large indigenous trees must be avoided.
- During the construction activities, contain construction material to a designated laydown area and prevent unnecessary movement out of areas earmarked for clearing and construction.
- Educate all contracted and permanent employees on the value of biodiversity.
- Strict conditions prohibiting harvesting and poaching of fauna and flora should be part of employment contracts. This includes prohibitions or regulations on the collection of firewood.
- Regular inspection of fences and staff premises for snares, traps or any other illegal activities.
- Disciplinary actions to be taken against all employees failing to comply with contractual conditions related to poaching and the environment.

Mitigation:

- Report any extraordinary animal sightings to the Ministry of Environment and Tourism.
- Mitigation measures related to waste handling and the prevention of groundwater, surface water and soil contamination should limit ecosystem and biodiversity impacts.
- Avoid scavenging of waste by fauna.

Responsible Body:

- Contractor
- Proponent

Data Sources and Monitoring:

- All information and reporting to be included in a bi-annual report.

10.1.12 Groundwater, Surface Water and Soil Contamination

During construction and operations, sources will exist that may potentially pollute soil and subsequently groundwater. This include vehicles and machinery that leak oil or hydraulic fluids (e.g. tractors and harvesters). Increase of nutrient levels (from over application of fertilizers) in the soil that can leach to the groundwater, as well as excessive / incorrect application of pesticides, may also pose a risk.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Contamination from hazardous material spillages and hydrocarbon leakages	2	-1	2	2	1	-10	-2	Probable
Daily Operations	Contamination from hazardous material spillages and hydrocarbon leakages or sewage, over application of fertilizer and pesticides	2	-2	2	2	2	-24	-3	Probable

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

Actions

Prevention:

- Proper training of operators of machinery and vehicles and employees must be conducted on a regular basis (spill detection, spill control).
- All vehicles / machines at the farm should be maintained to be in a good working condition during operations.
- Vehicles and machinery may only be serviced on a suitable spill control structure.
- Employ drip trays and spill kits when servicing / repairs of equipment is needed.
- Vehicles may only be refuelled at the designated areas of the adjacent mining activities.
- A pesticide plan should be compiled by a specialist and reviewed annually. This plan should be strictly followed, deviations should be approved by the specialist.
- MSDS instructions should be strictly followed for the use and application of chemicals.
- The proponent should consider and investigate conservation tillage methods, as this may reduce the around of fertiliser and water required.

Mitigation:

- Any fuel spillage of more than 200 litre must be reported to the Ministry of Mines and Energy.
- Spill clean-up means must be readily available on site as per the relevant MSDS and spills must be cleaned up immediately.
- The spill containment (drip trays / bunding) of the chemical store must be cleaned if any products are present and this waste must be disposed of at a suitably classified hazardous waste disposal facility.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained. Inputs on soil quality and fertilisation requirements can be provided by a soil specialist.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Effluent Disposal Permit
- 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 farmers on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.
- A bi-annual report should be compiled on all information and of all spills or leakages reported. The report should contain the following information: date and duration of spill, product spilled, volume of spill, remedial action taken.

10.1.13 Groundwater Abstraction

The over abstraction of groundwater for irrigation and other activities may lead to declining water levels. This may negatively impacts on surrounding users as well as existing habitats that depend on groundwater. For example the availability of groundwater may be impacted on the farm and surrounding farms, as well as on a bigger scale due to the cumulative impact. Over abstraction from surrounding users may contribute to the decline in water levels (cumulative impact).

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Impact on aquifer and surrounding users	1	-1	2	2	1	-5	-1	Improbable
Daily Operations	Impact on aquifer and surrounding users	2	-2	2	2	2	-24	-3	Probable

Desired Outcome: To prevent the over abstraction of groundwater.

Actions

Prevention:

- Adhere to water abstraction permit regulations.
- Spread the water abstraction points over a larger area to diffuse the impact.
- Adhere to recommended abstraction rates provided during the borehole efficiency tests to ensure over abstraction does not take place.
- Set baseline values for abstraction, which included groundwater level and abstraction rate according to borehole efficiency tests, and install or use water monitoring devices to record water levels and usage. Reduce abstraction when the water levels nears 22 m below surface.
- To prevent unnecessary water loss all pipeline and water storage infrastructure must be inspected and maintained regularly, and over irrigation should be avoided.
- Pressure and flow censors can be installed that will shutoff water pumps if a leak is detected.

Responsible Body:

- Department of Water Affairs, Ministry of Agriculture, Water Affairs and Forestry
- Proponent

Data Sources and Monitoring:

- Monthly water rest water level monitoring.
- Baseline values should be reviewed every three years based on all historic water level data.
- 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.
- Bi-annual summary report based on all information.

10.1.14 Air Pollution

Excessive dust generated from the movement of heavy vehicles across the farm, as well as from the land preparation activities. Excessive dust may be generated during cultivation and tillage of soil. This will be aggravated during the dry season and periods of strong winds. Pesticides may pose a health risks if not applied correctly.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2)Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	Excessive dust generated from the construction and cultivation activities	2	-1	2	2	1	-10	-2	Definite
Daily Operations	Excessive dust generated from the operational activities	2	-1	2	2	2	-12	-2	Definite

Desired Outcome: To minimise the dust generated and prevent nuisance and health impacts.

Actions

Mitigation:

- Personnel issued with dust masks and regular dust suppression if required.
- Heavy vehicles to maintain low speeds on gravel roads.
- Cultivation and tillage of soils should be prevented on windy days if practically possible.
- A complaints register should be kept for any dust related issues and mitigation steps taken to address complaints where necessary.
- Conservation tillage methods should be investigated and considered as this may minimize the amount of tillage required and dust generated.
- All chemical applications should be according to regulations and material safety data sheet instructions.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Any complaints received regarding dust should be recorded with notes on action taken.
- All information and reporting to be included in a bi-annual report.

10.1.15 Visual Impact

This impact relates to the aesthetic appearance of the site during operations. This impact will be minimal due to the area already being disturbed and widely utilised for agricultural activities. The impact will therefore mostly relate to poor housekeeping and waste not disposed of timeously. This impact that not only affects the aesthetic appearance, but also the integrity of the farm.

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	Aesthetic appearance and integrity of the site	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 a low visual impact is maintained.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- A bi-annual report should be compiled of all complaints received and actions taken.

10.1.16 Impacts on Utilities and Infrastructure

Existing infrastructure and services supply like roads, pipelines and power lines may get damaged during operational and maintenance activities. This may lead to services disruption in certain sections of the area.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction Phase	Disruption of services and damage to infrastructure	2	-1	2	2	1	-10	-2	Unlikely
Daily Operations	Disruption of services and damage to infrastructure	2	1	2	2	1	-10	-2	Unlikely

Desired Outcome: No impact on utilities and infrastructure.

Actions

Prevention:

- Adhere to servitude restrictions around powerlines.
- Appointing qualified and reputable contractors and employees (for specific tasks) are essential.
- If applicable, the contractor must determine exactly where amenities and pipelines are situated before construction commences (utility clearance e.g. ground penetrating radar surveys).
- Liaison with the suppliers of services is essential.

Mitigation:

- Emergency procedures for corrective action available on file.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Utility maps.
- A bi-annual report should be compiled of all incidents that occurred and corrective action taken.

10.1.17 Heritage

The discovery / accidental destruction of archaeological or culturally important sites during construction and land clearing.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction Phase	The discovery /destruction of archaeologically or culturally important sites.	3	-1	3	3	1	-21	-3	Improbable
Daily Operations	The discovery /destruction of archaeologically or culturally important sites.	3	-1	3	3	1	-21	-3	Improbable

Desired Outcome: To prevent the damage to, or destruction of, any archaeological or culturally important (heritage) site.

Actions

Mitigation:

- If such a site or any other archaeologically important artefact is found during any phases, any work that may damage / impact the site must be halted and the relevant authorities must be informed. Firstly, the Namibian Police must be informed. Secondly, the National Monuments Council dealing with heritage should be informed. Construction work may only continue at that location once permission has been granted.

Responsible Body:

- Proponent
- Contractors

Data Sources and Monitoring:

- Record of any discoveries and proof of notifications to authorities on file.
- All information and reporting to be included in a bi-annual report.

10.1.18 Cumulative Impact

Possible cumulative impacts associated with the construction and operational phase are mainly linked to increased traffic, reduction in soil and groundwater quality and groundwater availability.

Project Activity / Resource	Nature (Status)	(A1) Importance	(A2) Magnitude	(B1) Permanence	(B2) Reversibility	(B3) Cumulative	Environmental Classification	Class Value	Probability
Construction	The build-up of minor impacts to become more significant	2	-1	2	2	1	-10	-2	Improbable
Daily Operations	The build-up of minor impacts to become more significant	2	-1	2	2	1	-10	-2	Probable

Desired Outcome: To minimise all cumulative 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 and annual reports for any new or re-occurring impacts or problems would aid in identifying cumulative impacts and help in planning if the existing mitigations are insufficient

Responsible Body:

- Proponent

Data Sources and Monitoring:

- Summary report based on all other impacts must be created to give an overall assessment of the impact of the operational phase.

10.2 DECOMMISSIONING AND REHABILITATION

Closure and decommissioning of proposed irrigation activities on farm Steinquelle as a whole, is not foreseen during the validity of the environmental clearance certificate or in the foreseeable future. However, it is more likely that certain components may be decommissioned as development continues. Decommissioning is therefore included for this purpose as well as the fact that construction activities may also include modification and decommissioning. 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 underground 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 and waste should be contained and disposed of at an appropriately classified and approved waste facility and not dumped in the surrounding areas. The environmental management plan 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.

10.3 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; and
- Periodic (internal and external) audits and reviews of environmental performance and the effectiveness of the EMS.
- The environmental management plan

11 CONCLUSION

Proposed irrigation activities on Farm Steinquelle will contribute positively to the agricultural sector of Namibia, and is in line with the development goals of the National Development Plan 5. Food and fodder will be produced for own use and national markets. The operations and construction will provide employment opportunities and skills development to a local workforce. Revenue will be generated that will contribute to the Namibian economy.

Negative impacts which may be associated with the proposed construction and operational activities can be successfully mitigated. Implementing a safety, health, environment and quality (SHEQ) policy will contribute to effective management procedures to prevent and mitigate impacts. During all phases of the proposed project, all regulations relating to agriculture and health and safety legislation should be implemented. Groundwater and soil pollution must be prevented at all times and groundwater abstraction regulations adhered to. Fire prevention should be key and fire response plans must be in place and regular training provided. All staff must be made aware of the importance of biodiversity and the poaching or illegal harvesting of animal and plant products prohibited. Any waste produced must be 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.

The environmental management plan (Section 10) should be used as an on-site reference document for the construction and operations of the proposed project. Parties responsible for transgressing of the

environmental management plan should be held responsible for any rehabilitation that may need to be undertaken. The proponent could use an in-house Health, Safety, Security and Environment Management System in conjunction with the environmental management plan. All operational personnel must be taught the contents of these documents.

Should the Department of Environmental Affairs of the MET find that the impacts and related mitigation measures, which have been proposed in this report, are acceptable, an environmental clearance certificate may be granted to the proponent. The environmental clearance certificate issued, based on this document, will render it a legally binding document which should be adhered to. Focus could be placed on Section 10, which includes an EMP for this project. It should be noted that the assessment process's aim is not to stop the activity, or any of its components, but to rather determine its impact and guide sustainable and responsible development as per the spirit of the EMA.

Table 14. Impact summary class values

Impact Category	Impact Type	Construction	Operations
	Positive Rating Scale: Maximum Value	5	5
	Negative Rating Scale: Maximum Value	-5	-5
EO	Skills and Development	2	2
EO	Revenue Generation and Employment	2	2
SC	Demographic Profile and Community Health	-1	-2
EO	Agricultural Produce and Economic Diversification		3
SC	Traffic	-2	-2
SC	Health, Safety and Security	-2	-2
PC	Fire	-3	-3
PC	Noise	-2	-1
PC	Waste Production	-2	-2
BE	Ecosystem and Biodiversity Impact	-2	-2
PC	Groundwater, Surface Water and Soil Contamination	-2	-3
BE/EO	Groundwater Abstraction	-1	-3
PC	Air Pollution	-2	-2
SC	Visual Impact	-1	-1
EO	Impacts on Utilities and Infrastructure	-2	-2
SC	Heritage	-3	-3
	Cumulative Impact	-2	-2

BE = Biological/Ecological EO = Economical/Operational PC = Physical/Chemical SC = Sociological/Cultural

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Appendix A: Public Consultation

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To: **Interested and Affected Parties** **24 June 2019**

Re: **Environmental Impact Scoping Assessment and Environmental Management Plan for Sand mining, quarrying, crushing and proposed irrigation activities on Portion 23 (Steinquelle) of Consolidated Farm Tsumore No 761 in the Oshikoto Region**

Dear Sir/Madam

Geo Pollution Technologies (Pty) Ltd was appointed by Henning Crusher (Pty) Ltd to undertake an environmental assessment for the irrigation, mining and associated activities on Portion 23 (Steinquelle) of Consolidated Farm Tsumore No 761. The assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

Project: Sand mining, quarrying, crushing and proposed irrigation activities on Portion 23 (Steinquelle) of Consolidated Farm Tsumore No 761 in the Oshikoto Region

Proponent: Keyser Henning Crusher (Pty) Ltd

Environmental Assessment Practitioner: Geo Pollution Technologies (Pty) Ltd

Sand and dolomite resources are mined where after the material is transported to an on-site crusher and processing facility. Once processed, material is loaded onto an existing rail system for transportation. Mining will be conducted over approximately 110 ha of the farm while proposed irrigation (pivot system) activities are planned for the central portion of the property.

All Interested and Affected Parties (I&APs) are invited to register with the environmental consultant to receive further documentation and communication regarding the project. By registering, I&APs will be provided with an opportunity to provide input that will be considered in the drafting of the environmental assessment report and management plan.

Please register as an I&AP and provide comments by **08 July 2019**.

To register, please contact:

Fax: 088-62-6368

E-Mail: hcrusher@thenamib.com

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

Thank you in advance.

Sincerely,
Geo Pollution Technologies

TSUMEB MUNICIPALITY
Administration Office
Date: 2019-06-27
Ref.
RECEIVED

Quzette Bosman
Social and Environmental Assessment Practitioner

Directors: P. Botha (B.Sc. Hons. Hydrogeology) (Managing)

TEL.: (+264-61) 257411 ♦ FAX.: (+264) 88626368
CELL : (+264-81) 1220082
PO BOX 11073 ♦ WINDHOEK ♦ NAMIBIA
E-MAIL: gpt@thenamib.com

To: **Interested and Affected Parties** **24 June 2019**

Re: **Environmental Impact Scoping Assessment and Environmental Management Plan for the Irrigation Activities on Farm Guinas-See 455 in the Otjozondjupa Region**

Dear Sir/Madam

Geo Pollution Technologies (Pty) Ltd was appointed by Henning Crusher (Pty) Ltd to undertake an environmental assessment for the irrigation and associated activities on Farm Farm Guinas-See 455, Otjozondjupa Region. The assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

Project: Environmental Impact Scoping Assessment and Environmental Management Plan for the Irrigation Activities on Farm Guinas-See 455 in the Otjozondjupa Region

Proponent: Henning Crusher (Pty) Ltd

Environmental Assessment Practitioner: Geo Pollution Technologies (Pty) Ltd

Henning Crusher (Pty) Ltd irrigates 109 ha on Farm Guinas-See 455. The main produce are maize, lucerne, sorghum, beans and oats (for animal feed). Irrigation is from Lake Guinas, by means of four centre pivot irrigation systems. The environmental assessment will include all operational activities associated with the agricultural activities on the farm.

All Interested and Affected Parties (I&APs) are invited to register with the environmental consultant to receive further documentation and communication regarding the project. By registering, I&APs will be provided with an opportunity to provide input that will be considered in the drafting of the environmental assessment report and management plan.

Please register as an I&AP and provide comments by **9 July 2019**.

To register, please contact:

Fax: 088-62-6368

E-Mail: guinas@thenamib.com

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

Thank you in advance.

Sincerely,
Geo Pollution Technologies

OTJOZONDJUPA REGIONAL COUNCIL
CHIEF REGIONAL OFFICER
2019 -06- 28
PO BOX 1682
OTJIWARONGO

Quzette Bosman
Social and Environmental Assessment Practitioner

Public Participation Notification: Environmental Assessment Sand mining, Quarrying, Crushing and Proposed Irrigation Activities on Portion 23 (Steinquelle) of Consolidated Farm Tsumore No 761

Name & Surname	Organisation	Tel / Mobile	Email	Signature
W. Bosch	Farmhouse Deli	Privacy Block		
LMJ Nel	Plaas Skaduwee			
WJ van Greunen	Plaas Skaduwee			
Hillary Kasete	Tsumeb Municipality			
Gustave Heins	Gedeelte 52, Tsumore			Verbal & telephonic acknowledgment

Interested and Affected Parties

Name and Surname	Organisation
Notified & Registered Authorities	
U Hoffman	Tsumeb Farmers Association
Oshikoto Regional Council	Chief Regional Office Mr. Frans Enkali Penda Yandakolo Str, Omithea
Municipality of Tsumeb	Tsumore FMB/00761/00006
Namibia Power Corporation (Pty) Ltd	Tsumore FMB/00761/00005
Eugene De Paauw	Roads Authority
Notified & Registered IAP	
Maja Brand	Farms Pasadena and Riepe
Burgert Brand	Farms Pasadena and Riepe
Eckert Brand	Farms Pasadena and Riepe
Francois and Ulla Pretorius	Farm Dannenberg
Lucas Nel	Farm Skaduwee

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2 NUUS Republikein Maandag 24 Junie 2019

PUBLIC PARTICIPATION NOTICE ENVIRONMENTAL ASSESSMENT FOR SAND MINING, QUARRYING, CRUSHING AND PROPOSED IRRIGATION ON PORTION 23 (STEINQUELLE) OF CONSOLIDATED FARM TSUMORE NO 761, OSHIKOTO REGION

Henning Crusher (Pty) Ltd intends to apply for an Environmental Clearance Certificate (ECC) for sand mining, quarrying, crushing and proposed irrigation activities on Portion 23 (Steinquelle) of Consolidated Farm Tsumore No 761 in the Oshikoto Region. Geo Pollution Technologies (Pty) Ltd was requested to undertake an Environmental Assessment for the activities and draft a related Environmental Management Plan (EMP). The Environmental Assessment and EMP will be submitted to the Ministry of Environment and Tourism as per the Environmental Management Act of 2007 in support of the ECC application.

Sand and dolomite resources are mined where after the material is transported to an on-site crusher and processing facility. Once processed, material is loaded onto an existing rail system for transportation. Mining will be conducted over approximately 110 ha of the farm while proposed irrigation (pivot system) activities are planned for the central portion of the property. For a location map please visit http://www.thenamib.com/projects/ or contact Geo Pollution Technologies directly.

All Interested and Affected Parties are invited to register with the environmental consultant to receive further documentation and communication regarding the ECC application. Reports for review and comment periods will be communicated to all registered parties.

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Speke sing kuslangs vir bemagtiging

VAN BL. 1

Leeming word as een van Australië se voorste vroue-ontdekkingsreisigers beskou en het al 'n afstand langer as twee keer om die wêreld by die ewenaar per fiets afgelê.

Haar laaste twee reuse-ekspedisies van 25 000 km deur Australië en 22 000 km deur Afrika, van Senegal tot Somalië, was deel van die Verenigde Nasies (VN) se bewusmakingsveldtog vir onderwys vir volhoubare ontwikkeling.

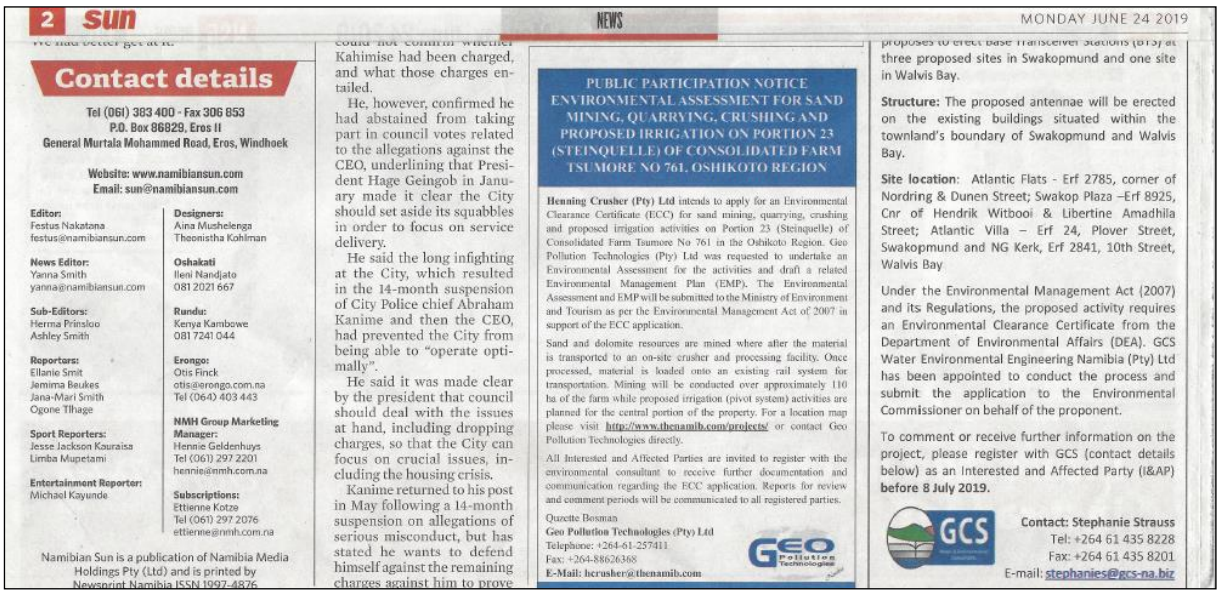
Leeming is met 'n eredoktorsgraad in onderwys van die Universiteit van Wes-Australië vereer vir uitstaande diens ten bate van onderwys.

Die doel van haar suksesvolle 2010-ekspedisie, Breaking the Cycle in Africa, was om die oorsake en gevolge van uiterste armoede te ondersoek en hoe om gemeenskappe te bemagtig.

"Tydens die reis deur 20 lande het ek 15 verskillende projekte besoek wat deur 10 ekspedisievennote bestuur word. In September sal ek die tweede deel van die projek aanpak.

"Dit behels 'n humanitêre ekspedisie waardeur ek 'n sonenergiestelsel sal laat aanbring om lig en uiteindelik toegang tot beter onderwys en ekonomiese bemagtiging vir Purros in die Noordweste moontlik te maak," sê sy.

Namdeb het 'n spesiale permit aan Leeming toegestaan wat haar toegelaat het om van Lüderitz af kuslangs deur die Sperrgebiet na Oranjemund te ry, sodat sy haar reis al langs die Namibiese kus kon voltooi.



2 sun NEWS MONDAY JUNE 24 2019

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Namibian Sun is a publication of Namibia Media Holdings Pty (Ltd) and is printed by Newsprint Namibia ISSN 1997-4876

Kahimise had been charged, and what those charges entailed.

He, however, confirmed he had abstained from taking part in council votes related to the allegations against the CEO, underlining that President Hage Geingob in January made it clear the City should set aside its squabbles in order to focus on service delivery.

He said the long infighting at the City, which resulted in the 14-month suspension of City Police chief Abraham Kanime and then the CEO, had prevented the City from being able to "operate optimally".

He said it was made clear by the president that council should deal with the issues at hand, including dropping charges, so that the City can focus on crucial issues, including the housing crisis.

Kanime returned to his post in May following a 14-month suspension on allegations of serious misconduct, but has stated he wants to defend himself against the remaining charges against him to prove

PUBLIC PARTICIPATION NOTICE ENVIRONMENTAL ASSESSMENT FOR SAND MINING, QUARRYING, CRUSHING AND PROPOSED IRRIGATION ON PORTION 23 (STEINQUELLE) OF CONSOLIDATED FARM TSUMORE NO 761, OSHIKOTO REGION

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Sand and dolomite resources are mined where after the material is transported to an on-site crusher and processing facility. Once processed, material is loaded onto an existing rail system for transportation. Mining will be conducted over approximately 110 ha of the farm while proposed irrigation (pivot system) activities are planned for the central portion of the property. For a location map please visit http://www.thenamib.com/projects/ or contact Geo Pollution Technologies directly.

All Interested and Affected Parties are invited to register with the environmental consultant to receive further documentation and communication regarding the ECC application. Reports for review and comment periods will be communicated to all registered parties.

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Fax: +264-88626368
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three proposed sites in Swakopmund and one site in Walvis Bay.

Structure: The proposed antennae will be erected on the existing buildings situated within the townland's boundary of Swakopmund and Walvis Bay.

Site location: Atlantic Flats - Erf 2785, corner of Nordring & Dunen Street; Swakop Plaza –Erf 8925, Cnr of Hendrik Witbooi & Libertine Amadhila Street; Atlantic Villa – Erf 24, Plover Street, Swakopmund and NG Kerk, Erf 2841, 10th Street, Walvis Bay

Under the Environmental Management Act (2007) and its Regulations, the proposed activity requires an Environmental Clearance Certificate from the Department of Environmental Affairs (DEA). GCS Water Environmental Engineering Namibia (Pty) Ltd has been appointed to conduct the process and submit the application to the Environmental Commissioner on behalf of the proponent.

To comment or receive further information on the project, please register with GCS (contact details below) as an Interested and Affected Party (I&AP) **before 8 July 2019.**

Contact: Stephanie Strauss
Tel: +264 61 435 8228
Fax: +264 61 435 8201
E-mail: stephanies@gcs-na.biz

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PUBLIC PARTICIPATION NOTICE ENVIRONMENTAL ASSESSMENT FOR IRRIGATION ACTIVTIES ON FARM GUINAS-SEE 455, OTJOZONDJUPA REGION

Henning Crusher (Pty) Ltd intends to apply for an Environmental Clearance Certificate (ECC) for irrigation activities on Farm Guinas-See 455 in the Otjozondjupa Region. Geo Pollution Technologies (Pty) Ltd was requested to undertake an Environmental Assessment for the activities and draft a related Environmental Management Plan (EMP). The Environmental Assessment and EMP will be submitted to the Ministry of Environment and Tourism as per the Environmental Management Act of 2007 in support of the ECC application.

Henning Crusher irrigates 90 ha on Farm Guinas-See 455. The main produce are maize, lucerne, sorghum, beans and oats (for animal feed). Irrigation is from Lake Guinas, by means of four centre pivot irrigation systems. The environmental assessment will include all operational activities associated with the agricultural activities on the farm.

For a location map please visit **http://www.thenamib.com/projects/** or contact Geo Pollution Technologies directly.

All Interested and Affected Parties are invited to register with the environmental consultant to receive further documentation and communication regarding the ECC application. Reports for review and comment periods will be communicated to all registered parties.

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E-Mail: guinas@thenamib.com

Miljoene betogers het die afgelope drie weke in Hongkong teen dié wetsontwerp, wat vir nou deur die owerhede laat vaar is, betoog. Die betogers wil hê die regering moet die wetsontwerp heeltemal skrap nadat Carrie Lam, Hongkong se leier, aangedui het dat sy bloot die wetsontwerp vir eers "sal bêre".

Die polisie het Maandag pepersproei teen betogers gebruik, terwyl die polisie met stokke op betogers afgestorm het.

Lam het die 22ste herdenking, waar dié voormalige Britse kolonie aan Chinese heerskappy teruggegee is, bygewoon, al dring die betogers aan dat sy bedank.

Sy sê die regering moet sy manier van doen verander en meer tegemoetkomend en oop wees om sodoende meer vir die jong mense te kan doen.

Lam sê die voorvalle die afgelope maande het tot spanning tussen die publiek en regering gelei, maar sy sê het ook tot die besef gekom dat die regering die publiek se sentiment beter moet probeer verstaan.

Die herdenking is die afgelope jare gekenmerk deur toenemende wanhoop oor wat baie inwoners van Hongkong sien as China se groeiende houvas op hulle.

– Netwerk24/Reuters

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PUBLIC PARTICIPATION NOTICE ENVIRONMENTAL ASSESSMENT FOR IRRIGATION ACTIVTIES ON FARM GUINAS-SEE 455, OTJOZONDJUPA REGION

Henning Crusher (Pty) Ltd intends to apply for an Environmental Clearance Certificate (ECC) for irrigation activities on Farm Guinas-See 455 in the Otjozondjupa Region. Geo Pollution Technologies (Pty) Ltd was requested to undertake an Environmental Assessment for the activities and draft a related Environmental Management Plan (EMP). The Environmental Assessment and EMP will be submitted to the Ministry of Environment and Tourism as per the Environmental Management Act of 2007 in support of the ECC application.

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

nayi."

Oomwedhi ndatu dha piti ngashiingeyi konima sho omunambelewa melelo lyuuministeli wuunamapya, Percy Misika a lombwele oshifokundaneki shoNamibian Sun kutya emanitho lyokatomeno hoka oli

Sho a pulwa kutya osha ende ngiini oshimaliwa shi londe pombanda noomiliyona 13, Amushila okwa popi kutya ina pyakudhukwa okupopya kombinga yomatompelo.

Uuna ka tameke okulonga okatomeno hoka otaka ka vulu okutomion (KERFU) Adolf Muremi, ope na oongombe dhi li po 900 dhoka dhategelelwa okutomwa mokatomeno hoka kopakathimbo.

Muremi okwa kala uule woomvula odhindji ta pula opo okatomeno hoka ka manithwe.

TAKA TUNGWA NATANGO: Okatomeno kaRundu ina ka pwa natango okutungwa. OMATHANO: KENYA KAMBOWE

MONKALO OMBWAANAWA: Aanafaalama yiimuna miitopolwa yaKavango oya hala okatomeno kaRundu ka manithwe meendelelo.

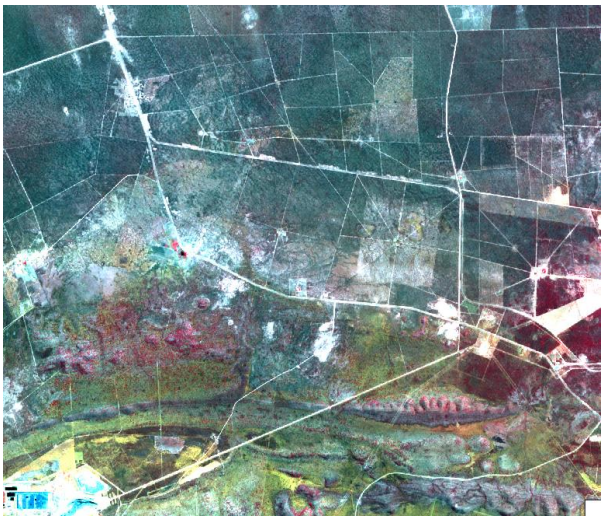
Environmental Assessment: Henning Crusher Quarry Operations
Comments and Responses Table

IAP	***Issue / Concern***	***Response***
Eckert Brand (Neighbour) Received via e-mail on 2019.08.14	1. Where exactly the property is in relation to the trust property. The map supplied is illegible; 2. Detail about the amount of trucks that will be moving on which roads on a daily basis and the cubic meters that are to be removed and over which period of time? 3.What rehabilitation steps are in place for the mining operation once it is concluded and whether a holding deposit for such rehabilitation will be required and who will oversee this process; 4. How big is the area that stands to be irrigated and what is the planned crop that will be planted? 5. How much water will be withdrawn from where? If the water is to be pumped from underground we wish to see a geohydrological engineers report of the impact this withdrawal may have on the general underground water table and also a prediction of what the impact will be in times of drought when the water table is in any event naturally lowered. In the same vein we would like to see the Department of Water Affairs' long term plan on the allocation of water licenses for the area for purposes of irrigation from the underground water and how many licenses for what amount of cubic meters have already been granted for the area impacted by a further license the applicant seeks.	1. Refer to Figure 3 of this report. 2. Ongoing sand mining and quarrying activities have been moved out of this EIA and will have its own EIA report that will be distributed for review. 3 Ongoing sand mining and quarrying activities have been moved out of this EIA and will have its own EIA report that will be distributed for review. 4. See section 4 of this report. 5. See the hydrogeological specialist study in Appendix B of this report.

Appendix B: Hydrogeological Specialist Study

MINING AND AGRICULTURAL ACTIVITIES ON FARM STEINQUELLE TSUMEB DISTRICT

HYDROGEOLOGICAL SPECIALIST STUDY



Assessed by:

Assessed for:

Henning Crusher (Pty) Ltd

November 2019

Project:	**MINING AND AGRICULTURAL ACTIVITIES ON FARM STEINQUELLE, TSUMEB DISTRICT: HYDROGEOLOGICAL SPECIALIST STUDY**	
Report Version/Date	V1/ 01 November 2019	
Prepared for	Henning Crusher (Pty) Ltd Private Bag 184 Tsumeb Namibia	
Lead Consultant	Geo Pollution Technologies (Pty) Ltd PO Box 11073 Windhoek Namibia	TEL.: (+264-61) 257411 FAX.: (+264) 88626368
Main Project Team	**Pierre Botha (Leader)** (B.Sc. Geology/Geography); (B.Sc. (Hons) Hydrology/Hydrogeology) **Christian Brunette** (B.Sc. Geology/Geography); (B.Sc. (Hons) Geology)	
Cite this document as:	Botha P, Brunette H.C.; November 2019; Mining and Agricultural Activities on Farm Steinquelle: Hydrogeological Specialist Study	
Copyright	Copyright on this document is reserved. No part of this document may be utilised without the written permission of Geo Pollution Technologies (Pty) Ltd.	
Report Approval	Pierre Botha Managing Director	

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1 INTRODUCTION

Henning Crusher (Pty) Ltd (the proponent) appointed Geo Pollution Technologies (Pty) Ltd to undertake a hydrogeological specialist study for existing mining and proposed agricultural activities on Portion 23 (Farm Steinquelle) of consolidated Farm Tsumore No 761 in the Tsumeb District, see Figure 1. Henning Crusher plans to irrigate approximately 90 ha for the production of maize, sorghum, beans and lucerne for livestock feed. Water supply is from three production boreholes, namely BH1, WW201938 and WW201939, and irrigated by means of centre pivot irrigation systems. Water will also be used for the 110 ha mining activities on the farm.

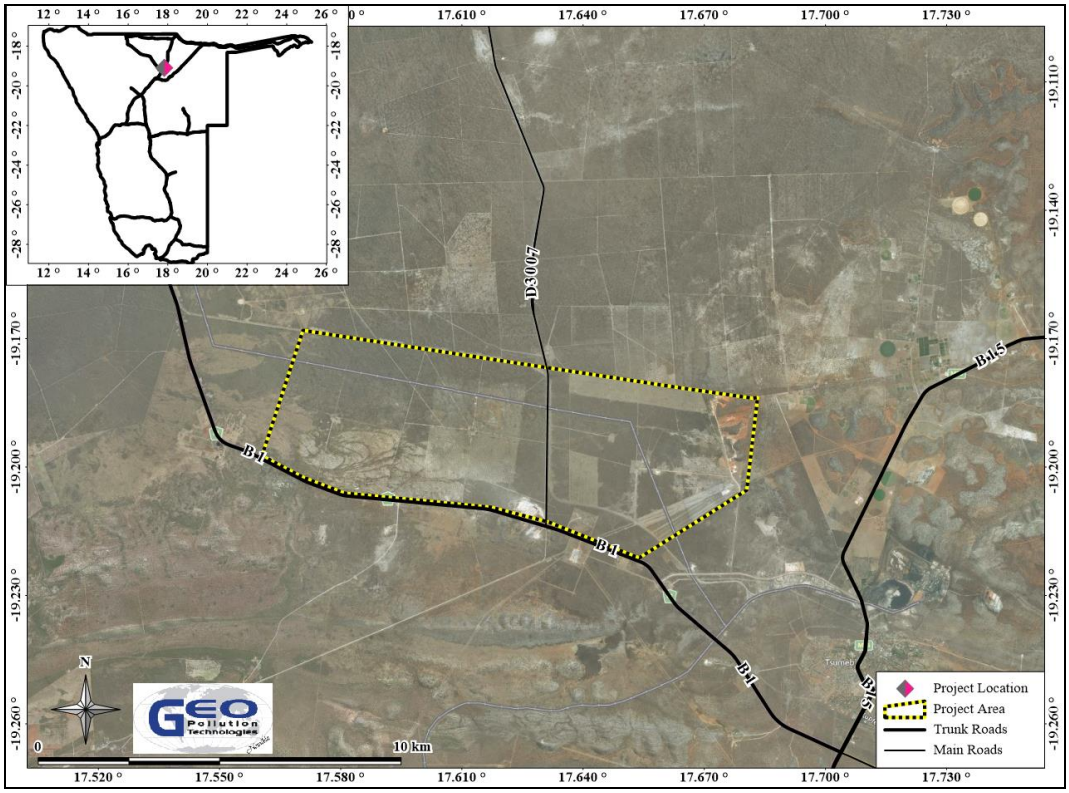


Figure 1. Project location

2 SCOPE OF WORK

The aims of the study were to:

1. Conduct a hydrogeological assessment based on data obtained from an in-field hydrocensus survey.
2. Gather historic information and compile a hydrogeological assessment based on the information.

3 METHODOLOGY

Obtain and review all 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 DWA database and hydrocensus data done on behalf of the proponent.

Obtain, process and review of historic composite satellite images of the investigation area – mainly ASTER. This will include various satellite image band combination evaluations for different time events to identify land cleared for irrigation purposes. The rate of expanding irrigation land will be correlated with historic variation of groundwater data. Prepare a specialist report of the investigation.

4 DESCRIPTION OF NATURAL ENVIRONMENT

4.1 LOCALITY AND SURROUNDING LAND USE

Farm Steinquelle FMB/00761/00023 (19.1948°S; 17.6747°E) is located approximately 5 km northwest of Tsumeb along the B1 trunk road. The farm is therefore accessible from the B1 trunk road and is situated in the Oshikoto Region. All adjacent properties are farms and land use mainly comprise of agriculture. Irrigation is planned to take place in the eastern part of the farm. Existing mining of sand takes place near the eastern border of the farm.

4.2 CLIMATE

The farm is situated in a semi-arid climatic region. Days are mostly warm with very hot days during the summer months, while nights are generally cool. Rainfall occurs from October to April. The highest rainfall is normally received during the months of January, February and March, while July and August are generally dry (Figure 2). Average annual rainfall received in area is high compared to most of Namibia and it ranges between 450 and 500 mm/a, with a rainfall variability of 30%. The main recharge area for groundwater is located in the Otavi area where the average rainfall is slightly higher, ranging between 550 and 600 mm/a, see Figure 5.

The average annual evaporation for the project area is exceeding 2,800 mm/a. Table 1 contains a summary of climate conditions for the area.

Table 1. Summary of climate conditions

Average annual rainfall (mm/a)	450-500
Variation in annual rainfall (%)	< 30
Average annual evaporation (mm/a)	2800-3000
Water deficit (mm/a)	1501-1700
Average annual temperatures (°C)	20-21

Average Monthly Rainfall (mm)											
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
0.0	**0.5**	**3.2**	**16.7**	**53.1**	**62.4**	**127.8**	**120.2**	**84.9**	**35.2**	**2.8**	**1.1**

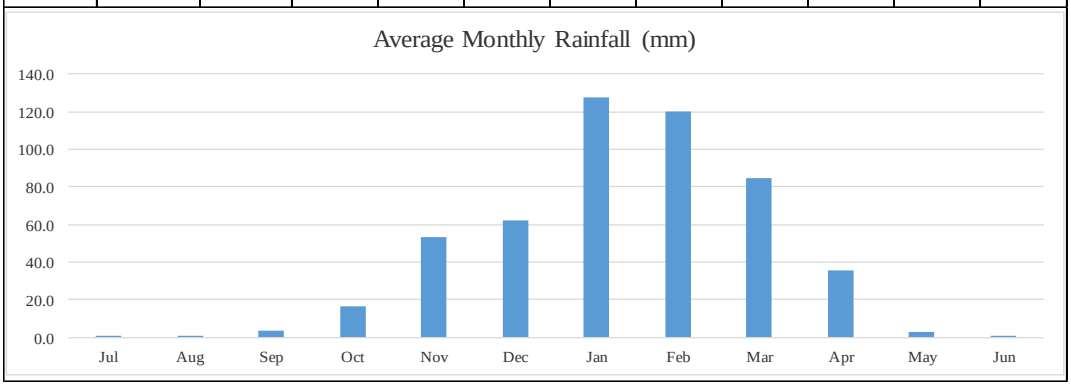


Figure 2. Average monthly rainfall (Atlas of Namibia)

4.3 TOPOGRAPHY & DRAINAGE

The project area forms part of the Karstveld Landscape, with Kalahari surface deposits in the form of pan deposits. The farm form part of the Otavi Mountain Land which is dominated by hills rising up to 500 m above the surrounding plains, with major east-west trending valleys with relatively flat valley bases. This is evident mostly to the east of the farm.

Drainage is poorly developed in the area. The site falls within the catchment of the Etosha Pan. The development of sinkholes, dolines and caves are common in the region. The sinkhole, Lake Otjikoto, occurs approximately 1 km west of the farm. A map showing slope and surface drainage directions, as generated from SRTM 30 m data, can be seen in Figure 3. It should be

noted that drainage lines are not as well developed as what the figure might present due to high infiltration rates. The slope of the project area is mainly less than 5° with some steeper slope areas near the eastern border of the farm.

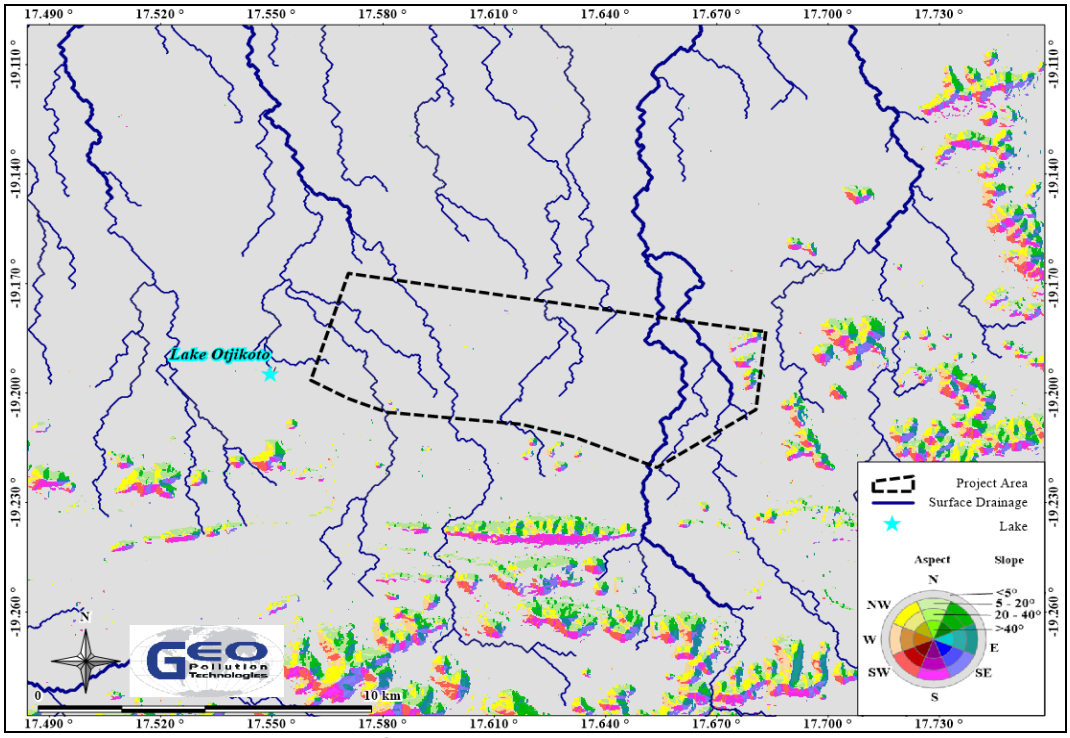


Figure 3. Aspect slope and surface drainage

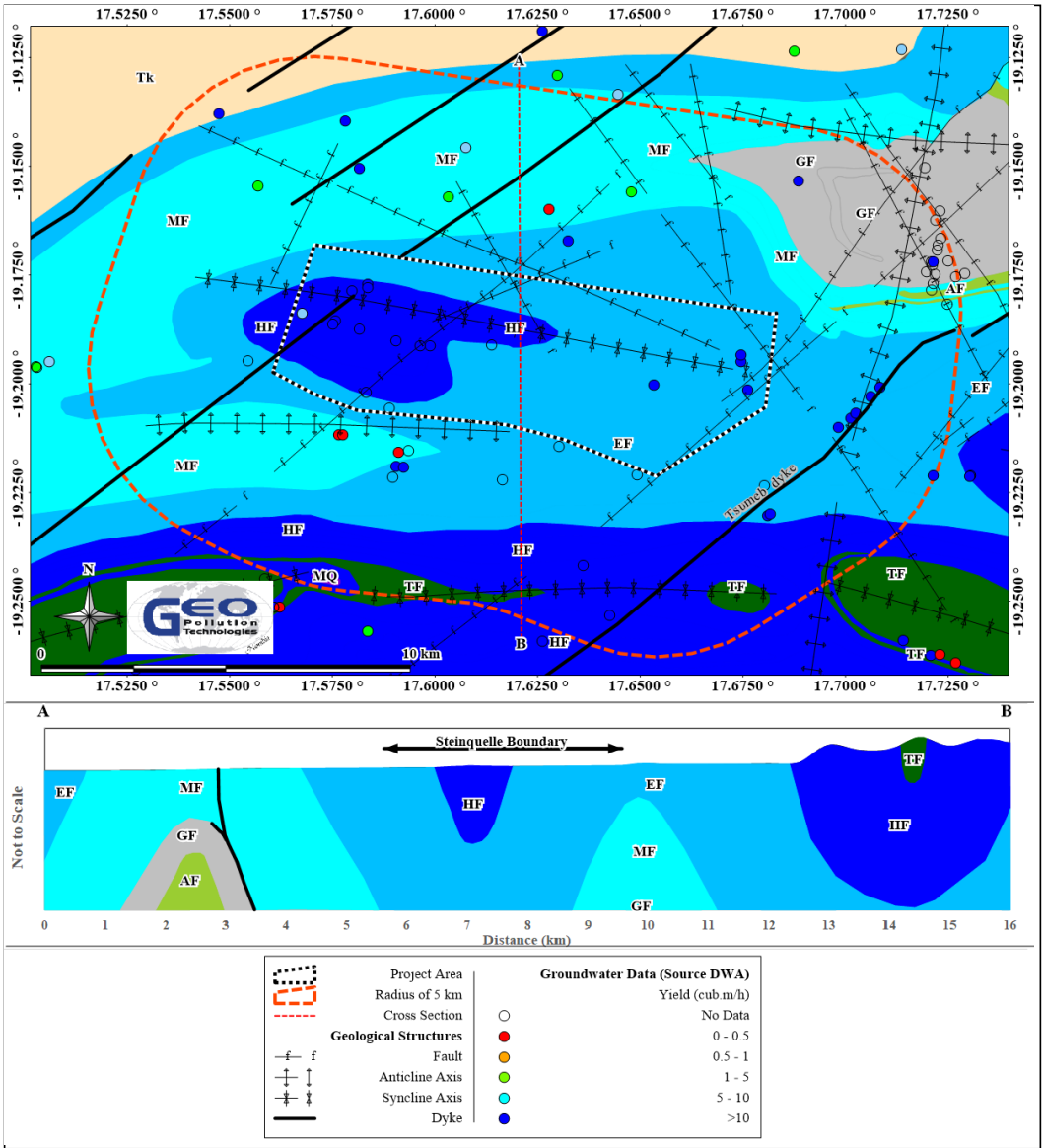
4.4 GEOLOGY AND HYDROGEOLOGY

The geology underlying the farm formed during the Quaternary-, Tertiary- and Namibian Age. Geology from the Quaternary and Tertiary Ages consist of the Kalahari Group deposits which typically is sand, calcrete and gravel. Sediments from the Kalahari Group originate mainly from fluvial deposition with some reworking of aeolian processes. The Kalahari Group sediments commonly overlie pre-Kalahari rocks, in this case rocks belonging to the Namibian Age. Damara Sequence rocks consists locally of the Mulden- and Otavi Groups. Arenite, subgreywacke and conglomerate of the Tschudi comprises the Mulden Group and overlies the older Otavi Group. Geology of the Tsumeb- and Abenab Subgroup make up the Otavi Group. Subsurface geology of the farm consist of dolomite, chert and breccia from the Huettenberg- and Elandshoek Formation.

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. A synclinal structure with fold limbs dipping toward the north and to the south occur in the central area of the farm, see Figure 4 for the hydrogeology map and an inferred cross section of the study area. It should be noted that a thin veneer of Quaternary and Tertiary Age Kalahari Group deposits are present further south than what is indicated in Figure 4. The thin veneer was not showed to better present the more important underlying formations.

The main fault orientation is roughly northeast - southwest and northwest - southeast. Geophysical-interpreted dykes occur in the area and strike towards the northeast. Figure 4 depicts geological structures interpreted from geophysical data for the farm and the surrounding area. The Tsumeb dyke is located about 2 km southeast of the farm and another dyke intersects

western portion of the farm. The Tsumeb dyke is a major exploration target for the NamWater exploration water supply programme to Windhoek. The nature of the dykes tend to be a mineralised fault with high hydraulic conductivity values. 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.



Lithcode	Age	Sequence	Group	Subgroup	Formation	Lithology
Tk	Quaternary & Tertiary		Kalahari			Sand, calcrete, gravel
TF	Namibian	Damara	Mulden	Otavi-Mulden	Tschudi	Arenite, subgreywacke, conglomerate
HF			Otavi	Tsumeb	Huettenberg	Dolomite, oolite, chert, shale, stromatolite, breccia
EF					Elandshoek	Dolomite, chert, breccia
MF					Maieberg	Dolomite, limestone
GF				Abenab	Auros	Stromatolite, chert, limestone
AF					Gauss	Breccia, oolite, dolostone, chert

Figure 4. Hydrogeology

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 dolomite and arenite, limestone or massive dolomite and creates favourable conditions to promote groundwater flow. Groundwater flow from the site can be expected in a north to north-western direction. Local flow patterns may vary due to groundwater abstraction (Figure 5).

A number of springs are present in the Otavi Mountain land and most of these springs are related to the contact zones between relatively impermeable formations and more permeable formations. The nearest of these contact zone springs is present approximately 40 km to the southeast of the farm, see Figure 12. Apart from Lake Otjikoto, no caves are known of near (<10 km radius) the project farm.

Table 2 indicates the groundwater statistics for a radius of 5 km around the project area, see Figure 4. The groundwater information was obtained from Department of Water Affairs (DWA) borehole database and from the proponent. The DWA database is generally outdated and more boreholes might be present. Groundwater is widely utilised in the study area, with a total of 187 boreholes within a 5 km radius. The groundwater quality falls under the Group A category which means it excellent quality.

Table 2. Groundwater statistics

Area of Interest:	Groundwater Quality: STEINQUELLE					Query Radius:		5 km
	Number of Known Boreholes	DEPTH (mbs)	YIELD (m^3/h)	WATER LEVEL (mbs)	TDS (ppm)	SULPHATE (ppm)	NITRATE (ppm)	FLUORIDE (ppm)
Data points	**187**	35	36	31	10	10	5	10
Minimum		18.30	2.70	6.00	392.00	10.00	0.20	0.10
Average		92.01	31.88	30.17	521.70	32.70	7.42	0.25
Maximum		235.30	100.00	108.00	856.00	73.00	28.40	0.30
Group A		25.71%	75.00%	12.90%	100.00%	100.00%	80.00%	100.00%
Limit		50	>10	10	1000	200	10	1.5
Group B		22.86%	2.78%	64.52%	0.00%	0.00%	0.00%	0.00%
Limit		100	>5	50	1500	600	20	2.0
Group C		48.57%	11.11%	9.68%	0.00%	0.00%	20.00%	0.00%
Limit		200	>0.5	100	2000	1200	40	3.0
Group D		2.86%	11.11%	3.23%	0.00%	0.00%	0.00%	0.00%
Limit		>200	<0.5	>100	>2000	>1200	>40	>3

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.

According to the Ministry of Agriculture, Water and Forestry (MAWF, 2006) the farm is located inside the Tsumeb-Otavi-Grootfontein Subterranean Water Control Area, Government Notice 1969 of 13 November 1970 and Proclamation 278 of 31 December 1976 (Extension). The farm also falls under a sub-division of the water control area (Guinas - B1), known as the western half of the Tsumeb-Abenab Synclinorium sub-catchment (Bäumle, 2004). Government regulates groundwater usage in this area and all other groundwater related activities like drilling, cleaning or deepening of boreholes and rates of water abstraction. See Figure 5 for a map indicating the water control area, groundwater basin and inferred groundwater flow.

The karst aquifer has high hydraulic conductivity and long term over abstraction may cause the formation of a localised cone of depression. Although high volume abstraction currently takes place in the Otavi Mountain land, the only significant cones of depression known to exist was at Tsumeb mine (Hoad, 1992) and Kombat mine.

During the peak activities of the Tsumeb mine, the water level was decreased to a depth of about 1,700 m. Groundwater was abstracted on average at 500 m³/h to 600 m³/h and during peak times at 1,000 m³/h. This abstraction lasted for several decades, with a stable cone of depression that developed at a radius of approximately 2 km around the mine shaft (GKW Consult, et. al.; 2003).

Groundwater quality data is presented in Figure 6 as a Maucha Plot. From the figure it is clear that the groundwater of the project location is mostly of a calcium-magnesium-bicarbonate water type 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 take place (Te Chow, 1964).

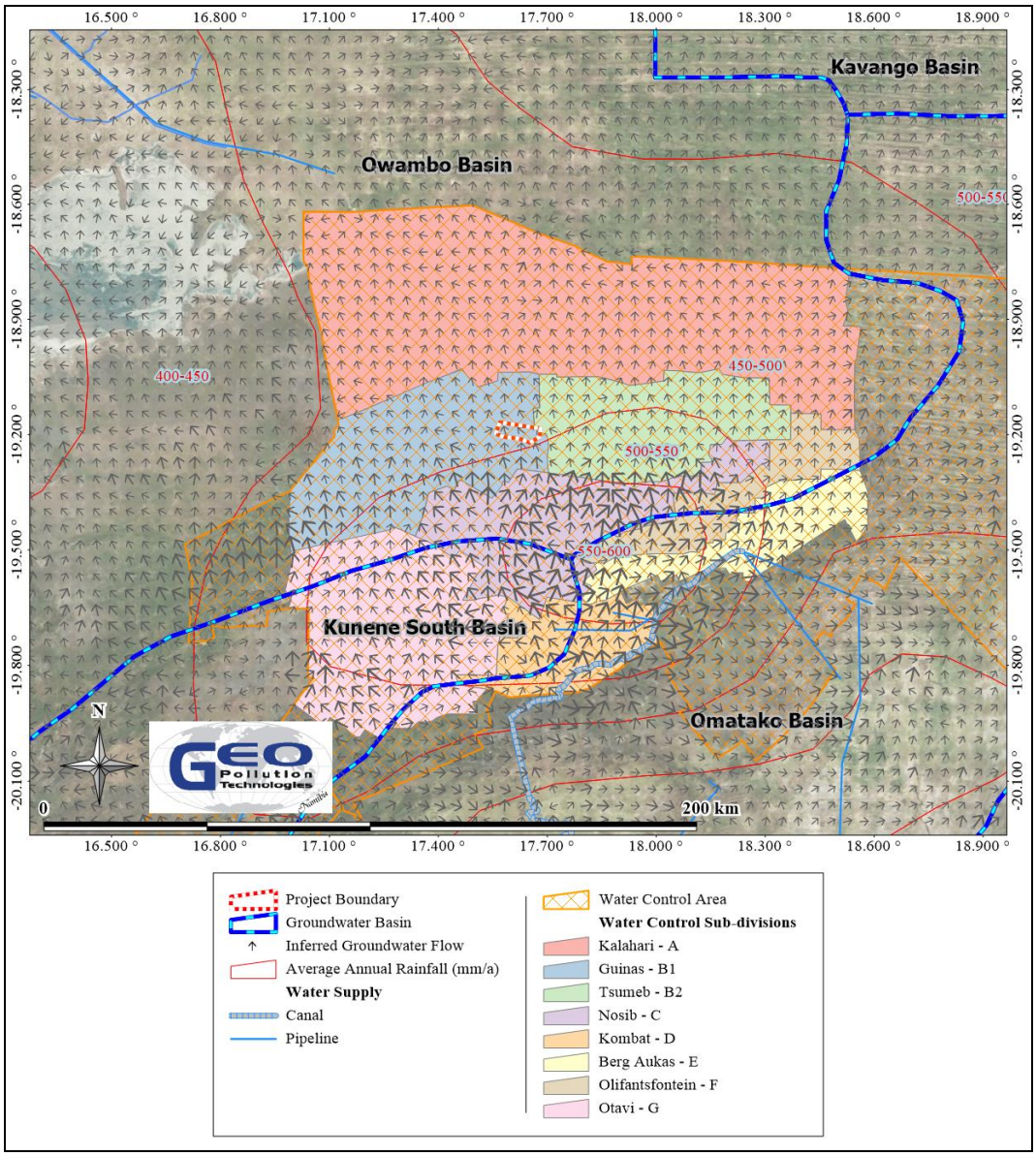


Figure 5. Groundwater basin with rainfall and inferred groundwater flow

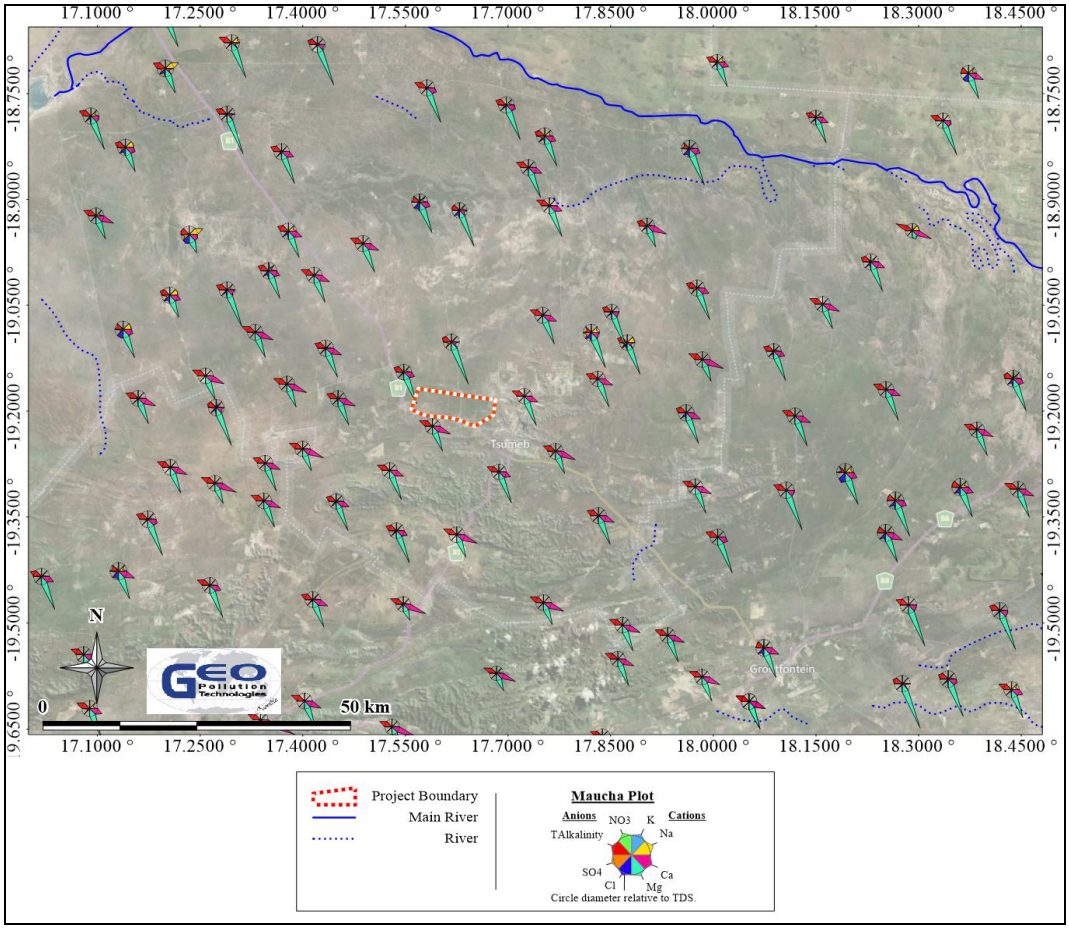


Figure 6. Groundwater quality

4.5 GROUNDWATER USAGE

An investigation of the available data indicates that at least 20 boreholes are present on the farm, see Figure 7. Some of the boreholes are currently used for stock watering and domestic use. There are nine groundwater monitoring installations within a 5 km radius of the farm. Three of these was identified to have adequate historic data and was utilized, namely WW9734 and WW9736 and WW81280 (Lake Otjikoto).

The only available water supply for the project area is groundwater. Water supply for irrigation is proposed to be shared with mining activities from three boreholes, known as BH1, WW201938 & WW201939. Borehole BH1 is a new borehole that was planned for the project. Irrigation will take place by means of centre pivot irrigation systems. All the boreholes have been subjected to test pumping, indicating a safe yield of 100 m^3/h. The boreholes may however have greater capacity since the pump tests could only accommodate volumes up to 100 m^3/h. If required, water may also be sourced for irrigation from an additional borehole located further west of the irrigation area known as BH4. A majority of the farms surrounding the project area rely on boreholes installed on the respective farms for water supply (Figure 7). Farms that border along Lake Otjikoto rely on the lake for water supply.

The project area falls under sub-division B1 of the water control area (Figure 5). Data supplied by DWA indicated that irrigation permits currently active for sub-division B1 amounts to a total of 2,453,000 m^3/a. Henning crushers is in the process of applying for groundwater abstraction permits at the Department of Water Affairs and Forestry. The irrigation is expected to require 950,000 m^3/a where daily water demand may peak to 15,000 m^3/day. Peak demand for

groundwater is expected to be between October and February. Water at the mining activities is primarily used for sand washing and dust suppression. Estimated use for mining activities per month amount to 50 m^3. All boreholes have been sampled annually by Water Affairs.

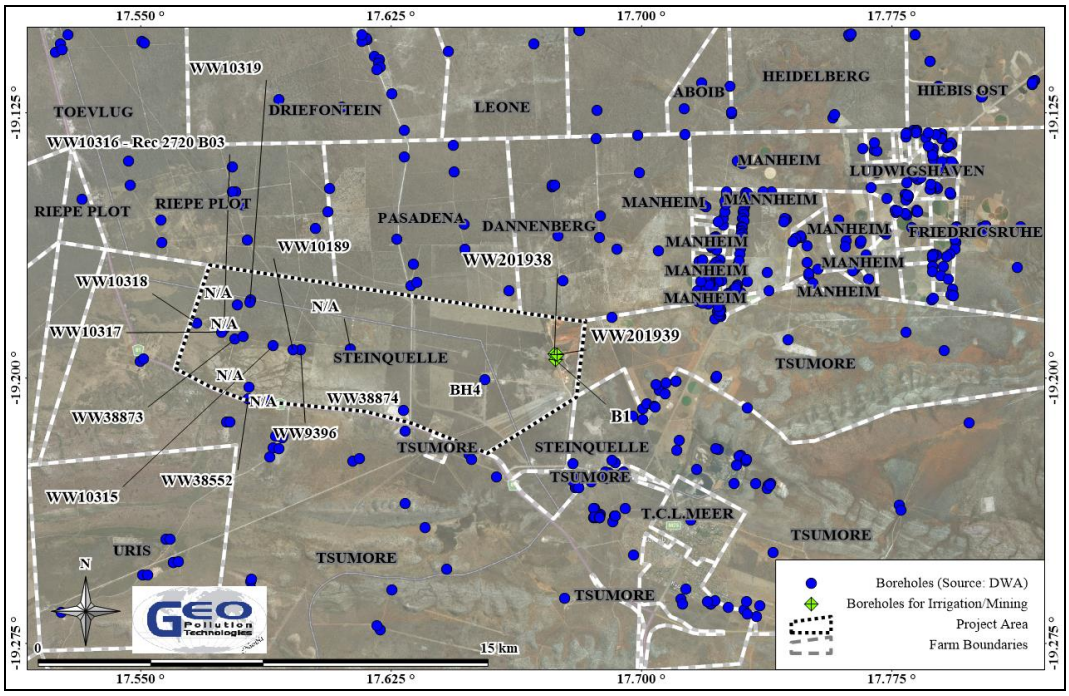


Figure 7. Borehole locations

5 ASSESSMENT OF REMOTE SENSING AND BOREHOLE DATA

5.1 REMOTE SENSING

Historic satellite composite imagery from ASTER (Advanced Space borne Thermal Emission and Reflection Radiometer) was utilised to study the rate at which land is cleared for crop cultivation purposes in the area. This was done by processing different ASTER composite datasets. The type of composite image utilised was the Ratio Vegetation Index (RVI) with the formula RVI = NIR band / Red band as per the 2019 ASTER Index Database for vegetation indices. The NIR band (Near Infrared) is otherwise labelled as Band 3 (780-860 nm) and the Red band labelled as Band 2 (630-690 nm).

RVI measures the ratio between the near-infrared indices which are reflected by vegetation and red light indices that are absorbed by vegetation and allows one to quantify vegetation concentrations on land. The greater the difference between the NIR band and Red band reflectance, the greater the amount of green vegetation present. Small differences between the NIR band and Red band reflectance indicate mostly bare soil or other non-green materials (CCPO, 2003).

The values for bare soils generally are near 1 and as the amount of green vegetation increases the ratio value increases for the RVI. The RVI is not bounded and its values can increase beyond 1 for vegetation densities (CCPO, 2003). Generally, very high RVI values are in the order of 30, in this case the maximum values for the RVI for the project area was 4.36. This formula was utilized to indicate the irrigated area, thus having green vegetation, and also the areas having bare soil, which was coincided with observable cleared areas.

The ASTER datasets were obtained for the dates of 2001/09/16, 2005/07/02, 2015/08/31 and 2019/04/20. Changes in the vegetation index between these images are clearly visible in Figure 8 and suggests an expansion in the irrigated areas.

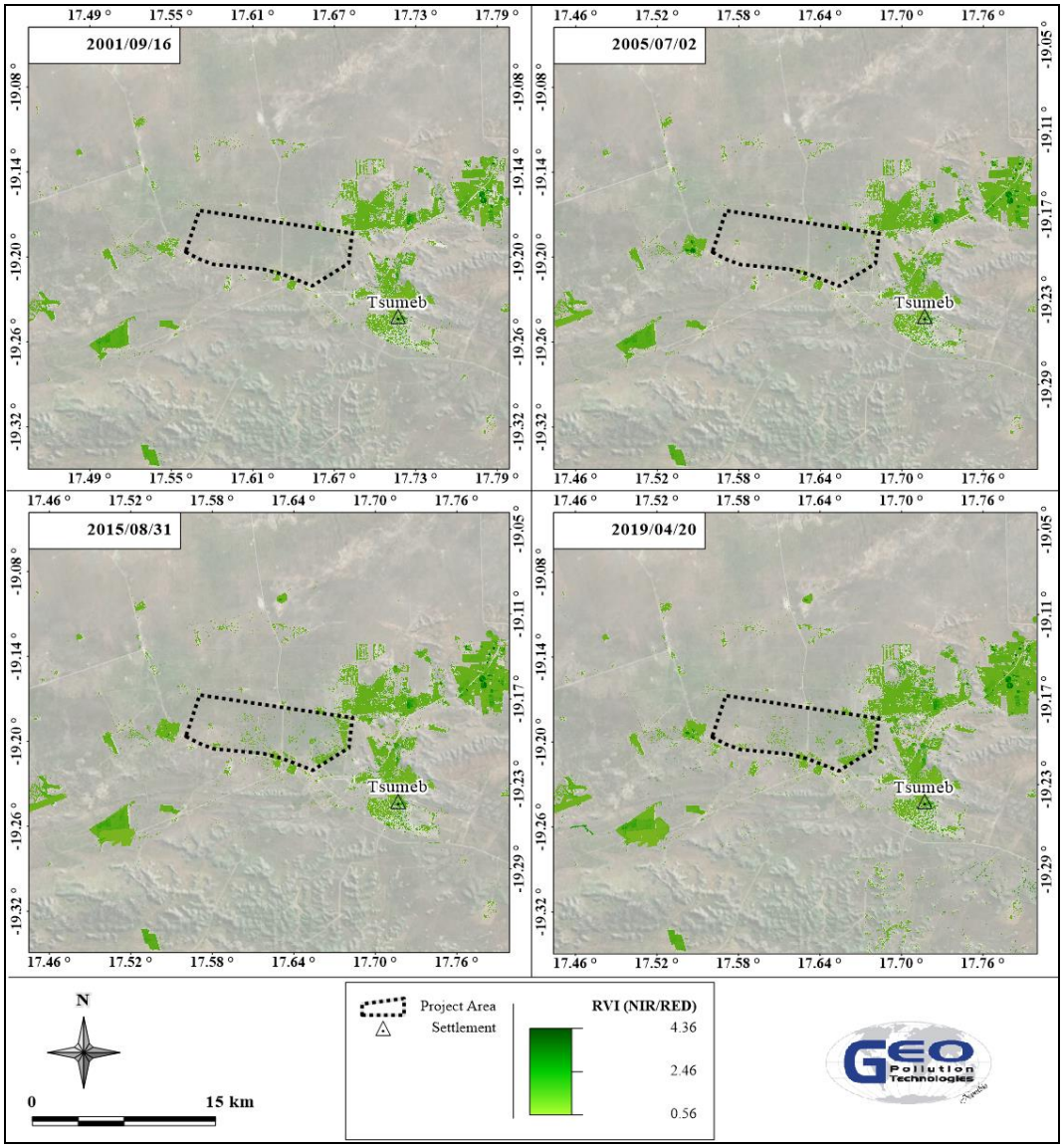


Figure 8. Comparison in vegetation index between 2001 and 2019

5.2 MONITOR BOREHOLE DATA

Groundwater abstraction data was obtained for farms in the vicinity of the project farm that has significant irrigation schemes. This includes schemes on the following farms: Hiebis Ost, Ludwigshafen, Manheim, Tsumore and Friedrichsruhe, see Figure 7.

See Figure 9 for a correlation between the water levels of the monitor installations WW9736, WW9734, WW30897, WW30898, WW30901 WW81280 (Lake Otjikoto), WW200206 and WW31485 with the total monthly abstraction of the irrigation farms. Historic rainfall data from the Mannheim meteorological station (SASSCAL WeatherNet 2018) and the Tsumeb Police Station which is the closest to the study area, is also presented in the figure together with the cumulative abstraction.

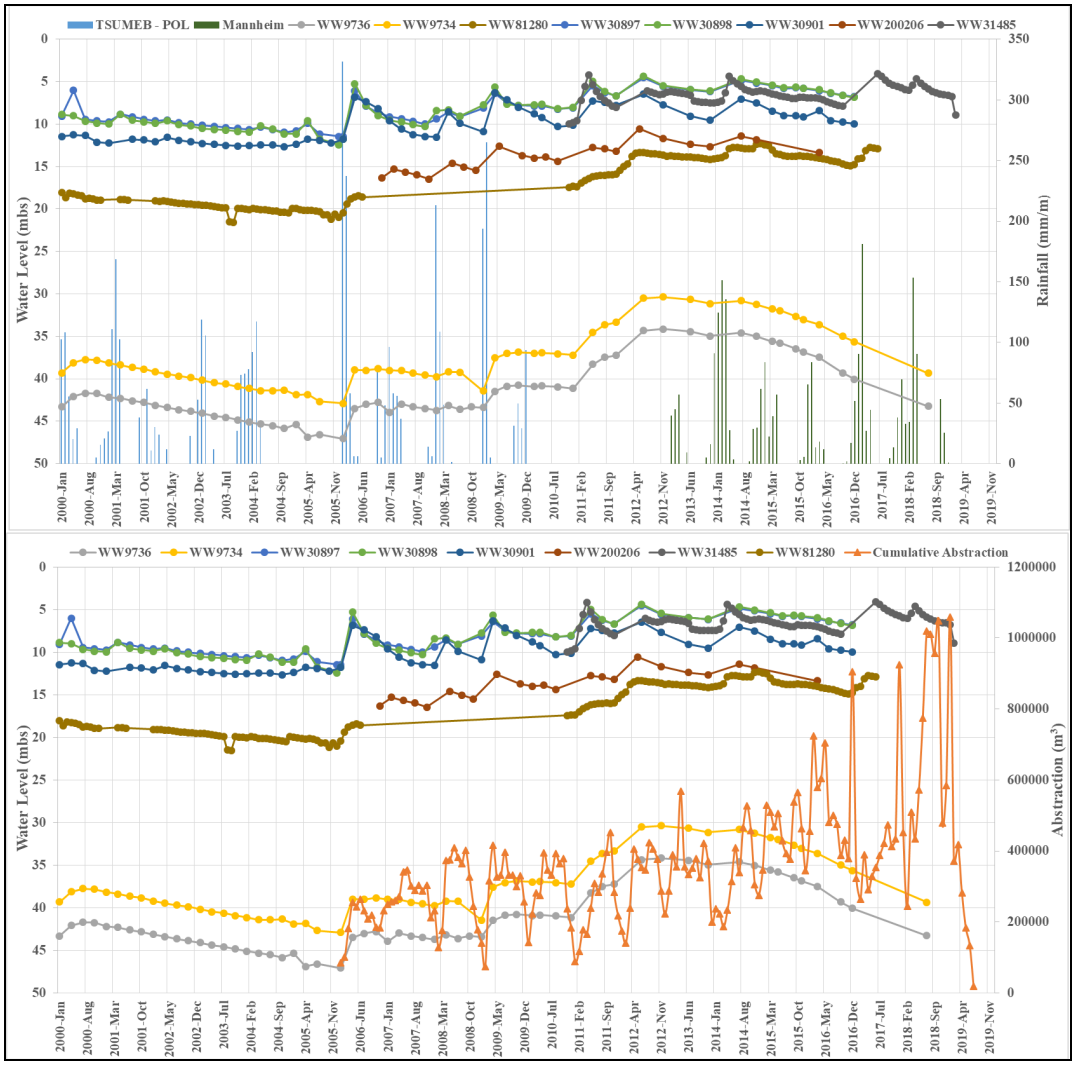


Figure 9. Water level data related to cumulative abstraction

From Figure 9 it is evident that there is a definite increase in water levels of the boreholes from January 2006 until the end of the data available. The abstraction volumes varied initially over this period, but showed an increase from January 2006 towards February 2019. Thereafter the abstraction volume decreased considerably up to where the data was available. The water level had small increases following periods of good rainfall, e.g. during January and February 2006 and March 2009. From June 2014 there was a general increase in the abstraction, peaking in December of 2016 and 2017, October 2018 and January 2019.

Ground water levels over this period continued on an increasing trend, despite a clear increase in abstraction volumes over the same time period. It seems as if local abstraction at the rates between 2006 and 2019 is not enough to cause a short term impact on the groundwater levels of the project area and that it should rather be seen as contributing to the regional water level impacts. Abstraction volume data was supplied by the Ministry of Agriculture Water and Forestry and is based on permit data returns made by the relevant permit owners.

Regional water level monitoring data sourced from the DWA is presented in Figure 10. Historic rainfall data for the Tsumeb Police Station (Namibia Meteorological Service) is also presented, as well as from the Manheim meteorological station (SASSCAL WeatherNet 2018). Data from the Tsumeb Police Station stopped during January 2010, while the Mannheim Station only

became operational during 2013. There is thus a gap in rainfall data for the area. The locations of the selected monitoring boreholes are presented in Figure 12.

Borehole WW25369 is located east of Otavi; WW9736 and WW9734 is 1.5 km south of the farm; WW81280 (Lake Otjikoto) 1 km to the west; WW30897, WW30898 and WW31485 about 7.5 km north of the farm; WW30901 13 km to the north; WW200206 about 7 km to the northeast and WW32626 just west of Tsintsabis. The selected boreholes present a range of boreholes stretching from near the water divide, past the project farm and beyond, roughly following the general groundwater flow direction (i.e. from near the water divide and past and beyond the farm).

Most of the data has a slight saw tooth profile, notably after January 2006 onwards. Rapid increases in water level are mostly associated with monthly rainfall exceeding 150 mm. These increases are subsequently followed by a steady decrease in water level.

Borehole WW25369, located east of Otavi, shows a slight downward trend in water level between 1990 and 1999, after which a slight upward trend is visible up to 2017. The variation in water level is however relatively small, as presented in Figure 11. A similar pattern is observed in borehole WW32626, where water levels showed a steady long-term drop in water level up to January 2006 from when the trend changed to a steady long-term rise in water level. Borehole WW25369 and WW32626 represent the top of the aquifer and the lower downstream part of the aquifer respectively. The two boreholes are set approximately 106 km apart and has a change in surface elevation of approximately 445 m. Water levels in both these boreholes seems to show little influence from abstraction taking place from the area between these two boreholes.

Overall most water levels showed a steady long-term drop in water level up to January 2006 from when the trend changed to a steady long-term rise in water level until no data is available. From January 2006 the data fluctuations are significantly larger than prior to January 2006. Borehole WW30897 is not shown in Figure 10 to better illustrate other monitor installation data.

Monitor boreholes WW9736 and WW9734 show a similar trend with monitor points WW81280 and WW81281. Monitoring points WW81280 and WW81281 represent the water levels in Lake Otjikoto and in Lake Guinas respectively. Lake Guinas is located about 23 km west-southwest of the project farm. Available monitoring data from both lakes stretches from 1971 until 2018, with short data gaps. Both lakes are roughly at the same elevation above sea level and both water level profiles are very similar, except for the water levels in Lake Guinas showing larger water level increases following good rainfall periods.

Pump test data of borehole WW9734, which is located 247 m from WW9736, indicate that the aquifer is leaky (Hoad, 1992). The pump test also data suggest that the local aquifer between the boreholes has a fissured nature and the water levels can be correlated over time. This correlation is evident in Figure 10. The area of borehole WW30897, WW30898 and WW31485 have approximately 70 m of Kalahari sediment cover. Borehole WW30897 was drilled on the contact zone of the Otavi dolomites and Mulden quartzites. During drilling of WW30897 there was a mixture of groundwater from the both the dolomite and Kalahari units. During test pumping analysis conducted on this borehole it was noted that the aquifer at this borehole also acted as a leaky aquifer and dewatering of the local aquifer was eventually not achieved (Hoad; 1992).

It is evident from the water level data that the water levels of most of the monitor installations is currently higher than what is was approximately 20 years ago. Careful monitoring is however required to properly manage this resource especially with increasing abstraction from the area.

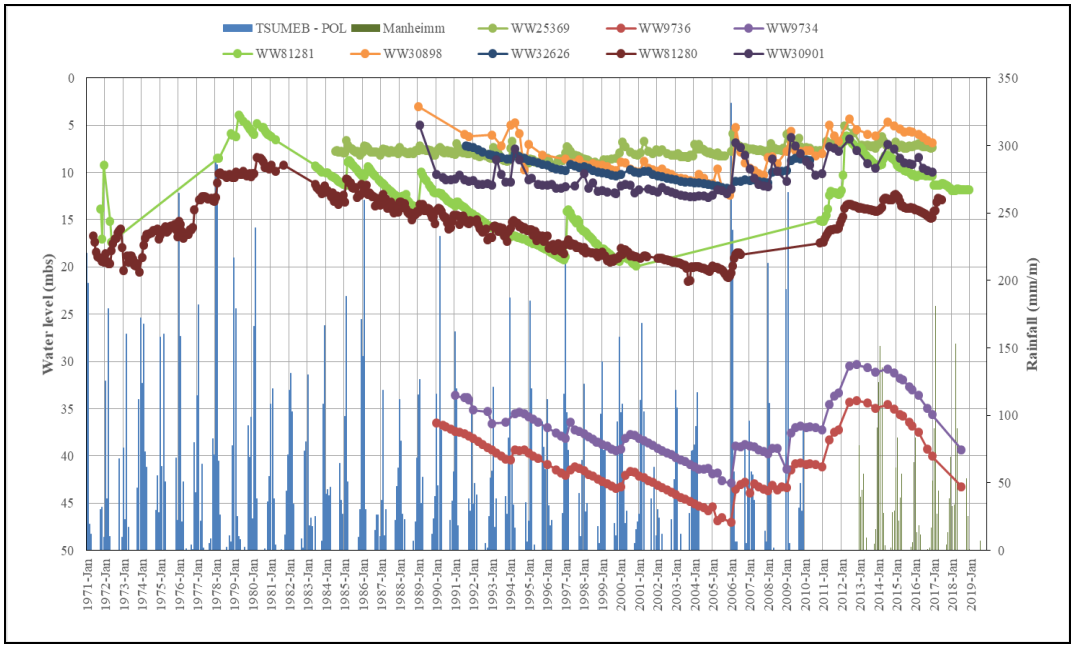


Figure 10. Regional water level changes and monthly rainfall

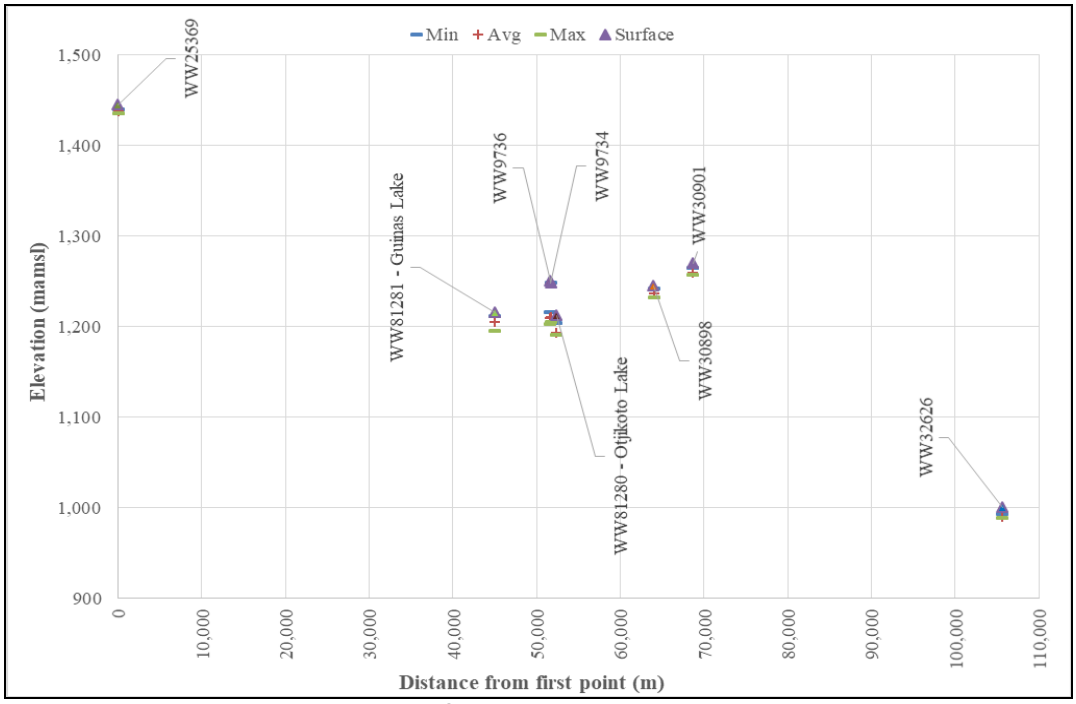


Figure 11. Regional water level profile

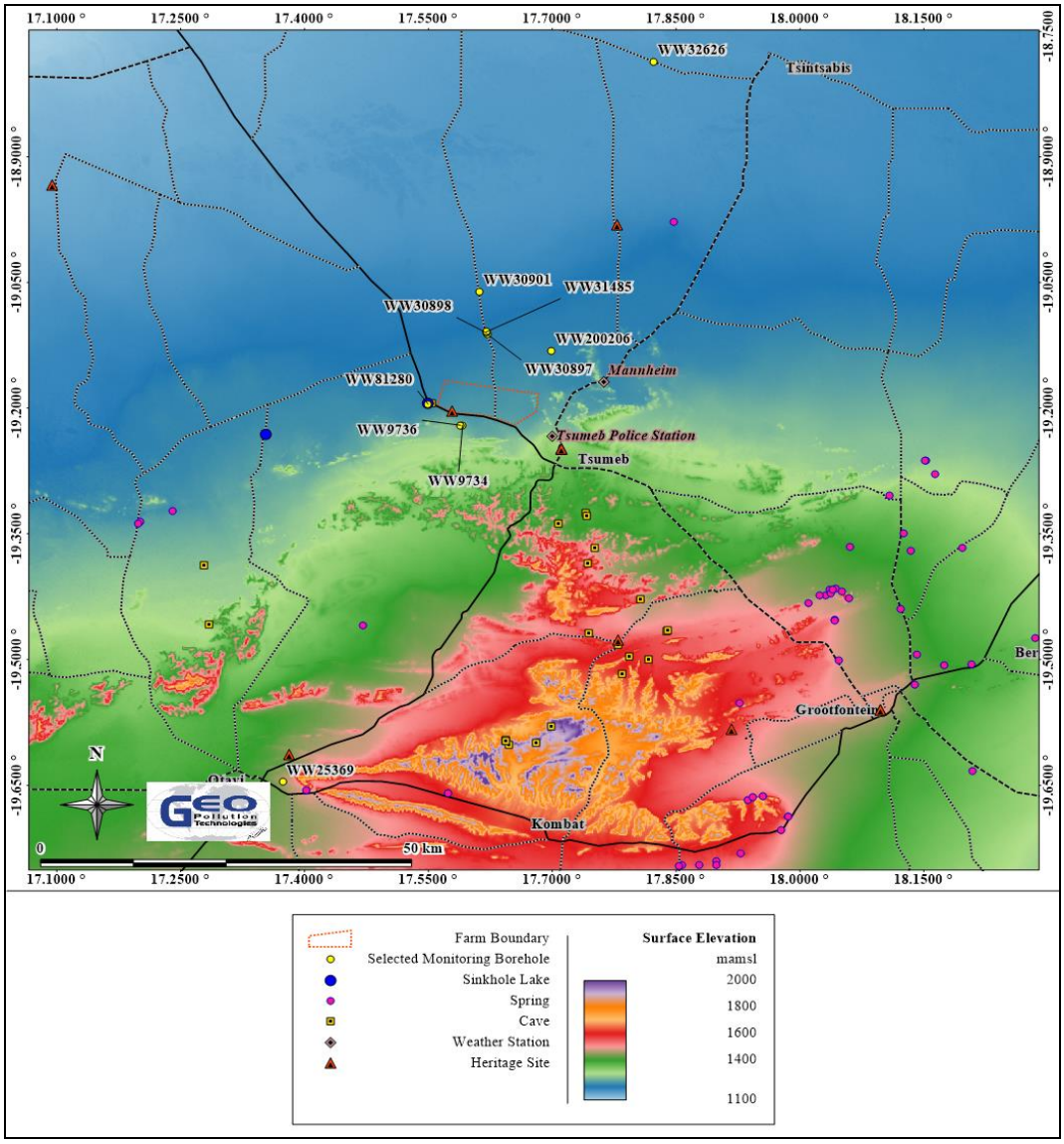


Figure 12. Borehole locations

6 WATER SUITABILITY FOR IRRIGATION PURPOSES

Two water samples, namely Lab Nr. 13/11 and Lab Nr. 14/03, was collected by the proponent in 2013 and 2014 respectively and was submitted for water analysis and the results was provided to the Consultant. The exact locations of the samples is unknown. Water sample Lab Nr. 13/11 did not contain sufficient data to calculate the Permeability Index and Magnesium Adsorption Ratio. Calculations based on the analysis of sample Lab Nr. 14/03 indicate that it can be classified as having a high salinity hazard (C3) and a low sodium hazard (S1). The samples had a good Permeability Index and a suitable Magnesium Adsorption Ratio (MAR).

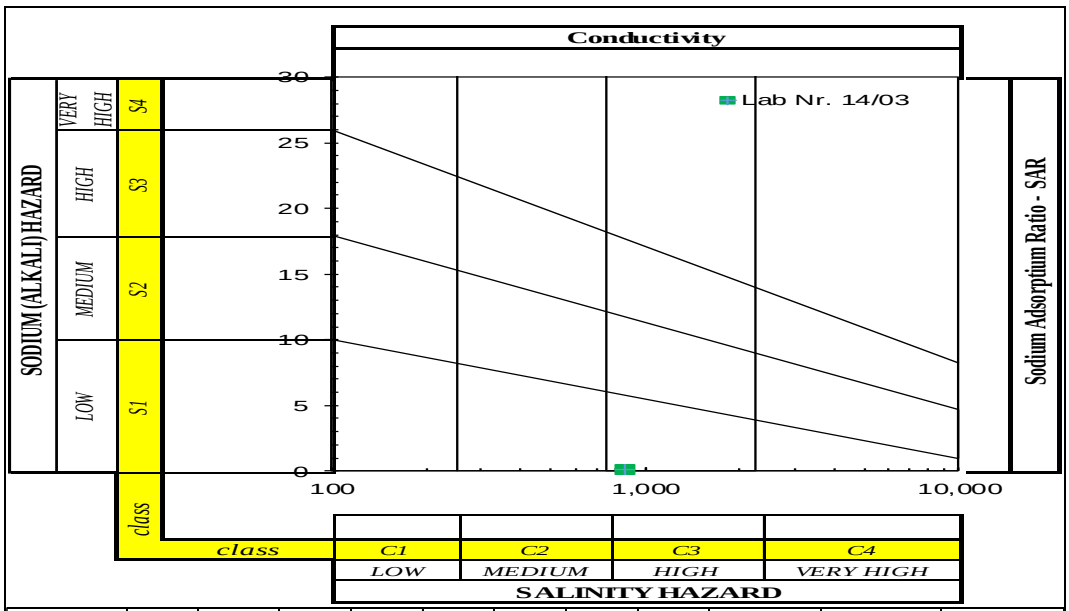
High-salinity water (C3) cannot be used on soils with restricted drainage due to salts accumulation in the crop root zone, reducing the amount of water available to the roots. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected. Reduced crop growth and yield can be expected.

Low sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium.

The Permeability Index of soil is affected by sodium, calcium, magnesium and bicarbonate contents of long term use of irrigation water. High sodium in the irrigation water can cause soil permeability problems. Permeability is also affected by CO_3^{2-} and HCO_3^- concentrations in the water. A part of CO_3^{2-} and HCO_3^- is precipitated as $CaCO_3$ (or) $MgCO_3$ removing Ca and Mg from irrigation water and leads to increased precipitation.

Magnesium is essential for plant growth, but excess magnesium can have severe toxicity effect on plants. A Magnesium Adsorption Ratio exceeding 50 is considered unsuitable for plants as it may increase the salinity of soil.

Care must be exercised when long term irrigation takes place on unsuitable soil. Soil suitability should therefore be assessed.



Sample	pH	EC	Na	Ca	Mg	K	Palk	HCO_3^-	Sodium adsorption ratio (SAR)	Permeability Index (PI)	Magnesium adsorption ratio (MAR)
		µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l			
Lab Nr. 14/03	7.8	860	5.70	99.0	58.0	0.5	0.0	577.9	0.1	33 - Good	49 - Suitable

Figure 13. Groundwater sodium adsorption ratio

7 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. The Environmental Classification of impacts is provided in Table 3.

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 4).

Environmental Classification = A1 x A2 x (B1 + B2 + B3)

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). See Table 5 and Table 6 for the final assessment of expected impacts.

Table 3. Environmental classification of impacts according to the rapid impact assessment method of 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

Table 4. 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

7.1 GROUNDWATER ABSTRACTION

Groundwater abstraction is a very sensitive topic in a dry country where the value of land is drastically reduced if no or 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 Figure 14. 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 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 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 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, as presented in Figure 9 and Figure 10, 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.

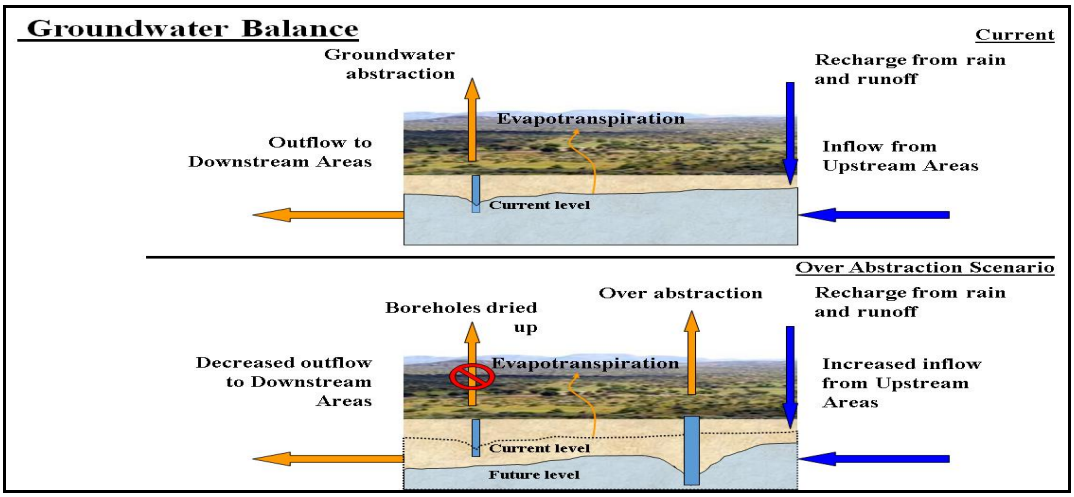


Figure 14. Conceptual groundwater balance with over abstraction scenario

Table 5. 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 on a sustainable base.

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 MAWF in the abstraction permit.

Mitigation:

- Reduce abstraction when the water levels nears 5 m below the long term average water level.

Responsible Body:

- Henning crusher (Pty) Ltd

Data Sources and Monitoring:

- Monthly water rest water level monitoring.
- Baseline values should be reviewed every 3 years based on all historic water level data.
- 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.

7.2 GROUNDWATER, SURFACE WATER AND SOIL CONTAMINATION

Leakages and spillages hazardous substances from earthmoving vehicles and accidental fuel, oil or hydraulic fluid spills during the construction phase. Contaminations from water used at the mining (sand washing and dust suppression). Increase of nutrient levels by over application of fertilizers in the soil can leach to the groundwater. Overuse / incorrect application of pesticides, herbicides and fertilisers may pose a risk. Leakage from sewerage systems.

Table 6. 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
Construction	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery.	2	-2	2	2	1	-20	-3	Improbable
Daily Operations	Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery. Over application of fertilizer, pesticides, etc. Sewerage system malfunction.	2	-2	2	2	2	-24	-3	Probable

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 should be stored in a sufficiently bunded area.
- Follow prescribed dosage of fertilizers and pesticides 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.

Mitigation:

- Any spill must be cleaned up immediately.
- Consult relevant Material Safety Data Sheet information and a suitably qualified specialist where needed.

Responsible Body:

- Henning Crusher (Pty) Ltd
- 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 farmers 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.

8 CONCLUSION

Groundwater on the farm is high yielding and of excellent quality, ideal for human consumption and utilisation for irrigation purposes, although care must be exercised when long term irrigation takes place on unsuitable soil.

Based on current water level fluctuations in the area, as presented in Figure 9 and Figure 10, a short term threshold of 5 m below the long term average water level is set from where abstraction rates should be reduced. This is the deepest water level recorded from 1971. 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 and beyond 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 water levels in the area 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 volume permits when needed and if justified.

Groundwater vulnerability to contamination would be the highest around boreholes, Lake Otjikoto, around geological structures as well as where shallow groundwater is present. 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 current water level and abstraction volumes it seems as if higher abstraction volumes may be considered.

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Appendix C: Curriculum Vitae of Environmental Practitioners

HYDROGEOLOGIST **Pierre Botha**

Pierre Botha is the Managing Director of Geo Pollution Technologies, Namibia. Mr. Botha has excellent experience and knowledge in Environmental Impact Assessments, groundwater pollution assessment, groundwater exploration, resource evaluation, urban and rural water supply, groundwater management, monitoring and hydrochemistry. He gained most of his experience in Namibia and is involved in the Namibian groundwater industry since 1992.

Mr Botha's experience in the environmental / groundwater field has been gained from various projects ranging from groundwater exploration, groundwater management and modelling, environmental impact assessments, pollution mapping and rehabilitation to health risk evaluations.

CURRICULUM VITAE PIERRE BOTHA

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	PIERRE BOTHA
Profession	:	Hydrogeologist / Hydrologist Environmental Assessment Practitioner
Years' Experience	:	27
Nationality	:	Namibian
Position	:	Managing Director
Specialisation	:	Hydrogeology
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent

EDUCATION AND PROFESSIONAL STATUS:

B.Sc. Geology & Geography	:	University of OFS, 1992
B.Sc. (Hons.)(*cum laude*) Geohydrology/Hydrology	:	University of OFS, 1994

First Aid Class A	EMTSS, 2017
Basic Fire Fighting	EMTSS, 2017

PROFESSIONAL SOCIETY AFFILIATION:

Environmental Assessment Professionals of Namibia (EAPAN) – *President 2014 - Vice President 2012, 2013*
Hydrogeological Association of Namibia (HAN)
Geological Association of Namibia

AREAS OF EXPERTISE:

Knowledge and expertise in:

- risk based corrective action analyses
- bioremediation
- monitoring, mapping and evaluation of groundwater pollution
- hydrochemistry studies
- environmental impact assessments
- project management
- soil vapour surveys
- groundwater modelling
- groundwater monitoring
- hydrocensus
- hydrogeological data evaluation and interpretation
- groundwater exploration and resource evaluation
- geophysical interpretations (Ground Penetrating Radar, Electrical Resistivity, Electromagnetic & Magnetic)
- urban and rural water supply
- groundwater management
- borehole siting, drilling and test pumping supervision, aquifer testing

EMPLOYMENT:

1998-Date	:	Geo Pollution Technologies (Pty) Ltd
1995	:	Parkman Namibia (Groundwater Consulting Services) - Hydrogeologist
1994	:	Institute for Groundwater Studies, University of the Orange Free State - Hydrogeologist
1992-1993	:	Groundwater Consulting Services - Field Geologist
1988	:	Tsumeb Corporation Ltd - Student geologist

PUBLICATIONS:

Contract reports	: +400
Publications	: 1

ENVIRONMENTAL ASSESSMENT PRACTITIONER **Quzette Bosman**

Quzette Bosman has 11 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	:	8
Nationality	:	South African
Position	:	Senior Environmental Consultant
Specialisation	:	ESIA & ESMP; SIA
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent

EDUCATION AND PROFESSIONAL STATUS:

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

First Aid Class A	EMTSS, 2017
Basic Fire Fighting	EMTSS, 2017

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, 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:	+150
Publications:	1

ENVIRONMENTAL SCIENTIST **André Faul**

André entered the environmental assessment profession at the beginning of 2013 and since then has worked on more than 120 Environmental Impact Assessments including assessments of the petroleum industry, harbour expansions, irrigation schemes, township establishment and power generation and transmission. André's post graduate studies focussed on zoological and ecological sciences and he holds a M.Sc. in Conservation Ecology and a Ph.D. in Medical Bioscience. His expertise is in ecotoxicological related studies focussing specifically on endocrine disrupting chemicals. His Ph.D. thesis title was The Assessment of Namibian Water Resources for Endocrine Disruptors. Before joining the environmental assessment profession he worked for 12 years in the Environmental Section of the Department of Biological Sciences at the University of Namibia, first as laboratory technician and then as lecturer in biological and ecological sciences.

CURRICULUM VITAE ANDRÉ FAUL

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	ANDRÉ FAUL
Profession	:	Environmental Scientist
Years' Experience	:	17
Nationality	:	Namibian
Position	:	Environmental Scientist
Specialisation	:	Environmental Toxicology
Languages	:	Afrikaans – speaking, reading, writing – excellent English – speaking, reading, writing – excellent

EDUCATION AND PROFESSIONAL STATUS:

B.Sc. Zoology	:	University of Stellenbosch, 1999
B.Sc. (Hons.) Zoology	:	University of Stellenbosch, 2000
M.Sc. (Conservation Ecology)	:	University of Stellenbosch, 2005
Ph.D. (Medical Bioscience)	:	University of the Western Cape, 2018

First Aid Class A	EMTSS, 2017
Basic Fire Fighting	EMTSS, 2017

PROFESSIONAL SOCIETY AFFILIATION:
Environmental Assessment Professionals of Namibia (Practitioner and committee member)

AREAS OF EXPERTISE:
Knowledge and expertise in:

- Water Sampling, Extractions and Analysis
- Biomonitoring and Bioassays
- Biodiversity Assessment
- Toxicology
- Restoration Ecology

EMPLOYMENT:

2013-Date	:	Geo Pollution Technologies – Environmental Scientist
2005-2012	:	Lecturer, University of Namibia
2001-2004	:	Laboratory Technician, University of Namibia

PUBLICATIONS:

Publications:	5 + 1 in preparation
Contract Reports	+120
Research Reports & Manuals:	5
Conference Presentations:	1

HYDROGEOLOGIST **Jannie van der Merwe**

Jannie van der Merwe holds an honours degree in hydrology and geohydrology from the Northwest-University Potchefstroom (NWU) South Africa. He first completed a B.Sc. degree in Geology and Geography in the required time also from the Northwest University Potchefstroom South Africa.

His honours project entailed Preparing Groundwater Resource Directed Measures for Catchment: J21A Beaufort West in South Africa. In his honours year he also completed an advanced course in ArcMap (GIS). He started working at Geo Pollution Technologies at the beginning of 2016 and he regularly conducts or assists in soil vapour surveys, groundwater monitoring and sampling, soil sampling, tank pit surveys, geophysics (borehole siting), hydrocensus studies, pump testing and groundwater specialist studies.

CURRICULUM VITAE JANNIE VAN DER MERWE

Name of Firm	:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff	:	JANNIE VAN DER MERWE
Profession	:	Hydrogeologist
Nationality	:	Namibian
Position	:	Environmental Scientist
Specialisation	:	Groundwater, Geology
Languages	:	Afrikaans – speaking, reading, writing English – speaking, reading, writing

EDUCATION AND PROFESSIONAL STATUS:

B.Sc. Geology and Geography	:	Northwest University (NWU) 2014
B.Sc. (Hons.) Hydrology and Geohydrology	:	Northwest University (NWU) 2015
First Aid Class A		EMTSS, 2017
Basic Fire Fighting		EMTSS, 2017

AREAS OF EXPERTISE:

Knowledge and expertise in:

- Groundwater
- Geology
- Geophysics
- Basic Geographic Information Skills (ArcGIS, Manifold)

EMPLOYMENT:

2016 - Date : Geo Pollution Technologies – Environmental Scientist

PUBLICATIONS:

Contract Reports: +30

ENVIRONMENTAL SCIENTIST **Henri Christian Brunette**

Christian Brunette holds an honours degree in geology and geohydrology from the University of Namibia, UNAM. He first completed a B.Sc. degree in Geology from the University of the Free State (UFS) in Bloemfontein, South Africa.

His honours project entailed the hydro-geological and hydro-chemical characteristics of the deeper part of the Windhoek Aquifer. He started working part-time at Geo Pollution Technologies during the university holidays from 2013 and started working full time at the beginning of 2017. He is looking forward to learn more about the geological and hydro-geological environment in all aspects and the implementation of relevant technologies. He is an efficient, dynamic young man that has the ability to achieve results through his excellent strong leadership qualities, environmental, geological and hydrogeological skills.

He has experience in geological field reconnaissance, groundwater specialist studies and geophysical methods for groundwater assessment. He has also experience in soil vapour surveys, conducting tank pit studies, groundwater monitoring and sampling, auger-drilling and soil sampling. He also has experience in assisting in environmental impact assessments and the preparation of environmental management plans. In addition he has specialist knowledge in the field of mineralogy, petrography/geology and using graphical information systems (GIS).

CURRICULUM VITAE CHRISTIAN BRUNETTE

Name of Firm:	Geo Pollution Technologies (Pty) Ltd.
Name of Staff:	HENRI CHRISTIAN BRUNETTE
Profession:	Hydrogeologist
Nationality:	Namibian
Position:	Environmental Scientist
Specialisation:	Geology, Groundwater
Languages:	Afrikaans – speaking, reading, writing English – speaking, reading, writing

EDUCATION AND PROFESSIONAL STATUS:

B.Sc. Geology and Geography:	University of the Free State (UFS), 2015.
B.Sc. (Hons.) Geology:	University of Namibia (UNAM), 2016.
First Aid Class A	EMTSS, 2017
Basic Fire Fighting	EMTSS, 2017

AREAS OF EXPERTISE:

Knowledge and expertise in:

- Groundwater
- Geology/Petrography
- Mineralogy
- Basic Geographic Information Skills (Sentinel Application Platform, Mudflow, QGIS, Manifold)

EMPLOYMENT:

Jan 2017 onwards:	Geo Pollution Technologies (Pty) Ltd	(Environmental Scientist)
Jan 2016 – Aug 2016:	Environmental Engineering Services CC	(Drilling Supervisor)
Nov 2014 – Jan 2015:	Geo Pollution Technologies (Pty) Ltd	(Part-Time)
Jun 2014 – Jul 2014:	Geo Pollution Technologies (Pty) Ltd	(Part-Time)
Nov 2013 – Dec 2013:	Geo Pollution Technologies (Pty) Ltd	(Part-Time)

PUBLICATIONS:

Contract Reports: +15