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ENVIRONMENTAL ASSESSMENT FOR THE *OPUNTIA FICUS-INDICA* IRRIGATION PROJECT, FARM NAMSEB NO. 24, HARDAP REGION, NAMIBIA

Source: Kolberg (2024)

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ABBREVIATIONS / ACRONYMS / SYMBOLS / UNITS

The following is a list of the abbreviations, acronyms, symbols, units, technical terms, and definitions used in this Report:

AIDS	Acquired Immunodeficiency Syndrome
ANC	Antenatal Care
ART	Anti-retroviral Therapy
AU	African Union
CBD	Convention on Biological Diversity
CBR	Crude Birth Rate
CBC	Classical Biological Control
CCARDESA	Centre for Coordination of Agricultural Research and Development
CDR	Crude Death Rate
CE	Circular Economy
CEDAW	Convention on the Elimination of All Forms of Discrimination against Women
CEO	Chief Executive Officer
CITES	Convention on International Trade in Endangered Species
cm	centimetre
CNRs	Case Notification Rates
°C	degrees centigrade
CO_2	carbon dioxide
DEA	Directorate of Environmental Affairs
DEAF	Directorate of Environmental Affairs and Forestry
DWA	Department of Water Affairs
EA	Environmental Assessment
EAP	Environmental Assessment Practitioner
EAPAN	Environmental Assessment Professionals of Namibia
EC	Electrical Conductivity
ECC	Environmental Clearance Certificate
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMA	Environmental Management Act

EMP	Environmental Management Plan
EPA	Environmental Protection Agency/Authority
FAO	Food and Agriculture Organization of the United Nations
GBV	Gender-based Violence
GHG	Greenhouse Gas
GIIP	Good International Industry Practice
GIS	Geographic Information System
GN	General Notice / Government Notice
GRN	Government of the Republic of Namibia
ha	hectare
HACCP	Hazard Analysis Critical Control Points
HIV	Human Immunodeficiency Virus
I&APs	Interested and Affected Parties
IBA	Important Bird Area
ICCPR	International Covenant on Civil and Political Rights
ICESCR	International Covenant on Economic, Social and Cultural Rights
IEC	Independent Electrical Contractor
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
ILO	International Labour Organization
INM	Integrated Nutrient Management
IPM	Integrated Pest Management
IRENA	International Renewable Energy Agency
ISA	International Solar Alliance
ISO	International Organization for Standardization
IUCN	International Union for the Conservation of Nature and Natural Resources
IWM	Integrated Waste Management
kg	kilogramme
km	kilometre
km^2	square kilometre
l	litre
LAC	Legal Assistance Centre
LFPR	Labour Force Participation Rate
m	metre
m^3	cubic metre
m^3/annum	cubic metre per annum
m^3/day	cubic metre per day
m^3/h	cubic metre per hour
m amsl	metre above mean sea level
m bgl	metre below ground level
mm	millimetre
MAWLR	Ministry of Agriculture, Water and Land Reform
MDGs	Millennium Development Goals
MET	Ministry of Environment and Tourism
MEFT	Ministry of Environment, Forestry and Tourism
MFMR	Ministry of Fisheries and Marine Resources
MHSS	Ministry of Health and Social Services
MME	Ministry of Mines and Energy
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheets
MTCT	Mother-To-Child Transmission
NAMPHIA	Namibia Population-Based HIV Impact Assessment
NCE	Namibia Chamber of Environment
NDP5	National Development Plan 5
NHIES	Namibia Household Income and Expenditure Survey
NHSS	National HIV Sentinel Survey
NIDS	Namibia Inter-censal Demographic Survey
NLFS	Namibia Labour Force Survey
NSA	Namibia Statistics Agency
NSF	National Strategic Framework

NUST	Namibia University of Science and Technology
PAYE	Pay As Your Earn
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PHC	Population and Housing Census / Primary Health Care
PLHIV	Person Living with HIV
PM	Particulate Matter
PMP	Pest Management Plan
PMTCT	Prevention from Mother to Child Transmission
PPE	Personal Protective Equipment
RIAM	Rapid Impact Assessment Matrix
SA	South Africa
SADC	Southern African Development Community
SANS	South African National Standards
SDGs	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SHE	Safety, Health, Environment
STIs	Sexually Transmitted Infections
TB	Tuberculosis
TDS	Total Dissolved Solids
UK	United Kingdom
UN	United Nations
UNAM	University of Namibia
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USA	United States of America
VAT	Value Added Tax
VLS	Viral Load Suppression
WHO	World Health Organization
WSASP	Water Supply and Sanitation Policy

Aspect	Element of an organization's activities or products or services that can interact with the environment (International Organization for Standardization (ISO), 2004).
Biodiversity	Defined in the Convention on Biological Diversity (CBD) as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems."
Biological Control	Using living organisms or their products to prevent or reduce the losses or harm caused by pest organisms (International Organization for Biological Control (IOBC); Hill, 2024). Biological control can be divided into three broad categories: i) Conservation biological control is the suppression of populations of harmful species by living organisms that occurs without deliberate intervention by humans other than the preservation of natural ecosystems to enhance natural enemies for pest control; ii) Classical biological control (CBC) is the deliberate importation, release, and establishment of natural enemies in areas where they did not previously exist to reduce non-native invasive pest populations; and iii) Augmentative biological control, in which natural enemies of pests are mass-reared under controlled conditions and released to temporarily suppress pests (Hill, 2024).
Circular Economy (CE)	A CE is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems (see https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy). Organisations need to engage in the transition from waste management to resource management. The Institute of Environmental Management and Assessment (IEMA) translated the concept into four practical areas of business action: i) Efficiency: making the most of material resources while minimising the production of waste; ii) Effectiveness: optimising resource efficiency to avoid environmental harm and drive societal benefits; iii) Security: responsibly sourcing a reliable and affordable supply of materials; and iv) Cycling: ensuring unused and end of use materials are returned to productive use (IEMA, 2014). Key materials may include: oil, steel, rare earth minerals, timber; there is also conflict materials and palm oil.

Cladodes	Also called cladophylls or phylloclades, are shoot systems in which leaves do not develop; rather, the stems become flattened and assume the photosynthetic functions of the plant (Britannica).
Disposal	The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid or hazardous waste on or in the land or water (United States (US), Environmental Protection Agency (EPA)).
Environment	Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation (ISO, 2004).
Environmental Assessment (EA)	The process of identifying, predicting and evaluating the effects of proposed activities on the environment. It should include information about the risks and consequences of activities, possible alternatives, and steps which can be taken to mitigate (minimise or off-set) any negative impacts. It should also discuss steps to increase positive impacts and to promote compliance with the principles of environmental management. Both Government bodies and private persons or groups (such as private companies) can be required to carry out environmental assessments (Ministry of Environment and Tourism (MET) (now Ministry of Environment, Forestry and Tourism (MEFT)), 2008).
Environmental Clearance Certificate (ECC)	A certificate which allows a listed activity to go ahead. The certificate means that the Ministry of Environment and Tourism (now MEFT) is satisfied that the activity in question will not have an unduly negative impact on the environment. It may set conditions for the activity to prevent or to minimize harmful impacts on the environment (MET (now MEFT), 2008).
Environmental Management Plan (EMP)	A key document that should consist of the set of measures to be taken during implementation and operation to eliminate, offset, or reduce adverse environmental impacts to acceptable levels. Also included in the plan are the actions needed to implement them (Directorate of Environmental Affairs (DEA) (now Directorate of Environmental Affairs and Forestry (DEAF)), 2008).
Erosion	The breaking down and subsequent removal of either rock or surface material by wind, rain, wave action, freezing and thawing and other processes (The Northern Miner, 2007).
Glochids	Glochids or glochidia (sg.: "glochidium") are hair-like spines or short prickles, generally barbed, found on the areoles of cacti in the sub-family *Opuntioideae*. Cactus glochids easily detach from the plant and lodge in the skin, causing irritation upon contact. The tufts of glochids in the areoles nearly cover the stem surfaces of some cactus species, each tuft containing hundreds of glochids; this may be in addition to, or instead of, the larger, more conspicuous cactus spines, which do not readily detach and are not generally barbed (Wikipedia)
Good International Industry Practice (GIIP)	The exercise of professional skill, diligence, prudence, and foresight that would reasonably be expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally or regionally. The outcome of such an exercise should be that the project employs the most appropriate technologies in the project-specific circumstances (International Finance Corporation (IFC), 2007a).
(Grouped) Hazardous Substance	Any substance, mixture of substances, product or material declared in terms of section 3 (1) to be a hazardous substance of any kind (Hazardous Substances Ordinance No. 14 of 1974).
Hazardous Waste	Waste that poses substantial or potential threats to public health or the environment. There are four factors that determine whether or not a substance is hazardous: i) ignitability (i.e. flammable); ii) reactivity; iii) corrosivity; and iv) toxicity (Wikipedia).
Impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects (ISO, 2004).
Innovation Principle	Innovation Principle: policy or regulatory decisions and controls should consider the role of innovation as a driver for jobs, growth, social and environmental improvement (IEMA, 2017)
Integrated approach	Integrated approach: systems thinking should underpin an integrated approach to environmental management, helping to prevent shifting environmental burdens and optimise outcomes (IEMA, 2017).
Integrated Waste Management (IWM)	Concept of employing several waste control and disposal methods to minimise the environmental impact of commercial and industrial waste streams (Business Dictionary). The generation of waste should be avoided as far as practicable; where it cannot be avoided, waste should be reduced, re-used and recovered (including recycling and composting); where waste cannot be reduced, re-used and/or recovered, it should be disposed of in an environmentally sound manner.

Interested and Affected Party (I&AP)	"Interested and affected party", in relation to the assessment of a listed activity (see below) includes - (a) any person, group of persons or organisation interested in or affected by an activity; and (b) any organ of state that may have jurisdiction over any aspect of the activity (Environmental Impact Assessment Regulations 2012: Environmental Management Act (EMA) 7 of 2007)
Invasive Alien Species	The intentional or accidental introduction of alien, or non-native, species of flora and fauna into areas where they are not normally found can be a significant threat to biodiversity, since some alien species can become invasive, spreading rapidly and out-competing native species (IFC, 2012).
Listed Activity	An activity listed in terms of Section 27(1) or 29 of the EMA 7 of 2007 (see List of activities that may not be undertaken without ECC 2012: EMA 7 of 2007).
Mitigation	Any action intended to either reduce or avert exposure or the likelihood of exposure to sources that are not part of a controlled practice, or which are out of control as a consequence of an accident (DEA (now DEAF), 2008).
Mitigation Hierarchy	Adoption of a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimise, or compensate/offset for risks and impacts to workers, Affected Communities, and the environment is widely regarded as a Good International Industry Practice (GIIP) approach to managing environmental and social risks and impacts: Avoidance requires the client to identify and, where available and technically and financially feasible, make changes to the project's design (or potential location) to avoid adverse risks and impacts on social and/or environmental features. Avoidance is considered to be the most acceptable form of mitigation. Minimisation: where avoidance is not possible, adverse impacts and risks can be minimised through environmental and social measures/treatments/design. Acceptable options to minimise will vary and include: abate, rectify, repair, and/or restore impacts, as appropriate. Compensation/Offset: where avoidance or minimisation measures are not available, it may be appropriate to design and implement measures that compensate/offset for residual risks and impacts. It should be noted that these measures do not eliminate the identified adverse risks and impacts, but they seek to offset it with an (at least) comparable positive one (IFC, 2012).
Monitoring	The repetitive and continued observation, measurement and evaluation of environmental data to follow changes over a period of time to assess the efficiency of control measures (DEA (now DEAF), 2008).
Pollution	The direct or indirect introduction of something which is harmful to people, property, or the environment into the air, land, or water. Pollution can be caused by substances, vibrations, heat, radiation or noise. One of the key ideas behind the law is that the polluter must pay the costs of pollution (MET (now MEFT), 2008).
Pollution Prevention	Reducing or eliminating pollution at source based on taking an integrated approach to environmental protection (IEMA, 2017).
Polluter Pays Principle	The environmental costs of pollution should be borne by those who cause the pollution (IEMA, 2017).
Precautionary Principle	Where there is the potential for significant or irreversible environmental damage, lack of full scientific evidence should not be used as the basis for not taking appropriate measures to prevent or mitigate environmental harm (IEMA, 2017).
Proximity Principle	Environmental damage should be rectified, compensated or treated at or as near to source as practicable and waste should be dealt with as close as possible to where it is produced (IEMA, 2017).
Renewable energy	Energy that comes from natural resources, such as sunlight or wind, and that are renewable (Wikipedia).
Sewage	The subset of wastewater that is contaminated with faeces and/or urine; it includes domestic, municipal, or industrial liquid waste products disposed of, usually via a pipe or sewer or similar structure (Wikipedia).
Significant Effect	Having, or likely to have, a consequential qualitative or quantitative impact on the environment, including changes in ecological, aesthetic, cultural, historic, economic and social factors, whether directly or indirectly, individually or collectively (EMA 7 of 2007).
Stormwater	Water that originates during precipitation (rainfall) events. Stormwater that does not soak into the ground becomes surface runoff. Stormwater is of concern for the following two reasons: one is related to the volume and timing of runoff water (for flood control and the supply of water) and the other is related to the potential contaminants that the water may be carrying and subsequent water pollution (Wikipedia).

Sustainable Development	Meeting the needs of the present, without compromising the ability of future generations to meet their own needs (IEMA, 2017).
Sustainable Use	Using natural resources in a way and at a rate that does not lead to a long-term decline, so that the environment will be able to meet the needs of future generations, i.e. the natural resources of the earth must be shared fairly between present and future generations (MET (now MEFT), 2008).
Transparency & Inclusivity	Multi-level and multi-sector stakeholder engagement, accountability and empowerment should underpin environmental policy development. Local level buy-in and participation should guide the design of local solutions (IEMA, 2017).
Waste	An unwanted or undesired material or substance. It is also referred to as rubbish, trash, refuse, garbage, or junk, depending on the type of material. Litter is waste that has been carelessly disposed of in plain sight. Waste is “dumped” in order to avoid paying waste disposal fees (Wikipedia).
Waste Management	The collection, transport, processing, recycling or disposal, and monitoring of waste materials (Wikipedia).
Wastewater	Any water that has been adversely affected in quality by anthropogenic (human) influences, i.e. liquid waste discharged by domestic residences, commercial properties, industry, and/or agriculture and can encompass a wide range of potential contaminants and concentrations (Wikipedia).
Water Protection Area	An area declared under section 85 (Water Resources Management Act No. 11 of 2013) to be a water protection area; the Maltahöhe Artesian Area is a Water Protection Area (as per Proclamation 154 of August 1960).

1 Introduction

1.1 Background

Nopal Namibia PLC is a private company that was founded, and is owned and led by Mrs Nicole Maske of Windhoek, Namibia, along with Nopal Corp. and its team from Portugal. Nopal Namibia PLC was established for the development of large-scale cactus production farms in Namibia, and with the particular goal to contribute to local communities and economies.

It is currently proposed to establish the first such production farms / irrigation projects together with the Gusinde Von Wietersheim Successors Trust. The proposed irrigation project will entail the planting of 500 hectares (ha) of *Opuntia ficus-indica* on Farm Namseb No. 24, around 17 kilometres (km) north-west of Maltahöhe (see Figure 1), in the Hardap Region, Namibia.

Figure 1: Map showing the location of Farm Namseb No. 24, Hardap Region, Namibia (*Source: Miss A.N. Nicodemus, GIS Specialist, 09 February 2024*).

1.2 Activities Requiring Environmental Clearance

According to Government Notice (GN) No. 29 (Government Gazette of the Republic of Namibia, No. 4878, 06 February 2012) the following activities may not be undertaken without an Environmental Clearance Certificate (ECC):

ENERGY GENERATION, TRANSMISSION AND STORAGE ACTIVITIES The construction of facilities for - (a) the generation of electricity; (b) the transmission and supply of electricity
WASTE MANAGEMENT, TREAMENT, HANDLING AND DISPOSAL ACTIVITIES 2.3 The ~~import, processing, use and recycling~~, temporary storage, ~~transit or export~~ of waste.
AGRICULTURE AND AQUACULTURE ACTIVITIES 7.5 Pest control. 7.8 The introduction of alien species into local ecosystems.

WATER RESOURCE DEVELOPMENTS 8.1 The abstraction of ground or surface water for ~~industrial or~~ commercial purposes. 8.7 Irrigation schemes for agriculture excluding domestic irrigation.
HAZARDOUS SUBSTANCE TREATMENT, HANDLING AND STORAGE 9.1 The ~~manufacturing~~, storage, handling ~~or processing~~ of a hazardous substance defined in the Hazardous Substances Ordinance, 1974.

1.3 Terms of Reference

LM Environmental Consulting was appointed by the Gusinde Von Wietersheim Successors Trust to undertake a Scoping, conduct an Environmental Impact Assessment (EIA), and to prepare an Environmental Management Plan (EMP) for the *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region on 15 January 2024. A site visit to the area took place on 27 February 2024.

1.4 Environmental Assessment Practitioner and Specialist Team

The author of this Report is Dr Lima Maartens who has more than 31 years' experience in natural resource management (*she gained her doctorate (Ph.D.) in Fisheries Science from Rhodes University, South Africa (SA) while working for the Namibian Ministry of Fisheries and Marine Resources (MFMR) in 2000*), lecturing (*University of Namibia (UNAM)*), environmental science and management (*De Beers Marine Namibia and the Canadian Forsys Metals Corp*), and consulting (*LM Environmental Consulting was established by Dr Maartens in October 2009*). Sectors that she worked in as an Environmental Assessment Practitioner (EAP) include: exploration (including offshore oil and gas); mining and quarrying; renewable energy (solar and wind); tourism; manufacturing; agriculture; aqua- and mariculture; township, property (including medicine storage facilities) and waterfront developments, transport (rail and road), and infrastructure. Dr Maartens is registered as a Lead Practitioner and Reviewer with the Environmental Assessment Professionals of Namibia (EAPAN) (she served on the Executive Committee during 2016/17), an Associate Member and Environmental Auditor with the Institute of Environmental Management and Assessment (IEMA) in the United Kingdom (UK), a Full Member of the Namibia Chamber of Environment (NCE), and a Member of the Namibia Scientific Society. She has published five peer-reviewed scientific research articles (and three as co-author), six popular articles (and one as co-author), one book chapter (and one book chapter as co-author), 168 technical reports (LM Environmental Consulting), three technical reports (for De Beers Marine Namibia), and one conference paper.

Specialist input to the Report was obtained from: Miss Amelia N. Nicodemus (GIS/Mapping); Dr Diganta Sarma (Hydrogeology Specialist Report); and Mrs Herta Kolberg (Vegetation Specialist Report).

Miss Amelia N Nicodemus has more than 10 years of experience in the GIS industry. She obtained her master's in Geo-Information Science and Earth Observation from the Namibia University of Science and Technology (NUST) in 2018 while working as a GIS consultant and is currently registered with the University of Namibia (UNAM) pursuing a PhD in Geography.

Dr Sarma has 28 years' experience in hydrogeology in the Southern African region. His experience includes groundwater exploration and development, groundwater management, mining related hydrogeology and environmental assessments. He has a firm understanding of the regional hydrogeology, exploration techniques, aquifer hydraulics, numerical groundwater flow modelling, and GIS applications to hydrogeology. Dr Sarma has authored peer-reviewed scientific papers on arid region hydrogeology in international journals and presented in local and international conferences. He is currently the managing member and principal hydrogeologist at Namib Hydrosearch CC, a thirty three year old Namibian hydrogeology firm.

Mrs Herta Kolberg is an independent botanical consultant with a M.Sc. from the University of Birmingham (UK) specialising in plant genetic resources conservation (seed banking). During her career of over 40 years, first at Namibia's National Botanical Research Institute and then as consultant, she has gained experience on a wide range of plant or plant-related subjects. She has done baseline studies and vegetation impact assessments for a range of Namibian developments. She is a member of the Namibian Invasive Alien Working Group. Particular fields of interest are plant taxonomy, conservation, data management, ecological restoration and invasive alien species.

2 Description of the Project

2.1 Project Location

Farm Namseb No. 24 is located around 17 km north-west of Maltahöhe (see Figures 1 and 2) , in the Hardap Region, Namibia.

The total (farm) area is 12,000 ha in size; the Project area will constitute an area of around 630 ha (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

Figure 2: Map showing the location of Farm Namseb No. 24, Hardap Region, Namibia (*Source: Miss A.N. Nicodemus, GIS Specialist, 09 February 2024*).

2.2 Land Use

Farm Namseb No. 24, 12,000 ha in size, is a small stock (sheep) and game farm. The Namseb Lodge (see http://www.namseb.com/) was closed during the COVID-19 pandemic (2020-2022).

2.3 Access

Access to the area can be attained via a 15 km gravel road (to the farmhouse), continuing (west) from the crossroad west of Maltahöhe. The crossroad links Maltahöhe to Solitaire and Walvis Bay (C14 to the right) and Helmeringhausen, Sesriem and Sossusvlei (C14 to the left).

2.4 Opuntia ficus-indica

During February/March 2024, Mrs Herta Kolberg compiled a Vegetation Specialist Report on the Namseb Spineless *Opuntia ficus-indica* orchard and processing development (see Kolberg, 2024: Annexure C). A brief summary of the findings / extracts from the report is / are provided below (unless otherwise stated):

Prickly pear (*Opuntia* species) have been well known as a livestock feed and for household consumption throughout the world, including in Namibia, for many years. Recently, many other uses, like offsetting carbon dioxide (CO_2) emissions, have been documented for *Opuntia* (Inglese *et al*., 2017; Bautista *et al.*, 2018; see Kolberg, 2024). With concerns about climate change and its influence on food security, there has been increased research on crops that are suited for the less productive, drier and hotter areas on the world (Inglese *et al*., 2017; Fouché, 2019; 2023; and Alves, 2023; see Kolberg, 2024). *Opuntia* is one such crop that could be produced in dry, hot areas, like Namibia, especially as a forage for livestock (Louacini *et al*., 2012; De Wit and Fouché, 2015; De Wit *et al*., 2019; Pessoa *et al*., 2020; and Thakuria, 2020; see Kolberg, 2024), which is the predominant agricultural activity in these areas (see Kolberg, 2024).

2.4.1 Proposed Farming Activities

It is proposed to plant 500 ha of spineless *Opuntia ficus-indica* cv. Rossa and cv. Gialla (Mrs Nicole Maske, Partner: Africa, Nopal Corp., pers. comm., 2024) on Farm Namseb No. 24. The cultivars, originating from Italy, are primarily fruit producing cultivars (Inglese *et al*, 2019; see Kolberg, 2024). Cultivar “Rossa”, with red fruit, is known in South Africa, while cultivar “Gialla”, with orange-yellow fruit, does not seem to be known in southern Africa (Fouché *et al*., 2019; see Kolberg, 2024). It is unknown whether cultivar "Rossa" is present in Namibia. Differences in morphological characteristics are mostly minute, and only the breeders of a cultivar can identify it with one hundred percent certainty (Mrs Herta Kolberg, Herta Kolberg Botanical Consulting, Seed Conservation Scientist/Botanist, pers. comm.). The propagation material (cladodes; modified stems that resemble and function as leaves (Coleman, 2023)) will be obtained from the existing Nopal Corp. farm in Portugal, shipped in containers to Walvis Bay, and then transported via truck to the site.

Note that no planting will take place in the pan-areas (around 100 ha of the 630 ha); the area will also not be completely de-bushed (planting will take place in-between e.g. the Smelly shepherds-bush or Noeniebos *Boscia foetida*).

The planting density will be high (10, 000 plants per ha: 40 rows per ha with 250 plants per row). The top 40 centimetres (cm) of the soil will be ripped, using a one-tooth ripper and a tractor. The planting of the cladodes and the closing of the rows will be done using manual labour. Each plant requires up to 48 litres (l) of water per annum and it is proposed to make use of drip irrigation.

It is proposed to use organic fertilizer (e.g. dung from local sheep and goats), as well as bio-stimulants (e.g. kelp extract and wood vinegar). NPK (Nitrogen, Phosphorus, and Potassium) plus MgO (Magnesium Oxide) fertilizer in liquid form may be applied through the dripper system, as or when required.

Pest management (pesticides, and including herbicides (weed management) and insecticides (for e.g. Cochineal *Dactylopius* spp. and Cactus moth *Cactoblastis cactorum*)) may be needed. It is proposed to use organic spot treatment with e.g. neem oil, or wood vinegar (vs pesticides); the following insecticides may be used: carbaryl, deltamethrin and methidathion, as well as tralomethrin (pesticide).

The fruit will be harvested for (local and overseas) consumption. The cladodes will be used as animal feed (sold wet to local farmers especially during times of drought / dried whole or chopped and sold to animal feed companies / processed on site and made into pellets and fodder blocks which can be sold directly to farmers or to agricultural wholesalers). Both the fruit and cladodes will be harvested using manual labour (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

2.4.2 Opuntia ficus-indica – General Comments

Kolberg (2024) noted that in Namibia, and to date, there is no knowledge of any serious invasion of natural vegetation by spineless *Opuntia ficus-indica*. However, as new, genetically different material will be imported (from Portugal into Namibia) *Opuntia ficus-indica*’s behaviour in the proposed Project-area cannot be predicted and caution must thus prevail. This is particularly important against evidence of reversion of spineless *O. ficus-indica* to spiny forms, as well as the often vastly different performance and behaviour of spineless

cultivars and forms in different environments (strong genotype x environment interaction) (Potgieter and Smith, 2004; Potgieter, 2007; De Wit *et al*., 2010; Mashope *et al*., 2011; and Gajender *et al*., 2014; see Kolberg, 2024).

Note that data regarding the spread/distribution/presence of alien plants in Namibia are limited. Often the information provided to botanists is hear-say, vague and only proof that a species is present at a certain location; seldom information regarding the abundance of the species, whether it occurs in natural veld, and whether was planted, or spread by itself, is provided. Should there be a serious infestation in Namibia, it may also very well go unnoticed; for example, a severe infestation of boxing glove cactus *Cylindropuntia fulgida* in southern Namibia has gone unnoticed and unreported until last year (2023) (Mrs Herta Kolberg, Herta Kolberg Botanical Consulting, Seed Conservation Scientist/Botanist, pers. comm.).

Opuntia species, including spineless *O. ficus-indica*, are able to propagate both sexually (by seed) and vegetatively (by cladodes or fruit rooting). The high number of seed per fruit, the ease by which seed germinate (no dormancy, no need for scarification i.e. ingestion by animals), the attractiveness of the fruit (and cladodes) to dispersing animals, the scarcity of natural enemies, pests and diseases, as well as the almost perfect adaptation to harsh environments (CAM photosynthesis, cladode orientation, water retaining mucilage) all contribute to its successful establishment and spread (Novoa *et al*., 2019a; 2019b; see Kolberg, 2024).

Kolberg (2024) noted that after consulting the literature, as well as other countries' legislation, the consensus is that spineless *Opuntia ficus-indica* is not invasive. Las Casas *et al*. (2017; see Kolberg, 2024) found that cultivars grown for fruit have a very narrow genetic base and all cultivars tested originated from wild *O. ficus-indica*. The forage cultivars, however, had a much wider genetic base originating from species like *O. stricta* (a serious invader, also in Namibia), *O. spinulifera*, *O. undulata*, *O. cochenillifera*, *O. robusta* and *O. atropes*. In South Africa, *O. spinulifera* and *O. robusta* (except spineless forms) are listed as Category 1 invasive species (Department of Environmental Affairs, 2016). Given the parentage of invasive species, there is a risk that such cultivars could revert back to invasive (and spiny) forms if propagated by seed. Inglese *et al*. (2017) reported that spineless forms can produce spiny branches after periods of stress; Kolberg (2024) could not verify this in more than (this) one reference and noted that it is unlikely. Novoa *et al*. (2019b; see Kolberg, 2024) tested spineless cultivars of *Opuntia* for reverting back to spiny forms, including those grown for fruit. All the seedlings (100%) of all cultivars reverted back to spiny when cultivated from seed. The only exception was cv. Rossa (from Italy) where seed did not germinate – the reasons behind this need to be investigated further. This cultivar had the lowest number of seed per fruit, which would also reduce the risk of spread by seed. Novoa *et al*. (2019b), however, also observed that reversion to spiny forms is not often seen in the field.

Opuntia species are predominantly cross-pollinated (pollination between two different flowers of the same plant or between flowers of two different plants). However, self-pollination (from the same flower) can also occur, and this is another reason why these plants are so successful in reproducing. Various bee species are the predominant pollinators. Beetles are often found on the flowers, but are considered less important pollinators, as they rarely move between flowers during the day (Agüero, 2006; Ávila-Gómez, 2019; see Kolberg, 2024). Cross-pollination with any "wild" forms of *Opuntia* that may occur outside the proposed orchard area, will give rise to fruit and seed that contains wild characters, like for instance spininess. This will not have any consequences for the crop from the orchard, but if recruitment from such seeds should occur, the seedlings may have invasive and undesirable characteristics and this will increase the severity of spreading into natural vegetation (see Kolberg, 2024).

2.4.3 Opuntia ficus-indica - Livestock Feed

Kolberg (2024) noted that some challenges have been reported with the use of spineless *Opuntia* as feed. The cladodes do not bear any large spines, but they do bear glochids. The latter are little hollows in the cladode surface which contain many minute spines that do pierce the skin of humans and animals (the latter both externally and internally). Fruit in particular have many glochids, and may also have a few thin spines, and because of the many seeds, may cause intestinal blockage, leading to death if eaten in large amounts by livestock. Cladodes eaten fresh by livestock have caused injury and infection of the eyes, ears, skin, mouths, tongues and digestive tracts (Rakowitz, 1997; Da Silva, 2021; Ncebere, 2021; and Pequeno, 2021; see Kolberg, 2024). The latter mostly leads to emaciation and death of animals as they cannot feed normally. The severe impact of glochids on livestock can be best illustrated by the need for special Personal Protective Equipment (PPE) for those working with spineless *Opuntia ficus-indica*: boots; long, thick rubber gloves; thick plastic or rubberised aprons; eye and airway protection (see Fouché *et al*., 2019). The glochids must thus be removed from any parts that are going to be fed to livestock.

Rakowitz (1997) noted that ulceration and infection of the lips, tongue, gums, palate, and gastrointestinal tract are symptoms from ingesting the spines. Also, the seeds may cause rumen impaction which results in death. However, in times of drought or hard winters, south Texas cattle ranchers rely on the prickly pear as an emergency feed to feed their cattle and it has been used for more than 150 years (in 1997) by ranchers in Texas and northern Mexico. Absolutely necessary, however, is that the spines are singed from both sides of the pads/cladodes by using a pear burner. Also noted is that not only the livestock in south Texas is dependent on prickly pear, but also the wildlife (e.g. the javelina or peccary, a pig-like ungulate of the family *Tayassuidae*, the bobwhite quail, white-tailed deer, the Texas tortoise, the roadrunner, etc.). Da Silva *et al*. (2021) found that Miúda, IPA-Sertânia, and Orelha de Elefante Mexicana (O.E.M.) cactus cladodes, and especially the Miúda and O.E.M. varieties, cause lesions in the tissue morphology of the cecum and colon of sheep, but improve productive performance. The studies by Ncebere *et al*. (2021) and Pequeno *et al*. (2021) deal with the effects of goats feeding on *Opuntia stricta* and with the grazing and ingestion of the cactus *Tacinga inamoena* by sheep and goats, respectively.

Processing *Opuntia* into dried feedstuff (meal, pellets, and dried-chopped) to overcome the above-mentioned challenges, however, presents its own difficulties. Cladodes have to be cut for these to dry within a reasonable time. Crushing the cladodes with, for example, a hammer mill, does not work as the mucilage blocks the machinery. Even dried material may cause blockage of mills or crushers because of the mucilage. As the glochids also remain in the dried material, and cannot be easily removed or made harmless during processing, the glochids must thus be removed from the fresh material (see Kolberg, 2024).

Kriel (2024) indicated that the whole plant can be used as feed, from the roots to the leaves. Normally the leaves are used as feed, and these can be supplied fresh (whole or chopped into strips or squares), or dried (the leaves are chopped or carved and then sundried for up to two weeks). Should the leaves be bruised during the carving process, the material will become slimy and this will make it difficult to dry.

Dr C.F. (Stoffel) du Toit, a medical doctor from Bloemfontein, South Africa, noted: ''In my experience these theoretically possible problems are not actually a problem in practice at all. The very fine glochids on the spineless opuntia can be spread by the wind when handling the cladodes and fruit during processing. That is why we recommend gloves, goggles and plastic aprons. When cladodes are shredded and dried for feeds the glochids become very brittle and actually break up into powder so that it does not pose any danger or problems for the animals in the feeds produced. I have not experienced any eye, throat or skin problems in any of my sheep, goats or cattle feeding on the cladodes or processed feeds since I started using opuntia about 10 years ago'' (Dr C.F. (Stoffel) du Toit, pers. comm., 19 June 2024) (also see Du Pisanie, 2022 and Norval, 2022).

Kolberg (2024) indicated that a number of studies has found that *Opuntia* can only be fed as part of a diet, comprising of between 30 and 75% on a dry matter basis (of the diet), and depending on the type of livestock and the aim of production (milk, meat, keeping alive) (Tegegne, 2007; Shiningavamwe, 2009; Lima, 2019; Thakuria, 2020, Rakotoarivonona, 2021; see Kolberg, 2024). *Opuntia* also has to be mixed with other sources of feed as the nutritional value of *Opuntia* is on the low side and other forms of energy, protein and dry matter have to be added.

Tegegne *et al*. (2007) concluded that cactus pear could optimally substitute pasture hay (for sheep) up to 60%. Also, it has a substantial contribution in satisfying the water requirement of sheep (also see below). No indication of serious digestive disturbances in sheep fed diets containing up to 80% cactus pear was found. The study conducted by Lima *et al*. (2019) evaluated the ruminal parameters (pH, N-NH3, and microbial protein) and morphometry of the rumen and intestine of sheep fed with a diet containing four different levels of the spineless cactus variety, Baiana. Thakuria *et al*. (2020) concluded that ''Edible spineless cactus can be grown easily in the lands with low water content due to its higher water conversion efficiency. Moreover, it has more tolerance to higher soil salinity. Therefore, growing cactus as a forage source for livestock can lead to a proper utilization of waste lands. Nutritional value of spineless cactus cladode is almost similar to some of the other conventional cereal fodders. Use of its cladodes as ruminant forage source reduces the water requirement as its cladodes are significantly high in moisture content which is of significance to the livestock farmers particularly in draught prone areas. Therefore, edible spineless cactus could be an alternate source of green fodder for livestock particularly small ruminants with due supplementation of nutrients especially protein, however, nutritional worth of different clones/varieties in different ruminant species need to be evaluated for formulation of balanced rations.'' Rakotoarivonona *et al*. (2022) concluded that the inclusion of red cactus (*Opuntia stricta* (Haw.) Haw.) in goat diet up to 50%

DM (dry matter) promotes an efficient nutrient utilisation and animal performance, without causing digestive disturbances and adverse effects on the intestinal mucosa. Shiningavamwe (2010) noted that according to Zeeman (2005), Einkamerer (2008) and Menezes (2008), sundried and coarsely ground *Opuntia* cladodes can be used to replace up to 360 g/kg of lucerne and some corn in sheep rations. Overall, *Opuntia* has a high moisture content (70% to 95%; also see below) and apparent digestibility of around 75%. The cladodes (on a dry matter basis) are rich in readily available carbohydrates, ash and calcium, but are low in crude protein (4% to 7%; see Kriel, 2024), fibre, sodium, and phospohorus. The diet should thus be balanced with supplementary protein (e.g. oilseed cakes or non-protein nitrogen such a urea) in order to meet the maintenance and production requirements of animals (Misra *et al*., 2006; see Shiningavamwe, 2010).

Dry matter production of *Opuntia* per ha is generally higher than that of natural rangeland of dry areas, but because of the high moisture content, it has low dry matter per kilogramme (kg) of wet cladodes and livestock has difficulty ingesting enough dry matter (Pessoa, 2020). The high water content can, however, replace the need for animals to drink, which may be important in dry areas or during droughts. *Opuntia* is generally considered as an emergency feed for drought situations, because it can maintain the production of livestock, but usually does not improve it (see Kolberg, 2024).

2.4.4 Opuntia ficus-indica - Fruit Crop

The consumption of *Opuntia* fruit is very much a matter of historical/cultural acceptance (Nazareno, 2017).

In Namibia, cactus pear is consumed as a fresh fruit, with some established juice and jam production businesses, but all on a relatively small (household) scale (Kolberg, 2024).

Mr Guido von Wietersheim (Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.) noted that Farm Dabis near Helmeringhausen produces juice, jam, gum, etc. on a commercial scale for distribution to shops in Namibia (e.g. to Spar).

Fruit production, as planned at Farm Namseb No. 24, would therefore have to aim mostly at export markets and where the appearance and quality of the fruit are very important. In Europe, for example, customers prefer fruit with red skin and flesh, while in its native Mexico, green/yellowish fruit are the ones mostly consumed (Liguori and Inglese, 2015). The harvesting, further processing, and transport to the markets would require careful planning, handling, processing and often the use of specialised equipment to get fruit of acceptable quality to the markets in time (the shelf life under an uninterrupted cold chain is maximum two weeks) (Corbo *et al*., 2004; and Potgieter and D'Aquino, 2017; see Kolberg, 2024).

It is foreseen that fruit from Farm Namseb No. 24 will also be supplied (at low cost) to small businesses in the area, making it more accessible (and affordable) to the local population (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

Kolberg (2024) noted that in fruit production orchards, the risk of spread through seed can be higher than in cladode production orchards. Fruit ready for marketing will contain seed that is mature and that can germinate, while in feed orchards, fruit (with cladodes) can be harvested and processed earlier, before the seed matures. Plants arising from seed also have a higher chance of having characteristics that promote spread and invasion, as well as characteristics that would make an invasion more serious, like spininess. The prevention of spread from fruit orchards can therefore be much more intensive and costly.

Dr C.F. (Stoffel) du Toit, a medical doctor from Bloemfontein, South Africa, noted: ''As far as the spread of seeds are concerned it was decided in a workshop at the UFS (*University of the Free State*) during 2023 that although it may pose a theoretical problem spineless opuntia is still not regarded as an invader plant.'' Dr du Toit noted that Prof Wynand Swart gave a well-researched opinion on that during the workshop in 2023 (Dr C.F. (Stoffel) du Toit, pers. comm., 19 June 2024). *The author of this report has not been able to locate the said study and Prof Wynand Swart has since retired*.

2.4.5 Opuntia ficus-indica – Control and Closure Plans

Kolberg (2024) noted that a closure plan for the proposed Project must have the objective to return the developed area as closely as possible to its original, natural state. In essence it means removing the *Opuntia*

plants (and destroying the plants by deep burial), as well as removing the associated infrastructure (note that the latter may be retained depending on the requirements of the landowner).

Nopal Corp. (2023) prepared a Control Plan for the *Opuntia* Species (see Annexure C). The objective of the document ''is to provide preventive measures and actions to be adopted by management, managers, supervisors, and field workers on Nopal farm operations to minimize the effects that the cultivation and production of cultivated plants of the company's varieties of *Opuntia ficus-indica*, (hereinafter also referred to as "of the species"), may provoke, in order to limit their introduction and expansion and not compromise the habitats where other species occur, safeguarding the present biodiversity, should one exist or in close proximity of the farm.''

Kolberg (2024) proposes the following changes to the Control Plan for the *Opuntia* Species:

3. Control Plan Measures 3.1. Prevention and control measures (in the Nopal Control Plan for the *Opuntia* Species) should be amended to make it clear that any *Opuntia* plants found in the 100 metre (m) buffer strip surrounding the orchard, must be removed and destroyed, not just recorded. Any unwanted removed material that is not going to be used for planting, must be destroyed in a designated area within the orchard perimeter fence by deep burial. Seedlings that have established themselves in the security or buffer zone, must be destroyed, since the genetics of these cannot be guaranteed to be the same as that of the planted orchard material. Plants that have established by vegetative means could be used for planting.

4. Good Practices for Cultivation and Control (in the Nopal Control Plan for the *Opuntia* Species) should also cover transport of planting material into the area. Planting material must be packaged properly so that no material can fall off the vehicles transporting it. Also, specifically mention (in this paragraph) the establishment of a clean down area at the gate where vehicles and persons are inspected for adhering plant material. Special attention must be given to any seed adhering to tyres or boots.

The composting of unwanted *Opuntia* material is mentioned under Sections 3.1.1, and 4.2 (in the Nopal Control Plan for the *Opuntia* Species). This is not recommended, as the glochids will remain in the compost for a long time and make handling of it hazardous for humans, as well as spread these in the environment wherever the compost is used.

Dr C.F. (Stoffel) du Toit, a medical doctor from Bloemfontein, South Africa, noted: ''… The very fine glochids on the spineless opuntia can be spread by the wind when handling the cladodes and fruit during processing. That is why we recommend gloves, goggles and plastic aprons. When cladodes are shredded and dried for feeds the glochids become very brittle and actually break up into powder so that it does not pose any danger or problems for the animals in the feeds produced. … (Dr C.F. (Stoffel) du Toit, pers. comm., 19 June 2024). It is advised that the matter of composting of unwanted *Opuntia* material be further investigated.

There is no mention in the Nopal Control Plan for the *Opuntia* Species of fencing the orchard. As discussed under Section 5.2.5 (see Kolberg, 2024), spread by seed is an issue and the orchard has to be fenced to effectively keep out baboons, birds and rodents. This means the entire orchard has to be encaged on the sides as well as on top with mesh wire of which the openings are small enough to keep out the most common frugivorous birds of the area, like red-eyed bulbul or mousebirds, yet strong enough to keep out baboons. For a 500 ha area, this is impractical so alternatively, fruit must be removed from the orchard before seed ripens and becomes viable. Should the latter not be viable, controls outside the orchard should be sharpened (Mrs Herta Kolberg, Herta Kolberg Botanical Consulting, Seed Conservation Scientist/Botanist, pers. comm.). It may, however, not be sufficient to just control plants that establish in the control strips around the orchard, as these animals move considerable distances where they defecate and deposit the seeds in ideal, fertilised spots for them to germinate and grow. It is better to prevent seed from spreading outside the orchard than controlling plants established outside it.

There is no mention of any education or awareness measures for staff at the orchard regarding control of *Opuntia* spread in the Control Plan for the *Opuntia* Species. This must be included as it is important that everyone that enters the orchard is aware of the risks and how to minimise these.

The Control Plan for the *Opuntia* Species must be updated to include all the mitigation measures proposed by Kolberg (2024: Section 6).

5. Measures to restore the situation prior to the installation of the culture (in the Nopal Control Plan for the *Opuntia* Species) is a closure plan, but should be a little bit more detailed, possibly a separate document. The last sentence should refer to the procedure in point 3., not point 4.

Kolberg (2024) proposes the following, in terms of a **Closure Plan**:

A detailed closure plan must be developed for the proposed Project. This plan must consider both scenarios of the project failing and being abandoned during any stage of its development, as well as it being closed down or stopping operation for any of a number of reasons. It must include re-establishment of indigenous flora at least in the orchard area – whether by passive or active means.

Abandonment here is taken as the owners/operators of the Namseb orchard stopping operations at the site and leaving the site without undertaking any mitigation or closure measures. A closure plan needs to address what would happen in such a situation. The persons responsible for the proper closing down of the site and the financing thereof, need to be clearly stated. It must include the removal and destruction by deep burial, as described in the mitigation measures above, of any *Opuntia* material at the site. The removal of individual infrastructure must be evaluated for its impact on the natural environment if it should remain. What infrastructure can or cannot remain will depend on this assessment and the wishes of the landowner. A timeframe for the completion of tasks must be included.

Closure here is taken as the owners/operators of the Namseb orchard deciding to stop operations and following a closure plan before leaving the site. This closure plan will be the same as the closure plan upon abandonment, except that the responsibilities for executing it will be assigned to specific positions (manager, agronomist, safety officer, etc.) in the owners/operators' establishment.

The detail of a closure plan can probably only be determined once all infrastructure and staff are in place and operations have started. This does not mean that a basic closure plan cannot be drafted before operations begin. Provision must also be made for the closure plan to be revised regularly to cover any changes in the system.

2.5 Project Rationale

Nopal Corp.'s Goal is "Reversing climate change through large-scale agricultural developments." The latter is to be achieved through:

i) mass scale, dense nopal cactus farming on currently unused land;
ii) large scale delivery of millions of carbon units, tonnes of valuable biomass for energy and food, and massive local socio-economic benefits;
iii) development of the Nopal Partner Network (*world class project deployment around the globe*);
iv) creation of the Nopal Land Bank (*mission of one (1) million ha for the steady and consistent supply of carbon units and clean biomass; 100,000 ha are currently being directly pursued under Joint Ventures (JVs) in four countries in the Middle East and Africa (Namibia, Angola, and Tanzania); and 500,000+ ha are being secured through Memorandums of Understanding (MOUs) with partners in 16 countries in Africa, Asia, South America, and the United States of America (USA)*); and
v) expanding the Nopal Community Trust (*ensuring the health of our ecosystems and our communities for generations to come*) (Nopal Corp., 2024).

2.6 Project Infrastructure and Engineering Services

2.6.1 Infrastructure

It is foreseen that the following infrastructure will needed: i) office; ii) processing warehouse (possibly two) (and including cold storage facilities); iii) solar system (*the details are not yet available*); iv) workshop; v) fuel storage (*the details are not yet available*); vi) paved turnaround and loading; vii) weighbridge; viii) guardhouse; ix) manager and guest houses; and x) two accommodation units.

Figure 3: Map showing the proposed infrastructure to be constructed on Farm Namseb No. 24, Hardap Region, Namibia (*Source: Miss A.N. Nicodemus, GIS Specialist, 09 February 2024*).

An electrical fence will be constructed around the entire Project area (630 ha) (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

2.6.2 Fuel Supply

The details re fuel supply and storage are not yet available.

Note that a consumer fuel installation certificate is required from the Ministry of Mines and Energy (MME) should someone wish to have in possession more than 200 litres (l) of petrol or diesel in an urban area or more than 600 litres (l) of petrol or diesel in a rural area.

2.6.3 Water Supply

Initially, it was foreseen that the water will be obtained from six solar-powered boreholes (depth of less than 100 m). The daily water requirement was estimated at around 660 (658) cubic metres per day (m^3/day) or 110 m^3/day from each of the six boreholes. The annual water requirement (for 500 ha) was estimated at 240,000 m^3 (0.24 Mm^3/year) (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.). The location of the six boreholes is shown in Figures 3 and 9.

The drilling of the six (and ultimately eight) (project) boreholes (see Figure 9) commenced on the 4th of April 2024 (see Sarma, 2024: Appendix A - drilling licence). Two project boreholes struck water with blow out yields of 8 m^3/h and these were test pumped. Three of the existing farm boreholes were also test pumped (see Figure 9).

The test pumping data were interpreted and the estimated aquifer and well parameters were used to estimate production pumping rates. Information on water strikes and borehole construction of existing boreholes were not available except for few records in the GROWAS database (DWA, 2011). Although these boreholes were drilled in the 1960s, they continue to produce water and are therefore useable for the proposed Project.

The estimated parameters, aquifer types, and recommended yield of the boreholes selected for supply to the proposed Project can be seen in Sarma (2024: Table 4). Test pumping interpretations are graphically presented in Sarma (2024: Appendix C), together with the projections made for five (5) years of pumping assuming no recharge would occur during this period. Shallow water strikes, resulting in limited available drawdown, have restricted the amount of water that can be pumped from each borehole despite high blowout yields achieved after drilling.

From the test pumping data interpretation and projections, the available resource is calculated as 23 m^3/h (201,480 m^3/year), which amounts to 84% of the total water requirement (240,000 m^3/year) for the entire 500 ha to be irrigated. Further groundwater exploration and development is planned to meet the full water requirement within one year of the Project's initiation (Sarma, 2024; see Section 3.1.7 for more information).

2.6.4 Waste Management

Liquid waste/sewage will be treated using a septic tank-system and it is foreseen that the Maltahohe Village Council would be able to pump and remove the contents as needed (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

> An application for a licence to discharge effluent, or to construct or operate a wastewater treatment facility (or a waste disposal site) must be submitted to the Executive Director, Department of Water Affairs (DWA), Ministry of Agriculture, Water and Land Reform (MAWLR) (see Part 8, Regulation 66 (1) of Government Gazette Notice, No. 8187 of 29 August 2023, as promulgated under Part 13, Section 72 (1) of the Water Act, Act No. 11 of 2013 - as published in the Government Gazette of the Republic of Namibia, No. 5367, of 19 December 2013, Government Notice No. 332).
>
> Effluent discharged must comply with the water quality standards set out in Annexure 11 (see Part 8, Regulation 67 of Government Gazette Notice, No. 8187 of 29 August 2023, as promulgated under Part 13, Section 72 (1) of the Water Act, Act No. 11 of 2013 - as published in the Government Gazette of the Republic of Namibia, No. 5367, of 19 December 2013, Government Notice No. 332).

An Integrated Waste Management (IWM) approach will be followed for solid waste. Several waste control and disposal methods will be employed in order to minimise the environmental impact of the commercial waste streams; where the generation of waste cannot be avoided or reduced, it should be re-used, recovered (including recycling and composting) and disposed of in an environmentally sound manner.

2.7 Employment

It is anticipated that around 20 persons will be employed during the initial set-up phase of the proposed Project. During maintenance, approximately 20 persons will be employed, and another 50 persons during periods of harvesting. Only one to two people will be living on site at any time; the remainder of the staff will mainly reside in Maltahöhe and will be transported to and from the Project-area (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, and Mrs Nicole Maske, Founder Nopal Namibia PLC and Partner Africa, Nopal Corp., pers. comm.).

2.8 Alternatives

Maintaining the status quo, i.e. the *Opuntia ficus-indica* Irrigation Project and Associated Activities do not realise, will mean that there will be no large scale delivery of carbon units, no tonnes of valuable biomass for energy and food, and no local socio-economic benefits.

3 Natural Environment

3.1 Physical Environment

3.1.1 Regional Setting

The Hardap Region is located in central Namibia. The Region is 109,659 square kilometres (km²) in size and covers 13.3% of the total surface area of the Country. The Hardap Region is bordered by the Khomas Region (north), the Erongo Region (north-west), the Atlantic Ocean (west), the //Karas Region (south), the border between Namibia and Botswana (east), and the Omaheke Region (north-east).

The Region is subdivided into eight political constituencies: Rehoboth West Urban (population in 2023: 11,912), Rehoboth East Urban (population in 2023: 29,299), Rehoboth Rural (population in 2023: 9,439), Mariental Urban (population in 2023: 18,368), Mariental Rural (population in 2023: 12,812), Daweb (population in 2023: 6,092), Gibeon (population in 2023: 8,034), and Aranos (population in 2023: 10,722). Rehoboth and Mariental are the two main towns in the Hardap Region.

Key economic activities include agriculture and tourism. In 2010, around 75% of the Hardap Region was owned by private farmers; the Namibian Government was the second largest landowner (i.e. with two resettlement farms, two Government agricultural areas, and the Hardap Game Reserve). By 2018, the resettlement farms amounted to 91 (689,445.07 ha), as well as two group resettlement farms. The westernmost 15% of the area is part of the Namib-Naukluft National Park, and in 2010 communal farmland made up 10% (central-southern area). Other conservation areas include the Namib Rand Private Nature Reserve and two registered conservancies (Oskop and /Huibes). Popular tourist attractions in the Hardap Region include the Oanob Dam, the Hardap Resort, Duwisib Castle, Sesriem Canyon, Sossusvlei, Deadvlei, and Dune 45.

April (2022) noted that agriculture remains the key economic driver in the Hardap Region. However, farmers are faced with the realities of high production input costs (seeds, fertilizers, machinery, etc), high livestock production costs, threats of diseases, and pests outbreaks which hampers increased production and directly affects employment and wealth creation.

In order to ensure increased production, the Ministry of Agriculture, Water and Land Reform (MAWLR) developed the Harambee Comprehensively Coordinated and Integrated Agriculture Development Programme (HACCIADEP). The HACCIADEP aims to provide farmers with subsidised farming inputs and linkages to the market; the programmes include: i) the Namibia Agricultural Mechanization and Seed System Improvement Project (NAMSIP); ii) the National Horticulture Value Chain; iii) the Poultry Value Chain Development Scheme; and iv) the Small Stock Distribution & Development in Communal Areas.

The Directorate of Agriculture Production, Extension and Engineering Services continues to provide extension services to the farming communities in the form of advice on projects, practices, skills and technologies, information dissemination, farm visits, exposure visits and training. During the 2021/22 financial year, over 4,000 farmers (including schools, hostels, hospices, backyard/community/individual gardens) received advisory and training services.

Of concern is the fact that the average age of farmers is 67 and the Region has identified youth as dynamic forces that are not tapped into. April (2022) indicated that ''it becomes very critical that we need to address difficulties in accessing land for farming and finances by the youth.''

Developmental partners such as the World Food Programme (WFP), Food and Agriculture Organization (FAO), UNDP-BBB, RISE, AgriBank, RISE-Namibia and GIZ have also contributed to the food security in the Hardap Region. In the Daweb Constituency, UNDP-BBB (Build Back Better) provided technical support, advice and training in the horticulture value chains to the Daweb Desert Fresh Project, and RISE Namibia funded the training of 30 women in Maltahöhe on backyard green houses and also provided with seeds and polybags to the women (April, 2022).

The main railway line and main trunk road that transverse the Region, provide direct links to Windhoek and South Africa. An all-weather landing strip for small to medium-sized aeroplanes can be found at Mariental

(Ministry of Regional and Local Government, Housing and Rural Development, 2010; Namibia Statistics Agency (NSA), 2014b; 2018b; April, 2021; April, 2022; NSA, 2024).

3.1.2 Topography and Drainage

Sarma (2024) noted that Farm Namseb No. 24 is at an elevation of around 1,400 metres above mean sea level (m amsl) with a gradual slope towards the east. Along the eastern boundary of the farm, a north-south ridge forms a prominent topographical feature. Ephemeral drainages originating in the north and south converge and cut through this ridge to join the east flowing Hudup River (see Figure 4). These rivers only flow annually for brief periods during rainy seasons, except when drought conditions prevail (e.g. hydrological year 2023-24). Flow in these rivers is slow and the Hudup River holds some water for most of the year as seen in pools and areas of shallow saturated alluvium.

Figure 4: Map showing the location of the proposed Project, and the topography and major rivers in the area (*Source: Sarma, 2024*).

On Farm Namseb No. 24, cover is generally thin (less than 1 m thick), except where alluvial sediments are present close to the ephemeral drainages. Soils are commonly very fine grained and poorly drained (see Sarma, 2024 and Section 3.1.5).

3.1.3 Climate

At Maltahöhe, the climate is hot and dry. Average annual temperatures range between 18 to 22 degrees centigrade (°C); the average maximum temperatures during the hottest month range between 28 and 30°C and the average minimum temperatures during the coldest month (July) are between 4 and 8°C (Atlas of Namibia Team, 2022).

The Hardap Region experiences summer rainfall (from October to April) (Mendelsohn *et al*., 2009). Sarma (2024) downloaded rainfall data for the period between 1981 and 2024 from the CHIRPS daily data set (Funk *et al*., 2014) for the farm location (16.8522E, -24.7472S) (see Figures 5 and 6). The mean annual precipitation (MAP) over this period was found to be 105 mm, confirming arid conditions.

Figure 5: Graph showing the annual total rainfall (mm) and five-year moving average of annual rainfall (*Source: Sarma, 2024*).

Rainfall occurs during the summer months of January to April, and monthly averages exceed 20 mm only during February and March (see Figure 6).

Rainfall variability is high and events lower than 50 mm/year of the MAP were recorded recently in 2018/19 and 2022/23; events larger than 150 mm/year were reported during the 1986/87, 1999/2000, 2005/06, 2006/07, 2007/08, and 2010/11 seasons.

Water deficit conditions prevail in the area for most of the year; potential evapotranspiration rates exceeds average rainfall during all months except in January, February, March and April (Terra MODIS, 2024, appeears.earthdatacloud.nasa.gov) (see Figure 6). Under the arid conditions prevalent in the area, above average rainy seasons are usually required to recharge groundwater and for the water table to recover (Sarma, 2024).

Figure 6: Graph showing the average monthly rainfall and potential evapotranspiration (*Source: Sarma, 2024*).

Relative humidity in the Maltahöhe area ranges between 50 and 70% during the most humid months and between 10 and 20% during the least humid months (Atlas of Namibia Team, 2022).

The wind speed and direction for Maltahöhe during 2023 is shown in Figure 7 (see https://www.meteoblue.com; simulated historical (2023) climate & weather data for Maltahöhe).

Figure 7: Graphs showing: i) the temperature (including relative humidity in hourly intervals); ii) clouds (grey background) and clear sky (light blue background), the darker the grey background, the more dense is the cloud cover; and iii) wind speed and direction (in degree 0° = North, 90° = East, 180° = South and 270° = West); the green line represents wind speed, and the wind rose shows the wind direction for 2023 (*Source: https://www.meteoblue.com*).

3.1.4 Archaeology

There are no known heritage sites and/or sites of archaeological importance at Farm Namseb No. 24 (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

3.1.5 Soil Type

The soil types in the general Maltahöhe area are Fluvisols and Regosols (Atlas of Namibia Team, 2022).

Fouché (2023) noted that soils should be well-drained (the plants cannot tolerate water logged soils), any soil type (from clay to sandy) is suitable, and that the ideal pH is between 6.5 and 7.0.

Three soil samples were collected and analysed by Analytical Laboratory in October/November 2023 (see Table 1).

Table 1: Summary of the results for the soil sample analyses (*Source: Analytical Labortory Services*).

Test	Sample 1	Sample 2	Sample 3
pH (H_2O)	7.1	7.7	7.5
Conductivity (mS/m)	12.7	11.8	8.1
Total Nitrogen (mg N/kg)	570	743	608
Organic carbon (% m/m C)	0.0	0.3	0.1
Organic matter (% m/m OM)	<0.2	0.6	0.2
Phosphorus (mg P/kg)	5	10	5
Sodium (mg Na/kg)	15	3	7
Potassium (mg K/kg)	174	104	198
Magnesium (mg Mg/kg)	456	156	373
Calcium (mg Ca/kg)	1402	1380	866
Particle Size Analysis			
Sand (2 mm-53 µm) (%)	66.2	82.9	72.7
Silt (53-2 µm) (%)	17.2	10.9	15.4
Clay (<2 µm) (%)	16.6	6.2	12.0
Textural class	Sandy Loam	Loamy Sand	Sandy Loam

3.1.6 Geology

Dr Diganta Sarma compiled a Specialist Report: Hydrogeology in June 2024 (see Sarma, 2024: Annexure B). A brief summary of the findings / extracts from the report is / are provided below (unless otherwise stated):

In general, the area is underlain by sedimentary rocks of the Nama Group of the Fish River Basin (Geological Survey of Namibia Map Sheet 2416, Lohe *et al*., 2020). At the proposed Project-area, sandstone and siltstone of the Kreyrivier Member and the overlying Niep Member of the Nomtsas Formation are exposed (see Table 2 and Figure 8). Dips of 3° - 6° SE (N132° to N152°) were measured on the generally flat lying strata. Jointing is clearly visible affecting these lithologies. Near vertical to steep dips were noted in fracturing close to joints and visible on satellite imagery (e.g. 63° dip towards SE).

Table 2: Lithostratigraphic units of the Mariental - Maltahöhe area (Map sheet 2416) (*Source: Sarma, 2024*).

Age	Group	Subgroup	Formation	Member	Lithology
Recent					Alluvial and aeolian deposits
PALAEOZOIC	Nama	Visrivier	Breckhorn		Grey, red and purple sandstone, minor shale
			Stockdale	Wasserfall	Red friable sandstone with minor shale
				Inachab	Grey to reddish quartzite and shale, with thin basal pebbly sandstone
				Haseweb	Red friable sandstone with red sandstone
				Kabib	Thin basal conglomerate
		Schwarzrand	Vergesig		Green shale with green and red sandstone
			Nomtsas	Niep	Red sandstone with a few interbeds of red shale
				Kreyrivier	Reddish shale and reddish sheet sandstone
UPPER PRECAMBRIAN			Urusis		Greenish shale and greenish sheet sandstone
			Nudaus	Vingerbreek	Green shale with minor intercalated greenish sheet quartzite
				Niederhagen	Grey to greenish quartzite with intercalated green shale
		Kuibis	Zaris	Schlip	Two pink stromatolitic limestone layers separated by shale and quartzite
				Urikos	Bluish-green shale with interbeds of quartzite and minor limestone
				Hoogland	Blackish grey to greyish limestone, in places oolitic and stromatolitic

Within a radius of 3 km of the centre of the proposed irrigation field, boreholes intersected uniform grey indurated fine sandstone, weathered at shallow levels (0 to 30 m) to reddish brown or purplish brown (see Sarma, 2024: Appendix B - borehole logs).

Figure 8: Map showing the geology of the Project area (*Source: Sarma, 2024*).

3.1.7 Hydrogeology

Sarma (2024) noted: As the arenaceous units of the Nomtsas Formation are fine grained and have negligible primary porosity, groundwater occurrence is restricted to secondary features such as fractures and joints. These lithologies are known to have N-S joint systems of moderate to high groundwater potential. Borehole sites are usually selected on such fractures or joints which are visible on satellite imagery or on the ground. When targeting such fractures, drilling must be on the down-dip (hanging wall) side of non-vertical structures (Bockmühl, F., in Lohe *et al*., 2020) to ensure that they are intersected below the water table.

The GROWAS database (DWA, 2011) has 33 borehole records within a 10 km radius of the proposed Project-area. Of these (33 boreholes), 16 (48%) are recorded as dry; the average yield of successful boreholes is 8 m³/h. Some 375 m from the northwestern corner of the proposed Project-area, on the Farm Marion Reitz (25), a borehole is recorded with a blowout yield of 45 m³/h (Sarma, 2024).

The drilling of the six (and ultimately eight) boreholes commenced on the 4th of April 2024 (see Section 2.6.3). Water strikes encountered in the eight (project) boreholes were at 11 m to 50 m below surface, while the depth to the water table is between 6.5 m and 14 m (see Figure 9). From the lithology, depth to water table, and test pumping interpretation, the aquifer encountered is interpreted to be under unconfined conditions, whereas an artesian flowing aquifer, also hosted by Nama Group sandstones, south of Farm Namseb No. 24, has been protected by a Sub-terranean Water Control Area (see Figures 4 and 8).

Groundwater level contours were drawn using the data collected during the hydrocensus (see Figure 9). It was found that the groundwater flow direction is from north to south, following the topographical slope; surface water drainage is towards the Hudup River. Recharge to unconfined aquifers in arid regions is often dependant on flow in ephemeral rivers. This is confirmed by the influence on groundwater elevation contours by river courses shown in Figure 9 (Sarma, 2024).

ID	Description	Depth	Water level (m)	Yield (m^3/h)
WW207160	Project borehole, test pumped	100	9.38	8
WW207162	Project borehole, test pumped	100	10.97	8
WW207159	Project borehole	100	10.62	0
WW207161	Project borehole	153	10.56	0
WW207163	Project borehole	100	11.58	0
WW207164	Project borehole	50	9.2	0.5
PBH7	Project borehole	146	11.53	0.5
PBH8	Project borehole	219	13.54	0
WW84774	Farm borehole, test pumped	38.2	6.48	14
FBH4_TP	Farm borehole, test pumped	NULL	11.25	13
FBH5_TP	Farm borehole, test pumped	45	11.74	1.5
WW84188	Farm borehole	10.7	8.2	4.5
FBH9	Farm borehole	40	12	2
WW71240	Farm borehole	16.7	7.97	45
FBH6	Farm borehole	NULL	NULL	3

Figure 9: Map showing the borehole information and groundwater elevation contours (*Source: Sarma, 2024*).

Irrigation source water quality and vulnerability: Groundwater from the Nomtsas Formation aquifers in the Project-area (GROWAS database (DWA, 2011) and project data) is of Group-D quality (as per the Namibian Water Quality Guidelines; see Sarma, 2024: Table 5). This classification is mainly due to elevated levels of nitrate and fluoride and to high total hardness indicators. Elevated nitrate is usually from anthropogenic sources (human or farm animal waste) and not of natural origin (Tredoux and Talma, 2006; see Sarma, 2024) while fluoride and total hardness originate naturally through interaction of groundwater with the aquifer material.

A Piper Diagram provides a useful graphical method to interpret groundwater evolution. Sarma (2024: Figure 6) found that higher salinity groundwater, away from the river channels, is seen to be of the sodium-magnesium-sulphate or sodium-magnesium-chloride type. Closer to the river channels, salinity is reduced by dilution due to recharge and the water type generally becomes calcium-bicarbonate type (e.g., FBH4_TP). In the Project-area other water types evolve from mixing of these two main types of water.

Sarma (2024) noted that a first pass assessment of the suitability of water for irrigation is commonly carried out examining the calculated sodium and salinity hazards. Excess of salts content is one of the major concerns with water used for irrigation. A high salt concentration present in the water (and/or soil) may negatively affect crop yields and can lead to degradation the land and groundwater quality. Both indicators have been calculated for the water samples collected during this Project (see Sarma, 2024: Table 6).

Groundwater in the area has variable salinity, as reflected in the electrical conductivity (EC) and total dissolved solids (TDS) values (see in Sarma, 2024: Table 5). Higher salinity results from increase of dissolved ions, including sodium, which in turn elevates both the salinity and sodium hazards of the water (see Sarma, 2024: Table 6). Excess irrigation water that is not drained, therefore, poses a risk of salinization of the soil and possible increase of groundwater salinity if the excess water infiltrates underground. This risk can be lowered by blending of different source water (e.g. relatively lower salinity water from boreholes PBH1 and FBH4_TP can be blended with the other sources). Irrigation rates will also require to be optimised so that infiltration is minimised. Overall, the water requirement for prickly pear irrigation is low (240,000 m^3/year) thus reducing the risks.

With a shallow water table (6.5 to 13.5 m) and therefore a thin unsaturated zone, the aquifer must be considered vulnerable to pollution from surface, (e.g. domestic and livestock waste and fertiliser). Elevated nitrate levels in groundwater indicates surface pollution, confirming the vulnerability of the aquifer. In areas of outcrop or coarse alluvium the vulnerability will be highest, although where soil covers bedrock the risk is slightly reduced due to the low permeability of the soil. This should be borne in mind when planting (Sarma, 2024).

Sarma (2024) concluded: i) *Sustainable use of groundwater as planned for the project is feasible and can be met by the identified sources. The Nomtsas Aquifer is being utilised for supply and in the scale of abstraction proposed, close monitoring of water levels, abstraction and rainfall followed by periodic evaluation of monitoring data will be needed to ascertain sustainability*; ii) *The project site is under arid conditions with mean annual rainfall of 105 mm. Recharge to the aquifer is expected to be episodic occurring during years of higher than average rainfall. Therefore, in estimating recommended pumping rates no recharge for a 5 year period (is) assumed*; iii) *The aquifer is unconfined in the project site and vulnerable to pollutants released at the ground surface such as wastewater and hazardous liquids*; and iv) *The groundwater quality is variable with some supply boreholes having salinity and sodium hazards. Application of excessive irrigation water may lead to soil salinisation and deterioration of soil quality. Optimisation of irrigation needs through soil moisture monitoring is recommended which can reduce the risk and also limit water usage.*

Potential impacts and mitigation measures: more information re the potential groundwater-related impacts, including the assessment of the potential impacts, is provided under Section 6.3 (this Report) and the proposed mitigation measures are contained in the Environmental Management Plan (EMP) (see Section 7.4).

3.2 Biophysical Environment

The general area is commonly referred to as the Dwarf Shrub Savanna vegetation type of the Nama-Karoo biome (Atlas of Namibia Team, 2022).

Kolberg (2024) noted that the vegetation is sparse (see Figure 10) and consists of small shrubs, interspersed with mostly annual grasses and a few scattered trees and larger shrubs mainly along drainage lines and ephemeral rivers. Annual plants and bulbous species only appear after good rainfall.

In this part of Namibia, overall (all terrestrial species) diversity is regarded as “low” and endemism is regarded as “high” (Mendelsohn *et al.*, 2009).

Two hundred and seventeen (217) species of mammals occur in Namibia, of which the rodents, bats and carnivores are the most diverse groups. In the general Maltahöhe area, between 61 and 75 species of mammals can occur, and including between 14 and 17 of the 32 carnivore species and one to two of the 16 species of herbivores.

The following (larger) species of mammal occur in the proposed Project-area: springbok *Antidorcas marsupiali*, oryx *Oryx gazella*, kudu *Tragelaphus strepsiceros*, Hartmann's mountain zebra *Equus zebra hartmannae*, blue or common wildebeest *Connochaetes taurinus*, steenbok *Raphicerus campestris*, warthog *Phacochoerus africanus*, Chacma baboon *Papio ursinus*, black-backed jackal *Canis mesomelas*, rabbits/hares, cheetah *Acinonyx jubatus jubatus*, and leopard *Panthera pardus pardus*. There are eight waterholes on Farm Namseb No. 24, but these as well as the animal migration routes fall outside the proposed Project area (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

Between 111 and 140 species of avifauna (birds) can occur in the general Maltahöhe area; the area is not regarded as an Important Bird Area (IBA). Reptile diversity is estimated at between 51 and 60 species, and amphibian diversity at between 9 and 12 species (Atlas of Namibia Team, 2022).

The most common species of birds in the proposed Project-area include: doves, pigeons, Cape sparrow or mossie *Passer melanurus*, Southern masked-weaver *Ploceus velatus*, Sociable Weavers *Philetairus socius*, Namaqua sandgrouse *Pterocles namaqua*, helmeted guineafowl *Numida meleagris*, and Kori bustard *Ardeotis kori* (Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.).

<u>Potential impacts and mitigation measures</u>: the assessment of the potential impacts is provided under Section 6.3 (this Report) and the proposed mitigation measures are contained in the EMP (see Section 7.4).

3.2.1 Flora

During February/March 2024, Mrs Herta Kolberg compiled a Vegetation Specialist Report on the Namseb Spineless *Opuntia ficus-indica* orchard and processing development (see Kolberg, 2024: Annexure C). A brief summary of the findings / extracts from the report is / are provided below:

Herta Kolberg Botanical Consulting’s database houses more than 100,000 Namibian plant records. This database was used to determine the list of species found in the immediate vicinity (20 km radius) of the proposed Project (core list), as well as within a wider radius of about 35 km from the proposed Project on Farm Namseb No. 24 (extended list).

In the area in a 35 km radius around the proposed Project, 666 plant records (most likely an underrepresentation) were found in the database. The 666 records represent 190 different plant species in the core area and 364 different plants in the extended area (including the core area). A list of the recorded species with their attributes can be found in Kolberg (2024: see Annex 1).

Some of the vegetation within the proposed Project area on Farm Namseb No. 24 can be seen in Figure 10.

Amongst the 364 plants recorded for the proposed Project-area, 41 species are endemic to Namibia, 60 species are near-endemic, 17 species are protected by the various laws (*Nature Conservation Ordinance 4 of 1975, the Forest Act 12 of 2001, and the Convention on International Trade in Endangered Species of Flora and Fauna (CITES)*), and no species are threatened.

The IUCN (International Union for the Conservation of Nature) system evaluates species’ extinction risk and several of the plants in the proposed Project-area have been evaluated and assigned threat categories. There is one critically endangered species (*Gazania thermalis*), which, however, only occurs at a restricted locality

with specific habitat, that happens to fall within the extended area and is not expected to occur at the proposed Project-area. Fourteen species are of least concern (LC), and 17 species are DD (data deficient) (see Kolberg, 2024: Table 1).

Figure 10: Pictures showing: a) sparse vegetation (looking east); b) Smelly shepherds-bush or Noeniebos *Boscia foetida*; c) sparse vegetation (looking west); d) Brosdoring or Brittle-thorne *Phaeoptilum spinosum*; e) Green-hair Tree or Lemoendoring *Parkinsonia Africana*; and f) small shrubs on the one pan (*Source: L Maartens, 27 February 2024*).

3.3 Socio-Economic Environment

A baseline socio-economic study was compiled using data from the following Government documents: the Namibia Household Income & Expenditure Survey (NHIES) 2009/2010 (NSA, 2012); the NHIES 2015/2016 (NSA, 2018a); the Namibia 2011 Population & Housing Census Main Report (NSA, 2013); the Hardap 2011 Census Regional Profile (NSA, 2014a); the 2011 Population and Housing Census Hardap Regional Based on 4th Delimination (NSA, 2014b); the Namibia Inter-censal Demographic Survey (NIDS) 2016 Report (NSA, 2017a); the Namibia Labour Force Survey 2016 (NSA, 2017b); and the Namibia Labour Force Survey 2018 (NSA, 2019); summary data from the Socio-Economic Survey carried out October 2020 (Mrs Armanda Pieters, Senior Administrative Officer, Daweb Constituency Office), and the 2023 Population & Housing Census Preliminary Report (NSA, 2024; the final report will only be available end-October 2024).

Population and Housing Censuses for Namibia were conducted in 1991, 2001 and 2011. In 2016, the NSA conducted the Namibia Inter-censal Demographic Survey (NIDS); it is a sample survey taken at five years between the censuses in order to provide up to date data on demographic, socio-economic characteristics of the population and its housing units. The fourth Population and Housing Census (PHC) for Namibia took place between 18 September and 05 November 2023.

Potential impacts and mitigation measures: note that the assessment of the potential impacts is provided under Section 6.3 (this Report) and the proposed mitigation measures are contained in the EMP (see Section 7.4).

3.3.1 Population Characteristics

Farm Namseb No. 24 is located in the Daweb Constituency of the Hardap Region, Namibia. Selected indicators for the areas are summarised in Table 3.

The Village of Maltahöhe has 3,464 inhabitants (1,647 males and 1,817 females and 19.8 persons/km^2) (NSA, 2024).

Development needs in Maltahöhe include (2020 figures): water, electricity, toilets, street lights, own land, and better houses (Socio-Economic Survey data, October 2020).

'RuralRevive' is a medium- to long-term development and community revitalisation project (under the Wolwedans 'AridEden Project) to take shape in Maltahöhe, a settlement that is marred by high unemployment, destitution, pollution and social disintegration. The project will be tackled in partnership with the people of Maltahöhe and with initial financial support from the Social Security Commission Development Fund and the Julius Bäer Foundation. The 'RuralRevive' Project Activity Areas include: Laundry; Horticulture; The Barn; DesertRunner; and Clean-up & Waste Management. EconoMix, an overarching activity and a capacity building programme in 'business basics', will be on offer. Eventually, it is hoped that Maltahöhe could again be a thriving business hub, creating jobs and sustaining livelihoods (see https://www.arideden.org/community/ruralrevive).

Table 3: Selected indicators for the Daweb Constituency (2011 and 2023), and the Hardap Region and Namibia during 2023 and 2016 (vs 2011) (*Source: Matthys, 2024; Namibia Statistics Agency, 2014b; 2017a; 2024*).

Indicator	**Daweb Constituency 2023 (2011)**	**Hardap Region 2023 2016 (2011)**	**Namibia 2023 2016 (2011)**
Population Size	6,092 (8,528)	106,680 (79,507)	3,022,401 (2,113,077)
Percent of total population	0.2 (0.3)	3.5 3.8	
Annual growth rate (%)	-	1.8 (1.5)	3.0 (1.4)
Percent in Urban/Rural Areas:			
Urban	-	72 (60)	49.5 (43)
Rural	-	28 (40)	50.5 (57)
Sex ratio: males to 100 females	-	105 (104)	95 (94)
Population density (people per square kilometre (km^2))	-	1.0 (0.7)	3.7 (2.6)
Age Composition (%):			
0–4	(11)	15 (11)	14 (14)
5–14	(21)	18 (21)	23 (23)
15–59	(59)	59 (59)	56.1 57 (57)
60+	(9)	8 (7)	6.8 6 (6)
Three main languages spoken at home (percent of households):			
Oshiwambo	-		50 (49)
Nama/Damara	-	49 (43)	11 (11)
Afrikaans	-	29 (41)	
Kavango	-		10 (9)
Otjiherero	-		
Private households:			
Number	1,496	30,108 (19,307)	756,339 (464,839)
Average size	3.3	3.6 (4.0)	3.8 (4.4)
Literacy Rate (15+ years) (%)	(85.3)	85 (91)	89 (89)
Education (15+ years) (%):			
Never attended school	(18) (5+years)	8 (11)	11 (13)
Currently at school	(23) (5+years)	7 (9)	18 (17)
Left school	(56) (5+years)	82 (79)	71 (66)
Don't know	(3) (5+years)		
Fertility (Crude Birth Rate (CBR) per 1,000 population)	-	29.2 (26.2)	32.6
Mortality (Crude Death Rate (CDR) per 1,000 population)	-	15.8 (13.0)	10.8

3.3.2 Economic Profile

The economic context of the Daweb constituency is illustrated by means of economic indicators such as employment, source of income, and main working activities:

During 2011 (*the 2023 statistics are not yet available*), approximately 75% of the population in the Daweb constituency formed part of the potential labour force (15+ years). Of these persons, 69% had been absorbed by the economy and was actively working (vs the national average of ~63%); the remainder of the people was classified as unemployed (31%) and outside the labour force (19%) (NSA, 2014b).

Results from the 2016 and 2018 Namibia Labour Force Surveys (NLFSs) (the last survey was carried out in 2018) indicate that the Labour Force Participation Rate (LFPR; the number of persons in the labour force given as a percentage of the working age population in that population group) for the Hardap Region was 74.1% (vs 69.4% for Namibia) and 67.4% (vs 71.2% for Namibia) during 2016 and 2018, respectively. The broad unemployment rate (i.e. people being without work, or who are available for work, irrespective of whether they are actively seeking work) for the Hardap Region was 37.7% (vs 34.0% for all the Regions of Namibia) during 2016 and 34.5% (vs 33.4% for all the Regions of Namibia) during 2018. The unemployment rate for the youth aged 15 to 34 years in the Hardap Region was 41.9% (vs 46.1 for the country) in 2018 (NSA, 2017b; 2019).

Namibia's Vision 2030 envisaged an unemployment rate of 5% by 2030; the current unemployment rate is around 50%. In 2011, the Namibian Government made attempts to address unemployment. Through the Targeted Intervention Programme for Employment and Economic Growth (TIPEEG), 104,000 direct and indirect jobs were to be created between 2011 and 2014. The budget allocation was N$14,7 billion and the priority sectors were agriculture, transport, housing, sanitation, tourism and public works. In the end, only around 15,000 permanent jobs were created. The National Employment Policy (NEP) of 2013 was expected to create a much larger number of additional jobs. However, despite a detailed implementation plan, the policy failed to make the much needed difference. Jauch (2023) notes "Unless there are deliberate interventions to create a large number of decent jobs and to change economic structures away from extractivism (mining) towards beneficiation and local production, thousands of unemployed Namibians will continue to queue for a handful of jobs. We need bold interventions now, including the utilisation of natural resources for public benefit – away from elite capture that only benefits a selected few. These are the issues we need to confront. Banning protest marches and arresting the youth is draconian and counter-productive and will not solve the unemployment crisis."

Ya Nangoloh (2023) identified several factors which have direct and indirect negative consequences for job creation (in Namibia). One such factor is corruption which includes conflict of interest in the government – there is an apparent or real reluctance from government to ensure that certain foreign investors pay taxes to the government, there are also widespread credible allegations that the government is reluctant to collect taxes from mainly black-owned companies, and there are corruption around tenders worth millions, if not billions, of dollars, to companies which have no capacity to create employment. Another principal factor contributing to high unemployment is the (small) size of the Namibian economy (vs that of e.g. South Africa); Namibia's economy cannot sustain the growing number of young people who need jobs. In 2022, for example, there were 576,000 youths in Namibia, 265,770 (46%) of which were unemployed (Petersen, 2022a).

In 2023, it was found that 71.1% of the Namibian population are under 35 years old (NSA, 2024); the youth unemployment rate is 46.1%. Mashwahu (2024) notes: ''Addressing youth unemployment demands more than just policy reform—it requires a societal shift. It necessitates investment in education, skills development and entrepreneurship. It calls for collaboration between government, the private sector and civil society to create an environment ripe for job-creation and economic prosperity. Namibia stands at a critical juncture, where the fate of its youth intertwines with the trajectory of its economy. By unlocking the potential of its young population, Namibia can chart a course towards a brighter, more inclusive future.''

Key industries in the Daweb constituency, in terms of employment are (*2011 statistics*): agriculture forestry and fishing (39.5%); accommodation and food service activities (23.3%); administrative and support service activities (11.9%); construction (5.1%); activities of private households (3.9%); education (3.2%); and manufacturing (3.1%).

In the Daweb constituency, the main occupation of employed population (+15 years) is (*2011 statistics*): elementary occupations (41.1%); service workers (23.4%); skilled agricultural and fishery workers (15.1%); and craft and related trades workers (6.0%) (NSA, 2014b).

In Maltahöhe (2020 figures), and out of 2,162 persons, 45.8% were students/children (< 18 years), 32.1% were unemployed, 7.1% were pensioners, 5.6% were domestic workers, 5.2% were students (> 18 years), 3.6% were formally employed, and 0.6% of people were self-employed (Socio-Economic Survey data, October 2020).

The household main source of income in the Daweb constituency was (*2011 statistics*): salaries and wages (56.6%); pension (15.9%); farming (10.6%); cash remittances (9.0%); and business activity - non farming (4.1%) (NSA, 2014b).

In 2020, more than 12,000 workers in Namibia were retrenched. This was the result of Namibia's slumping economy, worsened by the COVID-19 pandemic (Petersen, 2022a). In 2021, 3,244 Namibians were retrenched. Of the 15,442 people that lost their jobs in 2020/21 (almost definitely an under estimate), 4,349 people worked in the travel, tourism, hospitality and catering sectors, 1,880 worked in wholesale and retail, 1,777 worked in mining and quarrying, 763 worked in manufacturing, and 719 people worked in construction (Petersen, 2022b).

3.3.3 Poverty Levels

According to the 2009/10 NHIES, people in the Hardap Region had an average household income of N$68,788 and income per capita of N$16,210; the average annual household income in Namibia was around N$68,878 and the per capita income was about N$14,559. The highest income per capita was found in the Khomas Region, followed by Erongo; the lowest income per capita was found in the Kavango (N$5,682) and Oshikoto (N$6,912) Regions (NSA, 2012).

In 2015/16, average household consumption and consumption per capita in the Hardap Region were N$146,157 (vs the national average N$119,065) and N$35,675 (vs the national average N$28,434). Households spent most of their money on housing (38.7%), food/beverages (26.3%), other (recreation, culture, accommodation services and miscellaneous goods and services; 12.7%), transport/communication (9.9%), furnishing/equipment (5.9%), clothing/footwear (3.8%), health (1.3%), and education (1.3%) (NSA, 2018a).

In 2009/10, around 6.4% and 6.7% of households in the Hardap Region were rated as poor (where 60% or more of the household's total consumption is spent on food) and severely poor (where 80% or more of the household consumption is spent on food), respectively (NSA, 2012). In 2015/16, NSA (2018a) indicated that there were very high levels of poverty (above the national average of 17.4 %) in the Kunene, Kavango East, Zambezi and Omaheke Regions. Lower levels of poverty were observed in the Khomas, Erongo and //Karas Regions. The distribution of severely poor households across the country (poverty rate above the national average of 10.7%) was highly concentrated in the Kunene, Kavango East, Zambezi and Omaheke Regions. Lower levels of severely poor households were found in the Khomas and Erongo Regions.

In Maltahöhe (2020 figures), and out of 288 persons, 65.3% earned more than N$1,201, 24.3% of persons earned between N$100 and N$600, and 10.4% of persons earned between N$601 and N$1,200 (assumed to be per month); heads of households earned N$1,003.6 on average, and the average household income amounted to N$1,085.5 (Socio-Economic Survey data, October 2020).

In 2020, the COVID-19 pandemic pushed around 200,000 more people into poverty; an estimated 1.6 million people in Namibia were living in poverty. In 2022, around 773,463 people received social grants funded by a budget of N$5,4 billion meant for social safety net programmes (Petersen, 2022a).

In September 2023, Van Rooi and Kooper reported: i) 618,000 Namibians are surviving on social grants; ii) 461,829 pupils receive food from a feeding programme; iii) between July and September 2023, at least 579,000 people in Namibia experienced food insecurity; a projected amount of 695,000 would face food insecurity between October 2023 and March 2024; iv) in 2022, more than 6,700 children under five were submitted to hospitals with severe acute malnutrition; v) 43% of the Namibian population is experiencing multidimensional poverty; and vi) Namibia is the second most unequal country in the world.

3.3.4 Housing

In the Daweb constituency (*2011 statistics*), 60.8% of households lived in detached houses, 19.9% lived in improvised housing (shacks), and 8.0% of households lived in semi-detached houses (NSA, 2014b).

In 2016, an estimated 52.8% of households in the Hardap Region lived in improvised housing (shacks); 37.5% of households lived in detached/semi-detached houses, 5.1% lived in single quarters, 3.7% lived in apartments/flats, and 0.8% of households lived in "other" (NSA, 2017a).

In 2020, 98.6% of people in Maltahöhe lived in self-built houses, and 1.4% of people rented accommodation (out of 491 people interviewed). Shelter material included: 99.4% corrugated iron; and 0.6% traditional material (Socio-Economic Survey data, October 2020).

In 2021, Honourable Reverend April noted that his Office has worked closely with the Shack Dwellers Federation, the National Housing Action Group, and the Mobile Telecommunication Company Namibia (MTC), to fast-track access to land and low-cost housing. Altogether 87 houses were constructed in the 2020/21 financial year; 24 houses were constructed in Maltahöhe (Daweb Constituency) (April, 2021). In the 2021/22 financial year, 24 out of the targeted 26 houses (92,3%) were constructed under the Shack Dwellers program in Maltahöhe (April, 2022).

3.3.5 Information and Communication Technology

In 2011, 71.8% of the population in the Hardap Region had access to a radio, i.e. the most widespread means of communication in Namibia. Only 36.9% of rural households had access to a TV, compared to 74.9% in the urban areas (NSA, 2014a). In 2016, 76.4% of people older than 15 years in the Hardap Region owned a mobile phone and 8.8% of people older than 15 years used his/her own computer or laptop (in the last three months) (83.3% of people did not use any computer or laptop). At the time, and in the last three months, 88.1% of people older than 15 years did no use the internet, 5.4% used the internet on their own mobile phone, 3.7% used it on their mobile phone/computer/laptop/tablet, and 2.8% used the internet on a computer/laptop/tablet (NSA, 2017a).

3.3.6 Access to Services

<u>Water</u>

During 2016, 97.6% of households in the Hardap Region had access to safe drinking water (NSA, 2017a).

In the Daweb constituency (*2011 statistics*), the majority of the households obtained their main source of water for cooking/drinking/households from piped water inside (34.8%), piped water outside (23.4%), boreholes with tank covered (21.0%), and public pipe (11.7%) (NSA, 2014b).

In 2020, 97.2% out of 464 people in Maltahöhe obtained their water from a communal tap/pre-paid, 1.5% from a private tap, and 1.3% of people obtained water from their own tap (Socio-Economic Survey data, October 2020).

In 2021/22, the Hardap Regional Council completed a water purification plant completed in Hoachanas Settlement, 47 erven were connected to the water and sewer systems in Klein Aub settlement, and the water pipeline in Schlip was upgraded (April, 2022).

<u>Energy</u>

In 2011, the majority of households in the Daweb constituency (59.4%) prepared their food using wood/charcoal from wood; the remainder of the households made use of electricity from the main grid (22.3%) and gas (16.5%) to cook their food.

Energy for lighting was mainly obtained through using candles (49.8%) and electricity from the main grid (34.5%) (NSA, 2014b).

In Maltahöhe (2020 figures), sources of energy included: firewood (47.6%); candles (32.9%); electricity (13.4%); gas (5.2%); and paraffin (0.9%) (849 persons were interviewed) (Socio-Economic Survey data, October 2020).

Sanitation
In 2016, 44.0% of households in the Hardap Region had no toilet facility (NSA, 2017a).

In the Daweb constituency (*2011 statistics*), 46.9% of households had no toilet facility, 35.1% had access to private/shared flush toilets (connected to a sewer), 14.2% had access to private/shared flush toilets (connected to a septic/cesspool), 1.1% and 1.6% had access to pit latrines with ventilation pipes and covered pit latrines without ventilation pipes, 0.6% of households had access to uncovered pit latrines without a ventilation pipes, and 0.5% had access to bucket toilets (NSA, 2014b).

In 2020, 98.7% out of 460 people in Maltahöhe used the bush (as toilet), and only 1.3% of people had access to flush toilets (Socio-Economic Survey data, October 2020).

Waste Disposal
In 2016, the most common means of disposing garbage in the Hardap Region was regular collection (39.7%), followed by burning (24.6%), rubbish pit (23.5%), and roadside dumping (6.7%) (NSA, 2017a).

Health Care
The Hardap Regional Health Directorate has the following facilities: one Hospital; three Health Centres (in Rehoboth, Aranos and Maltahohe), and 12 Primary Health Care Clinics (see http://154.0.193.136/web/mhss/hardap-region).

The following types of health problems were identified in Maltahöhe (2020 figures): other (40.0%); high blood pressure (25.0%); Tuberculosis (TB) (22.5%); infections/colds (7.5%); and diarrhoea (5.0%) (Socio-Economic Survey data, October 2020).

Education
There is one Primary School in Maltahöhe, the Rev. P. A Schmidt Primary School (see https://www.facebook.com/PASchmidt2020/). The Secondary School, Daweb, offers education up to Grade 11 only (see https://www.arideden.org/community/education-support/dabeb-school-maltahoehe).

There are 68 Early Childhood Development (ECD) centres in the Hardap Region; 1,724 children were enrolled at ECDs during 2021/22 (April, 2022). During the 2020/21 financial year, five million (assumed N$) was received from the Community Empowerment Division, European Union, to construct three ECDs, that is in the Aranos, Daweb, and Rehoboth Urban East Constituencies (April, 2021).

Six (6) schools are offering Advanced Subsidiary in the Region namely: Dr Lemmer Secondary School; M&K Gertze Technical School; Mariental Secondary School; C //Oaseb Secondary School; Rooiduin Secondary School; and Rehoboth Secondary School (April, 2022).

The Kai //Ganaxab Vocational Training Centre, 12 km west outside Mariental, can train 300 students per annum and can also accommodate 160 students in the hostel (Klukowski, 2023).

3.3.7 Healthcare, HIV/AIDS, and TB

In Namibia, health services are, either private (serving 18% of the population with medical aid), or public (serving the remainder, i.e. 82%).

The private health sector consists of 844 private health facilities, 72% of the doctors, and a little less than 50% registered nurses.

Overall access to healthcare in Namibia is good; 76% of the population lives within a 10 km radius of a health facility. In the rural areas, on average, there are about 5,780 people per PHC (primary health care) clinic and 58,825 people per district hospital.

The Ministry of Health and Social Services (MHSS) is the manager and provider of public health services in Namibia. It operates a four-tiered health system, consisting of PHC sites, district hospitals, intermediate hospitals, and a referral hospital.

Clinics are staffed by nurses and pharmacy technicians or assistants; here, primary health care services for common diseases (e.g. HIV), syndromic management of Sexually Transmitted Infections (STIs), Antenatal Care (ANC), and HIV Counselling and Testing (HCT; performed by a clinic-based community counsellor), are provided. The latter (services) also encourages all women to enrol for HIV testing via the Prevention from Mother to Child Transmission (PMTCT) programme. Monitoring a Person Living with HIV (PLHIV) to find out when they should start receiving Antiretroviral Treatment (ART) can only be initiated by medical doctors.

Health centres are staffed by doctors, pharmacists and nurses. Should a patient require more care (vs what can be provided in a primary care setting), they are then referred to a district hospital, then an intermediate hospital (to see a specialist), and then to the Central Hospital in Windhoek (as needed) (Ashby Associates cc, 2014; Christians, 2020).

Human Immunodeficiency Virus and Tuberculosis

Data for this section were obtained from: the Surveillance Report of the 2016 National HIV Sentinel Survey (MHSS, 2016); the Namibia Population-Based HIV (Human Immunodeficiency Virus) Impact Assessment (NAMPHIA) (MHSS, 2018); the Namibia Tuberculosis Disease Prevalence Survey Report (MHSS, 2019); the Namibia Country Operational Plans (COPs) 2020, 2021 and 2022 Strategic Direction Summary (PEPFAR Namibia, 2020, 2021, 2022).

In 2016, the 13th and last National HIV Sentinel Survey (NHSS) (Surveillance Trends in HIV Prevalence among Pregnant Women Receiving Antenatal Care in Namibia between 1992 and 2016) was conducted in Namibia. The following was observed: i) Namibia's HIV/AIDS epidemic remains in a period of stabilisation with slow yet sustained decreases in HIV prevalence among pregnant women since 2004; ii) the highest HIV prevalence was observed at the north central and eastern sites and ranged above 20% to 33% (2016); there were no apparent differences in the observed HIV prevalence between pregnant women residing in urban areas vs pregnant women residing in rural areas; iii) the highest age-specific prevalence in Namibia was observed among pregnant women age 35-39 years (32.3%) and pregnant women age 45-49 years (31.6%); HIV prevalence was lowest among pregnant women age 20-24 years (10.2%); and pregnant women age 15-19 years (5.7%) (the continuing shift in peak HIV prevalence from younger to older age groups can be expected in a mature and stabilised generalised HIV epidemic); iv) the overall HIV prevalence among pregnant women age 15-24 years was 8.5% and is 3.5% higher than Namibia's 2015/16 National Strategic Framework (NSF) target of 5%; new HIV infections thus continue to occur among young women across Namibia at a rate that will sustain a generalised epidemic into the foreseeable future; v) the percent HIV prevalence among pregnant females between 15 and 24 years in age in Mariental (*closest town to the Project for which statistics are available*) declined from 9.4 (2012) to 6.0 (2016); in the age group 25 to 49, percent HIV prevalence among pregnant females in Mariental decreased from 20.5% (2010) to 16.5% (2014) and then increased to 17.9 (2016); and vi) 62.5% of all women who tested HIV positive during the 2016 NHSS were already on ART (Anti-retroviral Therapy) before the survey (vs 49.1% in 2014); this indicates a notable success of the ART and PMTCT (Prevention of Mother to Child Transmission) programmes (MHSS, 2016).

Between June and December 2017, the Namibia Population-Based HIV Impact Assessment (NAMPHIA), a cross-sectional household-based survey to assess the progress of Namibia's National HIV response, was carried out. NAMPHIA was led by the MHSS, with funding from PEPFAR (the U.S.A.'s President's Emergency Plan for AIDS Relief), and technical assistance through the U.S.A.'s Centers for Disease Control and Prevention (CDC). Key findings included: i) the annual incidence was 0.36% (i.e. around 4,500 new cases of HIV annually) for persons aged 15 to 64 years; in the age group 15-24 years, incidence was higher for females (0.99%) vs males (0.03%); ii) HIV prevalence was 12.6% among adults aged 15 to 64 years (i.e. approximately 176,000 persons living with HIV (PLHIV)), and 1.0% among children aged 0-14 years (i.e. 9,000 children living with HIV); iii) prevalence of Viral Load Suppression (VLS) among HIV-positive adults aged 15 to 64 years was 77.4%, showing that Namibia has surpassed the UNAIDS 90-90-90 target (*90% of all PLHIV will know their HIV status; 90% of all people with diagnosed HIV infection will receive sustained ART; and 90% of all people receiving ART will have viral suppression*) for VLS (73.0%); iv) HIV prevalence peaked at 30.0% among females aged 45-49 years vs 26.4% among males aged 50-54 years; HIV prevalence was higher in women than men throughout the reproductive years (15-49 years); v) HIV prevalence varies across the Regions, with the highest prevalence in the Zambezi (22.3%), Ohangwena (17.9%), Oshikoto (17.3%), Omusati (16.9%), and Oshana (15.8%) Regions and the lowest prevalence in the Kunene (7.6%); Khomas (8.3%), Omaheke (8.4%), Otjozondjupa (8.5%), and Hardap (9.3%) Regions; vi) Namibia's HIV interventions have resulted in excellent progress towards the UNAIDS' targets; women in Namibia have achieved the UNAIDS 90-90-90 goals (*90% of all PLHIV to know their status, 95% of all people diagnosed with HIV to receive sustained antiretroviral (ARV) therapy, and 90% of all people on treatment to have viral suppression*); vii) once diagnosed,

over 90% of both female and male PLHIV were linked to ART and were virally supressed (MHSS, 2018). In 2023, Namibia stood at 94-99-92 of the UNAIDS 95-95-95 cascade; the Country has set targets to reach 97-97-97 on the cascade by 2028 (Nghidenga and Naftal, 2023).

National data related to the HIV/AIDS epidemic in Namibia can be summarised as follows (see PEPFAR Namibia, 2020, 2021, 2022): i) HIV/AIDS remains the leading cause of death in Namibia (2019 figures from the Institute of Health Metrics and Evaluation (IHME)); in 2022, an estimated 3,165 people will have died of HIV/AIDS; ii) the highest estimated incidence can be found in the Khomas and six northern regions (i.e. areas with the highest population density); iii) people at high risk of HIV include: men who have sex with men (MSM); female sex workers (FSW); and transgender women (TGW); iv) an estimated 0.77% of female and male children <15 years of age are infected with HIV; prevalence amongst people aged 15-24 was estimated at 7.21% for females and 3.67% for males; in the age group 25+ HIV prevalence was estimated at 19.16% for females and 13.46% for males; v) approximately 215,889 persons in Namibia are living with HIV (PLHIV); of these 7,217 (3.34%) are in the age group <15 years, 26,357 (12.20%) are in the age group 15-24 years, and 182,314 (84.45%) persons are in the age group 25+ years; vi) the highest proportion of the estimated new infections (5,940 in 2022) is amongst females aged 25 and above (33.1%) (vs 23.8% for males in the age group 25 and above); and vii) Tuberculosis (TB) (see below) is the number one killer of people living with HIV; in 2020 Namibia reported 6,537 cases (57% male, 33% female, and 10% children) and a co-infection rate of about 32% (2019; possibly an underestimate).

The 2018 Tuberculosis Disease Prevalence Survey (DPS) Report showed: i) Namibia ranked ninth highest in the estimated incidence rate of TB in the world after South Africa, Lesotho and Kiribati (the top three) (World Health Organization (WHO), 2017; see MHSS, 2019); ii) the estimated incidence of TB in Namibia has been on the decline between 2004 and 2016; iii) Namibia did not reach the Millennium Development Goals (MDGs) and Stop TB target of reducing incidence by 50% relative to the 1990 levels; Namibia has since adopted the End TB Strategy as well as the Sustainable Development Goals (SDGs); iv) CNRs (Case Notification Rates) ranked highest in the Omaheke Region and lowest in the Omusati Region; however, Khomas Region had the largest absolute number of TB cases, as expected from its total population; v) of the 8,575 new and relapse TB notifications in 2017, 812 (9%) were children under the age of 15 years; vi) the epidemic is significantly skewed towards males from the age of 25 years and above; vii) adults 15-44 years are at higher risk (with a higher CNR for the specified age group); viii) the estimated HIV prevalence rate for the general population aged 15-64 years was 12.6% in 2017; HIV prevalence among TB patients peaked at 67% in 2006 gradually reducing to 36% in 2017; ix) in 2008/09, a Multi Drug Resistant-TB (MDR-TB) prevalence of 3.8% (among patients newly diagnosed with TB) and 16.5% (in patients previously treated for TB) was observed; in 2014/15 the prevalence of MDR-TB was 3.9% and 9.2% in patients newly diagnosed with TB and previously treated for TB, respectively; in 2017, Namibia reported 417 confirmed DR-TB cases (MHSS, 2019).

3.3.8 Gender

Legislation that promotes equal gender participation in all aspects of Namibian society includes: i) Articles 10 and 23(3) of the Constitution of the Republic of Namibia 1990; ii) Affirmative Action (Employment) Act 29 of 1998; and iii) National Gender Policy (2010 – 2020).

During the 2021/22 financial year, the following activities with regards to *Gender Equality and Woman Empowerment* took place in the Hardap Region: i) the establishment of Local Gender Permanent Task Force Committees; ii) stakeholder training for Church Leaders in all Constituencies; and iii) Male Engagement Training and Boys sensitised on GBV (Gender-based Violence). As far as *Gender Equality, Poverty Eradication, and Social Welfare* are concerned, the following was achieved (2021/22): i) Generating Activities (IGA) equipment and material were handed over to six beneficiaries in four constituencies (Daweb, Mariental Urban, Rehoboth East and West) for the amount of N$77,000; and ii) in Mariental, the House of Safety (Safe House) is now fully operational and two caregivers have since been recruited (April, 2022).

4 Regulatory Framework

The most pertinent legislation (Ruppel and Ruppel-Schlichting, 2022; and Legal Assistance Centre (LAC), 2023a, b), with the aim of informing the Gusinde Von Wietersheim Successors Trust of the legal requirements pertaining to the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, is listed in Table 4.

Note that, at present, there is no legislation in Namibia that specifically addresses alien invasive species (Nanyeni, 2023; see Kolberg, 2024).

An invasive aliens management programme, including the drafting of legislation, is currently being established by the Namibian Invasive Alien Species Working Group (https://n-c-e.org/namibian-invasive-alien-species-working-group), chaired by the Directorate of Forestry, Ministry of Environment, Forestry and Tourism (MEFT) and comprising members from a wide spectrum of stakeholder groups.
In the meantime, Namibian authorities lean on the experience of other countries like South Africa and Australia, which have similar environments, have severe infestations from alien invasive species, and have made great progress in managing these, including through legislation (see Kolberg, 2024).

Table 4: Regulatory framework for the *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia.

National Law
Acts of Parliament, Regulations, Ordinances, Proclamations
The Constitution of the Republic of Namibia 1990 (and First Amendment Act 34 of 1998, Second Amendment Act 7 of 2010, and Third Amendment Act 8 of 2014)
Employees' Compensation Act 30 of 1941 (as amended in South Africa prior to Namibian independence) (Amendment Act 5 of 1995 amends the Act substantially and changes its name from the Workmen's Compensation Act to the Employees' Compensation Act) (and the General Regulations 1961 (as amended))
Bonemeal and Superphosphates Control Proclamation 37 of 1944 (as amended by Proclamation 33 of 1947)
Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947 (as amended in South Africa to March 1978) (and amendments: Fertilizers, Farm Feeds, Seeds and Remedies Amendment Act 48 of 1950; Seeds Act 28 of 1961; Fertilizers, Farm Feeds and Remedies Amendment Act 60 of 1970; Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Amendment Act 17 of 1972; and Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Amendment Act 24 of 1977) (pre-independence regulations which appear to remain in force include: Regulations on returns to be rendered by manufacturers of fertilizers 1951; Regulations on returns by manufacturers and importers of farm feeds and prohibitions in connection with farm feeds of animal origin 1955 (as amended in1956); Regulations on the registration and sale of agricultural remedies 1951; Regulations relating to the registration and sale of stock remedies 1971 (and amendments); Regulations relating to the registration, importation, manufacture, movement and sale of farm feeds and the registration of sterilizing plants 1973 (and amendments); Regulations relating to the registration and sale of fertilizers 1977 (and amendments); Regulations relating to farm feeds 1980 (and 1981 amendment); Regulations relating to agricultural remedies 1981 (and 1983 amendment); Regulations relating to the registration of fertilizers, farm feeds, agricultural remedies, stock remedies, sterilising plants and pest control operators, appeals and imports 1983 (and amendments); and post-independence regulations 2007)
Weeds Ordinance 19 of 1957
Soil Conservation Act 76 of 1969 (as amended in South Africa to March 1978)
Hazardous Substance Ordinance 14 of 1974 (and the General Regulations 1979; no post-independence regulations have been promulgated)
International Health Regulations Act 28 of 1974 (as amended to December 1977); the International Health Regulations were replaced in turn by the International Health Regulations, 2005, which entered into force internationally on 15 June 2007 (*Source: World Health Organisation (WHO)*). Namibia is bound by these 2005 Regulations from that date in accordance with Articles 21(a) and 22 of the WHO Constitution.
Nature Conservation Ordinance 4 of 1975 (and the Regulations Relating to Nature Conservation 1976 and the amended Regulations)
Atmospheric Pollution Prevention Ordinance 11 of 1976 (Regulations are authorised by several sections of the Act; no post-independence regulations have been promulgated)
Petroleum Products and Energy Act 13 of 1990 (as amended by the Petroleum Products and Energy Amendment Act 29 of 1994, Act 3 of 2000, and Act 16 of 2003) (and the Regulations relating to the purchase, sale, supply, acquisition, possession, disposal, storage, transportation, recovery and re-refinement of used mineral oil 1991, Petroleum Products Regulations 2000 (amended in 2002 and 2016), Regulations for arbitration procedures 2003, Regulations on funding of approved agencies 2004 (withdrawn 2005) (GN 247/2013 purports to amend the regulations in GN 230/2004, leaving the correct text of these regulations uncertain), and the Regulations relating to the reselling price of petrol and petrol products (issued frequently, with each one revoking or replacing the previous one)
Foreign Investment Act 27 of 1990 (and amendment Act 24 of 1993) (and the Regulations 1992)

Agronomic Industry Act 20 of 1992 (as amended by the State-owned Enterprises Governance Act 2 of 2006/Public Enterprises Governance Act 2 of 2006)
Regional Councils Act 22 of 1992 (and Amendment Acts 17 of 1997, 30 of 2000, 12 of 2002, 12 of 2010, 16 of 2010, and 7 of 2017) (and the Regulations: Commercialisation Regulations 2001; Joint Business Venture Regulations 2001; and Tender Board Regulations 2001)
Local Authorities Act 23 of 1992 (and amendments) (and the Model Pound Regulations 1994, the Model Electricity Supply Regulations 1996, Model Water Supply Regulations 1996, Model Sewerage and Drainage Regulations 1996, Model Regulations for the Control of Dogs in Local Authority Areas 2008, Commercialisation Regulations 2001 (amended in 2007), Joint Business Venture Regulations 2001 (amended in 2007), and Tender Board Regulations 2001 (replaced in 2011), and Recruitment and Selection Regulations for Local Authority Councils 2019)
Namibian Ports Authority Act 2 of 1994 (as amended by the National Transport Services Holding Company Act 28 of 1998, the Namibian Ports Authority Amendment Act 12 of 2000, and the State-owned Enterprises Governance Act 2 of 2006) (and the Port Regulations 2001) & Environmental Management Plan for the Operations of the Operations of the Commercial Harbour: Port of Walvis Bay (Faul *et al*., 2019).
Social Security Act 34 of 1994 (as amended by the State-owned Enterprises Governance Act 2 of 2006/ Public Enterprises Governance Act 2 of 2006, and the Labour Act 11 of 2007 (and the General Regulations 1995, and amendments))
Affirmative Action (Employment) Act 29 of 1998 (as amended by Act 6 of 2007 and the Labour Act 11 of 2007) (and the General Regulations 1999)
Road Traffic and Transport Act 22 of 1999 (as amended by the Road Traffic and Transport Amendment Act 6 of 2008) (and the Road Traffic and Transport Regulations 2001)
Forest Act 12 of 2001 (as amended by the Forest Amendment Act 13 of 2005) (and the Forest Regulations 2015)
Electricity Act 4 of 2007 (and the Electricity Regulations: Technical 2004, the Electricity Regulations: Administrative 2011, and the Namibian Electricity Safety Code 2011 (amended 2012))
Environmental Management Act 7 of 2007 (and the Environmental Impact Assessment Regulations 2012)
Labour Act 11 of 2007 (and the Labour Amendment Act 2 of 2012) (and the Regulations relating to the Health and Safety of Employees at Work 1997, the Labour General Regulations 2008, and the Regulations relating to Domestic Workers 2017)
Plant Quarantine Act 7 of 2008 (and the Regulations relating to import and export permits, examination of imported plants, diseases or insects, and appeals 2012)
Tobacco Products Control Act 1 of 2010 (and the Regulations 2014)
Water Resources Management Act 11 of 2013 and the Water Resources Management Regulations 2023
Public and Environmental Health Act 1 of 2015 (and section 20(1) of the National Health Act 2 of 2015) (and the Public Health Covid-19 General Regulations 2021) (and amendments)
Policies, Guidelines, National Strategies & Action Plans
Policies
Conservation of Biotic Diversity and Habitat Protection 1994
National Drought Policy & Strategy 1997
Namibia: National Code on HIV/AIDS in Employment 2000
National Water Policy White Paper - Policy Framework for Equitable, Efficient, and Sustainable Water Resources Management and Water Services 2000
National Policy on HIV/AIDS 2007
Water Supply and Sanitation Policy (WSASP) 2008
National Gender Policy 2010 - 2020
National Health Policy Framework 2010-2020 - “towards quality health and social welfare services”
National Policy on Climate Change for Namibia 2011
National Rangeland Management Policy and Strategy 2012
Namibia Agriculture Policy 2015
Guidelines
Petroleum Products Regulations, 2000 Guidelines for Consumer Installations
(Updated) Forestry and Environmental Authorizations Process for Bush Harvesting Projects 2017
Standard Operational Procedures (SOPs) for importation of agronomic and horticulture products, SOP for exportation of agronomic and horticulture products; and SOP for transit of agronomic and horticulture products
National Strategies & Action Plans
Namibia’s Green Plan 1992
Vision 2030 2004
Integrated Water Resource Management Plan 2010
National Climate Change Strategy & Action Plan (2013 – 2020)
Namibia’s Second National Biodiversity Strategy and Action Plan (NBSAP 2) (2013 – 2022)
Third National Action Programme for Namibia to Implement the United Nations Convention to Combat Desertification (2014 – 2024)
Namibia’s 5th National Development Plan (NDP5) – Working together towards prosperity (2017/18 – 2021/22) (*consultation for NDP6 is underway; Fostering Recovery, Inclusiveness and Resilience for Quality and Sustainable Development, 2025/6 – 2030/31*)
National Solid Waste Management Strategy 2018

Town Planning Schemes, Structure Plans, & Land Use Plans
N/A
Strategic Environmental Assessments (SEAs)
N/A
International Law
African Union (AU)
African Charter on Human and Peoples' Rights (Banjul Charter) 1981 and the Protocol to the African Charter for Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol) 2003
Constitutive Act of the African Union 2000 (and Protocol relating to the Establishment of the Peace and Security Council of the African Union, 2002)
Convention of the African Energy Commission 2001
African Convention on the Conservation of Nature and Natural Resources (Revised Version) 2003 (not yet binding)
Agreement for the Establishment of the Africa Institute for the Environmentally Sound Management of Hazardous and Other Wastes Agreement 2004
Charter Establishing the Centre for Coordination of Agricultural Research and Development (CCARDESA) 2010
African Road Safety Charter 2016 (not yet binding)
Southern African Development Community (SADC)
Treaty of the Southern African Development Community (SADC) 1992 (and six amendments: Agreement Amending the Treaty 2001; Agreement Amending Article 22 of the Treaty 2007; Agreement Amending the Treaty 2008; Agreement Amending the Treaty 2009 (DES); Agreement Amending the Treaty 2009 (ORGAN); and Agreement Amending the Treaty 2015) (and Protocol to the Treaty establishing SADC on Immunities and Privileges 1992)
SADC Protocol on Energy 1996
SADC Protocol on Health 1999
SADC Protocol on Wildlife Conservation and Law Enforcement 1999
SADC Protocol on Forestry 2002
Charter of Fundamental Social Rights in SADC 2003
SADC Protocol on Gender and Development 2008 (and an Agreement Amending the SADC Protocol on Gender and Development 2016)
SADC Protocol on Environmental Management for Sustainable Development 2014 (not yet binding)
SADC Protocol on Employment and Labour 2014 (not yet binding)
United Nations (UN) / International Conventions
Constitution of the International Labour Organization (ILO) 1919 (as amended), and *Instrument of Amendment of the ILO Constitution, 1986 (not yet binding), and the Instrument of Amendment of the ILO Constitution 1997
Constitution of the United Nations Educational, Scientific and Cultural Organization (UNESCO) 1945
Constitution of the Food and Agriculture Organization of the United Nations (FAO) 1945
Constitution of the World Health Organization (WHO) 1946 (and *Amendment to Article 7 of the Constitution of the World Health Organization 1965 (not yet binding); *Amendment to Article 74 of the Constitution of the World Health Organization 1978 (not yet binding); Amendments to Articles 24 and 25 of the Constitution of the World Health Organization 1986; and Amendments to Articles 24 and 25 of the Constitution of the World Health Organization 1998)
Geneva Convention on Road Traffic 1949
International Plant Protection Convention 1951 (as revised in 1979 and 1997)
ILO Convention concerning Discrimination in Respect of Employment and Occupation (No. 111) 1958 (and including the Forced Labour Convention 1930 (No. 29); Abolition of Forced Labour Convention 1957 (No. 105); Freedom of Association and Protection of the Right to Organise Convention 1948 (No. 87); Right to Organise and Collective Bargaining Convention, 1949 (No. 98); Equal Remuneration Convention 1951 (No. 100); Discrimination (Employment and Occupation) Convention 1958 (No. 111); Minimum Age Convention 1973 (No. 138); and Worst Forms of Child Labour Convention 1999 (No. 182))
International Convention on the Elimination of All Forms of Racial Discrimination 1966
International Covenant on Civil and Political Rights (ICCPR) 1966 (and the Optional Protocol to the International Covenant on Civil and Political Rights 1966 and the Second Optional Protocol to the International Covenant on Civil and Political Rights, aiming at the Abolition of the Death Penalty 1989)
International Covenant on Economic, Social and Cultural Rights (ICESCR) 1966
Agreement Establishing the International Fund for Agricultural Development 1976
Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) 1979 and the Optional Protocol to the Convention on the Elimination of all Forms of Discrimination against Women 1999
Vienna Convention for the Protection of the Ozone Layer 1985 and the Montreal Protocol on Substances that Deplete the Ozone Layer 1987 (and Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Second Meeting of the Parties at London on 29 June 1990 (London Amendment); Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Fourth Meeting of the Parties at Copenhagen on 25 November 1992 (Copenhagen Amendment); Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Ninth Meeting of the Parties at Montreal on 17 September 1997 (Montreal Amendment); Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Eleventh Meeting of the Parties at Beijing on 3 December 1999 (Beijing Amendment); and Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, adopted by the Twenty-Eighth Meeting of the Parties at Kigali from 10 to 15 October 2016 (Kigali Amendment))

Convention on Biological Diversity (Biodiversity Convention) 1992, the Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Montreal 2000, and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity 2010
United Nations Framework Convention on Climate Change (UNFCCC) 1992, the Kyoto Protocol to the UN Framework Convention on Climate Change 1997 (and the not yet binding Doha Amendment to the Kyoto Protocol to the United Nations Framework Convention on Climate Change 2012), and the Paris Agreement 2015
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa 1994
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention) 1998 (with Annexes as amended)
International Treaty on Plant Genetic Resources for Food and Agriculture 2001
Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention) 2001 (and amendments)
WHO Framework Convention on Tobacco Control (WHO FCTC) 2003
Convention on the Protection and Promotion of the Diversity of Cultural Expressions 2005
Statute of the International Renewable Energy Agency (IRENA) 2009
Framework Agreement on the establishment of the International Solar Alliance (ISA) 2016
International Best Practice
International Finance Corporation (IFC) Environmental Health and Safety (EHS) Guidelines 2007 and the EHS Guidelines for Food and Beverage Processing 2007

5 Stakeholder and Public Consultation

5.1 Objectives

The purpose of Public Participation is to provide stakeholders, including the public, an opportunity to participate in the Environmental Assessment Process, in order to ensure that the intended development initiatives consider broad-based concerns. It further improves governance in that the intended development must consider a wide range of issues, e.g. the need to conserve the natural environment and the need to maintain a functioning ecology.

5.2 Consultation Process

Communication with stakeholders re the *Opuntia ficus-indica* Irrigation Project was facilitated through the following methods:

- Key stakeholders were identified from contacts of the Project Team (see Annexure D: List of Interested and Affected Parties (I&APs) Consulted);
- Written notices were sent via e-mail on 27 February 2024 to: the Office of the Governor Hardap Regional Council; the Office of the Acting Chief Regional Officer; the Councillor: Daweb Constituency; the Acting Chief Executive Officer (CEO) and Councillor, Maltahöhe Village Council; the Executive Director, Ministry of Agriculture, Water and Land Reform (MAWLR); the Executive Director and Director: Energy, Ministry of Mines and Energy (MME); the Acting Deputy Executive Director, Department of Land Reform, Resettlement and Regional Program and the Director: Land Reform, Directorate Land Reform, MAWLR (Resettlement Farms: Farm Halifax 113; Farm Grootplaas 95; Farm Christiania No. 44; Farm Daweb 43 and Farm Namseb Portion A); and the surrounding Farm /Owners (Farm Gluckauf 34; Farm Marion Reitz 25; Farm Karab 23; and Farm Nutupsdrift 112) (see Annexure D: List of I&APs Consulted, Notification Letter, and Correspondence with I&APs);
- Written notices were hand-delivered on 28 February 2024 to: the Senior Administrative Officer, Daweb Constituency Office; the Regional Councillor, Daweb Constituency; and the Acting CEO, Maltahöhe Village Council;
- Two laminated notices (with the Notice of the Environmental Assessment Process) were put up at the Daweb Constituency Office and Maltahöhe Village Council (28 February 2024); a copy of the written notice was put up at Agra Maltahöhe (28 February 2024) (see Annexure D: Notices Displayed);
- Advertisements (Notice of an Environmental Assessment Process) were placed in the Market Watch Section of three National newspapers, Republikein, Namibian Sun, and Allgemeine Zeitung on 28 February 2024 and 06 March 2024 (see Annexure D: Advertisements);
- The notices/posters, written notice, and advertisements provided details re the application; stated also was that the application was submitted to the Executive Director, MAWLR in terms of the EIA Regulations: EMA 7 of 2007, the nature and location of the proposed Project/Activities, and where, how and from whom additional information on the application/activity could be obtained;
- A courtesy meeting was arranged to be held with the Acting CEO, Maltahöhe Village Council (and attended by Mr Guido von Wietersheim and Dr Lima Maartens, LM Environmental Consulting) on 28 February 2024; the meeting was also attended by Me Swartbooi, Me Skrywer, Mr Böck, Mr Simon, and Me Ndeunyema (see Annexure D: Register of I&APs);
- A register of I&APs was opened (see Annexure D: Register of I&APs; also see Annexure D: Correspondence with I&APs);
- An electronic copy of the *Draft* Environmental Assessment Report was made available via e-mail to the registered I&APs (and the relevant Authorities) for comment (08 July 2024) (see Annexure D: Correspondence with I&APs); and
- The 14-day comment period commenced on 09 July 2024 and ended on 26 July 2024; no comments were received (see Annexure D: Correspondence with I&APs).

5.3 Summary of Issues and/or Concerns

A summary of the issues/concerns raised during the Public Consultation Process and the measures taken to address these issues, is provided in Table 5.

Table 5: A summary of the issues/concerns and measures taken to address these issues during the Environmental Assessment Process.

Issue/Concern	Response
Fruit and seeds of ficus indica are eaten and spread by birds and can not be stopped by electric fences.	See Sections 2.4.5, 6.3 and 7.4
Glochids are not harmless and need a lot of equipment for eyes and skin. They prevent useful fodder production.	See Sections 2.4.3, 2.4.5, 6.3 and 7.4
Cochineal insects and Cactoblastis cactorum are present in Namibia to prevent invasiveness.	See Sections 2.4.1, 6.3, 7.4, 7.5
According to law of heritage a share of descendants produces spines again and being invasive result in tremendous costs for others to be cleared.	See Section 2.4.2
Namibia must be very careful not to loose out ''grass fed meat'' status for export.	The comment is noted
Shallow root systems of cacti prevent rainwater from reaching the roots of Namibian vegetation.	Only around 500 ha of the 12,000 ha farm will be utilised; also see Sections 3.1.3 and 3.2.1

6 Environmental Impact Assessment

6.1 Introduction

Certain aspects related to the Gusinde Von Wietersheim Successors Trust's proposed activities may cause potential impacts to the environment. These impacts can occur under normal conditions, but also under abnormal and potential emergency conditions (e.g. fires (unlikely), flooding, explosions (unlikely), spills, and any accidents/incidents/near-misses (causing uncontrolled releases to air, water and land).

Aspect is defined by the International Organization for Standardization ISO 14001:2004 as an "element of an organization's activities or products or services that can interact with the environment"; *environment* is defined as "surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation" and *impact* is defined as "any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects."

Management actions (i.e. the adoption of the "mitigation hierarchy", and including monitoring), with the aim of avoiding, minimising, or compensating/offset the potential negative impacts (and maximising the potential positive impacts), are provided in the Environmental Management Plan (EMP) (see Section 7).

6.2 Methodology

The Rapid Impact Assessment Matrix (RIAM) Software Package (Pastakia, 1998) was used for the assessment of the potential impacts. Scoring takes place within a matrix, the latter that was designed to allow subjective judgements to be quantitatively recorded. The system thus provides an impact evaluation, as well as a record that can be re-assessed in the future (e.g. should more information become available).

First, through the process of scoping, specific assessment/environmental components, falling into four categories, needs to be defined:

Physical/Chemical (PC)	"all physical and chemical aspects of the environment, including finite (non-biological) natural resources, and degradation of the physical environment by pollution"
Biological/Ecological (BE)	"all biological aspects of the environment, including renewable natural resources, conservation of biodiversity, species interactions, and pollution of the biosphere"
Sociological/Cultural (SC)	"all human aspects of the environment, including social issues affecting individuals and communities; together with cultural aspects, including conservation of heritage, and human development"
Economic/Operational (EO)	"the economic consequences of environmental change, both temporary and permanent, as well as the complexities of project management within the context of the project activities"

Second, the impacts are scored using certain assessment criteria and scales.

The assessment criteria fall into two groups:	
A	These criteria are of importance to the condition
B	These criteria are of value to the situation
The assessment scales are as follows:	
Group A – Importance of condition (A1)	
4	Important to national/international interests
3	Important to regional/national interests
2	Important to areas immediately outside the local condition
1	Important only to the local condition
0	No importance
Group A - Magnitude of change/effect (A2)	
+3	Major positive benefit
+2	Significant improvement in status quo
+1	Improvement in status quo
0	No change/status quo
-1	Negative change to status quo
-2	Significant negative dis-benefit or change
-3	Major dis-benefit or change
Group B - Permanence (B1)	
1	No change/not applicable
2	Temporary
3	Permanent
Group B - Reversibility (B2)	
1	No change/not applicable
2	Reversible
3	Irreversible
Group C - Cumulative (B3)	
1	No change/not applicable
2	Non-cumulative/single
3	Cumulative/synergistic

Third, by means of a series of formulae, a value is ascribed to each of the groups of criteria. The use of a multiplier for Group A is important for it ensures that the weight of each score is expressed. Scores for Group B are added together, ensuring that the individual value scores cannot influence the overall score, but that the collective importance of all values in Group B is fully taken into account. The sum of the Group B scores is then multiplied by the result of the Group A scores and a final environmental (assessment) score (ES) for the condition is obtained:

$$(a1) \times (a2) = aT$$
$$(b1) + (b2) + (b3) = bT$$
$$(aT) \times (bT) = ES$$

where
(a1) and (a2) are the individual criteria scores for Group A
(b1) to (b3) are the individual criteria scores for Group B
aT is the result of multiplication of all Group A scores
bT is the result of summation of all Group B scores
ES is the environmental score for the condition

Finally, a matrix is produced for each project option and individual ES scores calculated and recorded. These individual ES scores are then banded together into ranges (Range Values (RV)) (see Table 6). For ease of

interpretation, significant and major positive impacts are indicated in green and significant and major negative impacts in red.

Table 6: The range bands used for the Rapid Impact Assessment Matrix (*Source: Pastakia, 1998*).

Environmental Score (ES)	Range Value (RV) (Alphabetic)	Range Value (RV) (Numeric)	Description of Range Band
72 - 108	E	5	Major positive change/impact
36 - 71	D	4	Significant positive change/impact
19 - 35	C	3	Moderate positive change/impact
10 – 18	B	2	Positive change/impact
1 - 9	A	1	Slight positive change/impact
0	N	0	No change/status quo/not applicable
-1 - -9	-A	-1	Slight negative change/impact
-10 - -18	-B	-2	Negative change/impact
-19 - -35	-C	-3	Moderate negative change/impact
-36 - -71	-D	-4	Significant negative change/impact
-72 - -108	-E	-5	Major negative change/impact

The lower limits of 'significant change', for example, can be taken as the point when a condition is outside local boundaries (A1 = 2), but is of major importance (A2 = 3), yet is temporary (B1 = 2) and reversible (B2 = 2), and non-cumulative (B3 = 2). A 'major change' can be taken as the point when the condition extends to a regional/national boundary (A1 = 3), is of major importance (A2 = 3), is permanent (B1 = 3) and irreversible (B2 = 3), and non-cumulative (B3 = 2) (Pastakia, 1998).

6.3 Opuntia ficus-indica Irrigation Project and Associated Activities

The various aspects and the potential related impacts per environmental component (PC, BE, SC and EO) for the Gusinde Von Wietersheim Successors Trust's proposed activities are summarised in Table 7.

Note that the RIAM does not include an assessment scale for Probability of Occurrence; the following scale was used to rate (the probability of occurrence of) the various impacts and the results are included in Table 7.

Probability of Occurrence	
Definite	Impact will occur
Highly probable	Impact is most likely to occur
Probable	Distinct possibility that the impact will occur
Low	Possibility of impact occurring is low

Table 7: The potential impacts, and probability of occurrence, that certain aspects related to the Gusinde Von Wietersheim Successors Trust's proposed activities may have on the environment (*PC = Physical/chemical; BE = Biological/ecological; SC = Sociological/cultural; and EO = Economic/operational*).

Impact Code	Potential Impact	Activity/Aspect	Probability of Occurrence
PC 1	Decreasing groundwater levels (abstraction of groundwater)	Abstraction of groundwater for irrigation of *Opuntia ficus-indica* orchard	Probable
PC 2	Contamination of soil and groundwater (irrigation return flow)	Excess irrigation of *Opuntia ficus-indica* orchard and infiltration of water with fertilizer and biocide input	Probable
PC 3	Salinisation of soil and infiltration of high salinity water to the underlying aquifer	Excess irrigation of *Opuntia ficus-indica orchard* and leaching of accumulated salts in the soil due to evaporation	Highly Probable
PC 4	Occupational and community health (use of groundwater for drinking)	Use of groundwater for drinking	Low
PC 5	Contamination of soil (and groundwater) (spills of hazardous materials)	Hazardous materials management (spills of fuel / oil / grease / chemicals / paint)	Highly probable
PC 6	Contamination of soil (and groundwater) (liquid and solid waste disposal)	Waste management (liquid and solid waste disposal)	Highly Probable
PC 7	Contamination of surface/runoff water during precipitation events (liquid and solid waste disposal)	Waste management (liquid and solid waste disposal)	Probable
PC 8	Contribution to scientific knowledge (hydrogeology)	Specialist study (hydrogeology)	Definite
PC 9	Reduction in Greenhouse Gasses (GHGs) (solar power)	Use of renewable energy (solar power)	Definite
PC 10	Air Quality (gaseous emissions) (transport of raw materials)	Presence of vehicles/trucks on roads (transport of raw materials)	Definite
PC 11	Air Quality (dust or Particulate Matter (PM) pollution and gaseous emissions) (transport of staff)	Presence of vehicles on gravel roads (transport of staff)	Definite
PC 12	Air Quality (gaseous emissions) (transport of produce)	Presence of vehicles/trucks on roads (transport of produce)	Definite
PC 13	Large scale delivery of carbon units (*Opuntia ficus-indic*a orchard)	Operation of *Opuntia ficus-indica* orchard	Definite
BE 1	Disturbance of terrestrial fauna (e.g. reptiles) and avifauna (ground-nesting birds) (clearing of land)	Clearing of land (orchard development/ construction of infrastructure)	Definite
BE 2	Loss of terrestrial fauna (e.g. reptiles) and avifauna (ground-nesting birds) (clearing of land)	Clearing of land (orchard development/ construction of infrastructure)	Highly Probable
BE 3	Loss of flora (clearing of land)	Clearing of land (orchard development/ construction of infrastructure)	Definite
BE 4	Invasion of natural vegetation by *Opuntia ficus-indica* and disruption to ecosystem balance (spread and establishment of *Opuntia ficus-indica* outside the fenced area)	Orchard development and operation (spread and establishment of *Opuntia ficus-indica* outside the fenced area)	Probable
BE 5	Introduction of other invasive alien plant species which invade natural vegetation (use of machinery / disturbance of soil surface)	Orchard development and operation (use of machinery / disturbance of soil surface)	Probable
BE 6	Loss of fauna and/or flora or disruption to ecosystem balance (use of chemicals and spread to natural vegetation outside the fenced area)	Orchard development and operation (use of chemicals and spread (via wind or water) to natural vegetation outside the fenced area)	Low
BE 7	Salinisation of the soil (inappropriate irrigation / fertilizer application)	Operation of *Opuntia ficus-indic*a orchard (inappropriate irrigation / fertilizer application)	Highly Probable
BE 8	Invasion of natural vegetation by *Opuntia ficus-indica* and disruption to ecosystem balance (no or failure to implement the closure plan)	Lack of or failure to implement a closure plan	Low

Impact Code	Potential Impact	Activity/Aspect	Probability of Occurrence
BE 9	Loss of flora / habitat for fauna and avifauna (irrigation of crops and decreasing groundwater levels)	Irrigation of *Opuntia ficus-indica* orchard and decreasing groundwater levels	Probable
BE 10	Increased biodiversity (attraction of fauna and avifauna)	Operation of *Opuntia ficus-indica* orchard	Definite
BE 11	Negative aspects related to increased biodiversity	Operation of *Opuntia ficus-indica* orchard	Probable
BE 12	Contribution to scientific knowledge (vegetation)	Desktop vegetation specialist study (spineless *Opuntia ficus-indica* orchard and processing development)	Definite
SC 1	Visual impacts (presence of people/equipment/dust) (clearing of land for orchard development and infrastructure)	Presence of people/equipment/dust (clearing of land for orchard development and infrastructure)	Definite
SC 2	Visual impact (*Opuntia ficus-indica* orchard)	Presence of *Opuntia ficus-indica* orchard	Definite
SC 3	Noise pollution (presence of people/equipment) (clearing of land for orchard development and infrastructure)	Presence of people/equipment/dust (clearing of land for orchard development and infrastructure)	Definite
SC 4	Occupational and community safety (increased traffic during orchard development and construction of infrastructure)	Increased traffic on the national roads (orchard development and construction of infrastructure)	Definite
SC 5	Occupational and community safety (transport of staff)	Increased traffic on the gravel road (transport of staff)	Definite
SC 6	Occupational and community safety (increased traffic during the transport of produce)	Increased traffic on the national roads (transporting of produce)	Definite
SC 7	Increased HIV infections (and other diseases)	Construction workers (clearing of land for orchard development and infrastructure)	Highly Probable
SC 8	Increased incidence of social ills (e.g. alcoholism, drug abuse, prostitution, gambling & criminality)	Construction workers (clearing of land for orchard development and infrastructure)	Highly Probable
SC 9	Occupational and community health and safety (use of fertilizers and pesticides)	Use of fertilizers and pesticides (herbicides / insecticides / fungicides)	Highly Probable
SC 10	Human (fruit) and animal (cladodes) food production	Operation of *Opuntia ficus-indica* orchard	Definite
EO 1	Economic losses (attraction of fauna and avifauna)	Operation of *Opuntia ficus-indica* orchard (attraction of fauna (e.g. baboon, kudu, warthog, etc.) (and even damage to infrastructure) and avifauna)	Definite
EO 2	Economic losses (Cochineal *Dactylopius* spp.)	Cochineal *Dactylopius* spp. infestation	Highly Probable
EO 3	Temporary job creation	Orchard development and construction of infrastructure	Definite
EO 4	Temporary economic benefits (direct/indirect/induced/government revenue)	Orchard development and construction of infrastructure	Definite
EO 5	Permanent job creation	Operation of *Opuntia ficus-indic*a orchard	Definite
EO 6	Permanent economic benefits (direct/indirect/induced/government revenue)	Operation of *Opuntia ficus-indic*a orchard	Definite

The Rapid Impact Assessment Matrix is summarised in Table 8.

Table 8: Rapid Impact Assessment Matrix for the Gusinde Von Wietersheim Successors Trust's proposed activities.

Impact Code	Potential Impact	ES	RV	A1	A2	B1	B2	B3
PC 1	Decreasing groundwater levels (abstraction of groundwater)	-28	**-C**	2	-2	2	2	3
PC 2	Contamination of soil and groundwater (irrigation return flow)	-28	**-C**	2	-2	2	2	3
PC 3	Salinisation of soil and infiltration of high salinity water to the underlying aquifer	-28	**-C**	2	-2	2	2	3
PC 4	Occupational and community health (use of groundwater for drinking)	-28	**-C**	2	-2	2	2	3
PC 5	Contamination of soil (and groundwater) (spills of hazardous materials)	-12	**-B**	1	-2	2	2	2
PC 6	Contamination of soil (and groundwater) (liquid and solid waste disposal)	-12	**-B**	2	-1	2	2	2
PC 7	Contamination of surface/runoff water during precipitation events (liquid and solid waste disposal)	-12	**-B**	2	-1	2	2	2
PC 8	Contribution to scientific knowledge (hydrogeology)	48	**D**	3	2	3	3	2
PC 9	Reduction in Greenhouse Gasses (GHGs) (solar power)	42	**D**	3	2	3	2	2
PC 10	Air Quality (gaseous emissions) (transport of raw materials)	-24	**-C**	4	-1	2	2	2
PC 11	Air Quality (dust or Particulate Matter (PM) pollution and gaseous emissions) (transport of staff)	-12	**-B**	2	-1	2	2	2
PC 12	Air Quality (gaseous emissions) (transport of produce)	-18	**-B**	3	-1	2	2	2
PC 13	Large scale delivery of carbon units (*Opuntia ficus-indic*a orchard)	64	**D**	4	2	3	3	2
BE 1	Disturbance of terrestrial fauna (e.g. reptiles) and avifauna (ground-nesting birds) (clearing of land)	-6	**-A**	1	-1	2	2	2
BE 2	Loss of terrestrial fauna (e.g. reptiles) and avifauna (ground-nesting birds) (clearing of land)	-16	**-B**	1	-2	3	3	2
BE 3	Loss of flora (clearing of land)	-16	**-B**	1	-2	3	3	2
BE 4	Invasion of natural vegetation by *Opuntia ficus-indica* and disruption to ecosystem balance (spread and establishment of Opuntia ficus-indica outside the fenced area)	-28	**-C**	2	-2	2	2	3
BE 5	Introduction of other invasive alien plant species which invade natural vegetation (use of machinery / disturbance of soil surface)	-28	**-C**	2	-2	2	2	3
BE 6	Loss of fauna and/or flora or disruption to ecosystem balance (use of chemicals and spread to natural vegetation outside the fenced area)	-32	**-C**	2	-2	3	3	2
BE 7	Salinisation of the soil (inappropriate irrigation / fertilizer application)	-28	**-C**	2	-2	2	2	3
BE 8	Invasion of natural vegetation by *Opuntia ficus-indica* and disruption to ecosystem balance (no or failure to implement the closure plan)	-28	**-C**	2	-2	2	2	3
BE 9	Loss of flora / habitat for fauna and avifauna (irrigation of crops and decreasing groundwater levels)	-24	**-C**	2	-2	2	2	2
BE 10	Increased biodiversity (attraction of fauna and avifauna)	24	**C**	2	2	2	2	2
BE 11	Negative aspects related to increased biodiversity	-24	**-C**	2	-2	2	2	2
BE 12	Contribution to scientific knowledge (vegetation)	48	**D**	3	2	3	3	2
SC 1	Visual impacts (presence of people/equipment/dust) (clearing of land for orchard development and infrastructure)	-12	**-B**	2	-1	2	2	2
SC 2	Visual impact (*Opuntia ficus-indica* orchard)	-12	**-B**	2	-1	2	2	2
SC 3	Noise pollution (presence of people/equipment) (clearing of land for orchard development and infrastructure)	-12	**-B**	2	-1	2	2	2
SC 4	Occupational and community safety (increased traffic during orchard development and construction of infrastructure)	-18	**-B**	3	-1	2	2	2
SC 5	Occupational and community safety (transport of staff)	-12	**-B**	2	-1	2	2	2
SC 6	Occupational and community safety (increased traffic during the transport of produce)	-18	**-B**	3	-1	2	2	2
SC 7	Increased HIV infections (and other diseases)	-54	**-D**	2	-3	3	3	3
SC 8	Increased incidence of social ills (e.g. alcoholism, drug abuse, prostitution, gambling & criminality)	-24	**-C**	2	-2	2	2	2
SC 9	Occupational and community health and safety (use of fertilizers and pesticides)	-24	**-C**	2	-2	2	2	2

Impact Code	Potential Impact	ES	RV	A1	A2	B1	B2	B3
SC 10	Human (fruit) and animal (cladodes) food production	48	**D**	3	2	3	3	2
EO 1	Economic losses (attraction of fauna and avifauna)	-12	**-B**	2	-1	2	2	2
EO 2	Economic losses (Cochineal *Dactylopius* spp.)	-18	**-B**	3	-1	2	2	2
EO 3	Temporary job creation	36	**D**	3	2	2	2	2
EO 4	Temporary economic benefits (direct/indirect/induced/government revenue)	36	**D**	3	2	2	2	2
EO 5	Permanent job creation	48	**D**	3	2	3	3	2
EO 6	Permanent economic benefits (direct/indirect/induced/government revenue)	48	**D**	3	2	3	3	2

Five moderate negative (PC 1, 2, 3, 4, and 10), five negative (PC 5, 6, 7, 11, 12), and three significant positive (PC 8, 9, and 13) impacts were identified under the physical/chemical component (see Table 8).

Sarma (2024) noted that the boreholes to be used for irrigation are of moderate to low yield with shallow water strikes; the water supply sources are thus vulnerable to over exploitation (PC 1).

Water demand for drip irrigation of prickly pear is estimated at approximately 240,000 m^3/year to be sourced from the Nomtsas Aquifer. The irrigation rate proposed is in the range of 'deficit irrigation' for this area and interception of infiltration by the crop is expected to limit excess water and therefore limit input to the groundwater regime. Nevertheless, salinisation of the soil due to precipitation of salts as a result of evaporation of irrigation water and subsequent mobilisation of the salts to the groundwater during rainfall is a possibility. The impacts could be damage to the soil and locally increase salinity of groundwater (PC 3).

Application of fertilisers, pesticides and herbicides in excess of the uptake capacity of the plants and subsequent leaching of these could cause a negative impact on downstream water quality (PC 2).

The groundwater from the identified irrigation supply boreholes (WW207160, WW207162, WW84774, FBH5_TP) is not suitable for drinking (high nitrate, fluoride, sodium, and / or salinity). Water from these sources will need treatment or water should be supplied from other sources (PC 4).

The Nomtsas Aquifer is unconfined and has a shallow water table (6.5 to 11.7 m bgl (metre below ground level)) and is therefore vulnerable to contamination from surface. Sources of pollution may include accumulations of agricultural, animal and human waste, including manure around livestock drinking troughs and kraals, French-drains and domestic waste disposal sites near homesteads. Other sources of potential contamination may include leakage from the storage of hazardous liquids (e.g. fuel, pesticides) (see Sarma, 2024) (PC 5, 6 and 7).

Nopal Corp. (2024) noted that their carbon units (PC 13) are: i) verified and validated (*Certis Certified: one of Europe's top science-backed accredited and independent agricultural carbon certification entities; the units can be further registered on Gold Standard or Verra, if desired by the client*); ii) additional (*they plant on largely empty/unused land (the baseline), turning low carbon storage land into a vibrant, carbon-dense, ecosystem*); and iii) permanent (*the new ecosystem lasts and grows for decades via the Nopal Community Trust; harvests leave the main plant intact; and the plant is 90% water so, unlike trees, it is far less susceptible to wildfires*).

Seven moderate negative (BE 4, 5, 6, 7, 8, 9, and 11), two negative (BE 2 and 3), one slight negative (BE 1), one moderate positive (BE 10), and one significant positive (BE 12) impacts were identified under the biological/ecological component (see Table 8).

Should *Opuntia ficus-indica* spread and establish outside the allocated, fenced area, it may lead to the invasion of the natural vegetation and disruption to ecosystem balance (BE 4).

Opuntia ficus-indica is not on the Australian Weeds of National Significance (WONS) list, therefore allowed into the country according to law, but this is greatly discouraged (Australian Parliament, 2004; Invasive Species Council, Australia, 2024; see Kolberg, 2024). In South Africa *Opuntia ficus-indica* is listed as a Category 1b invasive species on the National Environmental Management: Biodiversity Act 10 of 2004, also known as NEMBA (Department of Environmental Affairs, 2016; see Kolberg, 2024). Category 1b are species that may not be owned, imported into South Africa, grown, moved, sold, given as a gift, or dumped in a waterway. However, spineless cultivars or forms and fruit for human consumption are exempted (Department of Environmental Affairs, 2016; see Kolberg, 2024). Richardson *et al.* (2020; see Kolberg, 2024), using the proposed system of Blackburn *et al*. (2011), classified *O. ficus-indica* in South Africa as established (naturalised) with lesser impact, but a full impact assessment has not yet been done to confirm this. *O. ficus-indica* is also not on the IUCN's Invasive Species Specialist Group's list of the 100 worst invasive species globally (Lowe *et al*., 2000; see Kolberg, 2024).

The highest risk of invasion of environments surrounding spineless *O. ficus-indica* orchards comes from the spread of seed with vegetative spread a somewhat lower risk. Dean (2000; see Kolberg 2024) found that in the Karoo (South Africa) (and comparable to conditions found at Farm Namseb No. 24), baboons and crows were the principal spreaders of seed (note that no crows have been observed on Farm Namseb No. 24 to date; Mr Guido von Wietersheim, Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust, pers. comm.). Mokotjomela *et al*. (2021; see Kolberg 2024) noted that red eyed bulbul and starlings

were also found to be very effective in spreading seed. In a study by Dudenhoeffer (2018; see Kolberg 2024) it was found that small rodents also spread seed. However, the percentage of viable seed excreted by these animals is lower, as they chew and damage the seeds upon ingestion. The consumption of the fruit by humans, combined with open defecation, can also be a source of seed dispersal. The spread of vegetative material by vehicles, animals or persons is a secondary concern, but must nevertheless be controlled (see Kolberg, 2024).

Linked to the risk of spread by seed, is the hybridisation of orchard plants with plants of unknown genetic make-up. This could result in seed giving rise to plants with particularly strong invasive or undesirable properties (spines). The isolation distance recommended for bee- and cross-pollinated crops (which *Opuntia ficus-indica* is) varies between one (1) and five (5) km (Bateman 1947; Gabai-Hazera *et al*., 2018; and Fragoso and Brunet, 2023; see Kolberg, 2024). This is the distance over which it is deemed unlikely that pollen will be spread by bees. The distance over which bees will fly depends on many factors, like the species of bee, abundance, and spread of flowering plants or location of suitable nesting sites.

The establishment of the orchard and its management (e.g. introduction of machinery, the ripping of the soil, the addition of manure/fertilizers, and irrigation) may introduce new or promote the growth of already present alien species (weeds) in the area. These can spread from the orchard into the surrounding vegetation, and negatively impact on the ecosystem (see Kolberg, 2024) (BE 5).

The use of chemicals (fertilizers and pesticides, including herbicides, insecticides and fungicides) during the establishment and operation of a cactus orchard and processing of the product is generally recommended (Gajender *et al*., 2014; Inglese *et al*., 2017; Fouché *et al*., 2019; and Fouché, 2023; see Kolberg, 2024) and in some cases inevitable.

In order to achieve good yields, fertilizer must be applied twice per year (Gajender *et al*., 2014; and Inglese *et al*., 2017; see Kolberg, 2024). Fertiliser application may also be necessary to mitigate salt stress that may result from the orchard being watered incorrectly or with too saline water (Gajender *et al*., 2014; see Kolberg, 2024).

The use of pesticides may be required to treat for infestation by cochineal (*Dactylopius* sp.); the latter is present in Namibia and will kill the plants if not controlled.

Opuntia ficus-indica has a very shallow, spreading root system and severe weed infestations may negatively influence the yield (due to competition for water and nutrients from the same area in the soil (Inglese *et al*., 2017; see Kolberg, 2024). The application of herbicides may thus be needed as mechanical weed eradication is not recommended (it disturbs the *Opuntia* roots) and hand weeding may not be practical on an area of 500 ha.

There are a number of fungal diseases that cause rotting of roots, stems, cladodes or fruit which need to be counteracted with fungicides. It is also recommended that planting material (cuttings) and soil be treated before planting to prevent introduction of any pests or diseases.

Should the chemicals spread (via wind or water) to the surrounding natural vegetation (outside the fenced area), it may lead to the loss of fauna and/or flora and a disruption to the ecosystem balance (see Kolberg, 2024) (BE 6).

Salinisation of soil (also see PC 3; Sarma, 2024) due to irrigation with saline water or in inappropriate ways and amounts, is always a risk in crop production, more so in areas with high evaporation and low rainfall (Stavi *et al*., 2021; see Kolberg, 2024). This will cause a reduction in *Opuntia* crop yield and may also impact the re-establishment of natural vegetation if the orchard should be abandoned in future and native plants have to be restored (see Kolberg, 2024) (BE 7).

A lack of or failure to implement the closure plan (*abnormal condition*), may lead to the invasion of the natural vegetation by *Opuntia ficus-indica* and disruption to the ecosystem balance (see Kolberg, 2024) (BE 8).

Irrigation of the orchard may lead to decreasing groundwater levels, and the loss of flora / habitat for fauna and avifauna (BE 9).

The operation of the *Opuntia ficus-indica* orchard will lead to the attraction of fauna and avifauna (BE 10 and BE 11). Impacts will be positive (increased biodiversity) as well as negative (cross pollination may produce an

invasive or spiny plant; animals may cause the spread of *Opuntia ficus-indica*, and baboon and porcupines may damage the irrigation system).

During the clearing of the area for orchard development and the construction of infrastructure, terrestrial fauna and avifauna may be disturbed (BE 1), and/or lost (BE 2).

During the development of the orchard (ripping/planting), construction of infrastructure, and the operation of the orchard, some of the smaller indigenous vegetation will be destroyed. Also, any indigenous plants that re-establish in the orchard will be removed as part of weed management (see Kolberg, 2024) (BE 3).

Contribution to scientific knowledge (BE 12). Through this project, more knowledge (i.e. a baseline for any future assessments) on spineless *Opuntia ficus-indica* cultivation and the entire industry surrounding it, specific to Namibia, can be obtained and this will be beneficial for the entire country (e.g. to improve the management of cactus orchards, as well as to minimise their impacts on the natural environment) (see Kolberg, 2024).

As far as the <u>sociological/cultural components</u> are concerned, one significant negative (SC 7), two moderate negative (SC 8 and 9), six negative (SC 1, 2, 3, 4, 5, and 6) (note that SC 2 – visual impact due to the presence of the evergreen *Opuntia ficus-indica* orchard - may also be regarded as a positive impact; Alves, 2023), and one significant positive (SC 10) impacts were identified (see Table 8).

At some stage during the lifetime of the Project, there may be an increased incidence of HIV infections (and other diseases). There may also be other potential negative impacts (the use of drugs and alcohol, Sexually Transmitted Infections (STIs), and gender violence) as a result of staff/contractors moving into the area (and mixing with the local community(ies)) (SC 7 and SC 8).

Two negative (EO 1 and 2 - economic losses due to the attraction of fauna (e.g. baboon, kudu, warthog, etc.) (and even damage to infrastructure) and avifauna, and a potential Cochineal *Dactylopius* spp. infestation), and four significant positive (EO 3, 4, 5, and 6) impacts were identified under the <u>economical/operational component</u> (see Table 8).

Cochineal *Dactylopius* spp. is present in Namibia and will kill the plants if not controlled. Communication between the various farmers (that may have *Opuntia ficus-indica* plants on their land and that brought in Cochineal *Dactylopius* spp. for classical biological control (CBC) of the species) is advised so that the *Dactylopius* spp. do not spread to Farm Namseb No. 24 by accident (H. Kolberg, pers. comm.). The *Opuntia ficus-indica* orchard should be inspected at least once a month (preferably every two to three weeks) for any Cochineal *Dactylopius* spp. (Coleman, 2023; Spandiel, 2023) (also see Berhe and Mesele, 2024).

The benefits of the *Opuntia ficus-indica* irrigation project and associated activities, amongst others, will include: the creation of employment (including skills transfer) (EO 3 and 5); and direct (*i.e. salaries of the manager(s) and staff*), indirect (*i.e. and e.g. the inputs (e.g. steel or aluminium wire) purchased by the manufacturers of the fence, that in turn creates more employment and thus wages*), and induced (*i.e. from the goods and services purchased by the manager(s)/staff/contractors due to the salaries and wages received*) economic impacts/benefits; Government revenue be generated through a range of taxes (*i.e. Value Added Tax (VAT) on goods and services, import VAT, VAT derived from personal spending by employees and contractors, and Personal Income Tax (PAYE)*), as well as employment insurance contributions to the Social Security Commission and Workmen's Compensation Fund (as per Ashby, 2010) (EO 4 and 6).

A summary of the scores is provided in Table 9. It is evident that one significant negative, 14 moderate negative, 15 negative, one slight negative, one moderate positive, and nine significant positive impacts were identified.

Table 9: Summary of scores for the Gusinde Von Wietersheim Successors Trust's proposed activities (*PC = Physical/chemical; BE = Biological/ecological; SC = Sociological/cultural; and EO = Economic/operational*).

Range	**-108 -72**	**-71 -36**	**-35 -19**	**-18 -10**	**-9 -1**	**0 0**	**1 9**	**10 18**	**19 35**	**36 71**	**72 108**
Class	**-E**	**-D**	**-C**	**-B**	**-A**	**N**	**A**	**B**	**C**	**D**	**E**
PC	0	0	5	5	0	0	0	0	0	3	0
BE	0	0	7	2	1	0	0	0	1	1	0
SC	0	1	2	6	0	0	0	0	0	1	0
EO	0	0	0	2	0	0	0	0	0	4	0
Total	**0**	**1**	**14**	**15**	**1**	**0**	**0**	**0**	**1**	**9**	**0**

The impact assessment histogram for the Gusinde Von Wietersheim Successors Trust's proposed activities is shown in Figure 11.

Figure 11: Impact assessment histogram for the Gusinde Von Wietersheim Successors Trust's proposed activities (*PC = Physical/chemical; BE = Biological/ecological; SC = Sociological/cultural; and EO = Economic/operational*).

6.4 Conclusion

The Gusinde Von Wietersheim Successors Trust's proposed activities will have potential impacts on the environment and these will be of a positive, as well as a negative nature: one significant negative, 14 moderate negative, 15 negative, one slight negative, one moderate positive, and nine significant positive impacts were identified (see Table 9 and Figure 11).

The significant negative, moderate negative, negative, and slight negative impacts can be relatively easily mitigated through the implementation of certain management measures (see Section 7.4: EMP).

7 Environmental Management Plan

7.1 Goal, Aim and Structure of the Environmental Management Plan

The ultimate goal of an Environmental Management Plan (EMP) is to ensure that the physical, biophysical and socio-economic objectives are met to such an extent that the overall product of the activity will not result in a net negative impact.

The aim of the EMP is to assist the Gusinde Von Wietersheim Successors Trust and their contractor(s) to ensure that the day-to-day operations are carried out in an environmentally responsible manner, thereby preventing or minimising the negative effects and maximising the positive effects of the activities.

Once approved by the DEAF, MEFT, in the form of an ECC, the EMP will become a legally binding document and the Gusinde Von Wietersheim Successors Trust and their contractor(s) are required to abide to the conditions stipulated in the EMP.

The EMP is presented as a comprehensive matrix: for each Activity/Process and related Aspects and Impacts, Management Actions required to address the impacts arising directly and indirectly from the various aspects of Gusinde Von Wietersheim Successors Trust's proposed activities are listed.

A copy of the EMP should be made available at the Office at Farm Namseb No. 24; also, the EMP should be made available to all contractors/service providers on site (who need to confirm that they have read and understood the contents of the EMP in writing).

External auditing (and monitoring) should be carried out to ensure compliance with the EMP. Parties responsible for transgression of the EMP should be held responsible for any rehabilitation that needs to be undertaken.

Note that the EMP is not a static document and that the document should be updated as the Project progresses/more information re the activities becomes available.

7.2 Permits and Approvals

The most pertinent legislation, with the aim of informing the Gusinde Von Wietersheim Successors Trust of the legal requirements pertaining to the activities, is listed under Section 4 of this Report.

A summary of the relevant legislation and regulatory authorities (including contact details) as far as permits and/or approvals are concerned, is provided:

Legislation	Regulatory Authority	Permit/Approval	Contact Details
Water Resources Management Act 11 of 2013	Ministry of Agriculture, Water and Land Reform (MAWLR)	Water Licenses Effluent/Wastewater Discharge License	Mr Franciskus Witbooi Deputy Director: Law Administration Tel. 061-2087226 witbooif@mawlr.gov.na
Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act 36 of 1947		Pest Control Product (Conventional and Biological) Import Permit Fertilizer Import Permit	Mr David A. Shamena Agricultural Inspector Tel. 061-2087466/7467 Cell 081-2700625 david.shamena@mawlr.gov.na
Plant Quarantine Act 7 of 2008		Import of Plant and Plant Products (e.g. cladodes from Portugal)	Me Elize Hasholo Tel. 061-2087527 elize.hasholo@mawlr.gov.na
Petroleum Products and Energy Act, 1990 and the Petroleum Products Regulations, 2000	Ministry of Mines and Energy (MME)	Consumer Installation Certificate	Mr. Andreas Sheeham Chief Petroleum Inspector Tel: 284 8300 Email: Andreas.Sheehama@mme.gov.na
Forest Act 12 of 2001 (as amended by the	Ministry of Environment, Forestry and Tourism	A permit is also required prior to the	Mr Timoteus Mufeti Environmental Commissioner

Legislation	Regulatory Authority	Permit/Approval	Contact Details
Forest Amendment Act 13 of 2005)		removal of any protected tree and/or plant species	Tel. 061-2842751 Timoteus.Mufeti@met.gov.na
Environmental Management Act 7 of 2007	Ministry of Environment, Forestry and Tourism (MEFT)	Environmental Clearance Certificate	Mr Timoteus Mufeti Environmental Commissioner Tel. 061-2842751 Timoteus.Mufeti@met.gov.na
Labour Act 11 of 2007	Ministry of Labour, Industrial Relations and Employment Creation	Permission is needed to run 12-hour shifts (should it be required)	Ms. Kyllikki Sihlahla Labour Commissioner Tel. 061-2066800 Kyllikki.Sihlahla@mol.gov.na

7.3 Roles and Responsibilities

The Gusinde Von Wietersheim Successors Trust is responsible for fulfilling the requirements in the EMP pertaining to the Project.

In addition to the before-mentioned, the following actions are proposed:

- The provision by the Gusinde Von Wietersheim Successors Trust of, on an on-going basis, sufficient management sponsorship and human and financial resources for the implementation of the EMP;
- The development of a monitoring programme(s) (as needed) (see Section 7.5); and
- External auditing (by an independent, external auditor) of the management actions as contained in the EMP for the Gusinde Von Wietersheim Successors Trust's proposed activities.

7.4 Environmental Management Plan

This Section contains the EMP for the Gusinde Von Wietersheim Successors Trust's proposed activities i.e. the *Opuntia ficus-indica* Irrigation Project and Associated Activities (see Table 10) (also see EPA, 2004; IFC, 2007a and b; Cornell College of Agriculture and Life Sciences (CALS), 2020; Coleman, 2023; Kolberg, 2024; and Sarma, 2024).

Note that electrical works is subject to several South African National Standards (SANS) specifications, as well as the Independent Electrical Contractor (IEC) codes.

Table 10: Environmental Management Plan for the Gusinde Von Wietersheim Successors Trust's proposed activities i.e. the *Opuntia ficus-indica* Irrigation Project and Associated Activities, Farm Namseb No. 24, Hardap Region, Namibia.

Aspect	Impact	Mitigation
Social and Environmental Performance		
Management and Monitoring	Social and Environmental Performance	Adhere to all Namibian Legislation, including Best Practice Guidelines. Update, implement and maintain the **Control Plan for the *Opuntia* Species** (Nopal Corp., 2023). Develop, implement and maintain a **Closure Plan** for the *Opuntia ficus-indica* irrigation project and associated activities. Ensure that all aspects related to the Environmental Management Plan (EMP) are implemented.
Consultation and Disclosure	Social and Environmental Performance	Maintain open and direct lines of communication with the Authorities and Interested and Affected Parties (I&APs) (e.g. representatives from the Maltahöhe Village Council, the Ministry of Agriculture, Water and Land Reform (MAWLR), the Ministry of Environment, Forestry and Tourism (MEFT), etc.) with regards to environmental matters. Consult with I&APs throughout the project process and adequately incorporate I&APs' concerns.
Grievance Mechanism	Social and Environmental Performance	Implement a grievance mechanism for receiving and resolving any concerns and grievances related to the project's social and environmental performance throughout the project life cycle. Inform all I&APs about the mechanism. Address concerns promptly and transparently and in a culturally appropriate manner. Keep a register of all concerns/issues received from I&APs, as well as the measures taken to address these.
Training, including awareness and inductions	Social and Environmental Performance	Train employees in matters related to the project's social and environmental performance and Namibia's regulatory requirements. Ensure adequate environmental awareness training for all personnel. Give environmental induction presentations to all personnel.
Employment and procurement opportunities	Social and Environmental Performance	Source contracting companies/service providers/workers based on merit and expertise giving preference to local contractors/service providers/workers (from the local area, then the Region, and then the rest of Namibia) on condition that the local contractors/service providers/workers have the required experience and expertise. Ensure that contractors/service providers adhere to the Namibian Labour, Social Security, Health and Safety, and Affirmative Action laws.

Aspect	Impact	Mitigation
		Source maximally from local resources to ensure maximum economic beneficiation of local businesses in terms of new business sales.
Labour and Working Conditions	Social and Environmental Performance	Establish, maintain and improve the worker-management relationship. Base the employment relationship on equal opportunity and fair treatment and no discrimination to be allowed. Comply with Namibia's labour and employment laws. Promote safe and healthy working conditions and the protection and promotion of worker health. Document and communicate the Working Conditions and Terms of Employment. Respect Collective Agreements and the right of workers to organise and bargain collectively. Implement a Grievance Mechanism.
Occupational and Community Health and Safety and Security	Social and Environmental Performance	Adhere to all Namibia's Health and Safety Regulations (Labour Act, 1992: Regulations Relating to the Health and Safety of Employees at Work). Ensure that an **HIV/AIDS Policy and Programme** and **Health and Safety Plan** is in place. A SHE (Safety, Health, Environment) Representative to be appointed once the staff complement reaches 20. Occupational Health and Safety Training to be provided to all employees. Ensure that qualified first aid can be provided at all times. Comply with all safety regulations re. electricity supply. Ensure that employees are trained in the use of appropriate firefighting equipment and ensure that such equipment is on hand at all times. Provide and ensure the active use of Personal Protective Equipment (PPE). Make suitable arrangements, as far as practicable, for the maintenance of health, the prevention and overcoming of outbreaks of disease (e.g. Tuberculosis (TB)) and of adequate first aid services. Prevent communicable disease (e.g. Sexually Transmitted Infections (STIs) such as HIV transmission): provide surveillance and active screening and treatment of employees; prevent illness among employees (through health awareness and education initiatives); ensure ready access to medical treatment, confidentiality and appropriate care, particularly with respect to migrant workers; and promote immunization.

Aspect	Impact	Mitigation
		Implement measures to protect the entire team (including contractors) against the SARS-CoV-2 Virus that causes COVID-19. Train employees in the COVID-19 regulations. Provide adequate handwashing and hand sanitizing facilities; maintain the required physical distance and wear a face mask if applicable. Stay up-to-date on current COVID-19-related regulations in the Region and Country. Ensure that security arrangements are in place.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Orchard Panning and Cultivation**		
Import of cladodes (from Portugal)	Invasion of the natural vegetation through the spread of *Opuntia ficus-indica* and disruption to ecosystem balance	Obtain a permit from the MAWLR for the import of the cladodes from Portugal.
Establishment of orchard and infrastructure	Disturbance/loss of fauna	Inspect the areas to be ripped for planting / cleared for the construction of infrastructure and remove (e.g. capture) unique/sensitive fauna (e.g. tortoises, chameleons, etc.) (and/or species serendipitously located during the clearing activities) and relocate these to an area outside the area to be cleared / in the immediate area. Obtain the necessary permits from the MEFT prior to the collection, removal, and relocation of protected faunal species.
Establishment of orchard and infrastructure	Destruction of flora	Inspect the areas to be ripped for planting / cleared for the construction of infrastructure for any protected plants (note that e.g. *Lithops*, *Anacampseros* and the stapeliads (*Apocynaceae* family), are small and difficult to spot). Obtain the necessary permits from the MEFT prior to the collection, removal, and relocation of protected floral species.. Only remove protected species (e.g. shepherd's tree *Boscia albitrunca*) if there is no alternative. Obtain the help of an expert to remove and re-plant any protected plants in similar habitat outside the proposed Project-area (fence). Inspect the areas to be ripped for planting / cleared for the construction of infrastructure for any endemic, near-endemic and data deficient species (not protected by law) and remove and re-plant these plants in similar habitat outside the proposed Project-area (fence). Limit the creation of new roads/tracks outside the fenced area to the absolute minimum. Prohibit off-road/off-track driving as far as possible. Prohibit the collection of firewood from the natural surroundings; provide alternate methods for cooking to staff. Prohibit the removal of any indigenous plants outside the fenced area (plant poaching) by staff and/or visitors.

Aspect	Impact	Mitigation
		Educate staff on the importance of an intact ecosystem and the legal implications of plant poaching.
Soil preparation activities	Air quality (dust or Particulate Matter (PM) pollution)	Avoid burning organic material in the field. Avoid the handling of erodible materials under high wind conditions or when a visible dust plume is present.
	Soil erosion	Maintain organic matter (to prevent wind erosion of the soil).
Increased traffic / presence and movement of machinery (exhaust from diesel engines) / traffic on the farm road(s)	Air quality (including dust or Particulate Matter (PM) pollution) and Occupational and community health and safety	Maintain the road surface to preserve surface characteristics (e.g. texture and roughness). Use dust control/suppression methods, such as applying (semi-purified) water to minimise dust (oil and oil by-products is not a recommended measure to control road dust). Fleet owners/operators to implement manufacturer recommended engine maintenance programs (to control vehicle emissions: Carbon Monoxide (CO), Carbon Dioxide (CO_2), Nitrogen Oxide (NO_x), Sulphur Dioxide (SO_2), Particulate Matter (PM) and Volatile Organic Compounds (VOCs)). Adopt best transport safety practices by implementing the following measures: emphasize safety aspects among drivers; improve driving skills and require licensing of drivers; adopt limits for trip duration; avoid dangerous routes and times of day; and use speed control devices. Regularly maintain vehicles and use manufacturer approved parts. Use locally sourced materials (where possible) to minimise transport distances. Employ safe traffic control measures, including the use of traffic and safety warning signs and flag persons to warn of dangerous conditions.
Transport of *Opuntia* material (fruit, seed, cladodes) outside the fenced orchard area	Invasion of the natural vegetation through the spread of *Opuntia ficus-indica* and disruption to ecosystem balance	Avoid planting in drainage lines or washes to prevent water from carrying any propagation material outside the orchard area. Establish a cleared control strip of 5 metres (m) around the outside of the fenced production area, as well as a 100 m buffer strip outside of the 5 m strip. Remove any *Opuntia* species within 2.5 km from the orchard prior to planting in order to prevent hybridisation of the orchard cultivars with other species that may be found outside the fence. This will prevent the production of seed that may be more virulent or produce plants with undesirable characteristics (i.e. spiny, invasive). Install a small mesh fence around the orchard to keep any of the animal seed dispersal vectors, including smaller birds and rodents, out of the orchard (if feasible).

Aspect	Impact	Mitigation
		Carefully plan the tracks / areas for vehicle movement; the distance between the rows (proposed at 2.5 m) is too small for vehicles to move through once the plants mature and this may lead to cladodes and/or fruit breaking off and being spread by vehicles.
Establishment of orchard	Invasion of the natural vegetation through the spread of other invasive alien plant species	Create a small berm of soil along the base of the perimeter fence to prevent the spread of seed of alien species outside the fence by flowing water. Clean all machinery/vehicles that come into the area of any adhering soil or seeds (at the clean down area at the gate).
Establishment of orchard (use of chemicals)	Loss of fauna and/or flora and a disruption to the ecosystem balance	Avoid planting and thus the application of chemicals in drainage lines and watercourses.
Establishment of orchard	Salinisation of soil	Test soil texture and chemistry prior to planting in order to develop an appropriate irrigation and fertilisation programme. Test the *Opuntia* material (cladodes) to establish the most effective fertilisation rate (as applicable). Test salinity of irrigation water; do not use the water for irrigation if the salinity (Total Dissolved Solids (TDS)) is higher than 2,000 mg/l (= parts per million – ppm) (Amwele *et al.*, 2021; see Kolberg, 2024).
***Opuntia ficus-indica* Irrigation Project and Related Activities: Fauna and Flora**		
Operation of orchard	Destruction of flora	Create awareness amongst staff to identify, remove and re-plant any sensitive species in similar habitat outside the proposed Project-area (fence). Limit the creation of new roads/tracks outside the fenced area to the absolute minimum. Prohibit off-road/off-track driving as far as possible. Prohibit the collection of firewood from the natural surroundings; provide alternate methods for cooking to staff. Prohibit the removal of any indigenous plants outside the fenced area (plant poaching) by staff and/or visitors. Educate staff on the importance of an intact ecosystem and the legal implications of plant poaching.
Operation of orchard (annually during fruit ripening, pruning, harvesting, processing and transporting to markets)	Invasion of the natural vegetation through the spread of *Opuntia ficus-indica* and disruption to ecosystem balance	Inspect the 5 m cleared control strip around the outside of the fenced production area together with a 100 m buffer strip outside of the 5 m strip annually for any *Opuntia* plants. Uproot and destroy any *Opuntia* plants in the disposal area inside the fence. Do not use this material for re-planting in the orchard, as the genetic make-up of these plants is uncertain and will not be the same as that in the orchard. Do not allow any *Opuntia* species to be planted/grow within 2.5 km from the orchard in order to prevent hybridisation of the orchard cultivars with other species that may be found outside

Aspect	Impact	Mitigation
		the fence. This will prevent the production of seed that may be more virulent or produce plants with undesirable characteristics (i.e. spiny, invasive). If the installation of a small mesh fence is not feasible, remove any ripening fruit from the orchard before the seed matures and becomes viable. If fruit is not going to be marketed, this can be done once the flowers have wilted and the removed fruit destroyed with any other unwanted material. Should it not be viable to remove the fruit before the seed matures and becomes viable, sharpen the controls outside the orchard. Properly pack *Opuntia* propagation material before it is brought into the site so that no material can fall off the vehicles along the route. Control (at the gate) any vehicles or persons entering or leaving in order to prevent the spread of any *Opuntia* material outside the fenced orchard area. A clean down area at the gate is recommended where vehicles and people's boots can be inspected and cleaned of any plant material. Take special care that no seed (e.g. from fruit squashed by tyres or boots, and which may be harder to notice) is taken outside. All handling, processing, and packaging must be done inside the fenced, controlled area. Dispose of any unwanted material (diseased, pruned, not marketable) inside the fenced area only. Bury the material deep (covered by at least 1 m of soil). Do not locate the disposal site in or near any water courses or drainage lines (any water flow could expose and spread the material; rainfall and floods in this area often occur unexpectedly and at unusually high levels). Properly pack fresh *Opuntia* material (fruit/cladodes) to be marketed so that no material can fall off the vehicles along the route. Only processed material, that cannot produce new plants, should leave the fenced area (ideally, as this will further reduce the risk of the invasion of the natural vegetation through the spread of *Opuntia ficus-indica*). Selling whole cladodes as feed is risky as the producer can control the risk at the orchard, but has no control over what happens on the clients' site. The producer could then be responsible for spread of the species to an unapproved area. Remove the glochids from the cladodes and fruit (if feasible and as needed) before these are sold fresh. These small spines are a hazard to staff handling this material as well as the end-consumer, including livestock. There is machinery available to remove glochids from fruit, and cladodes are normally flamed to burn the glochids.

Aspect	Impact	Mitigation
		Do not allow the spread of seed through open defecation by humans; create awareness amongst / educate the staff and provide sufficient toilets.
Operation of orchard	Invasion of the natural vegetation through the spread of other invasive alien plant species	Clean all machinery/vehicles that come into the area of any adhering soil or seeds (at the clean down area at the gate). Implement an effective weeding programme inside the orchard area that removes these alien species before they seed. Dispose of any seeding material in the disposal area inside the fenced area. Do not use the seeding material for composting. Educate and train staff on the identification and removal of alien species. Prohibit the planting of alien invasive species by staff at their gardens/homes. Inspect the 5m and 100 m strips surrounding the fenced area for any alien invasive species at least annually; remove and destroy these together with the *Opuntia* material.
Operation of orchard (use of chemicals)	Loss of fauna and/or flora and a disruption to the ecosystem balance	Use chemicals only when necessary and use only Namibian registered and approved chemicals. Give preference to chemicals with the least effect on neighbouring plants. Use best practice for any chemical application; closely follow the instructions for each chemical (no over-dosing). Use spraying equipment that produces droplets of a diameter of not less than 100 micron. Small droplets drift much further away from the spraying source than larger droplets (Kruger *et al*., 2019; see Kolberg, 2024). Small droplets will hang in the air for much longer and any movement of air may take them away from the target plant. This means using lower pressure and larger nozzles for spraying equipment. Avoid spraying chemicals during windy conditions; wind increases the drift of spray droplets away from the spray source and the target plant. Early mornings are usually less windy. Avoid spraying chemicals during very hot and dry (low humidity) conditions; high temperatures and dry air causes rapid evaporation of water from the spray droplets, decreasing their size and increasing drift away from the target; spraying chemicals as early in the morning as possible. Avoid spraying chemicals during temperature inversion conditions (where cold air is trapped at soil level below a layer of warmer air; it is best detected by smoke from a fire moving horizontally rather that upward, despite there not being any detectable wind). Under such

Aspect	Impact	Mitigation
		conditions droplets of spray are either prevented from falling downwards or drift horizontally, often over large distances.
Operation of orchard	Salinisation of soil (and a reduction in *Opuntia* crop yield)	Test soil texture and chemistry (annually and prior to first fertilisation) to develop an appropriate irrigation and fertilisation programme. Test the *Opuntia* material (cladodes) to establish the most effective fertilisation rate (as applicable). Apply fertiliser strictly according to the recommended rates. Make use of drip-irrigation and do not over-water. Test salinity of irrigation water annually; do not use the water for irrigation if the salinity (Total Dissolved Solids (TDS)) is higher than 2,000 mg/l (= parts per million – ppm) (Amwele *et al.*, 2021; see Kolberg, 2024).
Operation of orchard	Disturbance/loss of fauna (including avifauna)	Implement a suitable and appropriate refuse removal policy (littering could result in certain animals (e.g. baboon, black-backed jackal, warthog, etc.) becoming accustomed to humans and the associated activity and result in typical human-wildlife conflict issues. Educate/inform staff and contractors re dangerous (e.g. snakes) and protected species (e.g. tortoises) to avoid the consequences of killing and/or the illegal collection of such species. Implement a policy of "no kill" with regards to fauna (e.g. poaching for meat (snares); the collection of veld foods e.g. tortoise, monitor lizard; the capture/killing of birds; the killing of snakes, etc.). No animal may be injured, fed, trapped, hunted or harmed in any way. Install owl and raptor perches, and bat boxes as roosting sites, around the orchard to stimulate bio-control methods.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Nutrient Management**		
Soil management	Soil degradation and/or erosion	Practice **Integrated Nutrient Management (INM)** (to avoid nutrient depletion / accumulation). Use appropriate machinery to avoid soil compaction. Increase the organic matter content in the soil to protect the soil from sun/rain/wind and to feed the biota in the soil (compost and/or manure can be used, but consider the potential for the spreading of pests). Assess the potential impacts of waste materials (e.g. manure and sludge) to soils and water resources prior to use for soil enhancement (the waste materials may contain harmful contaminants e.g. heavy metals, nitrogen, phosphorus and disease-causing agents).
Nutrient management / application of fertilizers	Pollution of biophysical environment (surface and groundwater)	Balance nutrient application according to INM recommendations. Conduct regular soil testing (to establish nutrient needs) in order to determine fertilizer application rates/correct doses.

Aspect	Impact	Mitigation
		Assess soil acidity (so that maximum uptake of phosphates can be achieved). Obtain a permit from the MAWLR for any fertilizer to be imported. Spills during transfer, mixing, and storage to be handled as per Hazardous Materials Management. Store fertilizers in their original packaging in a dedicated, locked area, with proper signage, and with access limited only to authorised personnel. Prepare a management plan covering the measures for containment, storage and ultimate destruction of obsolete fertilizers in accordance to the Food and Agriculture Organization (FAO) guidelines (and consistent with country commitments under the Stockholm, Rotterdam and Basel Conventions).
Use of manure	Odours / atmospheric emissions and Community health and safety	Store manure as far away from dwellings/homesteads as possible. Cover the manure (if feasible) to reduce odors and atmospheric emissions. Do not apply manure to the fields if the wind direction is toward nearby dwellings/homesteads.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Pest Management**		
Pest management / application of pesticides	Pollution of biophysical environment (surface and groundwater) and Occupational and community health and safety	Follow an Integrated Pest Management (IPM) strategy and prepare a **Pest Management Plan (PMP)**. Consider the following alternatives to using pesticides: use mechanical weed control and/or thermal weeding; use beneficial organisms to perform the biological control of pests (e.g. insects, birds, mites, microbial agents); protect natural enemies of pests (i.e. provide favourable habitats to house pest predators); or use mechanical controls (i.e. traps, barriers, light and sound to kill/relocate/repel pests). Electric (solar) insect traps may reduce Cactus moth *Cactoblastis cactorum* populations (see Coleman, 2023). Obtain a permit from the MAWLR for any Pest Control Product (Conventional and Biological) to be imported. Maintain a pesticide logbook: e.g. field observations, weather data, time and dosage of treatment, and effectiveness and apply pesticides based on these criteria. Ensure that only the minimum effective dose is applied. Avoid the use of pesticides that fall under the World Health Organization (WHO) Recommended Classification of Pesticides by Hazard Classes 1a and b, and by Hazard Class II. Also those that are listed in Annexes A and B of the Stockholm Convention (except

Aspect	Impact	Mitigation
		under the conditions noted in the convention). Avoid using any pesticide on the FSC (Forest Stewardship Council) Lists of highly hazardous pesticides (2019). Only use pesticides that are manufactured under license, registered and approved by the appropriate authority and in accordance with the FAO's International Code of Conduct on the Distribution and Use of Pesticides. Only use pesticides that are labeled in accordance with international standards and norms. Select application technologies and practices designed to reduce unintentional drift or runoff (as per IPM program) and under controlled conditions. Pesticide application equipment to be maintained and calibrated in accordance with manufacturer's recommendations. Store pesticides in their original packaging in a dedicated, dry, cool, frost-free, well aerated, locked area, with proper signage, and with access limited only to authorised personnel. Also ensure that spill containment measures are in place. Ensure that the personnel applying pesticides are properly trained; mixing and transfer of pesticides to be done in ventilated and well-lit areas using containers designed/dedicated for the task. Contaminated containers to be handled and treated as hazardous waste (see Hazardous Materials Management). Personnel that apply pesticides should use the correct PPE. Purchase and store only the required amounts of pesticides.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Irrigation and Water Management**		
Abstraction of groundwater for irrigation	Decreasing groundwater levels	Install a rain gauge at the Project-area; continue with the rainfall monitoring (daily totals) at the farm house. Install flow meters on all production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP) and record weekly pumping volumes after a recovery period of at least 12 hours. Do not exceed the recommended abstraction rates. Monitor the groundwater levels, abstraction rates, and rainfall. Record water level measurements in the monitoring boreholes (WW207159, WW207161, WW207163 and WW207164) on a weekly basis. Establish the monitoring network before commencement of the irrigation scheme. An assessment of the monitoring data to be conducted by a hydrogeologist on a yearly basis.

Aspect	Impact	Mitigation
		Prepare a **groundwater management plan** after one year of monitoring (the latter should cover both a wet and dry season).
Excess irrigation and infiltration of water containing fertilizers and biocides	Contamination of soil and groundwater	Monitor the soil moisture. Optimise the irrigation rate to minimise irrigation return flow (reduced water, fertilizer and biocide use will reduce costs).
Excess irrigation and leaching of accumulated salts in the soil due to evaporation	Salinisation of soil and infiltration of high salinity water to the underlying aquifer	Optimise the irrigation rate to minimise flooding and salt accumulation with evaporation (the water quality is classified as having a "salinity hazard")
***Opuntia ficus-indica* Irrigation Project and Related Activities: Harvesting of Fruit**		
Food Safety	Occupation and community health and safety	Provide and ensure the active use of Personal Protective Equipment (PPE). Remove the glochids from the fruit (if feasible and as needed) before these are sold fresh. There is machinery available to remove glochids from fruit. Food handling/processing to be performed as per internationally recognized food safety standards consistent with the principles and practices of e.g. Hazard Analysis Critical Control Points (HACCP) (ISO, 2005), and Codex Alimentarius (FAO and WHO, 1962-2005). Food safety principles include: i) strictly maintain cold chains and other preservation processes; and ii) full institutionalisation of HACCP prerequisites as well as Standard Operational Procedures, including: sanitation; Good Manufacturing Practice (GMP); pest control; chemical control; allergen control; staff hygiene and education; customer complaints mechanism; and traceability and reuse.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Harvesting of Cladodes**		
Food Safety	Occupational health and safety and emaciation and death of animals	Provide and ensure the active use of Personal Protective Equipment (PPE). Remove the glochids from the cladodes (if feasible and as needed) before these are sold fresh. Cladodes are normally flamed to burn the glochids.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Resource Use**		
Energy Management	Resource use (e.g. coal) / depletion of natural resources	Promote the sustainable use of energy (that will result in the reduction of use and cost reductions) (e.g. energy efficient light sources). Raise awareness amongst the residents, staff (and contractors) (to save energy).
Water Management	Resource use / depletion of natural resources	Implement a water conservation program, promoting the continuous reduction in water consumption. Raise awareness amongst the staff (and contractors) re the importance of saving water. Water storage tanks to be insect and animal-proof and to be covered to reduce evaporation.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Hazardous Materials Management**		
Hazardous Materials Management	Social and Environmental Performance	Establish hazardous materials management priorities (based on hazard analysis of risky operations).

Aspect	Impact	Mitigation
		Avoid, or minimise the use of hazardous materials. Prevent uncontrolled releases of hazardous materials to the environment or uncontrolled reactions that may result in fire or explosion. Implement management controls (procedures, inspections and training, communication and drills) to address residual risks.
Hazardous Materials Management	Pollution of biophysical environment (soil and water)	Implement prevention and control measures for the use, handling and storage of hazardous materials: Materials transfer: regularly inspect, maintain and repair fittings/pipes/hoses; make use of drip trays/other drip containment measures at connection/possible overflow points; Overfill protection: use trained filling operators; install gauges on tanks to measure the volume inside; make use of dripless hose connections (vehicle tanks) and fixed connections (storage tanks); use a catch basin/drip tray around the fill pipe to collect spills; Reaction, fire, and explosion prevention: hazardous materials to be stored in marked containers and separate (from non-hazardous materials); incompatible hazardous materials (acids, bases, flammables, oxidizers, reactive chemicals) to be stored in separate areas and with containment facilities separating material storage; smoking or working with open flames not to be permitted in the presence of these substances; limit access to hazardous waste storage areas and clearly label and demarcate the area; conduct regular inspections of the areas and document the findings; prepare and implement spill response and emergency plans; train employees in the use of appropriate firefighting equipment and ensure that such equipment is on hand at all times. Train workers on the correct transfer and handling of fuels and chemicals and the response to spills. Immediately report and clean up any accidental hydrocarbon spill: Sunsorb, Drizit, Peatsorb can be used to clean up small spills; in case of larger spills, the spill together with the polluted soil should be removed and disposed of at e.g. a biological remediation site.
Hazardous Materials Management	Occupational health and safety	Implement hazard communication and training programmes (including information on Material Safety Data Sheets (MSDS)) to make employees aware of workplace chemical hazards and how to respond to these. Provide and ensure the active use of PPE.
Consumer Fuel Installation	Pollution of biophysical environment	The fuel tank to be put into a bunded enclosure with a net capacity of at least 120% of the net capacity of the tank. Apply to the Ministry of Mines and Energy (MME) for a Consumer Installation Certificate.

Aspect	Impact	Mitigation
		Immediately remove any polluted soil around the diesel tank and dispose of the soil at a biological remediation site, or a recognised hazardous waste disposal site (e.g. Kupferberg outside Windhoek).
***Opuntia ficus-indica* Irrigation Project and Related Activities: Waste Management**		
Waste Management: Non-hazardous and Hazardous	Pollution of biophysical environment	Prepare an **Integrated Waste Management Plan**. The generation of waste should be avoided as far as practicable; where it cannot be avoided, waste should be reduced, re-used and recovered (including recycling and composting); where waste cannot be reduced, re-used and/or recovered, it should be disposed of in an environmentally sound manner. Raise awareness amongst staff and contractors (to reduce, recycle and re-use waste). Stamp down on any form of littering. Non-hazardous and hazardous waste to be collected and stored separately. Hazardous waste: recycle petroleum (fuels and lubricants) waste products and collect and recycle batteries and print cartridges. The remainder (e.g. empty pesticide packaging and containers and unwanted pesticides) to be transported by an approved contractor to a recognised hazardous waste disposal site (e.g. Kupferberg outside Windhoek).
Waste Management: Sanitary	Pollution of biophysical environment	Sanitary wastewater to be released into a French drain/Septic tank system; use bio-degradable detergents on site. Apply for and obtain a licence to discharge effluent from the DWA, MAWLR. Ensure that the discharge of sanitary wastewater to land conform to the water quality standards set out in Annexure 11 (see Part 8, Regulation 67 of Government Gazette Notice, No. 8187 of 29 August 2023, as promulgated under Part 13, Section 72 (1) of the Water Act, Act No. 11 of 2013 - as published in the Government Gazette of the Republic of Namibia, No. 5367, of 19 December 2013, Government Notice No. 332). Supply portable chemical toilets (1 toilet per 30 employees; preferred 1:15) for use by the staff during periods of planting / harvesting. The contents to be collected by an approved contractor and disposed of at an approved sewage site (with prior permission from the Maltahöhe Council).
Wastewater Management	Pollution of biophysical environment	Ensure that the discharge of process wastewater and/or sanitary wastewater and/or wastewater from utility operations and/or stormwater conform to the water quality standards set out in Annexure 11 (see Part 8, Regulation 67 of Government Gazette Notice, No. 8187 of 29 August 2023, as promulgated under Part 13, Section 72 (1) of the Water Act, Act No. 11 of 2013 - as published in the Government Gazette of the Republic of Namibia, No. 5367, of 19 December 2013, Government Notice No. 332). Runoff from areas where surface water might have become contaminated should be captured and treated to sewage effluent standards; uncontaminated runoff should be diverted around areas where such water might become contaminated.

Aspect	Impact	Mitigation
Wastewater Management - Stormwater Management	Soil erosion	Regular inspection and maintenance of permanent erosion and runoff control features.
***Opuntia ficus-indica* Irrigation Project and Related Activities: Closure of the Orchard**		
Closure of the Orchard	Social and Environmental Performance	Develop, implement and maintain a **Closure Plan** (including details re the roles and responsibilities and financial provision to implement the closure plan) for the *Opuntia ficus-indica* irrigation project and associated activities.
Closure of the Orchard	Invasion of the natural vegetation through the spread of *Opuntia ficus-indica* (and other invasive plant species) and disruption to ecosystem balance	Inspect the 5 m cleared control strip around the outside of the fenced production area together with a 100 m buffer strip outside of the 5 m strip annually for any *Opuntia* (and other invasive) plants. Uproot and destroy any *Opuntia* (and other invasive) plants in the disposal area inside the fence.
Solar PV Plant	Pollution of biophysical environment	Remove all the components and recycle / dispose of the components as per the suppliers requirements.

7.5 Monitoring and Reporting

The following monitoring and reporting, at least but not limited to, need to be carried out (also see Kolberg, 2024; and Sarma, 2024; see Figure 12):

Type	Parameter	Frequency
Climate data	Rainfall	*Ad hoc* (rainy season); record daily totals
Pumped volumes: Production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP)	Pumped volumes of groundwater for irrigation	Weekly; report totals to the Department of Water Affairs (DWA), Ministry of Agriculture, Water and Land Reform (MAWLR) as per abstraction license conditions
Groundwater levels: Monitoring boreholes (WW207159, WW207161, WW207163 and WW207164) Groundwater levels: Production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP)	Groundwater levels after overnight stoppage of pumping	Weekly; report to DWA, MAWLR as per abstraction license conditions
Groundwater quality: Production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP)	Groundwater quality (electrical conductivity and pH) (to monitor salinity and acidity changes)	Monthly during the life of the irrigation scheme
Groundwater quality: Production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP).	Groundwater quality (standard parameters, metals, major ions, pesticide and fertilizer traces)	Yearly during the life of the irrigation scheme and three (3) years after decommissioning
Irrigation (amount and frequency)	Soil moisture measurement (using probes)	During the operation of the irrigation scheme
Discharge of effluent	As per the DWA, MAWLR's conditions to the effluent discharge license	
Consumer Fuel Installation	As per the Ministry of Mines and Energy's (MME's) conditions to the Consumer Installation Certificate	
Hazardous materials management	Hydrocarbon spills of more than 200 litres	*Ad hoc*; inform the Minister, MME by completing form PP/11 (Petroleum Products Regulations 2000)
Stormwater and soil erosion	Soil erosion rates	*Ad hoc* (rainy season)
Invasive plant species	Identification, uprooting and destruction of any *Opuntia* (and other invasive) plants in the 5 metre (m) cleared control strip around the outside of the fenced production area, together with a 100 m buffer strip outside of the 5 m strip	Yearly during the life of the irrigation scheme and three (3) years after decommissioning (cease monitoring if nothing is found after one year)
Salinisation of soil	Soil texture and chemistry	Prior to planting
		Prior to first fertilisation and then yearly
	Salinity of irrigation water	Yearly
Cochineal *Dactylopius* spp.	Inspection of *Opuntia ficus-indica* for Cochineal *Dactylopius* spp. and treating, or destroying infected plants	Every two to three weeks
Environmental Management Plan (EMP)	Implement and observe the EMP; Environmental performance / corrective measures to be taken as or when required	Environmental Monitoring Reports to be submitted to the Directorate of Environmental Affairs and Forestry (DEAF), Ministry of Environment, Forestry and Tourism (MEFT) every six (6) months

Figure 12: Map showing the proposed production and monitoring boreholes (*Source: Sarma, 2024*).

8 Conclusions and Recommendations

The proposed *Opuntia ficus-indica* irrigation project to be located on Farm Namseb No. 24, near Maltahöhe in Namibia, will provide an important baseline for any future assessments regarding *Opuntia* cultivation and so improve the management of cactus orchards to minimise their impacts on the natural environment (see Kolberg, 2024).

The following statement, made by Dewald van der Berg from Farm Witkraal, near Petrusburg in the Free State, South Africa, should, however, be noted: ''*It's a fallacy that cactus pear orchards don't need much management because of the plants' hardiness and adaptability''… ''The orchards need to be cleared of weeds and inspected for pests on a regular basis. The plants require fertiliser at planting, and every year thereafter before the start of the new growing season* (Coleman, 2023).''

The Gusinde Von Wietersheim Successors Trust's proposed activities (*Opuntia ficus-indica* irrigation project and associated activities) will have impacts on the environment, both positive, as well as negative in nature. one significant negative, 14 moderate negative, 15 negative, one slight negative, one moderate positive, and nine significant positive impacts were identified.

The significant negative, moderate negative, negative, and slight negative impacts can be relatively easily mitigated through the implementation of certain management measures contained in the Environmental Management Plan.

It is advised that the Gusinde Von Wietersheim Successors Trust (and their employees and contractors) should implement and observe the Environmental Management Plan on an ongoing basis. Environmental performance should be regularly monitored (so that the lessons learnt can be incorporated into the improvement of the Environmental Management Plan over time) and corrective measures taken as or when required.

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Annexure A

MINISTRY OF ENVIRONMENT, FORESTRY AND TOURISM
DIRECTOR: ENVIRONMENTAL AFFAIRS
19 FEB 2024
Private Bag 13306
WINDHOEK NAMIBIA

environmental consulting
Telephone: +264 61 255750
Mobile: +264 81 2458790
e-mail: lima@iway.na
PO Box 1284
Windhoek Namibia

19 February 2024

The Executive Director
Ministry of Agriculture, Water and Land Reform
Private Bag 13184
Windhoek

CC: The Environmental Commissioner
Ministry of Environment, Forestry and Tourism
Private Bag 13306
Windhoek

Attention: Me Ndiyapuki Nghituwamata

Re: Application for an Environmental Clearance Certificate - APP-240217 002828

Dear Me Nghituwamata,

Attached to this letter please find:

1. Application Form 1;
2. Contact details of Proponent and Consultant (EAP);
3. Background Information Document (BID);
4. CV (EAP); and
5. ID (EAP).

All comments and queries as a result of the evaluation can be addressed to me.

Yours sincerely,

Dr. L. Maartens

Lizy Mathu

Received by:
(on behalf of the MAWLR)

Date: 2024-02-19

EXECUTIVE DIRECTOR'S OFFICE
MAWLR

MINISTRY OF ENVIRONMENT, FORESTRY AND TOURISM
ENVIRONMENTAL AFFAIRS

Pendapala-A

Received by:
(on behalf of the DEAF, MEFT)

19/02/2024
Date:

ANNEXURE 1
FORMS

Form 1

REPUBLIC OF NAMIBIA ENVIRONMENTAL

MANAGEMENT ACT, 2007 (Section 32)

APPLICATION FOR ENVIRONMENTAL CLEARANCE CERTIFICATE

App-240217 002828

MINISTRY OF ENVIRONMENT, FORESTRY AND TOURISM
DIRECTORATE ... AFFAIRS
19 FEB 2024
PRIVATE BAG ... WINDHOEK NAMIBIA

EXECUTIVE DIRECTOR
MAWF

NAMIBIA REVENUE N$100

NAMIBIA REVENUE N$200

PART A: DETAILS OF APPLICANT

1. Name: (person or business):	Gusinde Von Wietersheim Successors Trust
2. Business Registration / Identity No.:	T260/07 / 78090210732
3. Correspondence Address:	P.O. Box 333, Swakopmund
4. Name of Contact Person:	Mr Guido von Wietersheim
5. Position of Contact Person:	Trustee/Secretary of the trust
6. Telephone No.:	+264 81 325 4790
7. Fax No.:	N/A
8. E-mail Address (if any):	guido.vonwietersheim@commonwaters.de

PART B: SCOPE OF THE ENVIRONMENTAL CLEARANCE CERTIFICATE

1. The environmental clearance certificate is for:

Environmental Assessment for the *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

2. Details of the activity(s) covered by the environmental clearance certificate:

Title of Activity:

Environmental Assessment for the *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

Nature of Activity:

ENERGY GENERATION, TRANSMISSION AND STORAGE ACTIVITIES The construction of facilities for - (a) the generation of electricity; (b) the transmission and supply of electricity

WASTE MANAGEMENT, TREAMENT, HANDLING AND DISPOSAL ACTIVITIES 2.3 The ~~import, processing, use and recycling~~, temporary storage, ~~transit or export~~ of waste.

AGRICULTURE AND AQUACULTURE ACTIVITIES 7.5 Pest control. 7.8 The introduction of alien species into local ecosystems.

WATER RESOURCE DEVELOPMENTS 8.1 The abstraction of ground or surface water for ~~industrial or~~ commercial purposes. 8.7 Irrigation schemes for agriculture excluding domestic irrigation.

HAZARDOUS SUBSTANCE TREATMENT, HANDLING AND STORAGE 9.1 The ~~manufacturing~~, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974.

Location of Activity:

Farm Namseb No. 24, Hardap Region, Namibia
-24.747831° and 16.853894°

Scale and Scope of Activity:

Opuntia ficus-indica Irrigation Project

PART C: DECLARATION BY APPLICANT

I hereby certify that the particulars given above are correct and true to the best of my knowledge and belief. I understand the environmental clearance certificate may be suspended, amended or cancelled if any information given above is false, misleading, wrong or incomplete.

_____	Mr Guido von Wietersheim	Trustee/Secretary of the Trust
Signature of Applicant	Full Name	Position
on behalf of	Gusinde Von Wietersheim Successors Trust	07 February 2024
		Date

Contact Details of the Proponent

Mr Guido von Wietersheim
Trustee/Secretary of the Trust
Gusinde Von Wietersheim Successors Trust
P.O. Box 333
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Windhoek
Namibia

Farm Namseb No. 24, Hardap Region, Namibia

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Contact Details of the Environmental Assessment Practitioner

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MINISTRY OF ENVIRONMENT, FORESTRY AND TOURISM
SECRETARY FOR FORESTRY AFFAIRS
Private Bag
WINDHOEK NAMIBIA

environmental consulting

nopal

Background Information Document (BID)

Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

Purpose of the BID

LM Environmental Consulting is appointed by Gusinde Von Wietersheim Successors Trust to undertake an Environmental Assessment (*Scoping, Impact Assessment and Environmental Management Plan*) for the proposed Project.

The **Scoping** Process determines the extent of and approach to the detailed assessment; Scoping Report is defined as "*a document prepared by the proponent to present the case for the assessment of an activity as part of the initial assessment process*" (Government of the Republic of Namibia (GRN), 2012).

Environmental Assessment is the "*process of identifying, predicting and evaluating the effects of proposed activities on the environment. It should include information about the risks and consequences of activities, possible alternatives, and steps which can be taken to mitigate (minimize or off-set) any negative impacts. It should also discuss steps to increase positive impacts and to promote compliance with the principles of environmental management*" (Ministry of Environment and Tourism (MET), 2008).

An **Environmental Management Plan** is a "*key document that should consist of the set of measures to be taken during implementation and operation to eliminate, offset, or reduce adverse environmental impacts to acceptable levels. Also included in the plan are the actions needed to implement them*" (Directorate of Environmental Affairs (DEA) (now Environmental Affairs and Forestry (DEAF)), 2008).

Environment is defined as the "*surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation*" (International Organization for Standardization (ISO), 2004).

As part of the Environmental Assessment Process, a **Public Consultation Process** is being carried out. The purpose of Public Participation or Consultation is to provide stakeholders, including the public, an opportunity to participate in the Environmental Assessment Process, in order to ensure that the intended development initiatives consider broad-based concerns. It further improves governance in that the intended development must consider a wide range of issues, e.g. the need to conserve the natural environment and the need to maintain a functioning ecology.

The purpose of the BID is thus to: i) provide stakeholders, including the public, with more information regarding the Project; and ii) give stakeholders, including the public, an opportunity to register as Interested and/or Affected Parties (I&APs) and comment on, or raise any issues and/or concerns related to the Project.

Background

The Gusinde Von Wietersheim Successors Trust, in association with Nopal Corp. in Portugal, is proposing to plant 500 hectares (ha) of *Opuntia ficus-indica*.

According to Government Notice (GN) No. 29 (Government Gazette of the Republic of Namibia, No. 4878, 06 February 2012) the following activities may not be undertaken without an Environmental Clearance Certificate (ECC):

ENERGY GENERATION, TRANSMISSION AND STORAGE ACTIVITIES The construction of facilities for - (a) the generation of electricity; (b) the transmission and supply of electricity
WASTE MANAGEMENT, TREAMENT, HANDLING AND DISPOSAL ACTIVITIES 2.3 The ~~import, processing, use and recycling~~, temporary storage, ~~transit or export~~ of waste.

AGRICULTURE AND AQUACULTURE ACTIVITIES 7.5 Pest control. 7.8 The introduction of alien species into local ecosystems.
WATER RESOURCE DEVELOPMENTS 8.1 The abstraction of ground or surface water for ~~industrial or~~ commercial purposes. 8.7 Irrigation schemes for agriculture excluding domestic irrigation.
HAZARDOUS SUBSTANCE TREATMENT, HANDLING AND STORAGE 9.1 The ~~manufacturing~~, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974.

In line with the Commencement of the Environmental Management Act (EMA), 2007 (Act No. 7 of 2007) (06 February 2012; GN No. 28), the Listed Activities that may not be undertaken without an ECC (GN No. 29), and the Environmental Impact Assessment (EIA) Regulations (GN No. 30) (GRN, 2012), an application for an ECC was thus submitted to the Executive Director, **Ministry of Agriculture, Water and Land Reform** (MAWLR; Competent Authority), and the Environmental Commissioner, **Ministry of Environment, Forestry and Tourism** (MEFT).

Project Location

The proposed irrigation Project will be located on Farm Namseb No. 24, around 17 km north-west of Maltahöhe.

Project Description

An electrical fence will be constructed around the entire Project area (630 ha).

It is proposed to plant 500 ha of *Opuntia ficus-indica*; 10,000 plants will be planted per ha: 40 rows per ha with 250 plants per row.

Opuntia ficus-indica cladodes will be obtained from the existing Nopal Corp. farm in Portugal, shipped in containers to Walvis Bay, and then transported via truck to the site.

Each plant requires at least 48 litres of water per annum and it is proposed to make use of drip irrigation. The water will be obtained from six solar-powered boreholes (depth of less than 100 metres (m)). The daily water requirement is estimated at 660 cubic metres per day (m^3/day) or 110 m^3/day from each of the six boreholes. The annual water requirement (for 500 ha) is estimated at 240,000 m^3.

It is proposed to use organic fertilizer (e.g. dung from local sheep and goats), as well as bio-stimulants (e.g. kelp extract and wood vinegar). NPK+MgO fertilizer in liquid form may be applied through the dripper system, as or when required.

Pest management (pesticides, and including herbicides (weed management) and insecticides (for e.g. Cochineal *Dactylopius* spp. and Cactus moth *Cactoblastis cactorum*)) may be needed. It is proposed to use organic spot treatment with e.g. neem oil, or wood vinegar (vs pesticides); the following insecticides may be used: carbaryl, deltamethrin and methidathion, as well as tralomethrin (pesticide).

The fruit will be harvested for (local) consumption. The cladodes will be used as animal feed (sold wet to local farmers especially during times of drought / dried whole or chopped and sold to animal feed companies / processed on site and made into pellets and fodder blocks which can be sold directly to farmers or to agricultural wholesalers). Both the fruit and cladodes will be harvested using manual labour.

It is foreseen that the following infrastructure will needed: i) office; ii) processing warehouse (possibly two) (and including cold storage facilities); iii) solar system; iv) workshop; v) fuel storage; vi) paved turnaround and loading; vii) weighbridge; viii) guardhouse; ix) manager and guest houses; and x) two accommodation units.

Best practices for the management of *Opuntia ficus-indica* in order to minimise spread (or other potential negative impacts on the environment), will be implemented. A hydrogeological specialist study will also be carried out as part of the Environmental Assessment.

Employment

It is anticipated that around 20 persons will be employed during the initial set-up phase of the proposed Project. During maintenance, approximately 20 persons will be employed, and another 50 persons during periods of harvesting.

Future Involvement

If you would like to remain involved in this process, please register as an I&AP and submit any comments and/or concerns in writing by **20 March 2024**.

Note that the *Draft* Environmental Assessment Report will be made available to registered I&APs for review around **April/May 2023**. Comments received will be incorporated and a Final Environmental Assessment Report will then be submitted to the Executive Director, Ministry of Agriculture, Water and Land Reform (MAWLR), and the Office of the Environmental Commissioner, Ministry of Environment, Forestry and Tourism (MEFT) for review and decision-making.

Contact Details

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E-mail: lmecppp@gmail.com

References

Directorate of Environmental Affairs (DEA). 2008. *Draft Procedures and Guidelines for Environmental Impact Assessment (EIA) and Environmental Management Plans (EMP)*. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek.

Government of the Republic of Namibia (GRN). 2012. Ministry of Environment and Tourism. Government Notice No. 28. *Commencement of the Environmental Management Act, 2007*. Government Notice No. 29. *List of activities that may not be undertaken without Environmental Clearance Certificate: Environmental Management Act, 2007*. Government Notice No. 30. *Environmental Impact Assessment Regulations: Environmental Management Act, 2007*. Government Gazette of the Republic of Namibia. No. 4878. 6 February 2012.

International Organization for Standardization (ISO). 2004. *ISO 14001 Environmental management systems — Requirements with guidance for use*. Second Edition. 32 pp.

Ministry of Environment and Tourism (MET). 2008. *Guide to the Environmental Management Act 7 of 2007*. 64 pp.

Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

Registration as an Interested and Affected Party (I&AP)

Date:	
Title, Name & Surname:	
Organization & Designation:	
Postal Address:	
Telephone:	
Cell:	
E-mail / Fax:	

Declaration of Interest:

Issues / Concerns / Comments:

Please E-mail or Fax to:

E-mail: lmecppp@gmail.com

Fax2Mail: 088 61 9004

lm environmental consulting

Copy of Identification Document of the Environmental Assessment Practitioner

REPUBLIC OF NAMIBIA
NATIONAL IDENTITY CARD

NO. 690715 0048 9

SURNAME
MAARTENS

FIRST NAME(S)
LIMA

DATE OF BIRTH
1969-07-15

PLACE/COUNTRY OF BIRTH
WINDHOEK

GENDER HEIGHT/m
FEMALE 1,68

DATE OF ISSUE
1999-03-24

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Windhoek, Namibia

Skills

Environmental Scoping
Environmental Impact Assessments
Environmental Management Plans
Environmental Auditing
Environmental and Social Due Diligence & Legal Compliance
Technical Reviews & Proofreading
Project Management
Research & Monitoring

Education And Training

2000
Ph.D.: Fisheries Science
Rhodes University
Grahamstown, South Africa

1992
B.Sc. Hons: Animal Physiology
Stellenbosch University
Stellenbosch, South Africa
1991
B.Sc.: Zoology and Physiology
Stellenbosch University
Stellenbosch, South Africa

1987
Senior Certificate
Windhoek High School
Windhoek, Namibia

Languages
Afrikaans: First Language
English: Proficient

Membership in Professional Bodies

Associate Membership and Associate Environmental Auditor - Institute of Environmental Management & Assessment (IEMA), United Kingdom
Lead Practitioner, Practitioner, Reviewer - Environmental Assessment Professionals of Namibia (EAPAN)
Full Member - Namibian Chamber of Environment (NCE)
Member - Namibia Scientific Society

Lima Maartens

Summary

I have 31 years' experience in natural resource management, lecturing, environmental science and management, and consulting. Sectors that I worked in as an Environmental Assessment Practitioner include: exploration (including offshore oil and gas); mining and quarrying; renewable energy (solar and wind); tourism; manufacturing; agriculture; aqua- and mariculture; township, property (including medicine storage facilities) and waterfront developments, transport (rail and road), and infrastructure.

Employment Record

LM Environmental Consulting – Environmental Assessment Practitioner
10/2009 – Current; Windhoek, Namibia
Valencia Uranium (Pty) Ltd – Environmental Manager
09/2006 – 09/2009; Windhoek, Namibia
De Beers Marine Namibia (Pty) Ltd – Senior Environmental Scientist
01/2004 – 08/2006, Windhoek, Namibia
Simonis Storm Securities – Analyst
09/2002 – 12/2003, Windhoek, Namibia
University of Namibia – Lecturer
10/2000 – 06/2002, Windhoek, Namibia
Ministry of Fisheries and Marine Resources – Fisheries Biologist
01/1993 – 09/2000, Swakopmund, Namibia

Additional Skills

Oxford Climate Society, Oxford School of Climate Change: *Completion of the School of Climate Change* (2023 and 2022)
College of Agricultural Sciences, Pennsylvania State University, United States of America: *Beekeeping 101* (2020); Cornell University's College of Agriculture and Life Sciences, New York State, United States of America: *BF 160: Introduction to Beekeeping* (2020); and Thomas Carroll, PhD & Udemy: Background to Beekeeping: Start with Why! (2020)
SHEilds Ltd., United Kingdom: *NEBOSH Certificate in Environmental Management* (2018)
NOSA, Windhoek, Namibia: *Applying SHE (Safety, Health, Environment) Principles and Procedures* (2012)
Centre for Environmental Management, Potchefstroom, South Africa: *Introduction to Integrated Waste Management for Environmental Managers* (2009)
Crystal Clear, South Africa: *IEMA Approved Foundation Environmental Auditor* (2006)
Centre for Environmental Management, Potchefstroom, South Africa: *Implementing Environmental Management Systems (ISO 14001:2004)* (2005)
University of Stellenbosch Executive Development: *Project Management* (2004)

Publications

I have published five peer-reviewed scientific research articles (and three as co-author), six popular articles (and one as co-author), one book chapter (and one book chapter as co-author), 160 technical reports (LM Environmental Consulting), three technical reports (for De Beers Marine Namibia), and one conference paper.

Gusinde von Wietersheim Successors Trust

(Registration No. T260/07)

P.O.Box 333 – Swakopmund – Namibia

RESOLUTION

Extract from the minutes of a meeting of the Donor and Trustees of the **Gusinde von Wietersheim Successors Trust** held on the 7th day of December 2023 at Swakopmund.

Present:

Donor & Chairperson:	Anton Gusinde von Wietersheim
Trustee:	Monika Gertrud von Wietersheim
Trustee & Secretary:	Guido Kurt von Wietersheim

It was resolved that:

"The **Gusinde von Wietersheim Successors Trust** gives consent to drill new boreholes, rehabilitate existing boreholes and extract water on its Farm Namseb No. 24.

To this effect, Mr. Guido Kurt von Wietersheim is authorized to represent the **Gusinde von Wietersheim Successors Trust** for the purpose of:

1. Applying, on behalf of the **Gusinde von Wietersheim Successors Trust**, for borehole licenses, permits for boreholes in a water protected area, licenses to utilize a protected water source, licenses to extract and utilize water on Farm Namseb No. 24 with respect to any number of new boreholes to be drilled as well as with respect to existing boreholes being present on the property.
2. Applying for all licenses, permits, certificates, exemptions, or any other documents required, as well as appointing experts and representatives during the application process as agents on behalf of the **Gusinde von Wietersheim Successors Trust**."

Donor & Chairperson

Monika G. von Wietersheim

Trustee

Trustee & Secretary

I certify that this document is a true reproduction / copy of the original which was examined by me and that, from my observations, the original has not been altered in any manner.

Signature

NAMIBIAN POLICE FORCE
MALTAHÖHE POLICE STATION
2023 -12- 12
CHARGE OFFICE

OFFICE OF THE GOVERNOR – HARDAP REGION

Tel: 063-240944 / 240947
Fax: 063-241866

Hardap Regional Council
3rd Floor

Private Bag 2017
Mariental

HON. CALLE SCHLETTWEIN
THE MINISTER
MINISTRY OF AGRICULTURE, WATER & LAND REFORM
PRIVATE BAG 13343
WINDHOEK

Dear Hon. Schlettwein,

LETTER OF RECOMMENDATION FROM THE GOVERNOR'S OFFICE:

The Office of the Governor of the Hardap Region wishes to attest herewith that the Gusinde Von Wietersheim Successors Trust as the landholder in association with NOPAL CORP. (the investors) is currently in the process of implementing a 500 ha irrigation project for Prickly Pears in Hardap Region 15 km west of Maltahöhe.

This project is the first of its kind and is believed to create numerous employment, training and small business opportunities for the people of the region. The positive impact and development potential of this project for the region cannot be overstated.

The Office of the Governor has a vested interest in the timely and unhindered process of implementing the project for the benefit of the region and its people and is being kept updated about the development on a regular basis.

It is against this background that the Office of the Governor recommends that the Gusinde Von Wietersheim Successors Trust is to be supported in the timely acquisition of the necessary borehole and water abstraction permits needed for the project to proceed without delay.

Please accept Honourable Minster, the assurance of my highest esteem and regard for your office.

Yours sincerely,

SALOMON M. APRIL
HARDAP REGIONAL GOVERNOR

OFFICE OF THE GOVERNOR
HARDAP REGION
2024-02-27
P/BAG ...ENTAL
Tel: 063-240944
Fax: 063-241866

Annexure B

LM Environmental Consulting
PO Box 1284, Windhoek, Namibia

Trustee / Secretary of the Trust
Gusinde Von Wietersheim Successors Trust
P.O. Box 333,
Swakopmund,
Namibia

SPECIALIST REPORT

Hydrogeology Component of an Environmental Impact Assessment for Development of Irrigation Farming in Farm Namseb, Maltahöhe, Hardap Region

[rev1]

Project: NHN272

JUNE 2024

Namib Hydrosearch

PO Box 20690 Windhoek Namibia, diganta@namibhydro.com

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Abbreviations

DWA	Department of Water Affairs
DWRM	Directorate of Water Resource Management
EIA	Environmental Impact Assessment
EPL	Exclusive prospecting license
GIS	Geographical Information System
GROWAS	Groundwater information system of the DWA
Hk	Hydraulic conductivity (m/day)
Km	Kilometre
m	Meter
m amsl	Meter above mean sea level
m bgl	Meter below ground level
m^3	Meter cubed
m^3/day	Meter cubed per day
m^3/h	Meter cubed per hour
m^3/year	Meter cubed per year
Mm^3/year	Million meters cubed per year
mm	Millimetre
MAWLR	Ministry of Agriculture, Water and Land Reform, Government of Namibia
S	Storage coefficient (-)
Ss	Specific storage (m^{-1})

Glossary of terms

Aquifer, extent of	The boundaries of the geological unit from which groundwater may be abstracted.
Available drawdown	The depth from the static water table to the main water bearing zone or water strike penetrated by a borehole.
Constant rate test	A pumping test carried out for an extended period at a constant rate. (see "Pumping Test" below)
Dewatering	Decline of the water table or the piezometric head. This may result from pumping rates exceeding the capacity of boreholes.
Discharge	Outflow from the aquifer either naturally or through pumping.
Downhole geophysics	Measurement of physical properties of intercepted geological material down the length of a borehole.
Drawdown	The distance between the static water level and water level during or after pumping in a borehole.
Dry season peak demand	Highest water demand for mining and/or agriculture during the dry season in a year.
Effluent drainage	Surface drainage that receives groundwater (also called gaining stream)
Ephemeral drainage, leakage from	Drainages that experience seasonal flow, following rain events but otherwise remaining dry. Where water from such flow infiltrates the subsurface and recharges underlying groundwater it is referred to as leakage.
Drawdown forecast	Estimate of water level decline due to pumping from an aquifer based on hydraulic characteristics estimated by test pumping and/or groundwater flow modelling.
Groundwater recharge	Inflow of water to the saturated zone of an aquifer due to infiltration of rainwater or leakage from other surface or groundwater bodies.
Hydraulic conductivity	Hydraulic conductivity is the constant of proportionality relating water discharge per unit area of a porous medium under a unit hydraulic gradient according to Darcy's Law. Hydraulic conductivity reflects the ease with which water flows through a porous medium.
Influent drainage	Surface drainage that leaks to the subsurface (also called losing stream)
Isopach	Contours of equal thickness of a sedimentary layer.
Life of Mine	Duration for a which a mine is planned to operate.
Non-dry peak period	Highest water demand, for mining or agriculture, during the rainy season in a year.
Pumping test / Test Pumping	Pumping test carried out on a borehole at set rate(s) for a pre-defined period (s). Discharge and water level are recorded against time to facilitate the calculation of hydraulic characteristics.
Recovery phase	Period in which the water level recovers (rises) following a step drawdown or constant rate test.
Saturated zone	A level below ground where groundwater occupies all open spaces in an aquifer. The water is at a pressure higher than atmospheric pressure in the saturated zone.
Static water level	The distance from the ground surface to the water table in a borehole under normal, undisturbed, non-pumping conditions.
Step drawdown test	A borehole performance pumping test carried out in usually four to five steps of increasing rate. Each step is for an equal duration.
Storativity	Storativity is a measure of the capacity of an aquifer to store and release water.
Sustainable abstraction	Sustainable abstraction is the rate of groundwater withdrawn from an aquifer at a location and for a known duration with acceptable physical, economic, environmental, social, cultural, institutional and legal consequences. It takes into account other existing water demands and possible environmental impacts in assessing available water for use.
Transmissivity	Transmissivity is the product of the hydraulic conductivity and the saturated thickness of the aquifer and is a measure of the overall capacity of the aquifer to transmit water.
Unconfined aquifer	In an unconfined aquifer the water table forms the upper boundary.
Unsaturated zone	The zone between the ground surface and the water table where water and air occupy the open spaces in a porous medium.
Water budget	An account of all inflows (sources) and outflows (sinks) of water to an aquifer is called a water budget. Components of a water budget include water stored in the aquifer, recharge, discharge, pumping etc.

PROJECT INFORMATION

Project	SPECIALIST REPORT: Hydrogeology Component of an Environmental Impact Assessment for Development of Irrigation Farming in Farm Namseb, Maltahöhe, Hardap Region
Client	Trustee / Secretary of the Trust, Gusinde Von Wietersheim Successors Trust P.O. Box 333, Swakopmund, Namibia guido.vonwietersheim@commonwaters.de
Lead consultant	LM Environmental Consulting, PO Box 1284, Windhoek, Namibia lima@iway.na

REPORT REVIEW AND SUBMISSION

Author	Specialist report - Hydrogeology	Diganta Sarma	June 2024
Reviewer	Specialist report – Hydrogeology	Alan Simmonds	June 2024
Lead consultant	Specialist report – Hydrogeology	Lima Maartens	June 2024

DISCLAIMER

This report is prepared for exclusive use of LM Environmental Consulting and Nopal. It records the results of a hydrogeological study to assess environmental impacts from irrigated farming. The report is to be used for the purpose stated – to take decisions on sustainably groundwater supply and evaluate the risk of contamination of groundwater.

The author and Namib Hydrosearch CC are not responsible for the outcome and conclusions drawn in the context of the proposed abstraction and not liable for any consequences of using the report. The limitations in the study and available data are recorded in the report and may not be limited to those noted. The availability and quality of data, performance of software used and inherent limitations of software determine the quality of the results. All care has been taken to verify the data and use concepts and applications appropriately. The study is carried out on the basis of current scientific understanding of groundwater flow and knowledge of aquifers in the Nama Group rocks that may change in the future.

1 Introduction

Large-scale irrigated cultivation of prickly pears is planned on the farm Namseb 24 in the Maltahöhe District. Irrigation is to be from groundwater sources and therefore it is essential that a Water Abstraction License be obtained from the Department of Water Affairs. An Environmental Impact Assessment, focussing mainly on the hydrogeological impacts, is an essential requirement for the granting of the Water Abstraction License for the scale of irrigation that is intended.

An area of 500 hectares (Ha) has been demarcated for the planting of prickly pear (Figure 1). Irrigation water will be sourced from boreholes within the farm. A hydrogeological assessment has been conducted to determine the sustainability of abstracting groundwater, at the required rate, and to determine the environmental risks and impacts of irrigation to local water resources. This assessment is based on existing geological and hydrogeological information, augmented by drilling, test pumping and water quality data collected during the project.

2 Water demand

When fully developed the bulk water requirement of the project will be 658 m^3/day (0.24 Mm^3/year) (Table 1). More than eighty percent (84%) of the groundwater required is available from recent drilling (drilling licence given in Appendix A) and existing boreholes that can be used for the first phase of development. It is anticipated that further groundwater sources will be established to meet the remaining 26% within one year of the project's initiation.

Table 1: Project bulk water requirement

Description	Quantity	Unit
Water requirement per plant	48	litres/plant/year
Plant density	10,000	plants /Ha
Planting area	500	Ha
Total water requirement	240,000,000	litres / year
	240,000	m^3/year
	658	m^3/day

3 Physical setting

3.1 Topography and drainage

Namseb Farm is at an elevation of around 1400 m amsl with a gradual slope towards the east. Along the eastern boundary of the farm a north-south ridge forms a prominent topographical feature. Ephemeral drainages originating in the north and south converge and cut through this ridge to join the east flowing Hudup River (Figure 1). These rivers only flow annually for brief periods during rainy seasons, except when drought conditions prevail (e.g. hydrological year 2023-24). Flow in these rivers is slow and the Hudup River holds some water for most of the year as seen in pools and areas of shallow saturated alluvium.

On Namseb, cover is generally thin (less than 1 m thick) except where alluvial sediments are present close to the ephemeral drainages. Soils are commonly very fine grained and poorly drained.

Figure 1: Project area location, topography and major rivers

3.2 Rainfall

Rainfall data from 1981 to 2024 were downloaded from the CHIRPS daily data set (Funk et al. 2014) for the farm location (16.8522E, -24.7472S) and these are presented as graphs in Figure 2 and Figure 3. The mean annual precipitation (MAP) over this period is 105 mm confirming arid conditions. Average monthly rainfall figures (Figure 3) show that rainfall occurs during the summer months of January to April, and monthly averages exceed 20 mm only in February and March. Rainfall variability is high and events lower than 50 mm/year of the MAP were recorded recently in 2018-19 and 2022-23 while events larger than 150 mm/year were reported in 1986-87, 1999-00, 2005-06, 2006-07, 2007-08, and 2010-11 seasons.

Figure 2: Annual total rainfall (mm) and 5-year moving average of annual rainfall

Water deficit conditions prevail in the area most of the year, as illustrated by potential evapotranspiration rates (Terra MODIS 2024, appeears.earthdatacloud.nasa.gov) exceeds average rainfall during all months except in January, February, March and April. Under the arid conditions prevalent in the area above average rainy seasons are usually required to recharge groundwater and for the water table to recover.

Figure 3: Average monthly rainfall and potential evapotranspiration

3.3 Geology

In general, the area is underlain by sedimentary rocks of the Nama Group of the Fish River Basin (Geological Survey of Namibia map sheet 2416, Lohe et al., 2020). Specifically at the project area, sandstone and siltstone of the Kreyrivier Member and the overlying Niep Member of the Nomtsas Formation (Table 2) are exposed (Figure 4). Dips of 3° - 6° SE (N132° to N152°) were measured on the generally flat lying strata. Jointing is clearly visible affecting these lithologies. Near vertical to steep dips were noted in fracturing close to joints and visible on satellite imagery (e.g., 63° dip towards SE).

Within a radius of 3 km of the centre of the proposed irrigation field boreholes intersected uniform grey indurated fine sandstone, weathered at shallow levels (0 to 30m) to reddish brown or purplish brown. Borehole logs are given in Appendix B.

Table 2: Lithostratigraphic units of the Mariental - Maltahöhe area (Map sheet 2416)

Age	Group	Subgroup	Formation	Member	Lithology
Recent					Alluvial and aeolian deposits
PALAEOZOIC	Nama	Visrivier	Breckhorn		Grey, red and purple sandstone, minor shale
			Stockdale	Wasserfall	Red friable sandstone with minor shale
				Inachab	Grey to reddish quartzite and shale, with thin basal pebbly sandstone
				Haseweb	Red friable sandstone with red sandstone
				Kabib	Thin basal conglomerate
		Schwarzrand	Vergesig		Green shale with green and red sandstone
			Nomtsas	Niep	Red sandstone with a few interbeds of red shale
				Kreyrivier	Reddish shale and reddish sheet sandstone
UPPER PRECAMBRIAN			Urusis		Greenish shale and greenish sheet sandstone
			Nudaus	Vingerbreek	Green shale with minor intercalated greenish sheet quartzite
				Niederhagen	Grey to greenish quartzite with intercalated green shale
		Kuibis	Zaris	Schlip	Two pink stromatolitic limestone layers separated by shale and quartzite
				Urikos	Bluish-green shale with interbeds of quartzite and minor limestone
				Hoogland	Blackish grey to greyish limestone, in places oolitic and stromatolitic

4 Hydrogeology

As the arenaceous units of the Nomtsas Formation are fine grained and have negligible primary porosity, groundwater occurrence is restricted to secondary features such as fractures and joints. These lithologies are known to have N-S joint systems of moderate to high groundwater potential. Borehole sites are usually selected on such fractures or joints which are visible on satellite imagery or on the ground. When targeting such fractures drilling must be on the down-dip (hanging wall) side of non-vertical structures (Bockmuhl, F in Lohe et al., 2020) to ensure that they are intersected below the water table.

The GROWAS database has 33 borehole records within a 10 km radius of the project area. Of these 16 (48%) are recorded as dry and the average yield of successful boreholes is 8 m^3/h. Some 375 m from the northwestern corner of the proposed irrigation plot a borehole is recorded with a blowout yield of 45 m^3/h on the Farm Marion Reitz (25).

Water strikes encountered in the eight project boreholes were at 11m to 50m below surface while the depth to the water table is from 6.5 m to 14 m (Figure 5). From the lithology, depth to water table and test pumping interpretation the aquifer encountered is interpreted to be under unconfined conditions whereas an artesian flowing aquifer, also hosted by Nama Group sandstones, south of Farm Namseb, has been protected by a Sub-terranean Water Control Area (Figure 4).

Figure 4: Geology of the project area

ID	Description	Depth	Water level (m)	Yield (m^3/h)
WW207160	Project borehole, test pumped	100	9.38	8
WW207162	Project borehole, test pumped	100	10.97	8
WW207159	Project borehole	100	10.62	0
WW207161	Project borehole	153	10.56	0
WW207163	Project borehole	100	11.58	0
WW207164	Project borehole	50	9.2	0.5
PBH7	Project borehole	146	11.53	0.5
PBH8	Project borehole	219	13.54	0
WW84774	Farm borehole, test pumped	38.2	6.48	14
FBH4_TP	Farm borehole, test pumped	NULL	11.25	13
FBH5_TP	Farm borehole, test pumped	45	11.74	1.5
WW84188	Farm borehole	10.7	8.2	4.5
FBH9	Farm borehole	40	12	2
WW71240	Farm borehole	16.7	7.97	45
FBH6	Farm borehole	NULL	NULL	3

Figure 5: Borehole information and groundwater elevation contours

Groundwater level contours were drawn using data collected during the hydrocensus (Figure 5). Contours show that the groundwater flow direction is from north to south following the topographical slope and surface water drainage towards the Hudup River. Recharge to unconfined aquifers in arid regions is often dependant on flow in ephemeral rivers. This is confirmed by the influence on groundwater elevation contours by river courses shown in Figure 5.

4.1 Drilling

Eight drilling sites were selected by Messrs P van Wyk on request of the project management. A drilling licence application (Appendix A). was issued by the Department of Water Affairs, MAWLR as required by the Water Resources Management Act (2013)

Table 3summarises the drilling results and the borehole logs are given in Appendix B. Figure 5 shows the locations of the boreholes drilled.

4.2 Test pumping

Two project boreholes struck water with blow out yields of 8 m^3/h and were test pumped. Three existing farm boreholes were also test pumped (Figure 5). Test pumping data were interpreted and the estimated aquifer and well parameters were used to estimate production pumping rates. Information on water strikes and borehole construction of existing boreholes were not available except for few records in the GROWAS database. Although these boreholes were drilled in the 1960s, they continue to produce water and are therefore useable for the project.

Test pumping data interpretation was carried out using the type curve fitting method (Kruseman and De Ridder, 1994) and implemented using AQTESOLV Pro 4.5 software (Duffield, 2007). Aquifer transmissivity of 1 to 143 m^2/day was estimated from test pumping interpretation (Table 4). Specific yield values (dimensionless) used were in the range 0.2 to 0.02. As none of the tests had observation boreholes the initial specific yield values were taken from literature and adjusted to fit the observed field data.

Table 4 gives the estimated parameters, aquifer types and recommended yield of the boreholes selected for supply to the project. Test pumping interpretations are graphically presented in Appendix C together with the projections made for 5 years of pumping assuming no recharge would occur during this period. Shallow water strikes, resulting in limited available drawdown, have restricted the amount of water that can be pumped from each borehole despite high blowout yields achieved after drilling.

5 Available groundwater resources

From the test pumping data interpretation and projections discussed above the available resource is calculated as 23m^3/h (201,480 m^3/year), which amounts to 84% of the total water requirement (240,000 m^3/year) for the entire 500 Ha to be irrigated. This available 84% will be sufficient for the first phase of the project. Further groundwater exploration and development is planned to meet the full water requirement within the first year of the project. The location of the tested boreholes is shown in Figure 5.

Table 3: Project borehole information

Temporary Number	WW number	Longitude	Latitude	Blowout yield (m^3/h)	Static water level (m)	Stick up (m)	Depth (m)	Water strike (m)	Water level (m)
PBH1	WW207159	16.847733	-24.746300	0	10.87	0.25	100	-	10.62
PBH2	WW207160	16.851367	-24.746974	8	9.68	0.3	100	45 & 50	9.38
PBH3	WW207161	16.857000	-24.749117	0.25	11.1	0.54	153	-	10.56
PBH4	WW207162	16.856383	-24.745983	8	11.41	0.44	100	15 & 32	10.97
PBH5	WW207163	16.855979	-24.740455	0	12.13	0.55	100	-	11.58
PBH6	WW207164	16.853839	-24.766794	0.5	9.6	0.4	50	-	9.2
PBH7	WW207395	16.871683	-24.755250	0.5	11.88	0.35	146	34	11.53
PBH8	WW207396	16.881642	-24.785107	0	13.88	0.34	219	-	13.54

Note: Borehole logs are given in Appendix B

Table 4: Summary information on boreholes test pumped and recommended yield calculation

Temporary Number	WW number	Longitude	Latitude	Blowout yield (m^3/h)	Static water level (m)	Stick up (m)	Depth (m)	Water strike (m)	Water level (m)	Recommended yield (m^3/h)	Transmissivity (m^2/day)	Storativity	Specific yield	Available drawdown (m)	Remarks
PBH2	WW207160	16.851367	-24.746974	8	10.87	0.25	100	45 & 50	9.68	5.0	75	0.0030	0.035	2.2	Project borehole
PBH4	WW207162	16.856383	-24.745983	8	9.68	0.3	100	15 & 32	10.87	1.0	1	0.0053	0.057	2	Project borehole
BH3TP	WW84774	16.874049	-24.786861	14	6.53	0.05	38.2	11	6.48	7.0	51	0.0080	0.080	5	Existing farm boreholes
BH4TP	*applied for*	16.899161	-24.756447	13	11.55	0.3	49	13	11.25	9.0	143	0.0029	0.192	2	Existing farm boreholes
BH5TP	*applied for*	16.891371	-24.780469	1.5	12.04	0.3	45	12	11.74	1.0	35	0.0015	0.017	1	Existing farm boreholes
									Total	23 m^3/h					

Note: Test pumping interpretations are given in Appendix C

6 Irrigation source water quality and vulnerability

Groundwater from the Nomtsas Formation aquifers in the Namseb area (GROWAS database (DWA, 2011) and project data) is of Group-D quality according to the Namibian Water Quality Guidelines. This classification is mainly due to elevated levels of nitrate and fluoride and to high total hardness indicators. Elevated nitrate is usually from anthropogenic sources (human or farm animal waste) and not of natural origin (Tredoux and Talma, 2006) while fluoride and total hardness originate naturally through interaction of groundwater with the aquifer material. Determination of the source of nitrate is beyond the scope of the present study.

Table 5: Water analysis of irrigation water supply boreholes

Sample details		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Location of sampling point		Namseb Farm	Namseb Farm	Namseb Farm	Namseb Farm	Namseb Farm
Description of sampling point		**PBH2**	**PBH4**	**FBH3_TP**	**FBH4_TP**	**FBH5_TP**
Borehole Number		**WW207160**	**WW207162**	**WW84774**	***applied for***	***applied for***
Date of sampling		2024/05	2024/05	2024/05	2024/05	2024/05
Test item number		I241050/1	I241050/2	I241050/3	I241050/4	I241050/5
Parameter	Units	Values				
p H	-	7	9.2	7.1	6.9	6.7
Electrical Conductivity	mS/m	169.1	107.5	389	194.6	314
Turbidity	NTU	2.8	115	0.9	2	0.2
Total Dissolved Solids (calc.)	mg/l	1064	581	2639	1145	1945
P-Alkalinity as CaCO3	mg/l	<10	35	<10	<10	<10
Total Alkalinity as CaCO3	mg/l	370	195	370	420	395
Total Hardness as CaCO3	mg/l	442	14	810	631	1001
Ca-Hardness as CaCO3	mg/l	302	6	509	405	659
Mg-Hardness as CaCO3	mg/l	140	8	301	226	342
Chloride as Cl	mg/l	129	184	620	256	571
Fluoride as F	mg/l	1.5	21	1.8	1	1.1
Sulphate as SO4	mg/l	100	28	728	159	264
Nitrate as N	mg/l	59	0.6	59	20	58
Nitrite as N	mg/l	0.01	<0.01	0.01	0.001	0.01
Sodium as Na	mg/l	192	220	524	167	263
Potassium as K	mg/l	3.3	3.8	4.9	4.5	5
Magnesium as Mg	mg/l	34	2	73	55	83
Calcium as Ca	mg/l	121	2.4	204	162	264
Manganese as Mn	mg/l	0.02	0.13	0.05	<0.01	0.22
Iron as Fe	mg/l	<0.01	4.6	<0.01	<0.01	0.33
Stability pH, at 25°C		6.9	8.8	6.7	6.7	6.5
Langelier Index		0.1	0.4	0.4	0.2	0.2
Ryznar Index		6.7	8.4	6.2	6.5	6.3
Corrosivity ratio		0.8	1.5	4.4	1.3	2.7

	Group B
	Group C
	Group D

A Piper Diagram provides a useful graphical method to interpret groundwater evolution (Figure 6). In the Piper Diagram below higher salinity groundwater, away from the river channels, is seen to be of the sodium-magnesium-sulphate or sodium-magnesium-chloride type. Closer to river channels, salinity is reduced by dilution due to recharge and the water type generally becomes calcium-

bicarbonate type (e.g., FBH4_TP). In the Namseb area other water types evolve from mixing of these two main types of water.

Figure 6: Piper diagram of groundwater chemistry of the Nomtsas Aquifer. Symbol size is proportional to total dissolved solids.

First pass assessment of the suitability of water for irrigation is commonly carried out examining the calculated sodium and salinity hazards. Excess of salts content is one of the major concerns with water used for irrigation. A high salt concentration present in the water (and/or soil) may negatively affect crop yields and can lead to degradation the land and groundwater quality. Both indicators have been calculated for the water samples collected during this project and are presented in Table 6 below.

Groundwater in the area has variable salinity as reflected in the electrical conductivity and total dissolved solids values in Table 5. Higher salinity results from increase of dissolved ions including sodium which in turn elevates both salinity hazard and sodium hazard of the water (Table 6). Excess irrigation water that is not drained therefore poses a risk of salinization of the soil and possible increase of groundwater salinity if the excess water infiltrates underground. This risk can be lowered by blending of different source water (such as relatively lower salinity water from boreholes PBH1 and FBH4_TP can be blended with the other sources). Irrigation rates will also require to be optimised so that infiltration is minimised. In general, the water requirement for prickly pear irrigation is low (Table 1) reducing the risks.

With a shallow water table (6.5 - 13.5 m) and therefore a thin unsaturated zone, the aquifer must be considered vulnerable to pollution from surface, (e.g. domestic and livestock waste and fertiliser). Elevated nitrate levels in groundwater indicates surface pollution, confirming the vulnerability of the aquifer. In areas of outcrop or coarse alluvium the vulnerability will be highest although where soil covers bedrock the risk is slightly reduced due to the low permeability of the soil. This should be borne in mind when planting.

Table 6: Salinity and sodium hazard of irrigation source water. The groundwater has variable salinity hazard and sodium hazard

Borehole	Electrical Conductivity, microS/cm	SAR	Class	Sodium hazard	Salinity hazard
WW207160	1691	5.6	C3-S1	low sodium water	low salinity water
WW207162	1075	35.9	C3-S4	very high sodium water	high salinity water
WW84774	3890	11.3	C4-S3	high sodium water	very high salinity water
FBH4_TP	1946	4.1	C3-S1	low sodium water	high salinity water
FBH5_TP	3140	5.1	C4-S2	medium sodium water	very high salinity water

7 Proposed Agricultural Activities and Environmental impacts

The purpose of this section is to identify and assess the most pertinent environmental impacts and to outline possible mitigation measures. The Rapid Impact Assessment Method has been used to carry out this assessment (Pastakia, 1998).

7.1 Possible impacts

Considering the hydrogeological conditions and proposed activities possible environmental impacts are as follows:

- The boreholes to be used for irrigation are of moderate to low yield with shallow water strikes. The water supply sources are thus vulnerable to over exploitation.
- The Nomtsas Aquifer is unconfined and has a shallow water table (6.5 to 11.7 m bgl) and is therefore vulnerable to contamination from surface. Sources of pollution may include accumulations of agricultural, animal and human waste, including manure around livestock drinking troughs and kraals, french-drains and domestic waste disposal sites near homesteads. Other sources of potential contamination may include leakage from the storage of hazardous liquids (e.g. fuel, pesticides).
- Water demand for drip irrigation of prickly pear is estimated at approximately 240,000 m^3/year to be sourced from the Nomtsas Aquifer. The irrigation rate proposed is in the range of 'deficit irrigation' for this area and interception of infiltration by the crop is expected to limit excess water and therefore limit input to the groundwater regime. Nevertheless, salinization of the soil due to precipitation of salts as a result of evaporation of irrigation water and subsequent mobilisation of the salts to the groundwater during rainfall is a possibility. The impacts could be damage to the soil and locally increase salinity of groundwater.
- Application of fertilisers, pesticides and herbicides in excess of the uptake capacity of the plants and subsequent leaching of these could cause a negative impact on downstream water quality.

- Ill effects of using untreated irrigation supply borehole water that is not suitable for drinking due to high nitrates and salinity.

The environmental impact assessment ratings and mitigation measures are provided in Table 8 below.

7.2 Groundwater management plan and mitigation recommendations

The lack of long-term monitoring data at the start of the project precludes drafting a detailed groundwater management plan. In order to generate an appropriate groundwater management plan the following monitoring programmes are essential (also see summary in Table 7):

1. Baseline data collection: Baseline data was collected during the project and includes groundwater borehole records (hydrogeological logs, instantaneous groundwater levels, and quality); borehole and aquifer properties from test pumping; recommended borehole pumping rates; climatic data (rainfall); agricultural water use and geological maps.
2. Time-variant monitoring: Long term data is lacking for the project area. Early commencement of groundwater level, pumping and rainfall data collection is strongly advised.
3. Establish water level monitoring network: Groundwater level monitoring in pumping and monitoring boreholes is strongly advised. Monitoring boreholes have been selected within the irrigated farm and in the down flow direction (Figure 7). Boreholes not viable for pumping due to limited yield are selected for monitoring. These include boreholes monitoring boreholes WW207159, WW207161, WW207163 and WW207164 and the production boreholes WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP. The monitoring network is to be established before commencement of the irrigation scheme. Water levels in the production boreholes are to be measured weekly after overnight recovery of water levels after pumping (Figure 7).
4. Borehole abstraction monitoring: Pumping rates and total pumping volumes from each production borehole are to be monitored on a weekly basis.
5. Rainfall monitoring: Rainfall monitoring (daily totals) should be continued at the farm house and commenced at the irrigation scheme.
6. Water quality: Electrical conductivity and pH should be measured at site on a monthly basis to monitor salinity and acidity changes. Sample should be collected on an annual basis from production boreholes and submitted to a laboratory for water quality monitoring aimed at detecting the presence of fertilisers, pesticides and their breakdown products.
7. Soil moisture monitoring: During operation of the irrigation scheme, soil moisture monitoring for the optimisation of irrigation rates and timing is recommended. The management of irrigation rates can allow reduction of pumping, fertilizer and biocide use thereby reducing the risk of groundwater contamination.
8. Storage of hazardous materials such as fuel tanks, pesticides and chemicals, are to be concrete-lined with bunding to contain spillage within the concrete lining. Workshops are to be similarly concrete lined.
9. Domestic wastewater: Septic tanks are to be used for treatment of domestic wastewater at the accommodation and offices planned at the project site.

It is recommended that a comprehensive water management plan be drawn up once sufficient data have been accumulated to facilitate the evaluation of the impact of the scheme and its sustainability.

This will probably be after the first year of irrigated farming and should cover both a wet and a dry season.

8 Conclusions

Based on the above the following are concluded.

- Sustainable use of groundwater as planned for the project is feasible and can be met by the identified sources. The Nomtsas Aquifer is being utilised for supply and in the scale of abstraction proposed, close monitoring of water levels, abstraction and rainfall followed by periodic evaluation of monitoring data will be needed to ascertain sustainability.
- The project site is under arid conditions with mean annual rainfall of 105 mm. Recharge to the aquifer is expected to be episodic occurring during years of higher than average rainfall. Therefore, in estimating recommended pumping rates no recharge for a 5 year period assumed.
- The aquifer is unconfined in the project site and vulnerable to pollutants released at the ground surface such as wastewater and hazardous liquids.
- The groundwater quality is variable with some supply boreholes having salinity and sodium hazards. Application of excessive irrigation water may lead to soil salinisation and deterioration of soil quality. Optimisation of irrigation needs through soil moisture monitoring is recommended which can reduce the risk and also limit water usage.

9 References

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Figure 7: Selected project boreholes for monitoring of groundwater levels

Table 7: Monitoring requirements

Type	Parameter	Frequency
Monitoring of abstraction volumes from production boreholes.	Weekly pumped volumes from production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP).	Weekly. Report totals to DWA, MAWLR as per abstraction license conditions.
Monitoring boreholes (WW207159, WW207161, WW207163 and WW207164) Production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP)	Groundwater levels after overnight stoppage of pumping	Weekly. Report to DWA, MAWLR as per abstraction license conditions.
Monitoring of groundwater quality	Electrical conductivity and pH should be measured of production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP) on a monthly basis to monitor salinity and acidity changes.	Monthly during the life of the scheme.
Monitoring of groundwater quality	Water quality (standard parameters, metals, major ions, pesticide and fertilizer traces) of production boreholes (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP).	Yearly during the life of the scheme and three years after decommissioning.
Climate data	Rainfall on the farm.	Daily totals.
Discharge of effluent	As per DWA (MAWLR) conditions for effluent discharge permit.	As per DWA (MAWLR) conditions for effluent discharge permit.
Hazardous material management	Hydrocarbon spills of more than 200 litres.	Report to Minister, MME by completing the PP/11 (Petroleum Products Regulation, 2000)
Recommendations for soil moisture monitoring to manage irrigation frequency and amount	Soil moisture measurement through probes.	During the operation of the irrigation scheme.

Table 8: Environmental impact assessment ratings and mitigation measures, Namseb Farm

Impact Code	Potential Impact	Activity / Aspect	Importance of Condition (A1)	Magnitude of Change/Effect (A2)	Permanence (B1)	Reversibility (B2)	Cumulative (B3)	A	B	ES	Probability	Mitigation or Compensation	Comments
PC1	Decreasing groundwater levels	Irrigation	2	-2	2	2	3	-4	7	-28	Probable	Abstraction rates recommended should not be exceeded. Monitoring of groundwater levels, abstraction rates and rainfall and yearly assessment of the data by a hydrogeologist. Draft groundwater management plan after one year of monitoring.	• Abstraction rates recommended should not be exceeded. • Monitoring boreholesWW207159, WW207161, WW207163 and WW207164 identified for weekly water level measurements. • Production borehole (WW207160, WW207162, WW84774, FBH4_TP, FBH5_TP) water levels to be recorded weekly after a recovery period of at least 12 hours. • Flow meters to be installed on all production boreholes and record weekly pumping volumes. • Rain gauge to the installed at the irrigation farm area for daily measurement. • Assessment of monitoring data by a hydrogeologist yearly.
PC2	Contamination of soil and groundwater (irrigation return flow)	Excess irrigation and infiltration of water with fertilizer and biocide input; shallow groundwater	2	-2	2	2	3	-4	7	-28	Probable	Optimisation of irrigation rate to minimise irrigation return flow.	Cost reduction with reduced water, fertilizer and biocide use with optimisation.
PC3	Salinisation of soil and infiltration of high salinity water to the underlying aquifer .	Excess irrigation and leaching of accumulated salts in the soil due to evaporation.	2	-2	2	2	3	-4	7	-28	Highly Probable	Optimisation of irrigation rate to minimise flooding and salt accumulation with evaporation.	Water quality classified as having "salinity hazard"
PC4	Occupation and community health	Use of groundwater for drinking	2	-2	2	2	3	-4	7	-28	Low	Groundwater from irrigation supply borehole identified is not suitable for drinking. Water from these sources will need treatment or water should be supplied from other sources.	Ground D water with high nitrate, fluoride, sodium, and / or salinity (WW207160, WW207162, WW84774, FBH5_TP)
PC5	Contamination of soil (and groundwater) (spills of hazardous materials)	Hazardous Materials Management (spills of fuel/oil/grease/chemicals/paint)	1	-2	2	2	2	-2	6	-12	Highly Probable	Any spillage on soil to be removed to hazardous waste disposal site. Hazardous material must be transported and stored as per the relevant material safety procedures. Fuel storage facilities must be in accordance with the required standards.	Contamination of soil possible. Particular care must be taken as much of the project area is vulnerable to groundwater pollution and has a higher risk of being polluted.
PC6	Contamination of soil (and groundwater) (liquid and solid waste disposal)	Waste management (liquid and solid waste disposal)	2	-1	2	2	2	-2	6	-12	Highly Probable	Proper solid waste management with periodic disposal to controlled waste site. Waste should not be allowed to accumulate for more than one week.	Contamination of soil possible. Particular care must be taken as much of the project area is vulnerable to groundwater pollution and has a higher risk of being polluted.
PC7	Contamination of surface/runoff water during precipitation events	Waste Management (liquid and solid waste storage)	2	-1	2	2	2	-2	6	-12	Probable	Ensure that all chemicals are properly stored in a specific location. All chemicals stored in this area must be properly labelled. The area where chemicals will be stored and handled must be constructed with an impermeable surface and precipitation and surface runoff may not enter such areas.	The safety requirements must be followed at all appropriate sites. Overflow and spillages must be avoided

Appendix A: Drilling Licence

WW numbers issued:

WW207159
WW207160
WW207161
WW207162
WW207163
WW207164
WW207395
WW207396

Appendix B: Borehole Completion Reports, Namseb Farm

Appendix C: Test Pumping data interpretation and recommended abstraction rates from boreholes in Namseb Farm for irrigation use

Appendix D: Water Quality Data, Namseb Farm

Appendix A: Drilling Licence Pre-approval letter

WW numbers issued:

WW207159
WW207160
WW207161
WW207162
WW207163
WW207164
WW207395
WW207396

REPUBLIC OF NAMIBIA

MINISTRY OF AGRICULTURE, WATER AND LAND REFORM

Tel.: (061) 2087224
Fax: (061) 2087697
Enquiries: Ms. R. Feris
Reference: PR 351

Government Office Park
Private Bag 13193
WINDHOEK

11 March 2024

FARM NAMSEB NO. 24
P.O. Box 76
Maltahöhe
Namibia

Dear Mr Von Wietersheim

APPLICATION FOR A LICENCE TO DRILL SIX (6) BOREHOLES FOR IRRIGATION PURPOSES ON THE FARM NAMSEB NO. 24, MALTAHÖHE DISTRICT, HARDAP REGION, MR GUIDO KURT VON WIETERSHEIMEPL.

1. Your application dated 25 January 2024 for a borehole license to drill six (6) boreholes to an approximate depth of 100m for irrigation on farm Namseb No. 30, Maltahöhe district, Hardap Region was dully received.

2. This letter thus authorizes the drilling of six (6) boreholes for irrigation purposes on farm Namseb NO. 24 as an interim arrangement while the licence application is being processed.

3. The applicant is requested to comply with all conditions listed hereunder.

4. This pre-approval authorizes the drilling of six (6) boreholes identified as WW207159 to WW207164 for irrigation purposes.

Accept the assurance of my highest consideration.

Yours sincerely

Ndiyakuni Nghituwamata (Ms)
Executive Director

EXECUTIVE DIRECTOR
20 MAR 2024
Republic of Namibia
Ministry of Agriculture, Water and Land Reform

APPLICATION FOR SIX (6) BOREHOLES LICENCE FOR IRRIGATION USE IN A WATER PROTECTED AREA, MR HENRY COHEN, MALTAHOHE DISTRICT, HARDAP REGION

This license authorizes the drilling of six (6) boreholes identified as **WW207159 - 207164** for irrigation purposes on the farm planning map attached, subject to the following conditions:

1. If drilling is not completed within three years from the date of this licence, this licence automatically expires and application shall be made to the Executive Director for the issuing of a new licence.
2. Where a borehole is drilled in a riverbed, no embankments shall be constructed around the borehole in the riverbed which could result in the river damming up or its normal flow being impeded.
3. All installations, reservoirs, pipes and taps shall be leak proof to prevent any spillage of water. The licence holder shall take the necessary precautions to use the water on his property to the best advantage.
4. The Minister may amend a licence issued under the Water Resource Management Act 11 of 2013 to the extent necessary to prevent or rectify any significant adverse effect in relation to any matter mentioned in section 56 of this Act caused or likely to be caused by an activity carried out under the licence.
5. The Minister may suspend or cancel a licence issued under this Act, if the holder of the licence:
   a) fails to comply with a condition to which the licence is subject
   b) fails to comply with this Act or a directive given under this Act in connection with the licence
   c) fails to commence with operations under the licence within the period specified in the licence;
6. An authorised person may, at any reasonable time and without notice, enter any land or premises where activities under a licence issued under this Act are carried on for the purpose of –
   a) inspecting any waterworks or the use of water or the discharge of wastewater effluent or waste; or
   b) Ascertaining whether this Act or the conditions of the licence are being complied with.
7. Should the licence holder not comply with any of the licence conditions:

a) the Minister may seal the borehole until the conditions are complied with;

b) the licence holder may be held liable for any costs which the Minister may incur as a result thereof,

TECHNICAL DETAILS

1. At least one week before drilling commences, the license holder shall contact the Geohydrology Division: (Mr. Edward Godfried, 061-208 7105 or edward.godfried@mawlr.gov.na) at Windhoek indicating when drilling is to commence and who the appointed drilling contractor will be. As soon as the drilling operation is completed, the license holder shall inform the Geohydrology Division. Failure to do so will be seen in a serious light and punitive measures will be applied.
2. The drill cuttings shall be sampled every one metre during the entire drilling process of the six (6) boreholes by means of prescribed chip (drill cutting) trays and also each time the formation changes indicating on each chip tray the depths at which the sample was taken and the formation change occurred. A drilling record must be completed for each borehole, indicating the penetration rates and borehole completion reports must be fully completed and signed by the driller and supervising Hydrogeologist.
3. If the drilling is successful:

    a. the borehole shall be sufficiently developed in order to remove the fines and fumes that may have been produced or used during the drilling process. A borehole development report must be fully completed.

    b. a complete pumping test shall be conducted consisting of step draw-down test (SDT), constant discharge test (CDT) and recovery tests (RT) after SDT and CDT. Test pumping forms must be fully completed and signed by the supervising Hydrogeologist.

    c. the SDT should be of at least four (4) steps each of which is one hour long.

    d. the CDT should be at least 48 hours long.

    e. each pumping (for both SDT and CDT) should be followed by a Recovery Test lasting for as long as the duration of the preceding pumping or until at least 95% of the total drawdown has been recovered; whichever comes first.

    f. A water sample, at least one (1) litre, must be collected at the end of the CDT and taken to a registered laboratory for chemical analysis to determine the water quality.

4. If drilling is unsuccessful the surface steel casing shall be left in the borehole and a sanitary seal shall be tightly welded onto the top of the surface casing, with the borehole number scripted on it.

5. The drill chip samples, drilling record, borehole completion report, borehole development report, and test pumping data forms must be submitted to the Division of Water Law Administration (WLA).

6. This license is strictly for the drilling of a boreholes and no abstraction of groundwater is permissible. An aapplication for an abstraction license shall be submitted using form WA002 to the DWLA prior to the start of abstraction.

Appendix B: Borehole Completion Reports, Namseb Farm

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan.

WW207159

APPLICANT: Guido von Wietersheim	BOREHOLE NUMBER: WW 1
FARM: Nanseb NUMBER: 24	TOPO & WELL NUMBER:
DISTRICT: Maltahöhe	LATITUDE: S , 24 °44.778'
DATE COMMENCED: 04.04.24	LONGITUDE: E , 016 °50.864'
DATE COMPLETED: 04.04.24	COLLAR HEIGHT: m
	TOTAL DEPTH FROM SURFACE: 100 m

GEOLOGY

from - to in (m)	DESCRIPTION
0 - 6 m	Drill 273 mm
	with 6m x 219 mm
	Casing.
6m - 100m	Drill 94mm x 219 mm

DIAMETER OF BOREHOLE

273 mm from 0 to 6 m
219 mm from 6 m to 100 m
..... mm from ..... to .....

FIRST WATER STRIKE ..... m
SECOND WATER STRIKE ..... m
THIRD WATER STRIKE ..... m
WATER LEVEL ..... m
YIELD m³/h Dry
APPARENT QUALITY OF WATER: .....
TDS WHEN DRILLED: .....

INITIAL CAPACITY TEST

AIRLIFT YIELD * ☐
PUMP YIELD * ☐
YIELD IN m³/h: .....
DATE: .....
DURATION .....

DRILLING COSTS

ITEM	N $
m drilled N$ per m	
testing of borehole:	
CASING	
plain length m N$ per m	
perforated length m N$ per m	
TOTAL COST	

State whether the borehole is:*

☐ successful
☒ unsuccessful
☒ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct	I, the drilling inspector, declare that the information supplied above is true and correct
Signature:	Signature:
Rank: Driller	Rank:
Place: Nanseb Date: 04.04.24	Place: Date:

* mark applicable block

Remarks:

.....
RESPONSIBLE GEOHYDROLOGIST

.....
DATE

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH1
Borehole No	WW207159
Latitude	-24.74630
Longitude	16.847733
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 04/04/2024

	Diameter (mm)	Metres	
Steel surface casing	203	6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
EOH		100.0	

Notes:
BOREHOLE DRY

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	0
Water quality	-
RWL (m bgl)	10.62

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	3	vf		br	ss	weathered grey brown fine sandstone
3	26	vf		gy	ss	slightly weathered purple grey fine sandstone
26	100	vf		gy	ss	uniform dark grey fine sandstone.

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan. WW207160

APPLICANT: Guido van Wietersheim	**BOREHOLE NUMBER: WW** 2
FARM: Namseb **NUMBER:** 24	**TOPO & WELL NUMBER:**
DISTRICT: Maltahohe	**LATITUDE:** S, 24 ° 44.818'
DATE COMMENCED: 05-04-24	**LONGITUDE:** E, 016 ° ~~50.055'~~ 51.023
DATE COMPLETED: 05-04-24	**COLLAR HEIGHT:** m
GEOLOGY	**TOTAL DEPTH FROM SURFACE:** 100 m

from - to in (m)	DESCRIPTION
0 → 6m	Drill 273mm x 6m
	with 219 Casing.
6m - 100m	Drill 219 mm x 94m

DIAMETER OF BOREHOLE

273 mm from 0 to 6m
219 mm from 6m to 100m
..... mm from ..... to .....

FIRST WATER STRIKE 45 m
SECOND WATER STRIKE 50 m
THIRD WATER STRIKE ..... m
WATER LEVEL 45.50 m
YIELD m³/h ± 8
APPARENT QUALITY OF WATER: Good
TDS WHEN DRILLED: .....

INITIAL CAPACITY TEST

AIRLIFT YIELD * ☒
PUMP YIELD * ☐
YIELD IN m³/h: 8
DATE: 05-04-24
DURATION 1 Hour

DRILLING COSTS

ITEM	N $
m drilled N$ per m	
testing of borehole:	
CASING	
plain length m N$ per m	
perforated length m N$ per m	
TOTAL COST	

State whether the borehole is:*

☒ successful
☐ unsuccessful

☒ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct	I, the drilling inspector, declare that the information supplied above is true and correct
Signature:	Signature:
Rank: Driller	Rank:
Place: Namseb Date: 05-04-24	Place: Date:

* mark applicable block

Remarks:

.....
RESPONSIBLE GEOHYDROLOGIST

.....
DATE

WW207160

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH2
Borehole No	WW207160
Latitude	-24.746974
Longitude	16.851367
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 05/04/2024

	Diameter (mm)	Metres	
Steel surface casing	203	6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
EOH		100.0	

Notes:
First water strike: 45m; Second water strike: 50m

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	8
Water quality	-
RWL (m bgl)	9.38

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	3	vf		br	ss	weathered brown, purplish brown fine, white sandstone
3	15	vf		gy	ss	slightly weathered fine sandstone
15	27	vf		gy	ss	grey and grey purple fine sandstone
27	51	vf		gy	ss	grey fine sandstone, water strike at 45 m and 50m
51	100	vf		gy	ss	dark grey fine sandstone

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan. WW207161

APPLICANT: Guido von Wietersheim.	BOREHOLE NUMBER: WW 3
FARM: Nanseb NUMBER: 24	TOPO & WELL NUMBER:
DISTRICT: Maltahohe.	LATITUDE: S, 24 ° 44 . 947'
DATE COMMENCED: 06-04-24	LONGITUDE: E, 016 ° 51 . 420'
DATE COMPLETED: 06-04-24	COLLAR HEIGHT: m

GEOLOGY

from - to in (m)	DESCRIPTION
0 - 6 m	Drill 273mm with
	219mm Casing.
6m - 150m	Drill 219 mm

TOTAL DEPTH FROM SURFACE: 100 m

DIAMETER OF BOREHOLE

273 mm from 0 to 6m
219 mm from 6m to 150m
..... mm from ..... to .....

FIRST WATER STRIKE ..... m
SECOND WATER STRIKE ..... m
THIRD WATER STRIKE ..... m
WATER LEVEL ..... m
YIELD m³/h Dry
APPARENT QUALITY OF WATER: .....
TDS WHEN DRILLED: .....

INITIAL CAPACITY TEST

AIRLIFT YIELD * ☐
PUMP YIELD * ☐
YIELD IN m³/h: .....
DATE: .....
DURATION .....

DRILLING COSTS

ITEM	N$
m drilled N$ per m	
testing of borehole:	
CASING	
plain length m N$ per m	
perforated length m N$ per m	
TOTAL COST	

State whether the borehole is:*

☐ successful
☒ unsuccessful
☒ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct	I, the drilling inspector, declare that the information supplied above is true and correct
Signature:	Signature:
Rank: Driller	Rank:
Place: 06-04-24 Date: Nanseb	Place: Date:

* mark applicable block

Remarks:

.....
RESPONSIBLE GEOHYDROLOGIST

.....
DATE

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH3
Borehole No	WW207161
Latitude	-24.74912
Longitude	16.857000
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 06/04/2024

	Diameter (mm)	Metres	
Steel surface casing	203	6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
EOH		150.0	

Notes:
BOREHOLE DRY

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	0
Water quality	-
RWL (m bgl)	10.56

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	9	vf		br	ss	brown, grey, weathered fine sandstone
9	153	vf		gy	ss	dark grey very fine sandstone

Borehole 1 Step test ← up to 12.4 m³

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan. WW207162

APPLICANT: Guido von Wietershein	**BOREHOLE NUMBER: WW** 4
FARM: Nauseb **NUMBER:** 24	**TOPO & WELL NUMBER:**
DISTRICT: Maltahohe.	**LATITUDE:** S, 24 ° 44. 759'
DATE COMMENCED: 07-04-24	**LONGITUDE:** E, 016 ° 51. 383'
DATE COMPLETED: 07-04-24	**COLLAR HEIGHT:** m

GEOLOGY

from - to in (m)	DESCRIPTION
0 - 6 m	Drill 273mm with
	219 mm Casing.
6m - 100 m	Drill 219 mm

TOTAL DEPTH FROM SURFACE: 100 m

DIAMETER OF BOREHOLE

273 mm from 0 to 6 m
219 mm from 6m to 100m
mm from to

FIRST WATER STRIKE 15 m
SECOND WATER STRIKE 32 m
THIRD WATER STRIKE m
WATER LEVEL 32 m
YIELD m³/h ± 8
APPARENT QUALITY OF WATER: good
TDS WHEN DRILLED:

INITIAL CAPACITY TEST

AIRLIFT YIELD * ☒
PUMP YIELD * ☐
YIELD IN m³/h: 8
DATE: 07-04-24
DURATION 1 Hours

DRILLING COSTS

ITEM	N $
m drilled N$ per m	
testing of borehole:	
CASING	
plain length m N$ per m	
perforated length m N$ per m	
TOTAL COST	

State whether the borehole is:*

☒ successful
☐ unsuccessful

☒ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct	I, the drilling inspector, declare that the information supplied above is true and correct
Signature:	Signature:
Rank: Driller	Rank:
Place: Nauseb Date: 07-04-24	Place: Date:

* mark applicable block

Remarks:

RESPONSIBLE GEOHYDROLOGIST

DATE

WW207162

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH4
Borehole No	WW207162
Latitude	-24.74598
Longitude	16.85638
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 07/04/2024

	Diameter (mm)	Metres	
Steel surface casing	203	6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
EOH		100.0	

Notes:
First water strike: 15m; Second water strike: 32m

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	8
Water quality	-
RWL (m bgl)	10.97

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	15	vf		br	ss	brown, weathered very fine sandstone
15	26	vf		gy	ss	purplish grey very fine sandstone, slightly weathered
26	31	vf		gy	ss	grey very fine sandstone
31	32	vf		gy	ss	weathered very fine sandstone, purplish grey
32	100	vf		gy	ss	fresh dark grey very fine sandstone

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan. WW207163

APPLICANT: Guido von Wietershaim	**BOREHOLE NUMBER: WW** 5
FARM: Nanseb **NUMBER:** 24	**TOPO & WELL NUMBER:**
DISTRICT: Maltahohe	**LATITUDE:** S . 24 ° ~~46.005'~~ 44.42
DATE COMMENCED: 07-04-24	**LONGITUDE:** E . 016 ° ~~71.228'~~ 51.358
DATE COMPLETED: 08-04-24	**COLLAR HEIGHT:** m

GEOLOGY

from - to in (m)	DESCRIPTION
0 - 6 m	Drill 273 mm
	with 219 mm
	Casing
6m - 100m	Drill 219 mm

TOTAL DEPTH FROM SURFACE: 100 m

DIAMETER OF BOREHOLE

273 mm from 0 to 6m
219 mm from 6m to 100m
..... mm from ..... to .....

FIRST WATER STRIKE ..... m
SECOND WATER STRIKE ..... m
THIRD WATER STRIKE ..... m
WATER LEVEL ..... m
YIELD m³/h Dry
APPARENT QUALITY OF WATER: .....
TDS WHEN DRILLED: .....

INITIAL CAPACITY TEST

AIRLIFT YIELD * ☐
PUMP YIELD * ☐
YIELD IN m³/h: .....
DATE: .....
DURATION .....

DRILLING COSTS

ITEM	N $
m drilled N$ per m	
testing of borehole:	
CASING	
plain length m N$ per m	
perforated length m N$ per m	
TOTAL COST	

State whether the borehole is:*

☐ successful
☒ unsuccessful
☒ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct	**I, the drilling inspector, declare that the information supplied above is true and correct**
Signature:	**Signature:**
Rank: Driller	**Rank:**
Place: Nanseb **Date:** 08-04-24	**Place:** **Date:**

* mark applicable block

Remarks:

.....
RESPONSIBLE GEOHYDROLOGIST

.....
DATE

WW207163

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH5
Borehole No	WW207163
Latitude	-24.740455
Longitude	16.855979
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 07/04/2024 & 08/04/2024

	Diameter (mm)	Metres	
Steel surface casing	203	6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
	EOH	100.0	

Notes:
BOREHOLE DRY

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	0
Water quality	-
RWL (m bgl)	11.58

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	5	vf		bg	ss	weathered fine sandstone, grey purple, beige
5	35	vf		gy	ss	weathered fine sandstone, purple grey
35	100	vf		gy	ss	grey fine sandstone

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan. WW207164

APPLICANT: Guido von Wietersheim	BOREHOLE NUMBER: WW 6
FARM: Nauseb NUMBER: 24	TOPO & WELL NUMBER:
DISTRICT: Maltahohe	LATITUDE: S, 24 ° 46.003'
DATE COMMENCED: 09-04-24	LONGITUDE: E, 016 ° 51.228'
DATE COMPLETED: 10-04-24	COLLAR HEIGHT: m

GEOLOGY

from - to in (m)	DESCRIPTION
0 - 6m	Drill 273mm with
	6m x 219mm Casing.
6m - 50m	Drill 44m x 219 mm.

TOTAL DEPTH FROM SURFACE: 50 m

DIAMETER OF BOREHOLE
273 mm from 0 to 6m
219 mm from 6 to 50
mm from to
FIRST WATER STRIKE m
SECOND WATER STRIKE m
THIRD WATER STRIKE m
WATER LEVEL m
YIELD m³/h Dry.
APPARENT QUALITY OF WATER:
TDS WHEN DRILLED:

INITIAL CAPACITY TEST
AIRLIFT YIELD * ☐
PUMP YIELD * ☐
YIELD IN m³/h:
DATE:
DURATION

DRILLING COSTS

ITEM	N $
m drilled NS per m	
testing of borehole:	
CASING	
plain length m NS per m	
perforated length m NS per m	
TOTAL COST	

State whether the borehole is:*
☐ successful
☒ unsuccessful
☒ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct	I, the drilling inspector, declare that the information supplied above is true and correct
Signature:	Signature:
Rank: Driller	Rank:
Place: 10-04-24 Date: Nauseb	Place: Date:

* mark applicable block

Remarks:

RESPONSIBLE GEOHYDROLOGIST

DATE

WW207164

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH6
Borehole No	WW207164
Latitude	-24.766794
Longitude	16.853839
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 09/04/2024 & 10/04/2024

	Diameter (mm)	Metres	
Steel surface casing	203	6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
EOH		50.0	

Notes:
BOREHOLE DRY

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	0
Water quality	-
RWL (m bgl)	9.2

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	3	vf		br	ss	weathered fine sandstone, brown
3	18	vf		gy	ss	weathered grey fine sandstone
18	50	vf		gy	ss	light grey weathered fine sandstone.

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan. WW207395

APPLICANT: Guido van Wietershein	BOREHOLE NUMBER: WW 7
FARM: Namseb NUMBER: 24	TOPO & WELL NUMBER:
DISTRICT: Matterhoe.	LATITUDE: S , 24 045. 315'
DATE COMMENCED: 11 · 04 · 24	LONGITUDE: E , 016 052. 301'
DATE COMPLETED: 11 · 04 · 24	COLLAR HEIGHT: m

GEOLOGY

from - to in (m)	DESCRIPTION
0 - 6m	Drill 273mm with
	6m x 219mm Casing.
6m - 225m	Drill 219mm

TOTAL DEPTH FROM SURFACE: 225 m

DIAMETER OF BOREHOLE
273 mm from 0 to 6m
219 mm from 6m to 225m
mm from to
FIRST WATER STRIKE 30 m
SECOND WATER STRIKE m
THIRD WATER STRIKE m
WATER LEVEL ± m
YIELD m³/h ± 1 m³/h
APPARENT QUALITY OF WATER: Good
TDS WHEN DRILLED:

INITIAL CAPACITY TEST
AIRLIFT YIELD * ☑
PUMP YIELD * ☐
YIELD IN m³/h: ± 1
DATE: 11 - 04 - 24
DURATION 1 Hour

DRILLING COSTS

ITEM	N $
m drilled N$ per m	
testing of borehole:	
CASING	
plain length m N$ per m	
perforated length m N$ per m	
TOTAL COST	

State whether the borehole is:*
☑ successful
☐ unsuccessful
☑ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct
Signature:
Rank: Driller
Place: Namseb Date: 11·04·24

I, the drilling inspector, declare that the information supplied above is true and correct
Signature:
Rank:
Place: Date:

* mark applicable block

Remarks:

RESPONSIBLE GEOHYDROLOGIST

DATE

WW207395

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH7
Borehole No	WW207395
Latitude	-24.75525
Longitude	16.871683
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 11/04/2024 & 11/04/2024

	Diameter (mm)	Metres	
Steel surface casing		6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
EOH		225.0	

Notes:
Water strike: 30m

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	1
Water quality	-
RWL (m bgl)	11.53

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	23	vf		gn	ss	grey, green and purple weathered fine sandstone.
23	29	vf		gy	ss	weathered light grey fine sandstone
29	49	vf		gy	ss	grey fine sandstone
49	146	vf		gy	ss	dark grey fine sandstone
146	225	vf		gy	ss	light grey fine sandstone, micaceos, platy cuttings.

BOREHOLE COMPLETION REPORT

Please indicate at reverse side the position of the borehole and draw a casing plan. WW207396

APPLICANT: Guido van Wichaisheim.	BOREHOLE NUMBER: WW 3
FARM: Nanseb NUMBER: 24	TOPO & WELL NUMBER:
DISTRICT: Maltahohe.	LATITUDE: S, 24 °47. 107'
DATE COMMENCED: 12-04-24	LONGITUDE: E, 016 °52.899'
DATE COMPLETED: 13-04-24	COLLAR HEIGHT: m

GEOLOGY

from - to in (m)	DESCRIPTION
0 – 6 m	Drill 219 mm with
	177mm Casing
6m – 219m	Drill 177mm

TOTAL DEPTH FROM SURFACE: 219 m

DIAMETER OF BOREHOLE
219 mm from 0 to 6 m
177 mm from 6 m to 219 m
..... mm from ..... to .....

FIRST WATER STRIKE ..... m
SECOND WATER STRIKE ..... m
THIRD WATER STRIKE ..... m
WATER LEVEL ..... m
YIELD m³/h Dry
APPARENT QUALITY OF WATER: .....
TDS WHEN DRILLED: .....

INITIAL CAPACITY TEST

AIRLIFT YIELD * ☐
PUMP YIELD * ☐
YIELD IN m³/h: .....
DATE: .....
DURATION .....

DRILLING COSTS

ITEM	N $
m drilled N$ per m	
testing of borehole:	
CASING	
plain length m N$ per m	
perforated length m N$ per m	
TOTAL COST	

State whether the borehole is:*

☐ successful
☑ unsuccessful

☑ Casing left in borehole
☐ Casing recovered

DECLARATION BY DRILLER AND DRILLING INSPECTOR

I, the driller, declare that the information supplied above is true and correct	I, the drilling inspector, declare that the information supplied above is true and correct
Signature:	Signature:
Rank: Driller	Rank:
Place: Nanseb Date: 13-04-24	Place: Date:

* mark applicable block

Remarks:

.....
RESPONSIBLE GEOHYDROLOGIST

.....
DATE

WW207396

SKETCH/MAP

BOREHOLE DESIGN

SPECIFICATIONS

Project FARM NAMSEB 24 - GROUNDWATER DRILLING

BOREHOLE SITED BY PHILLIP VAN WYK

BOREHOLE LOG BASED ON DRILL CUTTINGS

Site No	BH8
Borehole No	WW207396
Latitude	-24.785107
Longitude	16.881642
Elevation	

Drilling contractor AFRICAN DRILLING CC

Date drilled 12/04/2024 & 13/04/2024

	Diameter (mm)	Metres	
Steel surface casing		6.0	Left: Yes
Steel casing	-	-	
Perforation (m)	-	-	
EOH		219.0	

Notes:
BOREHOLE DRY

Casing breakdown	Total	Billed
Plain (m)	6.00	
Perforated (m)	-	
Total installed (m)	6.00	

Apparent yield (m³/h)	0
Water quality	-
RWL (m bgl)	13.54

Depth from	Depth to	Grainsize		Colour	Lithology	Description
0	9	vf		gn	ss	weathered fine sandstone, green and grey.
9	31	vf		gy	ss	light grey fine sandstone
31	156	vf		gy	ss	dark grey fine sandstone
156	191	vf		gy	ss	grey fine sandstone
191	197	vf		gy	ss	light grey fine sandstone
197	207	vf		gy	ss	dark grey fine sandstone
207	219	vf		gy	ss	grey fine sandstone

Appendix C: Test Pumping data interpretation and recommended abstraction rates from boreholes in Namseb Farm for irrigation use

WW207160	STEP DRAWDOWN TEST				RECOVERY	
RWL (m)	Step	Time (min)	Water level (m)	Flow meter reading (m³/h)	Time (min)	Water level (m)
11.5	1	1	11.68	3	1	
	1	2	11.7	3	2	
	1	3	11.7	3	3	13.3
	1	5	11.71	3	5	13.07
	1	7	11.72	3	7	13.01
	1	10	11.73	3	10	12.92
	1	15	11.73	3	15	12.72
	1	20	11.74	3	20	12.33
	1	25	11.76	3	25	12.13
	1	30	11.77	3	30	12.09
	1	40	11.78	3	40	11.99
	1	50	11.79	3	50	11.91
	1	60	11.8	3	60	11.83
	2	1	12.12	6.3	70	
	2	2	12.19	6.3	80	
	2	3	12.21	6.3	90	
	2	5	12.24	6.3	100	
	2	7	12.25	6.3	120	
	2	10	12.28	6.3	150	
	2	15	12.3	6.3	180	
	2	20	12.31	6.3	210	
	2	25	12.33	6.3	240	
	2	30	12.34	6.3		
	2	40	12.35	6.3		
	2	50	12.36	6.3		
	2	60	12.37	6.3		
	3	1	12.77	10.28		
	3	2	12.9	10.28		
	3	3	13	10.28		
	3	5	13.14	10.28		
	3	7	13.19	10.28		
	3	10	13.21	10.28		
	3	15	13.25	10.28		
	3	20	13.28	10.28		
	3	25	13.35	10.28		
	3	30	13.38	10.28		
	3	40	13.42	10.28		
	3	50	13.49	10.28		
	3	60	13.56	10.28		
	4	1	13.61	12.4		
	4	2	13.75	12.4		
	4	3	13.72	12.4		
	4	5	13.72	12.4		
	4	7	13.73	12.4		
	4	10	13.76	12.4		
	4	15	13.75	12.4		
	4	20	13.77	12.4		
	4	25	13.78	12.4		
	4	30	13.8	12.4		
	4	40	13.92	12.4		
	4	50	13.94	12.4		
	4	60	13.96	12.4		

WW207160 CONSTANT RATE TEST RECOVERY

RWL (m)	Time (min)	Water level (m)	Flow meter	Time (min)	Water leve
11.5	1	12.7	10.5	1	21.4
	2	12.8	10.5	2	16.84
	3	12.83	10.5	3	13.65
	4	12.89	12.4	4	13.26
	5	12.94	12.4	5	13.25
	7	13.21	12.4	7	13.19
	10	13.36	12.5	10	13.11
	15	13.46	12.5	15	13.01
	20	13.53	12.3	20	12.91
	25	13.54	12.1	25	12.71
	30	13.59	12.1	30	12.34
	35	13.82	11.9	35	12.15
	40	14.42	11.7	40	12.08
	50	15.54	11.5	50	11.96
	60	16.32	11.3	60	11.84
	75	17.23	11.2	75	11.76
	90	18.15	11.2	90	11.68
	105	18.68	10.6	105	11.63
	120	19.1	10.2	120	11.57
	150	20.74	10.2	150	11.49
	180	21.73	10.2	180	11.44
	210	22.84	10.2	210	
	240	23.78	11.5	240	
	300	21	9.1	300	
	360	20.28	9.1	360	
	480	19.57	9.2	480	
	600	18.6	9.2	600	
	720	22.95	10.2	720	
	840	22.86	8.57	840	
	960	21.79	8.62	960	
	1080	20.98	8.57	1080	
	1200	24.53	9.35	1200	
	1440	26.97	9.2	1440	
	1450	26.7	8.2	1450	
	1460	26.58	8.2	1460	

WW207160

CONSTANT RATE TEST INTERPRETATION - RECOVERY DATA (AGARWAL PLOT)

FORWARD MODEL AT THE PRODUCTION PUMPING RATE OF 120 m^3/day TO 5 YEARS (2,628,000 min)

WW207162	STEP DRAWDOWN TEST				RECOVERY	
RWL	Step	Time (min)	Water level (m)	Flow meter reading (m³/h)	Time (min)	Water level (m)
11.77	1	1	12.26	3.4	1	48.32
	1	2	13.13	3.1	2	47.57
	1	3	15.23	3.1	3	46.95
	1	5	15.69	2.9	5	46.28
	1	7	16.44	3.2	7	45.69
	1	10	17.11	3.2	10	45.06
	1	15	18.21	3.4	15	43.79
	1	20	19.37	3.5	20	42.25
	1	25	20.31	3.5	25	39.98
	1	30	20.97	3.5	30	39.69
	1	40	22.28	3.5	40	37.11
	1	50	23.29	3.4	50	34.62
	1	60	24.21	3.5	60	32.41
	2	1	24.93	5.9	70	30.21
	2	2	25.76	5.9	80	28.04
	2	3	26.72	5.9	90	25.96
	2	5	28.14	6.3	100	23.84
	2	7	28.48	6.3	120	20.44
	2	10	29.58	6	150	17.04
	2	15	31.53	6.3	180	14.58
	2	20	32.52	6.3	210	13.27
	2	25	33.97	6	240	12.84
	2	30	35.45	7.7		
	2	40	37.95	6.6		
	2	50	38.82	5.7		
	2	60	39.75	6		
	3	1	40.15	7.7		
	3	2	40.47	7.7		
	3	3	40.73	7.8		
	3	5	41.43	7.8		
	3	7	41.83	8		
	3	10	42.72	8		
	3	15	43.84	7.5		
	3	20	44.88	7.9		
	3	25	45.55	7.8		
	3	30	46.21	7.8		
	3	40	47.37	7.8		
	3	50	48.47	7.9		
	3	60	49.46	8		
	4	pumping water level reached pump intake				
	4	dewatering trend, test stopped.				
	4					
	4					
	4					
	4					
	4					
	4					
	4					
	4					
	4					
	4					
	4					

WW207162	CONSTANT RATE TEST			RECOVERY	
RWL	Time (min)	Water level (m)	Flow meter reading (m³/h)	Time (min)	Water level (m)
11.77	1	14.06	4	1	47.69
	2	14.59	4	2	47.67
	3	15.27	4	3	47.44
	4	15.96	4.2	4	47.28
	5	17.37	6.1	5	47.14
	7	18.81	5.9	7	46.83
	10	20.88	6.4	10	46.41
	15	23.59	6.2	15	45.94
	20	25.98	6.6	20	45.53
	25	28.13	6.5	25	45.06
	30	29.84	6.4	30	44.66
	35	31.24	6	35	44.23
	40	32.34	5.7	40	43.68
	50	34.31	5.9	50	42.49
	60	36.72	6.3	60	41.34
	75	39.58	6.1	75	39.78
	90	41.78	6.3	150	32.72
	105	44.09	6.1	180	30.44
	120	45.69	5.8	210	25.82
	150	47.46	5.6	240	25.04
	180	47.33	4.4	360	22.2
	210	47.68	4.4	1200	15.26
	240	47.87	4		
	300	47.89	3.8		
	360	47.23	3.6		
	480	46.87	3.4		
	600	46.66	3.2		
	720	46.93	3.9		
	840	47.47	3.1		
	960	47.97	3.8		
	1080	47.79	3		
	1200	47.57	3.1		
	1440	47.69	3.2		

WW207162

CONSTANT RATE TEST INTERPRETATION - RECOVERY DATA (AGARWAL PLOT)

FORWARD MODEL AT THE PRODUCTION PUMPING RATE OF 24 m^3/day TO 5 YEARS (2,628,000 min)

WW84774

RWL	STEP DRAWDOWN TEST				RECOVERY	
6.49	Step	Time (min)	Water level (m)	Flow meter reading (m³/h)	Time (min)	Water level (m)
	1	1	6.96	4.4	1	7.68
	1	2	6.96	3.7	2	7.36
	1	3	6.96	3.7	3	7.24
	1	5	6.96	3.7	5	7.17
	1	7	6.97	3.6	7	7.08
	1	10	6.98	3.5	10	7.02
	1	15	7.02	3.7	15	6.97
	1	20	7.03	3.7	20	6.92
	1	25	7.03	3.6	25	6.89
	1	30	7.04	3.7	30	6.87
	1	40	7.06	3.6	40	6.81
	1	50	7.08	3.7	50	6.77
	1	60	7.09	3.7	60	6.73
	2	1	7.52	6.3	70	6.69
	2	2	7.54	6.3	80	6.65
	2	3	7.54	6.3	90	6.61
	2	5	7.59	6.2	100	6.57
	2	7	7.65	6.8	120	6.54
	2	10	7.66	6.7		
	2	15	7.67	6.8		
	2	20	7.69	6.8		
	2	25	7.7	6.5		
	2	30	7.75	6.8		
	2	40	7.77	6.8		
	2	50	7.79	6.8		
	2	60	7.82	6.8		
	3	1	8.14	8.3		
	3	2	8.42	10.2		
	3	3	8.38	9.6		
	3	5	8.38	9.4		
	3	7	8.38	9.5		
	3	10	8.45	9.5		
	3	15	8.47	9.7		
	3	20	8.5	9.7		
	3	25	8.52	9.8		
	3	30	8.53	9.7		
	3	40	8.57	9.8		
	3	50	8.59	9.6		
	3	60	8.61	9.6		
	4	1	8.95	11.6		
	4	2	9.03	11.5		
	4	3	9.09	12.2		
	4	5	9.16	12.2		
	4	7	9.2	12.2		
	4	10	9.23	12.4		
	4	15	9.28	12.4		
	4	20	9.33	12.5		
	4	25	9.35	12.6		
	4	30	9.36	12.5		
	4	40	9.39	12.6		
	4	50	9.425			
	4	60	9.46	12.6		

WW84774	CONSTANT RATE TEST			RECOVERY	
RWL	Time (min)	Water Level (mb collar)	Flow meter reading (m³/h)	Time (min)	Water Level (mb collar)
6.49	1	7.34	6.3	1	8.78
	2	7.84	8.8	2	8.26
	3	8.36	11.1	3	8.09
	4	8.74	12.0	4	7.98
	5	8.77	12.0	5	7.88
	7	9.22	12.5	7	7.81
	10	9.41	13.6	10	7.74
	15	9.86	15.2	15	7.63
	20	9.97	15.2	20	7.57
	25	10.28	15.4	25	7.51
	30	10.06	14.2	30	7.47
	35	10.31	15.4	35	7.41
	40	10.33	14.5	40	7.38
	50	10.46	15.2	50	7.33
	60	10.69	14.9	60	7.29
	75	10.81	14.9	75	7.25
	90	10.91	15.0	90	7.21
	105	11.02	14.7	105	7.17
	120	11.09	14.7	120	7.13
	150	11.29	15.0	150	7.06
	180	11.44	15.0	180	6.98
	210	11.54	14.5	210	6.93
	240	11.63	14.9	240	6.89
	300	11.68	14.7	300	6.83
	360	11.74	14.9	360	6.78
	480	11.79	14.9	480	6.71
	600	11.82	15.2	600	6.67
	720	11.94	15.1		
	840	12.04	15.0		
	960	12.17	15.0		
	1080	12.23	14.9		
	1200	12.27	15.0		
	1440	12.3	14.9		
	1680	12.3	14.8		
	1920	12.31	15.3		
	2160	12.33	15.0		
	2400	12.34	15.1		
	2640	12.34	15.0		
	2880	12.35	15.0		

WW84774

CONSTANT RATE TEST INTERPRETATION - RECOVERY DATA (AGARWAL PLOT)

FORWARD MODEL AT THE PRODUCTION PUMPING RATE OF 168 m^3/day TO 5 YEARS (2,628,000 min)

	STEP DRAWDOWN TEST				RECOVERY	
RWL	Step	Time (min)	Water level (m)	Flow meter reading (m³/h)	Time (min)	Water level (m)
11.46	1	1	11.47	2.2	1	11.73
	1	2	11.46	2.3	2	11.69
	1	3	11.46	3.7	3	11.67
	1	5	11.46	3.7	4	11.65
	1	7	11.46	3.6	5	11.65
	1	10	11.47	3.5	7	11.64
	1	15	11.48	3.7	10	11.63
	1	20	11.48	3.7	15	11.62
	1	25	11.48	3.6	20	11.6
	1	30	11.48	3.7	25	11.59
	1	40	11.48	3.6	30	11.58
	1	50	11.47	3.7	35	11.57
	1	60	11.48	3.7	40	11.56
	2	1	11.63	6.3	50	11.55
	2	2	11.63	6.3	60	11.55
	2	3	11.63	6.3	210	11.49
	2	5	11.63	6.2		
	2	7	11.63	6.8		
	2	10	11.63	6.7		
	2	15	11.63	6.8		
	2	20	11.63	6.8		
	2	25	11.63	6.5		
	2	30	11.63	6.8		
	2	40	11.63	6.8		
	2	50	11.63	6.8		
	2	60	11.63	6.8		
	3	1	11.81	8.3		
	3	2	11.81	10.2		
	3	3	11.81	9.6		
	3	5	11.81	9.4		
	3	7	11.81	9.5		
	3	10	11.82	9.5		
	3	15	11.82	9.7		
	3	20	11.83	9.7		
	3	25	11.84	9.8		
	3	30	11.85	9.7		
	3	40	11.86	9.8		
	3	50	11.87	9.6		
	3	60	11.88	9.6		
	4	1	11.96	11.6		
	4	2	11.95	11.5		
	4	3	12.02	12.2		
	4	5	12.03	12.2		
	4	7	12.05	12.2		
	4	10	12.08	12.4		
	4	15	12.08	12.4		
	4	20	12.09	12.5		
	4	25	12.11	12.6		
	4	30	12.11	12.5		
	4	35	12.12	12.6		
	4	40	12.13			
	4	50	12.13	12.6		
	4	60	12.14			
	5	1	12.24	12		
	5	2				
	5	3	12.3	12		
	5	5	12.37	13.5		

RWL	Step	Time (min)	Water level (m)	Flow meter reading (m³/h)	Time (min)	Water level (m)
	5	7	12.37	13.3		
	5	10	12.38	13.1		
	5	15	12.4	13.4		
	5	20	12.41	13.2		
	5	25	12.39	13.1		
	5	30	12.39	13.2		
	5	35	12.42	13.3		
	5	40	12.42	13.3		
	5	50	12.41	13.2		
	5	60	12.41	13.2		

	CONSTANT RATE TEST			RECOVERY	
RWL	Time (min)	Water Level (mb collar)	Flow meter reading (m³/h)	Time (min)	Water Level (m)
11.46	1	12.06	12.7	1	12.16
	2	12.09	12.9	2	12.13
	3	12.09	12.8	3	12.12
	4	12.09	12.8	4	12.11
	5	12.11	13.2	5	12.1
	7	12.13	13.2	7	12.09
	10	12.18	13.0	10	12.08
	15	12.19	13.0	15	12.06
	20	12.24	13.1	20	12.03
	25	12.26	13.0	25	12.02
	30	12.29	13.4	30	12.01
	35	12.28	13.0	35	12
	40	12.29	13.2	40	11.99
	50	12.32	13.0	50	11.97
	60	12.32	13.0	60	11.96
	75	12.33	13.1	75	11.94
	90	12.34	13.1	90	11.92
	105	12.36	13.0	105	11.91
	120	12.38	13.1	120	11.9
	150	12.42	13.1	150	11.88
	180	12.46	13.1	180	11.87
	210	12.49	13.0	480	11.78
	240	12.52	13.0	780	11.71
	300	12.56	13.0	900	11.66
	360	12.56	12.8		
	480	12.59	12.6		
	600	12.66	12.9		
	720				
	840	12.72	13.2		
	1110	12.78	12.9		
	1350	12.8	13.0		
	1490	12.82	13.0		
	1610	12.85	12.9		
	1730	12.87	13.0		
	1850	12.88	13.0		
	1970	12.89	12.9		
	2090	12.91	13.1		

BH4TP

CONSTANT RATE TEST INTERPRETATION - PUMPING & RECOVERY DATA

FORWARD MODEL AT THE PRODUCTION PUMPING RATE OF 216 m^3/day TO 5 YEARS (2,628,000 min)

	STEP DRAWDOWN TEST				RECOVERY	
RWL	Step	Time (min)	Water level (m)	Flow meter reading (m³/h)	Time (min)	Water level (m)
12.04	1	1	12.16	1	1	
	1	2	12.17	1.1	2	28.5
	1	3	12.18	1.1	3	26.68
	1	5	12.19	1.1	4	24.98
	1	7	12.19	1.1	5	22.68
	1	10	12.21	1.1	7	17.95
	1	15	12.22	1.1	10	13.95
	1	20	12.22	1.1	15	12.18
	1	25	12.23	1.1	20	12.12
	1	30	12.23	1.1	25	12.09
	1	35	12.24	1.1	30	12.08
	1	40	12.24	1.1	35	12.08
	1	50	12.24	1.1	40	12.07
	1	60	12.25	1.1	50	12.06
	2	1	12.38	2.1	60	12.05
	2	2	12.46	2.1		
	2	3	12.52	2.1		
	2	5	12.54	2.1		
	2	7	12.57	2.1		
	2	10	12.58	2.1		
	2	15	12.6	2.1		
	2	20	12.61	2.1		
	2	25	12.62	2.1		
	2	30	12.63	2.1		
	2	35	12.64			
	2	40	12.65	2.1		
	2	50	13.02	2.1		
	2	60	13.17	2.1		
	3	1		3.2		
	3	2	13.58	3.2		
	3	3	14.23	3.1		
	3	4	14.92	3		
	3	5	15.36	2.9		
	3	7	16.54	2.9		
	3	10	17.18	2.8		
	3	15	17.6	2.8		
	3	20	18.35	2.8		
	3	25	19.55	2.7		
	3	30	20.45	2.7		
	3	35	21.18	2.7		
	3	40	21.78	2.7		
	3	50	21.77	2.7		
	3	60	23.4	3.1		
	4	1	24.06	3.1		
	4	2	24.63	3.1		
	4	3	25.14	3.1		
	4	4	25.68	3.1		
	4	5	26.08	3.1		
	4	7	27.02	3.1		
	4	10	28.18	3		
	4	15	29.4	2.8		
	4	20	30.3	2.7		
	4	25	30.6	2.7		
	4	30	31.2	2.6		
	4	35	31.45	2.6		

Constant Rate Test

	CONSTANT RATE TEST		RECOVERY	
Time (min)	Water Level (m)	Flow meter reading (m³/h)	Time (min)	Water Level (m)
1	12.14	1.9	1	12.38
2	12.19	1.1	2	12.34
3	12.19	1.8	3	12.28
4	12.2	1.6	4	12.25
5	12.22	1.4	5	12.21
7	12.26	1.6	7	12.18
10	12.24	1.5	10	12.16
15	12.25	1.5	15	12.14
20	12.25	1.5	20	12.14
25	12.26	1.5	25	12.14
30	12.27	1.4	30	12.13
35	12.32	1.6	35	12.13
40	12.32	1.5	40	12.12
50	12.31	1.5	50	12.11
60	12.3	1.5	60	12.11
75	12.31	1.5	75	12.1
90	12.31	1.5	90	12.1
105	12.32	1.5	105	12.09
120	12.32	1.5	120	12.08
150	12.33	1.5	150	12.07
180	12.34	1.5	180	12.07
210	12.36	1.5	210	12.06
240	12.36	1.5	240	12.06
300	12.37	1.5	300	12.04
360	12.38	1.5		
480	12.4	1.5		
600	12.42	1.5		
840	12.44	1.5		
1080	12.47	1.5		
1320	12.49	1.5		
1560	12.5	1.5		
1800	12.52	1.5		
2040	12.54	1.5		
2280	12.56	1.5		
2760	12.57	1.5		
3000	12.59	1.5		
3080	12.59	1.5		

CONSTANT RATE TEST INTERPRETATION - RECOVERY DATA (AGARWAL PLOT)

FORWARD MODEL AT THE PRODUCTION PUMPING RATE OF 24 m^3/day TO 5 YEARS (2,628,000 min)

Appendix D: Water Quality Data, Namseb Farm

Analytical Laboratory Services
OUR QUALITY IS IN THE DETAIL

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Unit 16 & 17, Ben Amathila Ave.
P. O. Box 86782, Windhoek, Namibia

TEST REPORT I241050/1

To: **Nopal Carbon Farming (Pty) Ltd**
P.O.Box 11526
Windhoek

Date received: 20/May/24
Date analysed: 24-31 May 2024
Date reported: 31/May/24

Attn: Nicole
e-mail: nicole@nopal.co
Tel: 081-337 7847

Client Reference no.: Verbal
Quotation no.: QUA80899
Lab Reference: I241050
Enquiries: Ms Helena P. Daniel

Sample details	Water Sample
Location of sampling point	-
Description of sampling point	BH1
Date of sampling	2024/05
Test item number	I241050/1

				Recommended maximum limits			
				Human consumption			Livestock
Parameter	**Value**	**Units**	**Classification**	**Group A**	**Group B**	**Group C**	**watering**
p H	**7.0**		A	6-9	5.5-9.5	4-11	
Electrical Conductivity	**169.1**	**mS/m**	B	150	300	400	
Turbidity	**2.8**	**NTU**	B	1	5	10	
Total Dissolved Solids (calc.)	**1064**	**mg/l**					6000
P-Alkalinity as $CaCO_3$	**<10**	**mg/l**					
Total Alkalinity as $CaCO_3$	**370**	**mg/l**					
Total Hardness as $CaCO_3$	**442**	**mg/l**	B	300	650	1300	
Ca-Hardness as $CaCO_3$	**302**	**mg/l**	A	375	500	1000	2500
Mg-Hardness as $CaCO_3$	**140**	**mg/l**	A	290	420	840	2057
Chloride as Cl^-	**129**	**mg/l**	A	250	600	1200	1500-3000
Fluoride as F^-	**1.5**	**mg/l**	A	1.5	2.0	3.0	2.0-6.0
Sulphate as SO_4^{2-}	**100**	**mg/l**	A	200	600	1200	1000
Nitrate as N	**59**	**mg/l**	D	10	20	40	100
Nitrite as N	**0.01**	**mg/l**					10
Sodium as Na	**192**	**mg/l**	B	100	400	800	2000
Potassium as K	**3.3**	**mg/l**	A	200	400	800	
Magnesium as Mg	**34**	**mg/l**	A	70	100	200	500
Calcium as Ca	**121**	**mg/l**	A	150	200	400	1000
Manganese as Mn	**0.02**	**mg/l**	A	0.05	1.0	2.0	10
Iron as Fe	**<0.01**	**mg/l**	A	0.1	1.0	2.0	10
Stability pH, at 25°C	**6.9**						
Langelier Index	**0.1**	scaling	>0=scaling, <0=corrosive, 0=stable				
Ryznar Index	**6.7**	stable	<6.5=scaling, >7,5=corrosive, ≥6.5 and ≤7.5=stable				
Corrosivity ratio	**0.8**	increasing corrosive tendency	Applies to water in the pH range 7-8 which also contains dissolved oxygen ratios <0.2 no corrosive properties ratios >0.2 increasing corrosive tendency				

Approved Technical Signatory
Ms. Helena Daniel

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TEST REPORT I241050/2

To: **Nopal Carbon Farming (Pty) Ltd**
P.O.Box 11526
Windhoek

Date received: 20/May/24
Date analysed: 24-31 May 2024
Date reported: 31/May/24

Attn: Nicole
e-mail: nicole@nopal.co
Tel: 081-337 7847

Reference no.: Verbal
Quotation no.: QUA80899
Lab Reference: I241050
Enquiries: Ms Helena P. Daniel

Sample details	Water Sample
Location of sampling point	-
Description of sampling point	BH2
Date of sampling	2024/05
Test item number	I241050/2

				Recommended maximum limits			
				Human consumption			Livestock
Parameter	**Value**	**Units**	**Classification**	**Group A**	**Group B**	**Group C**	**watering**
p H	**9.2**		B	6-9	5.5-9.5	4-11	
Electrical Conductivity	**107.5**	**mS/m**	A	150	300	400	
Turbidity	**115**	**NTU**	D	1	5	10	
Total Dissolved Solids (calc.)	**581**	**mg/l**					6000
P-Alkalinity as $CaCO_3$	**35**	**mg/l**					
Total Alkalinity as $CaCO_3$	**195**	**mg/l**					
Total Hardness as $CaCO_3$	**14**	**mg/l**	A	300	650	1300	
Ca-Hardness as $CaCO_3$	**6**	**mg/l**	A	375	500	1000	2500
Mg-Hardness as $CaCO_3$	**8**	**mg/l**	A	290	420	840	2057
Chloride as Cl^-	**184**	**mg/l**	A	250	600	1200	1500-3000
Fluoride as F^-	**21**	**mg/l**	D	1.5	2.0	3.0	2.0-6.0
Sulphate as SO_4^{2-}	**28**	**mg/l**	A	200	600	1200	1000
Nitrate as N	**0.6**	**mg/l**	A	10	20	40	100
Nitrite as N	**<0.01**	**mg/l**					10
Sodium as Na	**220**	**mg/l**	B	100	400	800	2000
Potassium as K	**3.8**	**mg/l**	A	200	400	800	
Magnesium as Mg	**2.0**	**mg/l**	A	70	100	200	500
Calcium as Ca	**2.4**	**mg/l**	A	150	200	400	1000
Manganese as Mn	**0.13**	**mg/l**	B	0.05	1.0	2.0	10
Iron as Fe	**4.6**	**mg/l**	A	0.1	1.0	2.0	10
Stability pH, at 25°C	**8.8**						
Langelier Index	**0.4**	scaling	>0=scaling, <0=corrosive, 0=stable				
Ryznar Index	**8.4**	corrosive	<6.5=scaling, >7,5=corrosive, ≥6.5 and ≤7.5=stable				
Corrosivity ratio	**1.5**	increasing corrosive tendency	Applies to water in the pH range 7-8 which also contains dissolved oxygen ratios <0.2 no corrosive properties ratios >0.2 increasing corrosive tendency				

Approved Technical Signatory
Ms. Helena Daniel

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P. O. Box 86782, Windhoek, Namibia

TEST REPORT I241050/3

To: **Nopal Carbon Farming (Pty) Ltd**
P.O.Box 11526
Windhoek

Date received: 20/May/24
Date analysed: 24-31 May 2024
Date reported: 31/May/24

Attn: Nicole
e-mail: nicole@nopal.co
Tel: 081-337 7847

Client Reference no.: Verbal
Quotation no.: QUA80899
Lab Reference: I241050
Enquiries: Ms Helena P. Daniel

Sample details	Water Sample
Location of sampling point	-
Description of sampling point	BH3
Date of sampling	2024/05
Test item number	I241050/3

				Recommended maximum limits			
				Human consumption			Livestock
Parameter	**Value**	**Units**	**Classification**	**Group A**	**Group B**	**Group C**	**watering**
p H	**7.1**		A	6-9	5.5-9.5	4-11	
Electrical Conductivity	**389**	**mS/m**	C	150	300	400	
Turbidity	**0.90**	**NTU**	A	1	5	10	
Total Dissolved Solids (calc.)	**2639**	**mg/l**					6000
P-Alkalinity as $CaCO_3$	**<10**	**mg/l**					
Total Alkalinity as $CaCO_3$	**370**	**mg/l**					
Total Hardness as $CaCO_3$	**810**	**mg/l**	C	300	650	1300	
Ca-Hardness as $CaCO_3$	**509**	**mg/l**	C	375	500	1000	2500
Mg-Hardness as $CaCO_3$	**301**	**mg/l**	B	290	420	840	2057
Chloride as Cl^-	**620**	**mg/l**	C	250	600	1200	1500-3000
Fluoride as F^-	**1.8**	**mg/l**	B	1.5	2.0	3.0	2.0-6.0
Sulphate as SO_4^{2-}	**728**	**mg/l**	C	200	600	1200	1000
Nitrate as N	**59**	**mg/l**	D	10	20	40	100
Nitrite as N	**0.01**	**mg/l**					10
Sodium as Na	**524**	**mg/l**	C	100	400	800	2000
Potassium as K	**4.9**	**mg/l**	A	200	400	800	
Magnesium as Mg	**73**	**mg/l**	B	70	100	200	500
Calcium as Ca	**204**	**mg/l**	C	150	200	400	1000
Manganese as Mn	**0.05**	**mg/l**	A	0.05	1.0	2.0	10
Iron as Fe	**<0.01**	**mg/l**	A	0.1	1.0	2.0	10
Stability pH, at 25°C	**6.7**						
Langelier Index	**0.4**	scaling	>0=scaling, <0=corrosive, 0=stable				
Ryznar Index	**6.2**	scaling	<6.5=scaling, >7,5=corrosive, ≥6.5 and ≤7.5=stable				
Corrosivity ratio	**4.4**	increasing corrosive tendency	Applies to water in the pH range 7-8 which also contains dissolved oxygen ratios <0.2 no corrosive properties ratios >0.2 increasing corrosive tendency				

Approved Technical Signatory
Ms. Helena Daniel

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TEST REPORT I241050/4

To: **Nopal Carbon Farming (Pty) Ltd**
P.O.Box 11526
Windhoek

Date received: 20/May/24
Date analysed: 24-31 May 2024
Date reported: 31/May/24

Attn: Nicole
e-mail: nicole@nopal.co
Tel: 081-337 7847

Client Reference no.: Verbal
Quotation no.: QUA80899
Lab Reference: I241050
Enquiries: Ms Helena P. Daniel

Sample details	Water Sample
Location of sampling point	-
Description of sampling point	BH4
Date of sampling	2024/05
Test item number	I241050/4

				Recommended maximum limits			
				Human consumption			Livestock
Parameter	**Value**	**Units**	**Classification**	**Group A**	**Group B**	**Group C**	**watering**
p H	**6.9**		A	6-9	5.5-9.5	4-11	
Electrical Conductivity	**194.6**	**mS/m**	B	150	300	400	
Turbidity	**2.0**	**NTU**	B	1	5	10	
Total Dissolved Solids (calc.)	**1145**	**mg/l**					6000
P-Alkalinity as $CaCO_3$	**<10**	**mg/l**					
Total Alkalinity as $CaCO_3$	**420**	**mg/l**					
Total Hardness as $CaCO_3$	**631**	**mg/l**	B	300	650	1300	
Ca-Hardness as $CaCO_3$	**405**	**mg/l**	B	375	500	1000	2500
Mg-Hardness as $CaCO_3$	**226**	**mg/l**	A	290	420	840	2057
Chloride as Cl^-	**256**	**mg/l**	B	250	600	1200	1500-3000
Fluoride as F^-	**1.0**	**mg/l**	A	1.5	2.0	3.0	2.0-6.0
Sulphate as SO_4^{2-}	**159**	**mg/l**	A	200	600	1200	1000
Nitrate as N	**20**	**mg/l**	B	10	20	40	100
Nitrite as N	**0.001**	**mg/l**					10
Sodium as Na	**167**	**mg/l**	B	100	400	800	2000
Potassium as K	**4.5**	**mg/l**	A	200	400	800	
Magnesium as Mg	**55**	**mg/l**	A	70	100	200	500
Calcium as Ca	**162**	**mg/l**	B	150	200	400	1000
Manganese as Mn	**<0.01**	**mg/l**	A	0.05	1.0	2.0	10
Iron as Fe	**<0.01**	**mg/l**	A	0.1	1.0	2.0	10
Stability pH, at 25°C	**6.7**						
Langelier Index	**0.2**	scaling	>0=scaling, <0=corrosive, 0=stable				
Ryznar Index	**6.5**	scaling	<6.5=scaling, >7,5=corrosive, ≥6.5 and ≤7.5=stable				
Corrosivity ratio	**1.3**	increasing corrosive tendency	Applies to water in the pH range 7-8 which also contains dissolved oxygen ratios <0.2 no corrosive properties ratios >0.2 increasing corrosive tendency				

Approved Technical Signatory
Ms. Helena Daniel

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TEST REPORT I241050/5

To: **Nopal Carbon Farming (Pty) Ltd**
P.O.Box 11526
Windhoek

Date received: 20/May/24
Date analysed: 24-31 May 2024
Date reported: 31/May/24

Attn: Nicole
e-mail: nicole@nopal.co
Tel: 081-337 7847

Client Reference no.: Verbal
Quotation no.: QUA80899
Lab Reference: I241050
Enquiries: Ms Helena P. Daniel

Sample details	Water Sample
Location of sampling point	
Description of sampling point	FBH5_TP
Date of sampling	2024/05
Test item number	I241050/5

				Recommended maximum limits			
				Human consumption			Livestock
Parameter	**Value**	**Units**	**Classification**	**Group A**	**Group B**	**Group C**	**watering**
p H	**6.7**		A	6-9	5.5-9.5	4-11	
Electrical Conductivity	**314**	**mS/m**	C	150	300	400	
Turbidity	**0.20**	**NTU**	A	1	5	10	
Total Dissolved Solids (calc.)	**1945**	**mg/l**					6000
P-Alkalinity as $CaCO_3$	**<10**	**mg/l**					
Total Alkalinity as $CaCO_3$	**395**	**mg/l**					
Total Hardness as $CaCO_3$	**1001**	**mg/l**	C	300	650	1300	
Ca-Hardness as $CaCO_3$	**659**	**mg/l**	C	375	500	1000	2500
Mg-Hardness as $CaCO_3$	**342**	**mg/l**	B	290	420	840	2057
Chloride as Cl^-	**571**	**mg/l**	B	250	600	1200	1500-3000
Fluoride as F^-	**1.1**	**mg/l**	A	1.5	2.0	3.0	2.0-6.0
Sulphate as SO_4^{2-}	**264**	**mg/l**	B	200	600	1200	1000
Nitrate as N	**58**	**mg/l**	D	10	20	40	100
Nitrite as N	**0.01**	**mg/l**					10
Sodium as Na	**263**	**mg/l**	B	100	400	800	2000
Potassium as K	**5.0**	**mg/l**	A	200	400	800	
Magnesium as Mg	**83**	**mg/l**	B	70	100	200	500
Calcium as Ca	**264**	**mg/l**	C	150	200	400	1000
Manganese as Mn	**0.22**	**mg/l**	B	0.05	1.0	2.0	10
Iron as Fe	**0.33**	**mg/l**	A	0.1	1.0	2.0	10
Stability pH, at 25°C	**6.5**						
Langelier Index	**0.2**	scaling	>0=scaling, <0=corrosive, 0=stable				
Ryznar Index	**6.3**	scaling	<6.5=scaling, >7,5=corrosive, ≥6.5 and ≤7.5=stable				
Corrosivity ratio	**2.7**	increasing corrosive tendency	Applies to water in the pH range 7-8 which also contains dissolved oxygen ratios <0.2 no corrosive properties ratios >0.2 increasing corrosive tendency				

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Ms. Helena Daniel

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Annexure C

Namseb

Spineless *Opuntia ficus-indica* orchard and processing development

Vegetation Specialist Report

March 2024

Prepared for LM Environmental Consulting

by Herta Kolberg

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1. Background

Prickly pear (*Opuntia* species) have been well known as a livestock feed and for household consumption throughout the world, including in Namibia, for many years. Recently, many other uses, like offsetting carbon dioxide emissions, have been documented for *Opuntia* (Bautista *et al.* 2018; Inglese *et al*. 2017). With concerns about climate change and its influence on food security, there has been increased research on crops that are suited for the less productive, drier and hotter areas on the world (Inglese *et al*. 2017; Fouché 2019, 2023; Alves 2023). *Opuntia* is one such crop that could be produced in dry, hot areas, like Namibia, especially as a forage for livestock (De Wit & Fouché 2015; De Wit *et al*. 2019; Louacini *et al*. 2012; Pessoa *et al*. 2020; Thakuria 2020), which is the predominant agricultural activity in these areas. It must, however, be noted that the production of *Opuntia* fruit or feedstuff or fruit consumption on a commercial scale, as proposed by this development, is much more intensive than what is known in Namibia to date. Much higher inputs in terms of orchard establishment, management, harvesting and marketing are needed to achieve the yields and outcomes reported in recent papers and promotional material. The strong influence of growth environment on the genetics, and thus the performance of the plant (De Wit *et al*. 2010; Soni *et al*. 2015;) also means that results from other parts of the world cannot necessarily be achieved in Namibia. It is by no means a no-maintenance crop that easily grows anywhere.

On the negative side, *Opuntia* species, including spiny *Opuntia ficus-indica*, are also known to become invasive in many dry, hot parts of the world (Dean & Milton 2000; GRIIS 2024; Humphries *et al*. 2022; Novoa *et al*. 2019a, 2019b; Thomas *et al*. 2016). Since there is a lot of confusion in positively identifying *Opuntia* plants, some of the reports of invasion (especially on the GRIIS database) may be wrongfully attributed to *Opuntia ficus-indica*. There are many species of *Opuntia* (reports vary from 75 to 250 different species) and because species of *Opuntia* and members of the family Cactaceae in general, readily hybridise, and adding the many cultivars that have been developed as well as the different appearances of species outside of their native range, it is not easy to positively identify plants. Molecular methods to distinguish between species, cultivars and hybrids have only been improved recently but still cannot always be related to the morphology, origin or behaviour of plants (De Wit *et al*. 2010; Las Casas *et al*. 2017; Mashope *et al*. 2011; Modise *et al*. 2024). Consensus, however, seems to be that spineless *O. ficus-indica* is not invasive. *O. ficus-indica*, both spiny and spineless forms, are present in Namibia and there are no records of invasions of this species (yet), but definitely of *O. stricta* and other cacti. The origin or cultivar of the spineless types in Namibia could not be established, but they most likely hail from South Africa. Introduced species' impacts usually increase once they become established in the ecosystem, but some have impacts as soon as they are introduced (Jeschke *et al*. 2014). Caution must therefore prevail, since the behaviour in Namibia of the material imported for this development is not known yet. Equally, cultivation on the scale and with the intensity planned for Namseb has never been done in Namibia and this must be considered when assessing possible impacts.

Besides the risk of invasion of natural vegetation by *Opuntia* the intensive nature of production proposed here means that there will also be other impacts on the environment in which the orchards are established - similar or the same as for any intensive production of any plant or crop species. Even though the semi-desert areas may look bare and without life, they support functioning ecosystems that may not be evident at all times or to the untrained eye. These impacts and the risk of invasion from *Opuntia* orchards, need to be addressed in an impact assessment and environmental management plan.

2. The Namseb Project

The establishment of an *Opuntia ficus-indica* orchard and processing facility is proposed on Farm Namseb, north-west of Maltahöhe in the Hardap Region of Namibia (Fig. 1). This is an area of low rainfall with sparse vegetation consisting mainly of grasses and shrubs, with a few trees along rivers and larger drainage lines (Atlas of Namibia Team 2022).

It is proposed to plant about 400 ha of spineless *Opuntia ficus-indica* cv. Rossa and cv. Gialla (Maske, pers. comm. 2024) which are primarily fruit producing cultivars (Inglese *et al* 2019) originated from Italy. The propagation material will be imported from Portugal. Cultivar "Rossa", with red fruit, is known in South Africa while cultivar "Gialla", with orange-yellow fruit, does not seem to be known in southern Africa (Fouché *et al*. 2019). The planting density will be high (10,000 plants per ha) and drip irrigation of the plants from seven boreholes (see Fig. 2) will be applied. Infrastructure for processing of the *Opuntia* crop is planned (Fig. 2) and markets are envisaged to be local and international.

Many details are still unclear and depend on a multitude of factors that must be clarified as work progresses.

Figure 1: Location of the proposed Namseb Opuntia development
(Source: A.N. Nicodemus, GIS Specialist, 09 February 2024)

Figure 2: Proposed infrastructure at the Namseb development
(Source: A.N. Nicodemus, GIS Specialist, 09 February 2024)

3. Approach for this study

The consultant's database, housing over 100,000 Namibian plant records, was used to determine the list of species found in the immediate vicinity (20 km radius) of the Namseb development (core list) as well as within a wider radius of about 35 km from the Namseb development (extended list). For further analysis the extended list was used, as it is a better approximation of what could be found in the area but has just not been documented.

An extensive literature survey was conducted on *Opuntia* species in general as well as on *Opuntia ficus-indica*, its characteristics, cultivars, cultivation; impacts and their mitigation.

4. Assumptions

The list of indigenous plants used here does not contain all the species present at the development site but includes also species that may not be present at Namseb specifically.

The area, as provided by the proponent (Fig. 1), is the final and only area impacted by this development.

The propagation material to be imported from Portugal (spineless *Opuntia ficus-indica* cultivars "Rossa" and "Gialla") will be the only material used for establishment of the orchard at this site.

5. Results

5.1. Indigenous vegetation

5.1.1. Indigenous vegetation and legislation

Indigenous plants in Namibia are primarily covered by the Nature Conservation Ordinance (4 of 1975), the Forest Act (12 of 2001) and the Environmental Management Act (7 of 2007). The Nature Conservation Ordinance and the Forest Act both list protected species that may not be removed or destroyed without a permit from the Ministry of Environment, Forestry and Tourism. Both these laws as well as the Environmental Management Act (EMA) cover the general protection of indigenous flora, sometimes in specific localities or under specified conditions like plants growing in riverine or catchment areas. The EMA applies to the Namseb development because several listed activities will be undertaken, thus requiring an impact assessment prior to obtaining an Environmental Clearance Certificate (Office of the Prime Minister 2007). Some indigenous Namibian plants are also listed on the appendixes of the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). This does not specifically protect plants in Namibia, as it only governs movement across international borders, but a species that is listed on CITES is of conservation concern and must be well managed inside the country of origin.

5.1.2. Flora desktop study

The Namseb project site falls within the Dwarf Shrub Savanna vegetation type of the Nama-Karoo biome (Atlas of Namibia Team 2022). Vegetation is sparse and consists of small shrubs, interspersed with mostly annual grasses and a few scattered trees and larger shrubs mainly along drainage lines and ephemeral rivers. Annual plants and bulbous species only appear after good rainfall.

The area in a 35 km radius around the project has 666 plant records on the database. This is most likely an underrepresentation of what is really present in the area, but a good starting point. The 666 records represent 190 different plant species in the core area and 364 different plants in the extended area (including the core area). A list of recorded species with their attributes can be found in Annex 1.

Of particular concern amongst the 364 plant species that could be affected by the Namseb project are those under legal protection or those with an IUCN (International Union for the Conservation of Nature) threat category as well as endemic or near-endemic species. In this case, endemic species are found only in Namibia, while near-endemic species are distributed mainly in Namibia with a smaller area of their range extending into South Africa. In the study area species are present that are protected under the Nature Conservation Ordinance, the Forest Act and that are listed by CITES (see 5.1.1. above). The IUCN system evaluates species' extinction risk and several of the plants in the study area have been evaluated and assigned threat categories.

There are 41 species endemic to Namibia, with 60 species near-endemic amongst the 364 plants recorded for the area. Seventeen species are protected by the various laws and no species are threatened. There is one critically endangered species (*Gazania thermalis*), which, however, only occurs at a restricted locality with specific habitat, that happens to fall within the extended area and is not expected to occur at the Namseb site. Fourteen species are of least concern (LC). There are, however, seventeen species with a DD (data deficient) evaluation according to IUCN. This means that there is insufficient data available for these species to make a

threat assessment and that any of these plants could be threatened if more information becomes available. The species evaluated as DD are often those that are rare, causing the inadequate amount of information. Table 1 shows a summary of the numbers of species of concern, details of which can be obtained from Annex 1.

Table 1: Numbers of plant species of concern in the range, legal and threat categories. Note that some species fall into more than one of the categories.

Category		**No of species**
Range	Endemic to Namibia	41
	Near-endemic to Namibia	60
Legal	Nature Conservation Ordinance	6
	Forest Act	4
	Nature Conservation Ordinance **and** Forest Act	1
	Nature Conservation Ordinance **and** CITES	3
	CITES	3
Threat	Critically Endangered (CR)	1*
	Data Deficient (DD)	17
	Least Concern (LC)	14

*This species is not expected to occur at Namseb

5.1.3. Impacts on indigenous flora

The biggest impact on natural vegetation at the Namseb site is expected to come from destruction of plants during development of the orchard (ripping, planting) and construction of associated infrastructure. The 113 species in Table 1 (some species fall into more than one category) need special consideration during this phase. Plants in the legal categories may not be removed or destroyed without a permit from the Ministry of Environment, Forestry and Tourism. Many of the legally protected species, like *Lithops*, *Anacampseros* and the stapeliads (Apocynaceae family), are small and difficult to spot.

Another big impact on natural vegetation could be the spread of *Opuntia ficus-indica* outside the allocated, fenced area. If such plants get established and invade the surrounding area, the balance of the ecosystem may be disrupted with serious consequences for any living being in it, including any humans living off the land. This impact is discussed in more detail under 5.2 below.

The use of chemicals during establishment and operation of the cactus orchard and processing of the product is generally recommended (Fouché *et al*. 2019; Inglese *et al*. 2017) and in some cases inevitable. These could have negative impacts if blown or washed into natural vegetation. Not much is known about the effects of these chemicals on indigenous Namibian plants, meaning caution must prevail.

Other impacts that are common to any development also apply to Namseb. Improved access to the site and exposure to more people (contractors, staff and their families) bears the risk of increased plant poaching, increased firewood collection, pollution (rubbish left at inappropriate places, thrown out of vehicles) and off-road/track driving. All of these have negative impacts on indigenous vegetation and must be mitigated. The same goes for introduction and proliferation of any other alien plant species (other than spineless *Opuntia ficus-indica*) which usually goes hand-in-hand with any earthmoving works and irrigated crop production. This is discussed in more detail under 5.2 as well.

5.2. *Opuntia ficus-indica* cultivation

5.2.1. Alien plant species and legislation

At present there is no legislation in Namibia that specifically addresses alien invasive species (Nanyeni 2023). An invasive aliens management programme, including drafting of legislation, is being established by the Namibian

Invasive Alien Species Working Group (https://n-c-e.org/namibian-invasive-alien-species-working-group), chaired by the Directorate of Forestry and comprising members from a wide spectrum of stakeholder groups. In the meantime, Namibian authorities lean on the experience of other countries like South Africa and Australia, which have similar environments, have severe infestations from alien invasive species and have made great progress in managing these, including through legislation.

Opuntia ficus-indica is not on the Australian Weeds of National Significance (WONS) list, therefore allowed into the country according to law, but this is greatly discouraged (Australian Parliament 2004; Invasive Species Council, Australia 2024). In South Africa *Opuntia ficus-indica* is listed as a Category 1b invasive species on the National Environmental Management: Biodiversity Act, Act 10 of 2004, also known as NEMBA (Department of Environmental Affairs 2016). Category 1b are species that may not be owned, imported into South Africa, grown, moved, sold, given as a gift or dumped in a waterway. **But** spineless cultivars or forms and fruit for human consumption are exempted (Department of Environmental Affairs 2016). Richardson *et al.* (2020), using the proposed system of Blackburn *et al*. (2011), classified *O. ficus-indica* in South Africa as established (naturalised) with lesser impact, but a full impact assessment has not yet been done to confirm this. *O. ficus-indica* is also not on the IUCN's Invasive Species Specialist Group's list of the 100 worst invasive species globally (Lowe *et al*. 2000).

The Plant Quarantine Act (7 of 2008) applies for import of any plant material into Namibia. For the Namseb development therefore, the propagation material to be imported from Portugal requires an import permit from the Ministry of Agriculture, Water and Land Reform. Furthermore, the Environmental Management Act (Act 7 of 2007) applies, not because of an alien species being involved in particular, but because this development covers several activities listed as requiring an Environmental Clearance Certificate (land use and transformation; water use and disposal; resource removal, including natural living resources; agricultural processes; industrial processes; transportation; waste and sewage disposal; chemical treatment) (Office of the Prime Minister 2007). Other Namibian laws regulating aspects of environmental resource use (e.g. water) do apply but are outside the scope of this consultant's brief and knowledge. Any agrochemicals that will be used, must be registered for Namibia under the Fertilizers, Farm Feeds and Agricultural Remedies Act, 1947 (Act No. 36 of 1947), with amendments and regulations.

5.2.2. General comments about *Opuntia ficus-indica*

Although no serious invasion of natural vegetation by spineless *Opuntia ficus-indica* is known of in Namibia to date, the fact that new, genetically different material will be imported means that its behaviour in the proposed environment cannot be predicted and therefore caution must prevail. This is particularly important against evidence of reversion of spineless *O. ficus-indica* to spiny forms as well as the often vastly different performance and behaviour of spineless cultivars and forms in different environments (strong genotype x environment interaction) (De Wit *et al*. 2010; Gajender *et al*. 2014; Mashope *et al*. 2011; Potgieter 2007; Potgieter & Smith 2004).

Opuntia species, including spineless *O. ficus-indica*, are so successful because of them being able to propagate both sexually (by seed) and vegetatively (by cladodes or fruit rooting). The high number of seed per fruit, the ease by which seed germinate (no dormancy, no need for scarification i.e. ingestion by animals), the attractiveness of fruit (and cladodes) to dispersing animals, scarcity of natural enemies, pests and diseases as well as the almost perfect adaptation to harsh environments (CAM photosynthesis, cladode orientation, water retaining mucilage) contribute to successful establishment and spread (Novoa 2019a, 2019b).

From the literature and other countries' legislation consulted, the consensus is that spineless *Opuntia ficus-indica* is not invasive. Work done by Las Casas *et al*. (2017) shows that cultivars grown for fruit have a very narrow genetic base and all cultivars tested originated from wild *O. ficus-indica*. The forage cultivars, however, had a much wider genetic base originating from species like *O. stricta*, *O. spinulifera*, *O. undulata*, *O. cochenillifera*, *O. robusta* and *O. atropes*. *Opuntia stricta* is a serious invader, also in Namibia, while it, *O. spinulifera* and *O. robusta* (except spineless forms) are listed as Category 1 invasive species in South Africa (Department of Environmental Affairs 2016). Having a parentage of invasive species presents the risk that such cultivars could revert back to invasive (and spiny) forms if propagated by seed. It has even been reported that spineless forms can produce spiny branches after periods of stress (Inglese *et al*. 2017) but this could not be verified in more than one reference and is unlikely. Novoa *et al*. (2019b) tested spineless cultivars of *Opuntia* for

reverting back to spiny forms, including those grown for fruit. All the seedlings (100%) of all cultivars reverted back to spiny when cultivated from seed. The only exception was cv. Rossa (from Italy) where seed did not germinate – the reasons behind this need to be further investigated. This cultivar had the lowest number of seed per fruit, which would also reduce the risk of spread by seed. Novoa *et al*. (2019b), however, also observed that reversion to spiny forms is not often seen in the field.

Opuntia species are predominantly cross-pollinated (pollination between two different flowers of the same plant or between flowers of two different plants) but self-pollination (from the same flower) can also occur, another factor making these plants so successful in reproducing. Different bee species are the predominant pollinators. Beetles that are often found on flowers, are less important pollinators, as they rarely move between many flowers in a day (Ávila-Gómez 2019; Agüero 2006). Cross-pollination with any "wild" forms of *Opuntia* that may occur outside the orchard area, will give rise to fruit and seed that contains wild characters, like for instance spininess. This will not have any consequences for the crop from the orchard, but if recruitment from such seeds should occur, the seedlings may have invasive and undesirable characteristics that increase the severity of spreading into natural vegetation.

5.2.3. *Opuntia ficus-indica* as a livestock feed

Some problems have been reported with the use of spineless *Opuntia* as feed. Although the cladodes do not bear any large spines, they do bear glochids which are little hollows in the cladode surface which contain many minute spines that do pierce the skin of humans and animals (the latter both externally and internally). Fruit in particular have many glochids and may also have a few thin spines and because of the many seeds, may cause intestinal blockage, leading to death if eaten in large amounts by livestock. Cladodes eaten fresh by livestock have caused injury and infection of eyes, ears, skin, mouth, tongue and digestive tract (Da Silva 2021; Ncebere 2021; Pequeno 2021; Rakowitz 1997). This mostly leads to emaciation and death of animals as they cannot feed normally. The severe impact of glochids on livestock can best be illustrated by the need for extreme protective clothing for humans working with spineless *Opuntia ficus-indica* – boots, long, thick rubber gloves, thick plastic or rubberised aprons, eye and airway protection (see Fouché *et al*. 2019). Glochids must be removed from any parts that are going to be fed to livestock.

Processing *Opuntia* into dried feedstuff (meal, pellets, dried-chopped) to overcome the glochid problems, presents its own difficulties. Cladodes have to be cut for them to dry within a reasonable time. Crushing by, for example, a hammer mill, does not work as the mucilage blocks the machinery. Even dried material may cause blockage of mills or crushers because of the mucilage. Unless glochids are first removed, they also remain in dried material, cannot be easily removed or made harmless during processing. They must be removed from the fresh material.

A number of studies have found that *Opuntia* can only be fed as part of a diet, comprising between 30 and 75% on a dry matter basis, of the diet depending on the type of livestock and the aim of production (milk, meat, keeping alive) (Lima 2019; Rakotoarivonona 2021; Shiningavamwe 2009; Tegegne 2007; Thakuria 2020). *Opuntia* has to be mixed with other sources of feed. This is because the nutritional value of *Opuntia* is on the low side and other forms of energy, protein and dry matter have to be added. Dry matter production of *Opuntia* per ha is generally higher than that of natural rangeland of dry areas but because of the high moisture content, it has low dry matter per kg of wet cladodes and livestock has difficulty ingesting enough dry matter (Pessoa 2020). The high water content can, however, replace the need for animals to drink, which may be important in dry areas or during droughts. *Opuntia* is generally considered as an emergency feed for drought situations, because it can maintain the production of livestock, but usually does not improve it.

5.2.4. *Opuntia ficus-indica* as a fruit crop

The consumption of *Opuntia* fruit is very much a matter of historical/cultural acceptance (Nazareno 2017). In Namibia cactus pear is consumed as a fresh fruit with some juice and jam production businesses established, but this is all on a relatively small, household scale. Fruit production as planned at Namseb, would therefore have to aim mostly at export markets with their own set of difficulties. Here the appearance and quality of the fruit is very important. In Europe, for instance, the customer prefers fruit with red skin and flesh, while in its native

Mexico, green/yellowish fruit are the ones mostly consumed (Liguori & Inglese 2015). The harvesting, further processing and transport to the market require careful handling, planning, processing and often specialised equipment to get fruit of acceptable quality to the market in time considering the shelf life of maximally two weeks under an uninterrupted cold chain (Corbo *et al*. 2004; Potgieter & D'Aquino 2017).

In fruit production orchards the risk of spread through seed can be higher than in cladode production orchards. Fruit ready for marketing will contain seed that is mature and can germinate, while in feed orchards, fruit (with cladodes) can be harvested and processed earlier, before seed matures. Plants arising from seed also have a higher chance of having characteristics that promote spread and invasion as well as characteristics that would make an invasion more serious, like spininess. The prevention of spread from fruit orchards can therefore be much more intensive and costly (see discussion under 5.2.5).

5.2.5. Risks associated with *Opuntia ficus-indica* cultivation

Given the plant's characteristics and behaviour, the highest risk of invasion of environments surrounding spineless *O. ficus-indica* orchards comes from the spread of seed with vegetative spread a somewhat lower risk. Dean (2000) found that in the Karoo of South Africa, which is comparable to the Namseb area, baboons and crows (birds) were the principal spreaders of seed, while red eyed bulbul and starlings were also found to be very effective in spreading seed by Mokotjomela *et al*. (2021). In a study by Dudenhoeffer (2018) it was found that small rodents also spread seed, but that the percentage of viable seed excreted by these animals is lower, since they chew and damage them upon ingestion. Consumption of fruit by humans combined with open defecation can also be a source of seed dispersal. The spread of vegetative material by vehicles, animals or persons is a secondary concern, but must nevertheless be controlled.

Linked to the risk of spread by seed is the hybridisation of orchard plants with plants of unknown genetic make-up. This could result in seed giving rise to plants with particularly strong invasive or undesirable properties (spines). The isolation distance recommended for bee- and cross-pollinated crops (which *Opuntia ficus-indica* is) varies between 1 and 5 km (Bateman 1947; Gabai-Hazera *et al*. 2018; Fragoso & Brunet 2023). This is the distance over which it is deemed unlikely that pollen will be spread by bees. The distance over which bees will fly depends on many factors, like the species of bee, abundance and spread of flowering plants or location of suitable nesting sites.

The transport of any *Opuntia* material (fruit, seed, cladodes) outside the fenced orchard area presents a risk for spread into natural vegetation.

Establishment of the orchard and its management (introduction of machinery; soil ripping, addition of manure, fertilisation and irrigation) may introduce new or promote the growth of already present alien species (weeds). These can spread from here into surrounding vegetation, negatively impacting the ecosystem.

The use of chemicals – pesticides, fungicides, herbicides, fertilisers – are all recommended for cultivation of *O. ficus-indica* (Fouché 2023; Fouché *et al*. 2019; Gajender *et al*. 2014; Inglese *et al*. 2017). Pesticides may be necessary for infestation by cochineal (*Dactylopius* sp.), which is present in the country and kills plants if not controlled. There are a number of fungal diseases that cause rotting of roots, stems, cladodes or fruit which need to be counteracted with fungicides. It is also recommended that planting material (cuttings) and soil be treated before planting to prevent introduction of any pests or diseases. Because *Opuntia* has a very shallow, spreading root system, severe weed infestations can negatively influence yield because of competition for water and nutrients from the same area in the soil (Inglese *et al*. 2017). Mechanical weed eradication is not recommended as it disturbs the *Opuntia* roots. Hand weeding may not be practical on 400 ha. Herbicides may therefore be necessary. To achieve good yields, fertilizer must be applied twice per year (Inglese *et al*. 2017; Gajender *et al*. 2014). Fertiliser application may also be necessary to mitigate salt stress that may result from the orchard being watered incorrectly or with too saline water (Gajender *et al*. 2014). There is thus a risk of any of these chemicals getting into the surrounding ecosystem and affecting, amongst others, the natural vegetation.

Salinisation of soil due to irrigation with saline water or in inappropriate ways and amounts, is always a risk in crop production, more so in areas with high evaporation and low rainfall (Stavi *et al*. 2021). This will not only affect production of the *Opuntia* crop but also natural vegetation if the orchard should be abandoned in future and native plants have to be restored.

6. Impact assessment and mitigation measures

Description	6.1 Destruction of indigenous vegetation during establishment and operation of orchard and infrastructure
Status	Negative
Extent	Of the 500 ha project area (Fig. 1), about 400 ha will be planted and developed and thus impacted. Ripping of rows for planting will destroy some of the smaller indigenous vegetation. Any larger shrubs or trees and pan areas will be avoided. During orchard establishment and infrastructure construction, vehicles and machinery will move around, causing destruction of smaller plants. Areas for infrastructure construction will have to be cleared of vegetation. Any indigenous plants that re-establish in the orchard will be removed as part of weed management.
Duration	The impact is **long-term** and will remain as long as the orchard is operational and several years after implementation of a closure plan.
Intensity	Moderate. The area affected does not represent habitat of concern beyond the local level.
Frequency of occurrence	Throughout establishment and operation. There will be initial, larger-scale destruction of vegetation during establishment and construction with possibly annually recurring destruction (weeding) during operation.
Consequence	Medium Destruction of about 400 ha of vegetation at the site is small compared to the entire surface area of this vegetation type. The vegetation type is not of concern beyond the local level.
Probability	Definite Initial destruction of indigenous flora will occur at establishment of the orchard and infrastructure within the fenced area and within the orchard during operation.
Significance	Medium Mitigation measures during establishment and operation are limited and confined to the larger plant species; mitigation to reduce the significance of vegetation destruction can only be fully implemented after closure.
Mitigation	- Areas being ripped for planting or cleared for erection of infrastructure, must be inspected for any protected plants. Should any be found, a permit must be applied for and possibly the help of an expert enlisted to carefully remove and re-plant these in similar habitat outside the development area (fence). This will not be possible for all protected species though (e.g. shepherd's tree, *Boscia albitrunca*), and these must only be removed where there is no alternative. - Impacts on the endemic, near-endemic and data deficient species that are not protected by law, similarly need to be mitigated by relocation where possible or removal only where there is no alternative. - Destruction of indigenous plants in the fenced area during the operational phase will be reduced since sensitive species (Table 1) will have mostly been removed. It may, however, happen, that some plants are missed and only discovered during operation, or that they re-establish themselves in the orchard after the initial removal. Staff must be made aware of this and any plants re-located if they are going to be impacted by operations. - Making new access roads outside the fenced area must be limited to the absolute minimum. - Prohibit collection of firewood from natural surroundings; provide alternate methods for cooking to staff. - Prohibit removal of any indigenous plants outside the fenced area (plant poaching) by staff or visitors. - Educate staff on the importance of an intact ecosystem and legal implications of plant poaching. - Prohibit off-road/off-track driving as far as possible.
Degree of confidence in predictions	95%

Description	6.2 Invasion of natural vegetation through spread of *Opuntia*
Status	Negative
Extent	Local to national, extending beyond the immediate project area as material is transported to markets. Spineless *Opuntia ficus-indica* is not known to be aggressively invasive but the material to be introduced and its behaviour is unknown in Namibia and a chance remains that it may be invasive. Should this occur and in the absence of any mitigation, the extent could potentially be extensive beyond the local level.
Duration	The impact is long-term and will remain as long as the orchard is operational and several years after implementation of a closure plan. Seed in the soil has a long lifespan so that plants may establish long after closure of the orchard.
Intensity	Moderate to Low The area affected will initially be localised and with widely spaced occurrences. Mitigation can prevent the intensity becoming severe.
Consequence	High If spread is not controlled or mitigation measures applied, invasion can become severe making the surrounding land unusable for livestock farming and severely disrupting the local ecosystem.
Frequency of occurrence	Throughout the operation period annually during fruit ripening, pruning, harvesting, processing and transporting to markets. After closure annually with rainfall occurrences as seed in the soil may germinate and establish.
Probability	Conceivable Spineless *Opuntia ficus-indica* is not known to be aggressively invasive but the material to be introduced and its behaviour is unknown in Namibia and a chance remains that it may be invasive under these particular conditions.
Significance	Medium The impact will only have significance if mitigation measures are not implemented.
Mitigation	- Keep any of the animal seed dispersal vectors, including smaller birds and rodents, out of the orchard by appropriate fencing (small mesh fence). Should this not be feasible, any ripening fruit must be taken from the orchard before the seed matures and becomes viable. If fruit is not going to be marketed, this can be done once the flowers have wilted and the removed fruit destroyed with any other unwanted material. - Spread of seed through open defecation by humans must be addressed by awareness and education of orchard staff and provision of sufficient toilets. - Avoid planting in drainage lines or washes to prevent water carrying any propagation material outside the orchard area. - Spreading any *Opuntia* material outside the fenced orchard area must be prevented through control at the gate of any vehicles or persons entering or leaving. A clean down area at the gate is recommended where vehicles and people's boots are inspected and cleaned of any plant material. Special care must be taken that no seed, like for instance from fruit squashed by tyres or boots, which may be harder to notice, is taken outside. - A cleared control strip of 5m around the outside of the fenced production area must be established and this, together with a 100m buffer strip outside of the 5 m strip, inspected annually for any *Opuntia* plants. These must be uprooted and destroyed in the disposal area inside the fence. Do not use this material for re-planting in the orchard, as the genetic make-up of these plants is uncertain and will not be the same as that in the orchard. - To prevent hybridisation of the orchard cultivars with other species that may be outside the fence, it is recommended that any *Opuntia* species within 2.5 km from the orchard be removed prior to planting and that none be allowed to be planted/ grow within this distance. This will prevent production of seed that may be more virulent or produce plants with undesirable characteristics (spiny, invasive). - *Opuntia* propagation material brought into the site must be properly packed so that no material can fall off vehicles along the route. - Fresh *Opuntia* material (fruit, cladodes) to be marketed must be properly packed so that no material can fall off vehicles along the route. - All handling, processing and packaging must be done inside the fenced, controlled area. - Ideally, to reduce the risk further, only processed material, that cannot produce new plants, should leave the fenced area. Selling whole cladodes as feed is risky as the producer can

	control the risk at the orchard, but has no control over what happens at the clients' site. The producer could then be responsible for spread of the species to an unapproved area. - The disposal of any unwanted material (diseased, pruned, not marketable) must also happen inside the fenced area. This must be done by deep burial in a hole of sufficient depth that the material can be covered by at least 1 m of soil. Care must be taken to not place this disposal site in or near any water courses or drainage lines as any water flow could expose and spread the material. It must be kept in mind that rainfall and floods in this area often occur unexpectedly and at unusually high levels. - The distance between rows, as proposed (2.5 m), is too small for vehicles to move through once plants mature. This may lead to cladodes and/or fruit breaking off and being spread by vehicles. It is planned to have most work done through manual labour, but some vehicle movement will nevertheless be necessary. Tracks or areas where vehicles must move must be carefully planned during orchard establishment to leave sufficient room so that *Opuntia* plants are not damaged and broken-off parts adhere to vehicles. - Glochids must be removed from cladodes and fruit that are sold fresh. These small spines are a hazard to staff handling this material as well as the end consumer, including livestock. There is machinery available to remove glochids from fruit and cladodes are normally flamed to burn the glochids.
Degree of confidence in predictions	95%

Description	**6.3 Introduction of other invasive alien plant species which invade natural vegetation**
Status	Negative
Extent	Beyond the orchard site Once established in the orchard, these species can spread by seed into the surrounding vegetation.
Duration	The impact is medium-term and will remain as long as it takes to eradicate the aliens or deplete the seed source in the soil through a weeding programme
Intensity	Moderate to Low The area affected will initially be confined to the orchard/fenced area, but without proper mitigation (weeding) may become severe and spread into the surrounds.
Consequence	Medium Can be controlled through an appropriate weeding programme to prevent production of further seed from which these species can spread. Spread and establishment of aliens has an impact on the function of the natural ecosystem. Aliens may not be palatable, even poisonous and displace indigenous species that are utilised by livestock and wildlife.
Frequency of occurrence	Continuously within the orchard as it will be irrigated; during rainfall outside the orchard when seed germinate and establish.
Probability	Likely Machinery brought in for construction or preparation of the orchard (ripping) is likely to have been used in another area with soil, containing seeds, attached to it. During operation at the site, this is deposited and can establish species alien to the area. Disturbing the soil surface (ripping) and irrigation provides further conditions that are conducive to the establishment of alien species. This is commonly seen at crop production fields and any construction activity (e.g. roads). People living in the area often intentionally introduce invasive alien plants as ornamentals.
Significance	Medium The impact could be significant if no mitigation methods are implemented.
Mitigation	- Clean any machinery or vehicles that come into the area of any adhering soil or seeds (clean down area at the gate). - Implement an effective weeding programme inside the orchard area that removes these alien species <u>before</u> they seed. - Dispose of any seeding material in the disposal area inside the fenced area. Do not use it for composting. - Educate and train staff on the identification and removal of alien species. - Prohibit the planting of alien invasive species by staff at their gardens/homes.

	- Prevent spread of seed of alien species outside the fence by flowing water by making a small berm of soil along the base of the perimeter fence. - The 5m and 100 m strips surrounding the fenced area must be inspected at least annually for any alien invasive species too. These must be removed and destroyed together with the *Opuntia* material.
Degree of confidence in predictions	95%

Description	**6.4 Chemicals used in orchard killing plants or disrupting ecosystem balance outside fenced area**
Status	Negative
Extent	Vegetation in the immediate vicinity of the fenced orchard may be affected. Weed killers, pesticides, fungicides and/or fertilisers may be carried outside the orchard by wind or water. It is estimated that this will not impact natural vegetation beyond 1 – 2 km from the site as rainfall is generally low in the area so that water does not flow over large areas and distances. Distribution by wind can be successfully mitigated.
Duration	Long-term The impact will persist for as long as chemicals are used in the orchard. Residues will remain in the soil for some time after stopping the use of chemicals or closure.
Intensity	Low The exact impact of the types of chemicals that may be used in the orchard on Namibian indigenous plants is unknown, but it can be assumed that especially herbicides will kill indigenous plants just like they kill non-indigenous "weeds". Similarly the addition of fertiliser to indigenous vegetation can be assumed to promote extraordinary growth. Pesticides and fungicides will kill insects, whether inside or outside the orchard. The effect of all of this is a disruption of the ecological balance which could have as yet unforeseen negative impacts. The intensity of such impacts is going to be moderate but can be lowered with mitigation.
Consequence	Low Indigenous plants may die from herbicides, some will be more susceptible than others, disrupting the ecosystem function. Indigenous plants may flourish from fertilisers, some more so than others, again disrupting the ecosystem. Some fungi or insects may die from fungicides and pesticides, others not, which can cause certain plants to flourish and displace others. The resulting natural vegetation may no longer be utilisable by livestock or wildlife.
Frequency of occurrence	Several times in a year Fertiliser is recommended to be applied twice per year; it will mostly be spread by water, meaning spread will only occur if and when it rains or if excessive irrigation is applied. Herbicides, pesticides and fungicides must be applied if and when necessary and the frequency of their impact cannot be predicted at this stage.
Probability	Conceivable/Low The spread of chemicals from the orchard into its surroundings will occur, but can be managed to not occur on a regular or excessive basis.
Significance	Very Low With proper mitigation the drift (spread by wind, air movement) of herbicides, pesticides and fungicides can be reduced to a minimum and will be much diluted by the increasing distance from the orchard, thus only affecting the immediately adjacent vegetation. Rainfall in the area is usually not causing surface flow of water or deep infiltration. Drip irrigation, if applied correctly, will also not cause fertilisers (or other chemicals) to be washed into deep groundwater. Again, only indigenous plants close to the orchard may be affected.
Mitigation	- Use best practice for any chemical application. Closely follow the instructions for each chemical (no over-dosaging). - Use only Namibian registered and approved chemicals. - Use chemicals only when necessary. - Give preference to chemicals with the least effect on neighbouring plants. - Use spraying equipment that produces droplets of a diameter of not less than 100 micron. Small droplets drift much further away from the spraying source than larger droplets (Kruger *et al*. 2019). Small droplets will hang in the air for much longer and any movement

	of air may take them away from the target plant. This means using lower pressure and larger nozzles for spraying equipment. - Avoid planting and thus application of chemicals in drainage lines and watercourses. - Avoid spraying chemicals during windy conditions; wind increases the drift of spray droplets away from the spray source and the target plant. Early mornings are usually less windy. - Avoid spraying chemicals during very hot and dry (low humidity) conditions; high temperatures and dry air causes rapid evaporation of water from the spray droplets, decreasing their size and increasing drift away from the target. Since the Namseb area is mostly hot and dry, spraying must be done as early in the morning as possible. - Avoid spraying chemicals during temperature inversion conditions. These are conditions where cold air is trapped at soil level below a layer of warmer air. It is best detected by smoke from a fire moving horizontally rather that upward, despite there not being any detectable wind. Under such conditions droplets of spray are either prevented from falling downwards or drift horizontally, often over large distances.
Degree of confidence in predictions	95%

Description	**6.5 Soil salinisation due to inappropriate irrigation or fertiliser application causing reduction in *Opuntia* crop yield and inability of indigenous plants re-establishing after closure**
Status	Negative
Extent	Orchard area only Salinisation will only occur in the orchard area and mostly due to inappropriate irrigation or over use of fertiliser.
Duration	Long-term The impact will remain and increase for as long as the orchard is managed inappropriately.
Intensity	High Once soil salinisation occurs it is very difficult to reverse. The *Opuntia* crop, which is sensitive to salinity, will deliver lower yields, plants may even die and any rehabilitation of the site after closure of the project will be near impossible or very costly.
Consequence	Medium Only the orchard area will be impacted, which is a relatively small area of the entire vegetation type area. Mitigation measures are effective in preventing soil salinisation.
Frequency of occurrence	Constantly once soil salinisation has occurred.
Probability	Likely Soil salinisation is promoted by high evaporation and low rainfall, so the Namseb area is prone to it. Inappropriate irrigation (flood or sprinkler irrigation) as well as irrigation with water high in salts (common in Namibia) are main man-made causes. Over-fertilisation further exacerbates salinisation.
Significance	Medium Soil salinisation is significant to both the crop being produced as well as for rehabilitation after closure of the operation. The impact can be successfully mitigated.
Mitigation	- Test soil texture and chemistry prior to planting to develop an appropriate irrigation and fertilisation programme. Chemistry should be tested annually prior to first fertilisation. - *Opuntia* material (cladodes) may also have to be tested to establish the most effective fertilisation rate. - Apply fertiliser strictly according to recommended rates. - Use drip-irrigation. - Do not over-water. - Test salinity of irrigation water annually. Do not use for irrigation if the salinity (TDS – total dissolved solids) is higher than 2000 mg/l (= parts per million – ppm) (Amwele *et al.* 2021).
Degree of confidence in predictions	90%

Description	6.6 *Opuntia* cultivation project failing and/or being abandoned, leaving behind plants and infrastructure without mitigation of impacts 2 – 5 above and therefore increasing these impacts.
Status	Negative
Extent	Entire site The entire area where development has occurred, will have been disturbed with impacts on the natural environment. This may be the entire 500+ ha or part thereof, if abandoned before development of the entire allocated area.
Duration	Long-term The impact will remain for as long as a closure plan is not implemented.
Intensity	High Upon abandonment of the development many of the mitigation measures for impacts 2 to 5 above will not be implemented and their severity increased.
Consequence	Medium Unless a closure plan can be implemented after abandonment of the development, the impact will have considerable consequences on the natural habitat surrounding it. Constant mitigation of all the impacts identified above will be absent and therefore increased impact on the habitat expected, lasting for a very long time.
Frequency of occurrence	Constantly after abandonment of development.
Probability	Possible Considering the high intensity of the production system, the need for highly knowledgeable management, high input costs and uncertain markets, abandonment of the project is a possibility.
Significance	Low
Mitigation	- A detailed, comprehensive closure plan must be in place. - The closure plan must include financial provision for executing it. - Roles and responsibilities for execution of the closure plan must be clearly stipulated.
Degree of confidence in predictions	95%

Description	6.7 Increased knowledge about spineless *Opuntia ficus-indica* cultivation in Namibia
Status	Positive
Extent	Entire country Through this project more knowledge on spineless *Opuntia ficus-indica* cultivation and the entire industry surrounding it, specific to Namibia, can be obtained. This will be beneficial for the entire country.
Duration	Long-term The impact will remain until superseded by new, improved information.
Intensity	High There is no documented knowledge on *Opuntia ficus-indica* cultivation in Namibia.
Consequence	Very High More knowledge specific to Namibia will provide an important baseline for any future assessments regarding *Opuntia* cultivation and improve management of cactus orchards to minimise their impacts on the natural environment.
Frequency of occurrence	Cumulative as project progresses.
Probability	Definite The information already gathered for the impact assessment and data from the project through all its stages, is and will become available.
Significance	Very High
Mitigation	n/a
Degree of confidence in predictions	95%

7. Mitigation and Closure Plan

A closure plan for this project must have the objective to return the developed area as closely as possible to its original, natural state. This in essence means removing the *Opuntia* plants and any infrastructure. The removal of infrastructure is negotiable (with the landowner), but that of *Opuntia* plants not. The landowner or subsequent user of the land may want to, for instance, retain the buildings for some use. There is no further impact emanating from retaining such buildings on the natural habitat, but infrastructure that, without mitigation, has continuous impacts must be removed. The *Opuntia* plants must be removed and destroyed by deep burial, as they do have impacts on their natural surroundings without constant mitigation measures applied.

7.1. Nopal Control Plan for the Opuntia Species

The Nopal Control Plan for the *Opuntia* Species (Annex 2) in general grasps the essence of the problem and makes good suggestions to mitigate possible impacts. There are, however, a few issues that were either not considered or not in sufficient detail. These are discussed here.

Paragraph 3.1 should be amended to make it clear that any *Opuntia* plants found in the 100 m buffer strip surrounding the orchard, must be removed and destroyed, not just recorded. Any unwanted removed material that is not going to be used for planting, must be destroyed in a designated area within the orchard perimeter fence by deep burial. Seedlings that have established themselves in the security or buffer zone, must be destroyed, since the genetics of these cannot be guaranteed to be the same as that of the planted orchard material. Plants that have established by vegetative means could be used for planting.

Paragraph 4. should also cover transport of planting material into the area. This must be packaged properly so that no material can fall off the vehicles transporting it. In this paragraph, specifically mention establishment of a clean down area at the gate where vehicles and persons are inspected for adhering plant material. Special attention must be given to any seed adhering to tyres or boots.

Several paragraphs mention composting of unwanted *Opuntia* material. This is not recommended, as the glochids will remain for a long time in the compost and make handling of it hazardous for humans as well as spread these in the environment wherever the compost is used.

There is no mention in the Nopal Control Plan for the *Opuntia* Species (Annex 2) of fencing the orchard. As discussed under 5.2.5, spread by seed is an issue and the orchard has to be fenced to effectively keep out baboons, birds and rodents. This means the entire orchard has to be encaged on the sides as well as on top with mesh wire of which the openings are small enough to keep out the most common frugivorous birds of the area, like red-eyed bulbul or mousebirds, yet strong enough to keep out baboons. For a 400 ha area, this is impractical so alternatively, fruit must be removed from the orchard before seed ripens and becomes viable. It will not be sufficient to just control plants that establish in the control strips around the orchard, as these animals move considerable distances where they defecate and deposit the seeds in ideal, fertilised spots for them to germinate and grow. It is better to prevent seed from spreading outside the orchard than controlling plants established outside it.

The Plan does not mention any education or awareness measures for staff at the orchard regarding control of *Opuntia* spread. This must be included as it is important that everyone that enters the orchard is aware of the risks and how to minimise them.

This plan must be updated to include all the mitigation recommendations in 6. above.

Paragraph 5. is a closure plan and should be a little bit more detailed, possibly a separate document. The last sentence should refer to the procedure in point 3., not 4.

7.2. Suggestions for a closure plan

A detailed closure plan must be developed for the Namseb project. This plan must consider both scenarios of the project failing and being abandoned during any stage of its development, as well as it being closed down or stopping operation for any of a number of reasons. It must include re-establishment of indigenous flora at least in the orchard area – whether by passive or active means.

Abandonment here is taken as the owners/operators of the Namseb orchard stopping operations at the site and leaving the site without undertaking any mitigation or closure measures. A closure plan needs to address what would happen in such a situation. The persons responsible for the proper closing down of the site and the financing thereof, need to be clearly stated. It must include the removal and destruction by deep burial, as described in the mitigation measures above, of any *Opuntia* material at the site. The removal of individual infrastructure must be evaluated for its impact on the natural environment if it should remain. What infrastructure can or cannot remain will depend on this assessment and the wishes of the landowner. A timeframe for the completion of tasks must be included.

Closure here is taken as the owners/operators of the Namseb orchard deciding to stop operations and following a closure plan before leaving the site. This closure plan will be the same as the closure plan upon abandonment, except that the responsibilities for executing it will be assigned to specific positions (manager, agronomist, safety officer…..) in the owners/operators' establishment.

The detail of a closure plan can probably only be determined once all infrastructure and staff are in place and operations have started. This does not mean that a basic closure plan cannot be drafted before operations begin. Provision must also be made for the closure plan to be revised regularly to cover any changes in the system.

8. Recommendation

Assessment of the impacts has shown that the significance of negative impacts is low to medium. This assessment has taken into account the mitigation measures being applied rigorously and consistently, without which the significance of some impacts could be high.

From the perspective of a botanist and under the condition that mitigation measures and a closure plan are in place and monitored by an external entity, it is recommended that an environmental clearance certificate be issued to the applicant.

9. References

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Annex 1: List of indigenous Namibian plants in extended area (35 km radius) surrounding the Namseb project site

Family	Species	Status	Legal	IUCN	Lifeform	Regions
Leguminosae	Acacia nebrownii Burtt Davy				shrub	HAR KAR KUN OMA OSH OTJ SHN
Leguminosae	Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan				tree	ERO HAR KAV KHO KUN OSH OTJ
Amaranthaceae	Achyranthes aspera L. var. aspera	@			herb	ERO HAR KAV KHO KUN OHA OMA OSH OTJ SHN ZAM
Lamiaceae	Acrotome pallescens Benth.	N			herb	HAR KAR KHO
Passifloraceae	Adenia repanda (Burch.) Engl.				twiner/climber/creeper	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN
Iridaceae	Afrosolen gracilis (Vaupel) Goldblatt & J.C.Manning	E			geophyte	ERO HAR KAR KHO KUN
Asphodelaceae	Aloe hereroensis Engl. var. hereroensis		Z		succulent	ERO HAR KAR KHO KUN OSH OTJ
Amaranthaceae	Amaranthus dinteri Schinz				herb	ERO HAR KAR KHO KUN OTJ SHN
Amaranthaceae	Amaranthus praetermissus Brenan				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Asteraceae	Amellus tridactylus DC. subsp. arenarius (S.Moore) Rommel	N			herb	HAR KAR KHO
Amaryllidaceae	Ammocharis coranica (Ker Gawl.) Herb.				geophyte	ERO HAR KAR KHO KUN OMU OSH OTJ
Anacampserotaceae	Anacampseros karasmontana Dinter ex Poelln.	N	Z		succulent	HAR KAR
Colchicaceae	Androcymbium melanthioides Willd.				geophyte	ERO HAR KAR KHO KUN OMA OSH OTJ
Poaceae	Anthephora schinzii Hack.				grass	ERO HAR KAR KHO KUN OHA OMA OMU OSH OTJ SHN
Aponogetonaceae	Aponogeton desertorum Zeyh. ex A.Spreng.				hydrophyte or associated with water	ERO HAR KHO KUN OMA OSH OTJ
Aponogetonaceae	Aponogeton rehmannii Oliv.				hydrophyte or associated with water	HAR KAR KAV KHO OMA OSH OTJ ZAM
Scrophulariaceae	Aptosimum spinescens (Thunb.) Emil Weber			LC	shrub	ERO HAR KAR KHO
Papaveraceae	Argemone ochroleuca Sweet subsp. ochroleuca	@			herb	ERO HAR KAR KHO KUN OMA OTJ
Poaceae	Aristida adscensionis L.				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Poaceae	Aristida congesta Roem. & Schult.				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ ZAM
Poaceae	Aristida engleri Mez var. engleri	N			grass	HAR KAR
Poaceae	Aristida rhiniochloa Hochst.				grass	ERO HAR KAV KHO KUN OMU OSH OTJ SHN ZAM
Asparagaceae	Asparagus pearsonii Kies	N			hardened monocot herb	ERO HAR KAR KHO KUN OHA OSH OTJ SHN
Asparagaceae	Asparagus psilurus Welw. ex Baker				hardened monocot	HAR KAR KHO OMU OTJ
Asteraceae	Athanasia minuta (L.f.) Kaellersjo subsp. minuta				subshrub	HAR KAR
Amaranthaceae	Atriplex vestita (Thunb.) Aellen var. appendiculata Aellen				shrub	ERO HAR KAR KUN OMA OMU OSH SHN
Acanthaceae	Barleria rigida Nees var. latibracteata ined.			LC	shrublet	HAR KAR KHO OMA OTJ
Acanthaceae	Barleria rigida Nees var. rigida			LC	shrublet	ERO HAR KAR KHO OMA
Acanthaceae	Barleria schenckii Schinz	E		DD	subshrub	HAR KAR
Hyacinthaceae	Battandiera candida (Oberm.) Mart.-Azorin, M.B.Crespo & Juan	E			geophyte	ERO HAR
Hyacinthaceae	Battandiera stapffii (Schinz) Mart.-Azorin, M.B.Crespo & Juan	E			geophyte	ERO HAR KAR KHO KUN OSH OTJ
Hyacinthaceae	Battandiera tubiformis (Oberm.) Mart.-Azorin, M.B.Crespo & Juan	E			geophyte	ERO HAR KAR KHO
Asteraceae	Berkheya annectens Harv.				subshrub	HAR KAR
Asteraceae	Berkheya ferox O.Hoffm. var. ferox	N			shrublet	HAR KAR KHO
Asteraceae	Berkheya ferox O.Hoffm. var. glandulosa Roessler	E			subshrub	HAR KAR KHO
Asteraceae	Berkheya schinzii O.Hoffm.	E			shrublet	HAR KAR OHA
Acanthaceae	Blepharis mitrata C.B.Clarke				subshrub	ERO HAR KAR KHO KUN OMA OTJ
Nyctaginaceae	Boerhavia orbicularifolia Struwig	E			herb	HAR SHN
Nyctaginaceae	Boerhavia repens L.				herb	ERO HAR KAR KHO KUN OMU
Capparaceae	Boscia albitrunca (Schinz) Gilg & Gilg-Ben.		F		tree	ERO HAR KAR KAV KHO KUN OHA OMA OSH OTJ ZAM
Capparaceae	Boscia foetida Schinz				shrub/tree	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Poaceae	Brachiaria deflexa (Schumach.) C.E.Hubb. ex Robyns				grass	ERO HAR KAV KUN OHA OMU OSH OTJ SHN ZAM
Cyperaceae	Bulbostylis hispidula (Vahl) R.W.Haines				sedge	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Amaranthaceae	Calicorema capitata (Moq.) Hook.f	N			shrub	ERO HAR KAR KHO KUN OTJ
Aizoaceae	Callistigma inachabense (Engl.) Dinter & Schwantes	N			herb	HAR KAR
Leguminosae	Calobota acanthoclada (Dinter) Boatwr. & B.-E.van Wyk	N			shrublet	HAR KAR
Leguminosae	Calobota spinescens (Harv.) Boatwr. & B.-E.van Wyk			LC	shrub	HAR KAR
Amaranthaceae	Caroxylon arboreum (C.A.Sm. ex Aellen) Mucina	N		DD	shrub	ERO HAR KAR KUN

E = endemic to Namibia; N = near-endemic to Namibia; @ = not native to Namibia B = both Nature Conservation Ordinance and Forest Act; C = CITES listed; F = Forest Act 12 of 2001; P = Nature Conservation Ordinance 4 of 1975; Z = both Nature Conservation Ordinance and CITES CR = Critically Endangered; DD = Data deficient; LC = Least Concern = protected species = DD species; may be threatened

Family	Species	Status	Legal	IUCN	Lifeform	Regions
Amaranthaceae	Caroxylon barbatum (Aellen) Mucina	N		DD	shrub	ERO HAR KAR KUN
Amaranthaceae	Caroxylon columnare (Botsch.) Theodorova					
Amaranthaceae	Caroxylon gemmiferum (Botsch.) Mucina	N		DD	shrub	ERO HAR KAR SHN
Amaranthaceae	Caroxylon glabrum (Botsch.) Mucina	N		DD	shrub	ERO HAR KAR KUN
Amaranthaceae	Caroxylon kleinfonteini (Botsch.) Mucina					
Amaranthaceae	Caroxylon seminudum (Botsch.) Mucina	E		DD	shrub	ERO HAR KAR KUN
Bignoniaceae	Catophractes alexandri D.Don				shrub	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ
Poaceae	Cenchrus ciliaris L.				grass	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN ZAM
Verbenaceae	Chascanum garipense E.Mey.	N			shrub	
Verbenaceae	Chascanum pinnatifidum (L.f.) E.Mey.				herb	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN
Poaceae	Chloris virgata Sw.				grass	ERO HAR KAR KAV KHO KUN OHA OMA OSH OTJ SHN ZAM
Menispermaceae	Cissampelos capensis L.f.				shrublet	ERO HAR KAR KHO
Cucurbitaceae	Citrullus rehmii De Winter	E			twiner/climber/creeper	ERO HAR KAR KHO KUN
Cleomaceae	Cleome elegantissima Briq.				herb	ERO HAR KAR KHO KUN OHA OMU OSH OTJ
Cleomaceae	Cleome iberidella Welw. ex Oliv.				herb	HAR KAV OSH ZAM
Cleomaceae	Cleome rubella Burch.				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ
Cucurbitaceae	Coccinia rehmannii Cogn.				twiner/climber/creeper	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ
Burseraceae	Commiphora dinteri Engl.	E	F		shrub	ERO HAR KAR KHO KUN OTJ
Burseraceae	Commiphora glandulosa Schinz				tree	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Cucurbitaceae	Corallocarpus schinzii Cogn.	N			twiner/climber/creeper	ERO HAR KAR KHO KUN OMA OTJ
Malvaceae	Corchorus asplenifolius Burch.				herb	ERO HAR KAR KAV KHO KUN OMA OSH OTJ SHN
Amaryllidaceae	Crinum paludosum I.Verd.			LC	geophyte	HAR
Leguminosae	Crotalaria argyraea Welw. ex Baker				herb	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Leguminosae	Crotalaria barnabassii Dinter ex Baker f.				herb	ERO HAR KHO KUN OTJ
Leguminosae	Crotalaria damarensis Engl.				herb	ERO HAR KAR KAV KHO KUN OMA OTJ SHN
Leguminosae	Crotalaria heidmannii Schinz				herb	ERO HAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Leguminosae	Crotalaria leubnitziana Schinz				herb	HAR KAR KHO KUN OMA OTJ
Euphorbiaceae	Croton gratissimus Burch. var. gratissimus				tree	ERO HAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Aizoaceae	Cryophytum guerichianum (Pax) Schwantes				succulent	ERO HAR KAR KHO KUN
Apocynaceae	Cryptolepis decidua (Planch. ex Benth.) N.E.Br.				subshrub	ERO HAR KAR KHO KUN
Cucurbitaceae	Cucumis sagittatus Wawra & Peyr.				twiner/climber/creeper	ERO HAR KAR KHO KUN OTJ
Leguminosae	Cullen tomentosum (Thunb.) J.W.Grimes				herb	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Convolvulaceae	Cuscuta hyalina B.Heyne ex Roth				parasite or hemi-	ERO HAR KHO OMA OTJ
Leguminosae	Cyamopsis serrata Schinz				herb	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ
Cactaceae	Cylindropuntia fulgida (Engelm.) F.M.Knuth var. mamillata (Schott ex Engelm.) Backeb.	@			stem succulent	HAR KAR
Apocynaceae	Cynanchum orangeanum (Schltr.) N.E.Br.				herb	ERO HAR KAR KHO KUN OMA OTJ SHN
Apocynaceae	Cynanchum pearsonianum Liede & Meve	N			subshrub	HAR KAR KHO
Cyperaceae	Cyperus bellus Kunth				sedge	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Cyperaceae	Cyperus palmatus (Lye) C.Archer & Goetgh.				sedge	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN ZAM
Cyperaceae	Cyperus schinzii Boeckeler				sedge	ERO HAR KAR KHO KUN OMA OMU OSH OTJ SHN ZAM
Apiaceae	Deverra denudata (Viv.) Pfisterer & Podlech subsp. aphylla (Cham. & Schltr.) Pfisterer & Podlech				subshrub	ERO HAR KAR KHO OMA OTJ
Hyacinthaceae	Dipcadi bakerianum Bolus [1]				geophyte	HAR KAR KHO KUN OHA OMA OSH OTJ
Hyacinthaceae	Dipcadi crispum Baker				geophyte	ERO HAR KAR KHO KUN OHA OMA OMU OSH OTJ
Hyacinthaceae	Dipcadi gracillimum Baker				geophyte	ERO HAR KAR KUN OMA
Hyacinthaceae	Dipcadi longifolium (Lindl.) Baker				geophyte	ERO HAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Hyacinthaceae	Dipcadi papillatum Oberm.				geophyte	
Hyacinthaceae	Dipcadi platyphyllum Baker				geophyte	ERO HAR KAR KHO KUN OMA OTJ SHN
Hyacinthaceae	Dipcadi viride (L.) Moench				geophyte	ERO HAR KAR KHO KUN OSH OTJ
Convolvulaceae	Distimake bipinnatipartitus (Engl.) Simoes & Staples	E			twiner/climber/creeper	ERO HAR KUN OTJ
Aizoaceae	Drosanthemum floribundum (Haw.) Schwantes				shrublet	
Aizoaceae	Drosanthemum hispidum (L.) Schwantes				shrublet	HAR KAR KHO

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Family	Species	Status	Legal	IUCN	Lifeform	Regions
Poaceae	Echinochloa pyramidalis (Lam.) Hitchc. & Chase				grass	HAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Poaceae	Enneapogon cenchroides (Licht.) C.E.Hubb.				grass	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN ZAM
Poaceae	Enneapogon desvauxii P.Beauv.				grass	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN
Poaceae	Enneapogon scaber Lehm. var. scaber				grass	ERO HAR KAR KHO OTJ
Poaceae	Entoplocamia aristulata (Hack. & Rendle) Stapf	N			grass	ERO HAR KAR KHO KUN
Poaceae	Eragrostis annulata Rendle ex Scott-Elliot				grass	ERO HAR KAR KAV KHO KUN OMA OSH OTJ SHN
Poaceae	Eragrostis bergiana (Kunth) Trin.				grass	HAR KAR KHO
Poaceae	Eragrostis bicolor Nees				grass	HAR KAR KHO OMA OTJ SHN
Poaceae	Eragrostis homomalla Nees				grass	ERO HAR KAR KHO OMA
Poaceae	Eragrostis nindensis Ficalho & Hiern				grass	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Poaceae	Eragrostis pilosa (L.) P.Beauv.	@			grass	ERO HAR OTJ ZAM
Poaceae	Eragrostis porosa Nees				grass	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN ZAM
Poaceae	Eragrostis procumbens Nees				grass	ERO HAR KAR KHO OSH
Poaceae	Eragrostis rotifer Rendle				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Poaceae	Eragrostis truncata Hack.				grass	HAR KHO OMA OTJ
Poaceae	Eragrostis walteri Pilg.	E			grass	ERO HAR KAR KUN
Asteraceae	Eriocephalus ambiguus (DC.) M.A.N.Mueller				shrublet	ERO HAR KAR
Asteraceae	Eriocephalus ericoides (L.f.) Druce				shrub	ERO HAR KAR KHO
Asteraceae	Eriocephalus pauperrimus Merxm. & Eberle				subshrub	HAR KAR
Poaceae	Eriochloa fatmensis (Hochst. & Steud.) Clayton				grass	HAR KAR KHO KUN OHA OTJ ZAM
Eriospermaceae	Eriospermum bakerianum Schinz subsp. bakerianum				geophyte	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Eriospermaceae	Eriospermum rautanenii Schinz				geophyte	ERO HAR KAR KAV KHO KUN OMA OSH OTJ SHN
Eriospermaceae	Eriospermum roseum Schinz	N			geophyte	ERO HAR KAR KHO KUN OMA OMU OTJ
Hyacinthaceae	Ethesia prasina (Ker Gawl.) Raf.			DD	geophyte	
Ebenaceae	Euclea asperrima Friedr.-Holzh.	E	F		shrub	HAR KAR KHO
Ebenaceae	Euclea undulata Thunb.				shrub/tree	ERO HAR KAR KHO KUN OMA OSH OTJ ZAM
Euphorbiaceae	Euphorbia glanduligera Pax				herb	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Euphorbiaceae	Euphorbia inaequilatera Sond.				herb	ERO HAR KAR KAV KHO KUN OMA OSH OTJ SHN ZAM
Euphorbiaceae	Euphorbia lignosa Marloth	N	C		stem succulent	ERO HAR KAR KHO KUN
Euphorbiaceae	Euphorbia mauritanica L.		C		stem succulent	ERO HAR KAR KHO KUN
Euphorbiaceae	Euphorbia spartaria N.E.Br.		C	DD	succulent	ERO HAR KAR KHO OMA OTJ
Asteraceae	Euryops subcarnosus DC. subsp. vulgaris B.Nord.				shrublet	ERO HAR KAR KHO KUN
Asteraceae	Felicia clavipilosa Grau				subshrub	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Moraceae	Ficus cordata Thunb.		F		tree	ERO HAR KAR KAV KHO KUN OSH OTJ
Apocynaceae	Fockea angustifolia K.Schum.				geophyte	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN
Apocynaceae	Fockea sinuata (E.Mey.) Druce				geophyte	HAR KAR
Frankeniaceae	Frankenia pulverulenta L.				herb	ERO HAR KAR KHO
Funariaceae	Funaria rhomboidea J.Shaw				moss	
Aizoaceae	Galenia secunda (L.f.) Sond.				shrublet	
Asteraceae	Galeomma stenolepis (S.Moore) Hilliard				herb	ERO HAR KHO KUN OTJ
Asteraceae	Garuleum schinzii O.Hoffm. subsp. crinitum (Dinter) Merxm.	E			herb	HAR KAR KHO
Asteraceae	Gazania jurineifolia DC. subsp. scabra (DC.) Roessler	N			herb	ERO HAR KAR KHO KUN
Asteraceae	Gazania thermalis Dinter	E		CR	herb	ERO HAR KHO OTJ
Asteraceae	Geigeria acaulis Benth. & Hook.f ex Oliv. & Hiern				herb	ERO HAR KHO KUN OMU OSH OTJ
Asteraceae	Geigeria ornativa O.Hoffm. subsp. ornativa var. ornativa				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Asteraceae	Geigeria pectidea (DC.) Harv.				herb	ERO HAR KAR KHO OTJ
Asteraceae	Geigeria plumosa Muschl. subsp. plumosa	E			shrub	ERO HAR KHO OMA OTJ
Gisekiaceae	Gisekia africana (Lour.) Kuntze				herb	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN ZAM
Gisekiaceae	Gisekia pharnaceoides L.				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Asteraceae	Gnaphalium confine Harv.				herb	HAR KAR KHO OTJ
Celastraceae	Gymnosporia senegalensis (Lam.) Loes.				shrub	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM

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Family	Species	Status	Legal	IUCN	Lifeform	Regions
Asteraceae	Helichrysum candolleanum H.Buek				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Asteraceae	Helichrysum micropoides DC.				herb	ERO HAR KAR
Rhamnaceae	Helinus spartioides (Engl.) Schinz ex Engl.				shrublet	ERO HAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN
Boraginaceae	Heliotropium ciliatum Kaplan				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN
Boraginaceae	Heliotropium tubulosum E.Mey. ex DC.	N			herb	ERO HAR KAR KUN
Malvaceae	Hermannia gariepina Eckl. & Zeyh.				shrublet	ERO HAR KAR KUN
Malvaceae	Hermannia modesta (Ehrenb.) Mast.				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Malvaceae	Hermannia spinosa E.Mey. ex Harv.				shrublet	HAR KAR KHO
Amaranthaceae	Hermbstaedtia schaeferi (Schinz) Schinz & Dinter	N			herb	HAR KAR
Poaceae	Heteropogon contortus (L.) Roem. & Schult.				grass	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN ZAM
Malvaceae	Hibiscus elliottiae Harv.	N			herb	ERO HAR KAR KHO KUN OTJ
Malvaceae	Hibiscus fleckii Guerke	N			herb	ERO HAR KAR KHO KUN OMA OSH OTJ
Malvaceae	Hibiscus micranthus L.f.				shrub	ERO HAR KAR KHO KUN OHA OMA OSH OTJ ZAM
Apocynaceae	Hoodia gordonii (Masson) Sw. ex Decne.		Z		stem succulent	ERO HAR KAR KHO KUN
Hydnoraceae	Hydnora visseri Bolin, Maass & Musselman	N		LC	parasite or hemi-	HAR KAR
Molluginaceae	Hypertelis cerviana (L.) Thulin					
Asteraceae	Ifloga molluginoides (DC.) Hilliard				herb	ERO HAR KAR
Leguminosae	Indigastrum argyroides (E.Mey.) Schrire	N			herb	ERO HAR KAR KUN
Convolvulaceae	Ipomoea adenioides Schinz				shrublet	ERO HAR KAR KAV KHO KUN OHA OMU OSH OTJ SHN
Cyperaceae	Isolepis setacea (L.) R.Br.				sedge	HAR KAR KHO SHN
Scrophulariaceae	Jamesbrittenia adpressa (Dinter) Hilliard	N			herb	ERO HAR KAR KHO OMA
Scrophulariaceae	Jamesbrittenia barbata Hilliard	E			herb	ERO HAR KAR KUN
Scrophulariaceae	Jamesbrittenia canescens (Benth.) Hilliard var. canescens	N			shrublet	ERO HAR KAR KHO KUN
Acanthaceae	Justicia platysepala (S.Moore) P.G.Mey.	N			herb	ERO HAR KAR KHO KUN OHA OMU OSH OTJ SHN
Cucurbitaceae	Kedrostis africana (L.) Cogn.				twiner/climber/creeper	HAR KAR KHO OMA OTJ
Rubiaceae	Kohautia cynanchica DC.				herb	ERO HAR KAR KHO KUN OMA OMU OTJ
Anacardiaceae	Lannea schweinfurthii (Engl.) Engl. var. stuhlmanni (Engl.) Kokwaro				tree	HAR ZAM
Verbenaceae	Lantana dinteri Moldenke	N			subshrub	ERO HAR KAR KHO KUN OTJ SHN
Apocynaceae	Larryleachia marlothii (N.E.Br.) Plowes	N	P		stem succulent	ERO HAR KAR KUN
Asteraceae	Lasiopogon glomerulatus (Harv.) Hilliard				herb	HAR KAR
Asteraceae	Lasiopogon volkii (B.Nord.) Hilliard	E			herb	HAR KAR
Hyacinthaceae	Ledebouria scabrida Jessop	E		DD	geophyte	ERO HAR OMA OTJ
Hyacinthaceae	Ledebouria undulata (Jacq.) Jessop				geophyte	ERO HAR KHO KUN OMA OMU OSH OTJ SHN
Leguminosae	Leobordea furcata (Merxm. & A.Schreib.) B.-E.van Wyk & Boatwr.	N			herb	HAR KAR KHO OMU
Leguminosae	Leobordea platycarpa (Viv.) B.-E.van Wyk & Boatwr.				herb	ERO HAR KAR KAV KHO KUN OHA OMA OSH OTJ
Poaceae	Leptochloa fusca (L.) Kunth				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Leguminosae	Lessertia annularis Burch.				herb	HAR KAR
Leguminosae	Lessertia falciformis DC.				shrublet	HAR KAR KHO
Amaranthaceae	Leucosphaera bainesii (Hook.f) Gilg				shrub	ERO HAR KAR KAV KHO KUN OMA OSH OTJ SHN
Limeaceae	Limeum aethiopicum Burm.f. var. glabrum Moq.				herb	ERO HAR KAR KHO KUN SHN
Limeaceae	Limeum argute-carinatum Wawra & Peyr.				herb	ERO HAR KAR KAV KHO KUN OMA OSH OTJ SHN
Limeaceae	Limeum myosotis H.Walter				herb	ERO HAR KAR KHO KUN OHA OMA OMU OSH OTJ SHN
Limeaceae	Limeum rhombifolium G.Schellenb.	N			herb	HAR KAR
Limeaceae	Limeum sulcatum (Klotzsch) Hutch.				herb	ERO HAR KAR KAV KHO KUN OHA OMA OSH OTJ ZAM
Plumbaginaceae	Limonium dregeanum (C.Presl) Kuntze				herb	HAR KAR
Aizoaceae	Lithops schwantesii Dinter	E	P		succulent	HAR KAR
Asteraceae	Litogyne gariepina (DC.) Anderb.			LC	herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Lophiocarpaceae	Lophiocarpus polystachyus Turcz.				subshrub	ERO HAR KAR KHO KUN OMA OTJ
Solanaceae	Lycium bosciifolium Schinz			DD	shrub	ERO HAR KAR KHO KUN OMA OTJ SHN ZAM
Solanaceae	Lycium cinereum Thunb.			DD	shrub	ERO HAR KAR KHO KUN OTJ SHN
Solanaceae	Lycium eenii S.Moore	E		DD	shrub	ERO HAR KAR KAV KHO KUN OMA OTJ

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Solanaceae	Lycium pumilum Dammer				shrublet	ERO HAR KAR KUN
Solanaceae	Lycium tetrandrum Thunb.				shrub	ERO HAR KAR KUN
Aizoaceae	Malephora engleriana (Dinter & A.Berger) Dinter & Schwantes	E			shrublet	HAR KAR KUN
Malvaceae	Malva ludwigii (L.) Soldona, Banfi & Galasso	@				HAR
Scrophulariaceae	Manulea namibensis (Roessler) Hilliard	E			herb	HAR KAR
Scrophulariaceae	Manuleopsis dinteri Thell.	E			shrub	ERO HAR KHO KUN OSH OTJ
Cyperaceae	Mariscus squarrosus (L.) C.B. Clarke					
Leguminosae	Medicago laciniata (L.) Mill.	@			herb	HAR KAR KHO KUN OMA
Poaceae	Melinis repens (Willd.) Zizka subsp. grandiflora (Hochst.) Zizka				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Leguminosae	Melolobium microphyllum (L.f.) Eckl. & Zeyh.				shrublet	HAR KAR KHO OMA OTJ SHN
Asteraceae	Mesogramma apiifolium DC.				herb	ERO HAR KAR KHO KUN OMA OMU OSH OTJ SHN
Apocynaceae	Microloma armatum (Thunb.) Schltr. var. armatum				shrublet	HAR KAR
Apocynaceae	Microloma longitubum Schltr.				subshrub	HAR KAR KHO
Acanthaceae	Monechma distichotrichum (Lindau) P.G.Mey.	N			subshrub	HAR KAR
Acanthaceae	Monechma leucoderme (Schinz) C.B.Clarke	E			shrublet	ERO HAR KAR KHO OTJ SHN
Geraniaceae	Monsonia luederitziana Focke & Schinz	N			herb	ERO HAR KAR OMA
Geraniaceae	Monsonia umbellata Harv.				herb	ERO HAR KAR KHO KUN
Montiniaceae	Montinia caryophyllacea Thunb.				shrub	ERO HAR KAR KHO KUN OMA OMU OSH OTJ SHN
Iridaceae	Moraea polystachya (Thunb.) Ker Gawl.				geophyte	HAR KAR KHO OTJ
Iridaceae	Moraea venenata Dinter	N			geophyte	HAR KAR
Moringaceae	Moringa ovalifolia Dinter & A.Berger	N	B		pachycaul	ERO HAR KAR KHO KUN OMU OSH OTJ SHN ZAM
Leguminosae	Neltuma glandulosa (Torr.) Britton & Rose var. glandulosa	@			tree	ERO HAR KAR KHO
Leguminosae	Neltuma odorata (Torr. & Frem.) C.E.Hughes & G.P.Lewis	@			tree	HAR KAR KHO KUN OMA
Amaryllidaceae	Nerine laticoma (Ker Gawl.) T.Durand & Schinz				geophyte	ERO HAR KAR KAV KHO KUN OMA OSH OTJ ZAM
Hyacinthaceae	Nicipe flexuosa (Thunb.) Mart.-Azorin, M.B.Crespo & Juan					
Asteraceae	Nidorella resedifolia DC. subsp. resedifolia				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Meliaceae	Nymania capensis (Thunb.) Lindb.				shrub	HAR KAR KHO KUN OSH OTJ
Lamiaceae	Ocimum americanum L.				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Resedaceae	Oligomeris dipetala (Aiton) Turcz. var. dipetala				herb	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Asteraceae	Ondetia linearis Benth.	E			shrublet	ERO HAR KAR KHO KUN OTJ
Ophioglossaceae	Ophioglossum polyphyllum A.Braun				fern	
Apocynaceae	Orbea albocastanea (Marloth) Bruyns					
Apocynaceae	Orbea albocastanea (Marloth) Bruyns	E	P	DD	stem succulent	HAR KAR
Apocynaceae	Orbea lugardii (N.E.Br.) Bruyns		P	DD	stem succulent	ERO HAR KAR KHO KUN OMA OTJ
Colchicaceae	Ornithoglossum calcicola K.Krause & Dinter	E			geophyte	ERO HAR KHO KUN OSH OTJ
Colchicaceae	Ornithoglossum dinteri K.Krause				geophyte	ERO HAR KAR KUN
Colchicaceae	Ornithoglossum vulgare B.Nord.				geophyte	ERO HAR KAR KHO KUN OMA OSH OTJ
Asteraceae	Osteospermum muricatum E.Mey. ex DC. subsp. muricatum				herb	ERO HAR KAR KHO KUN OMA OSH OTJ
Asteraceae	Osteospermum spinescens Thunb.				shrublet	HAR KAR KHO
Asteraceae	Othonna lasiocarpa (DC.) Sch.Bip.	N			shrub	ERO HAR KAR KUN
Leguminosae	Otoptera burchellii DC.				twiner/climber/creeper	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ
Oxalidaceae	Oxalis luederitzii Schinz	E		LC	geophyte	HAR KAR
Oxalidaceae	Oxalis pes-caprae L.	@			geophyte	ERO HAR KAR
Oxalidaceae	Oxalis semiloba Sond.				geophyte	HAR KAR KHO OMU OTJ
Anacardiaceae	Ozoroa crassinervia (Engl.) R.R.Fern. & A.Fern.	N			tree	ERO HAR KAR KHO KUN OSH OTJ
Anacardiaceae	Ozoroa insignis Delile subsp. latifolia (Engl.) R.R.Fern.			DD	tree	KUN OMA OSH OTJ
Amaryllidaceae	Pancratium tenuifolium Hochst. ex A.Rich.				geophyte	ERO HAR KAR KAV KHO KUN OMA OSH OTJ
Poaceae	Panicum gilvum Launert				grass	ERO HAR KAV KHO KUN OSH OTJ SHN
Poaceae	Panicum lanipes Mez				grass	HAR KAR KHO KUN OMA OMU OSH OTJ SHN
Poaceae	Panicum pilgerianum (Schweick.) Clayton				grass	HAR KHO OMA OTJ
Poaceae	Panicum stapfianum Fourc.				grass	HAR KHO OSH OTJ SHN

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Leguminosae	Parkinsonia africana Sond.				shrub/tree	ERO HAR KAR KHO KUN OMA
Malvaceae	Pavonia burchellii (DC.) R.A.Dyer				shrublet	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Malvaceae	Pavonia rehmannii Szyszyl.	E			shrublet	ERO HAR KAR KHO KUN
Asteraceae	Pegolettia retrofracta (Thunb.) Kies				subshrub	HAR KAR KHO OMA OTJ
Geraniaceae	Pelargonium minimum (Cav.) Willd.				herb	ERO HAR KAR KHO
Scrophulariaceae	Peliostomum leucorrhizum E.Mey. ex Benth.			LC	shrub	ERO HAR KAR KAV KHO KUN OMA OSH OTJ SHN
Asteraceae	Pentatrichia petrosa Klatt	N			shrub	ERO HAR KAR KHO KUN OTJ
Asteraceae	Pentzia calva S.Moore	N			subshrub	ERO HAR KAR KHO KUN OMA
Asteraceae	Pentzia incana (Thunb.) Kuntze				subshrub	ERO HAR KAR KHO
Asteraceae	Pentzia lanata Hutch.				subshrub	HAR KAR KHO
Asteraceae	Pentzia monocephala S.Moore				subshrub	HAR KAR KHO
Apocynaceae	Pergularia daemia (Forssk.) Chiov. subsp. gariepensis (E.Mey.) Goyder	N		LC	twiner/climber/creeper	ERO HAR KAR KHO KUN OMA OTJ
Acanthaceae	Peristrophe namibiensis K.Balkwill subsp. namibiensis	E			subshrub	HAR KAR
Acanthaceae	Petalidium linifolium T.Anderson	E			subshrub	HAR KAR
Acanthaceae	Petalidium setosum C.B.Clarke ex Schinz	N			subshrub	ERO HAR KAR KHO KUN OTJ
Nyctaginaceae	Phaeoptilum spinosum Radlk.				shrub	ERO HAR KAR KHO KUN OMA OTJ
Phyllanthaceae	Phyllanthus maderaspatensis L.				herb	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN
Phyllanthaceae	Phyllanthus pentandrus Schumach. & Thonn.				shrublet	ERO HAR KAR KAV KHO KUN OHA OMA OSH OTJ SHN ZAM
Aizoaceae	Phyllobolus melanospermus (Dinter & Schwantes) Gerbaulet	N			shrublet	HAR KAR
Aizoaceae	Phyllobolus oculatus (N.E.Br.) Gerbaulet	N			shrublet	HAR KAR
Asteraceae	Platycarphella carlinoides (Oliv. & Hiern) V.A.Funk & H.Rob.				herb	ERO HAR KAR KHO OMA OTJ
Poaceae	Pogonarthria fleckii (Hack.) Hack.				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Polygalaceae	Polygala seminuda Harv.				shrublet	ERO HAR KAR OMA SHN
Leguminosae	Pomaria lactea (Schinz) B.B.Simpson & G.P.Lewis				shrublet	ERO HAR KAR KHO OTJ
Aizoaceae	Prenia tetragona (Thunb.) Gerbaulet				shrublet	HAR KAR
Hyacinthaceae	Pseudogaltonia clavata (Baker ex Mast.) E.Phillips				geophyte	ERO HAR KAR KAV KHO OMA OMU OTJ
Asteraceae	Psiadia punctulata (DC.) Oliv. & Hiern ex Vatke				shrub	HAR KAR KHO
Aizoaceae	Psilocaulon coriarium (Burch. ex N.E.Br.) N.E.Br.				shrub	ERO HAR KAR KHO KUN
Pedaliaceae	Pterodiscus ngamicus N.E.Br. ex Stapf				subshrub	HAR KAR OMA OTJ
Asteraceae	Pteronia acuminata DC.			LC	shrublet	HAR KAR
Asteraceae	Pteronia glauca Thunb.			LC	subshrub	ERO HAR KAR KHO KUN
Asteraceae	Pteronia lucilioides DC.	N		LC	shrublet	ERO HAR KAR
Leguminosae	Ptycholobium biflorum (E.Mey.) Brummitt subsp. biflorum				shrublet	ERO HAR KAR KHO OMA OTJ SHN
Cyperaceae	Pycreus chrysanthus (Boeckeler) C.B.Clarke				sedge	ERO HAR KAR KAV KHO OMU OSH OTJ SHN
Apocynaceae	Raphionacme namibiana Venter & R.L.Verh.	E			herb	HAR KAR
Bignoniaceae	Rhigozum trichotomum Burch.				shrub	ERO HAR KAR KHO OMA OTJ ZAM
Ricciaceae	Riccia okahandjana S.W.Arnell				liverworts	
Ricciaceae	Riccia runssorensis Steph.				liverworts	
Ricciaceae	Riccia stricta (Gottsche, Lindenb. & Nees) Perold				liverworts	
Zygophyllaceae	Roepera leucoclada (Diels) Beier & Thulin	N			shrublet	HAR KAR KHO
Asteraceae	Roessleria gazanioides (Harv.) Stangberg & Anderb.				herb	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN
Asteraceae	Rosenia humilis (Less.) K.Bremer					
Asteraceae	Rosenia humilis (Less.) K.Bremer				subshrub	HAR KAR KHO
Acanthaceae	Ruelliopsis setosa (Nees) C.B.Clarke				herb	
Lamiaceae	Salvia verbenaca L.	@			shrublet	
Dracaenaceae	Sansevieria aethiopica Thunb.				hardened monocot herb	HAR KAR KAV KHO KUN OHA OMA OSH OTJ SHN ZAM
Geraniaceae	Sarcocaulon marlothii Engl.	E			shrublet	ERO HAR KAR KHO KUN
Geraniaceae	Sarcocaulon salmoniflorum Moffett				shrublet	ERO HAR KAR KHO KUN
Poaceae	Schmidtia pappophoroides Steud.				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Anacardiaceae	Searsia burchellii (Sond. ex Engl.) Moffett				shrub	ERO HAR KAR KHO OTJ
Anacardiaceae	Searsia volkii (Suess.) Moffett	E			shrub	HAR KHO

E = endemic to Namibia; N = near-endemic to Namibia; @ = not native to Namibia B = both Nature Conservation Ordinance and Forest Act; C = CITES listed; F = Forest Act 12 of 2001; P = Nature Conservation Ordinance 4 of 1975; Z = both Nature Conservation Ordinance and CITES CR = Critically Endangered; DD = Data deficient; LC = Least Concern = protected species = DD species; may be threatened

Family	Species	Status	Legal	IUCN	Lifeform	Regions
Scrophulariaceae	Selago alopecuroides Rolfe	N			herb	ERO HAR KHO KUN OMA OTJ
Scrophulariaceae	Selago divaricata L.f.				shrublet	HAR KAR KHO
Scrophulariaceae	Selago divaricata L.f.					
Scrophulariaceae	Selago kurtdinteri Hilliard	N			shrublet	ERO HAR KAR KHO OMA
Scrophulariaceae	Selago nachtigalii Rolfe	E		LC	herb	HAR KAR
Asteraceae	Senecio inaequidens DC.				herb	ERO HAR KAR KHO
Asteraceae	Senecio niveus (Thunb.) Willd.				subshrub	HAR KAR
Amaranthaceae	Sericocoma heterochiton Lopr.	N			shrublet	ERO HAR KAR KUN OTJ
Amaranthaceae	Sericorema sericea (Schinz) Lopr.				herb	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN
Pedaliaceae	Sesamum capense Burm.f.				herb	ERO HAR KAR KHO KUN OTJ
Pedaliaceae	Sesamum triphyllum Welw. ex Asch. var. triphyllum				herb	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Aizoaceae	Sesuvium digynum Welw.				herb	ERO HAR KAR KAV KHO KUN OHA OMU OSH OTJ
Aizoaceae	Sesuvium sesuvioides (Fenzl) Verdc.				herb	ERO HAR KAR KUN OHA OMU OSH OTJ
Poaceae	Setaria appendiculata (Hack.) Stapf				grass	ERO HAR KAR KHO KUN OTJ
Poaceae	Setaria verticillata (L.) P.Beauv.				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Brassicaceae	Sisymbrium dissitiflora O.E.Schulz	E		DD	herb	HAR OTJ
Zygophyllaceae	Sisyndite spartea E.Mey. ex Sond.	N			shrub	HAR KAR OHA
Solanaceae	Solanum capense L.				shrublet	ERO HAR KAR KAV KHO KUN OMA OSH OTJ
Poaceae	Sporobolus acinifolius Stapf				grass	HAR KAR KAV KHO KUN OSH OTJ SHN
Poaceae	Sporobolus coromandelianus (Retz.) Kunth				grass	HAR KAR OMA OMU OSH OTJ SHN ZAM
Poaceae	Sporobolus engleri Pilg.	N			grass	ERO HAR KAR KHO KUN OSH
Poaceae	Sporobolus ioclados (Trin.) Nees				grass	HAR KAR KAV KHO KUN OMU OSH OTJ SHN ZAM
Poaceae	Sporobolus nervosus Hochst.				grass	ERO HAR KAR KHO SHN
Apocynaceae	Stapelia kwebensis N.E.Br.		P		stem succulent	ERO HAR KAR KHO KUN OSH OTJ SHN
Apocynaceae	Stapelia schinzii A.Berger & Schltr. var. schinzii	E	P		stem succulent	ERO HAR KAR KHO KUN OHA OMA OSH OTJ
Apocynaceae	Stapelia similis N.E.Br.					
Poaceae	Stipagrostis hirtigluma (Trin. & Rupr.) De Winter subsp. hirtigluma				grass	ERO HAR KAR KAV KHO KUN OSH OTJ SHN
Poaceae	Stipagrostis hochstetteriana (L.C.Beck ex Hack.) De Winter var. hochstetteriana	N			grass	ERO HAR KAR KUN OTJ
Poaceae	Stipagrostis obtusa (Delile) Nees				grass	ERO HAR KAR KHO KUN OMA OTJ
Poaceae	Stipagrostis uniplumis (Licht.) De Winter var. intermedia (Schweick.) De Winter	E			grass	ERO HAR KAR KHO KUN OTJ
Poaceae	Stipagrostis uniplumis (Licht.) De Winter var. uniplumis				grass	ERO HAR KAR KAV KHO KUN OMA OMU OSH OTJ SHN ZAM
Amaranthaceae	Suaeda plumosa Aellen				subshrub	ERO HAR KAR KUN OMA ZAM
Talinaceae	Talinum arnotii Hook.f				herb	ERO HAR KAR KAV KHO KUN OMA OSH OTJ ZAM
Leguminosae	Tephrosia dregeana E.Mey.				herb	ERO HAR KAR KHO KUN OMA OMU OSH OTJ SHN
Zygophyllaceae	Tetraena cylindrifolia (Schinz) Beier & Thulin	E			shrublet	ERO HAR KAR KHO KUN
Zygophyllaceae	Tetraena decumbens (Delile) Beier & Thulin				shrublet	HAR KAR KHO
Zygophyllaceae	Tetraena decumbens (Delile) Beier & Thulin				shrublet	
Zygophyllaceae	Tetraena microcarpa (Licht. ex Cham.) Beier & Thulin				shrub	ERO HAR KAR KHO
Zygophyllaceae	Tetraena retrofracta (Thunb.) Beier & Thulin				shrub	HAR KAR KUN
Zygophyllaceae	Tetraena tenuis (R.Glover) Beier & Thulin				shrublet	HAR KAR KHO
Aizoaceae	Tetragonia arbuscula Fenzl				shrublet	ERO HAR KAR KHO KUN OMA OTJ
Aizoaceae	Tetragonia calycina Fenzl				shrublet	ERO HAR KAR KHO KUN OMA OTJ
Aizoaceae	Tetragonia schenckii Schinz	N			shrub	HAR KAR KHO
Thesiaceae	Thesium lacinulatum A.W.Hill				shrublet	HAR KAR KHO
Aizoaceae	Trianthema parvifolia E.Mey. ex Sond.				twiner/climber/creeper	ERO HAR KAR KHO KUN OMA OSH OTJ SHN
Zygophyllaceae	Tribulus cristatus C.Presl	N			twiner/climber/creeper	HAR KAR KUN OTJ
Zygophyllaceae	Tribulus terrestris L.				twiner/climber/creeper	ERO HAR KAR KAV KHO KUN OHA OMA OSH OTJ SHN ZAM
Boraginaceae	Trichodesma angustifolium Harv. subsp. angustifolium				subshrub	ERO HAR KAR KHO OMA OTJ
Poaceae	Tricholaena capensis (Licht.) Nees subsp. arenaria (Nees) Zizka	N			grass	ERO HAR KAR KHO
Leguminosae	Trigonella anguina Delile					
Asteraceae	Tripteris aghillana DC. var. aghillana				herb	ERO HAR KHO OTJ

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Family	Species	Status	Legal	IUCN	Lifeform	Regions
Asteraceae	Tripteris microcarpa Harv. subsp. microcarpa	N			herb	ERO HAR KAR KHO KUN
Poaceae	Triraphis purpurea Hack.				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN
Poaceae	Triraphis ramosissima Hack.	N			grass	ERO HAR KAR KHO KUN OHA OMA OSH OTJ
Cucurbitaceae	Trochomeria debilis (Sond.) Hook.f				twiner/climber/creeper	ERO HAR KAR KAV KHO KUN OHA OMA OTJ
Amaryllidaceae	Tulbaghia tenuior K.Krause & Dinter	N		DD	geophyte	ERO HAR KAR KHO KUN OSH OTJ
Poaceae	Urochloa brachyura (Hack.) Stapf				grass	ERO HAR KAR KAV KHO KUN OHA OMA OMU OSH OTJ SHN ZAM
Asteraceae	Ursinia nana DC.				herb	ERO HAR KAR KHO KUN OMA OTJ
Leguminosae	Xerocladia viridiramis (Burch.) Taub.	N			shrublet	HAR KAR
Velloziaceae	Xerophyta humilis (Baker) T.Durand & Schinz				herb	ERO HAR KHO KUN OMA OTJ
Potamogetonaceae	Zannichellia palustris L.				hydrophyte or associated with water	ERO HAR KAR OSH OTJ SHN

E = endemic to Namibia; N = near-endemic to Namibia; @ = not native to Namibia B = both Nature Conservation Ordinance and Forest Act; C = CITES listed; F = Forest Act 12 of 2001; P = Nature Conservation Ordinance 4 of 1975; Z = both Nature Conservation Ordinance and CITES CR = Critically Endangered; DD = Data deficient; LC = Least Concern = protected species = DD species; may be threatened

Control plan for the Opuntia species

Preamble

The objective of this document is to provide preventive measures and actions to be adopted by management, managers, supervisors, and field workers on Nopal farm operations to minimize the effects that the cultivation and production of cultivated plants of the company's varieties of Opuntia ficus-indica, (hereinafter also referred to as "of the species"), may provoke, in order to limit their introduction and expansion and not compromise the habitats where other species occur, safeguarding the present biodiversity, should one exist or in close proximity of the farm.

The plan must be implemented on all Nopal operated farms dedicated to the cultivation or breeding of nopal cactus.

The containment and control and identification and eradication measures defined in this Control Plan aim to:

• Ensure that the necessary measures are implemented to prevent the species from dispersing and establishing itself outside the limits of the authorized field of cultivation;
• Provide guidance on prospecting, quick removal and destruction of any plants that occur outside the perimeter of the authorized crop field and within a 100-meter-wide strip (surrounding perimeter);
• Implement monitoring measures aimed at verifying the effectiveness of the control plan, and the effectiveness of any actions to remove and destroy plants that have dispersed outside the crop field.

The Control Plan for Opuntia ficus-indica plants applies to all Nopal operated farms or multiplication fields of this species, as well as to the area surrounding them as defined above.

Nopal personnel must take all measures and actions envisaged to prevent the spread of the species, keeping it confined to the authorized perimeter and proceed with its eradication once it is decided to end the culture. They must make reports regarding the application of the measures provided for in numbers 4 and 5 of this document, and which must be presented to the supervisory entities, whenever they request it.

2. Characterization of the species

The nopal cactus is an exotic species of the Cactaceae family, originating from Central America, which is naturalized and cultivated in the Mediterranean region and being introduced elsewhere in the world as a plant that grows where nothing else will, thereby regenerating arid soils, providing food security, and producing biomass for new biofuels.

Nopal's proprietary spineless strain, developed by its inhouse expert grower and researcher with more than a decade of experience, is now gaining wide acceptance globally due to its high production and non-invasive characteristics.

Nopal's cactus requires minimal water, thereby conserving precious local water supplies, restores soil health to make way for other plants and crops, and enhances local biodiversity by offering shelter and food for animals, birds, and bees.

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The nopal cactus can propagate easily and quickly, hence the stigma it continues to carry in many countries, and while Nopal's spineless variety is less invasive than the wild thorny varieties, our commitment is to develop best production practices that mitigate issues and concerns.

3. Control Plan Measures

3.1. Prevention and control measures
There must be a security strip 5 meters wide, surrounding the perimeter of the authorized culture area for the species Opuntia ficus-indica, to facilitate the detection and elimination of possible invasions by individuals of the species, outside the authorized perimeter. In addition to this 5-meter safety strip, an additional buffer strip of 100 meters is to be considered, in which the presence of the species should be observed and recorded, and which may originate from invasions of propagation material from the cultivation field.

3.1.1. Mechanical control
It is the preferred form of control, both for its cost and for its reduced environmental impact. In most cases, carrying out regular control inspections in the safety zone (1 inspection every 3 months), combined with adequate mechanical control, allow for the eradication of any contamination.

Individuals of the species that appear in the security strip surrounding the authorized culture perimeter must be removed manually or with the help of equipment, such as chain cutters or hammers; removal of the woody stem from the soil using a backhoe machine, leaving no portion of the woody stem on the ground, also proceeding with its crushing. Whenever the material collected in the scope of mechanical control actions is not used for replanting within the authorized perimeter, it must be destroyed on site (e.g. vegetable shredder, dehydration) and preferably directed to composting. If this is not possible, it must be ensured that transport to the place of destruction is carried out respecting the appropriate packaging, so that plant material capable of reproducing the plant (e.g. cladodes) does not accidentally fall on the ground (e.g. cladodes).

In the additional buffer strip, if the presence of viable individuals is observed and that may have originated from invasions of propagation material from the cultivation field, and if this strip is not under the management of the prickly pear producer, the respective owner or tenant should be contacted to obtain authorization so that the control action can be carried out.

Seedlings – Seedlings must be removed and destroyed as soon as possible, to avoid, in the future, the use of other more expensive forms of removal.

Plants – The entire plant must be removed, taking care not to leave cladodes, fruits or roots in the ground that could regenerate the plant.

3.1.2. Chemical control
The use of any herbicide must be previously authorized by the management, managers and local authorities, however, it must be limited, used as a last resort in addition to mechanical control, if necessary and only in the first stages of development as the larger the plant, the more difficult it is to control. For this, regular monitoring of the surrounding perimeter should be carried out (1 inspection every 3 months).

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4. Good Practices for Cultivation and Control

4.1. Agricultural machine cleaning
The operator or user of agricultural implements must verify that, when leaving the species' cultivation area, they do not accidentally transport plant residues (e.g. cladodes, fruits), which may be responsible for the dissemination of individuals of the species outside the authorized perimeter.

4.2. Transport of fruits and cladodes
In the transport phase, the plant material must be properly packaged, so that accidental dissemination does not occur on the way to the destination. Avoid the spread of vegetative material from pruning outside the holding, this material being crushed and composted.

4.3. Control of plant material
Control people and machines entering and leaving the holding, to prevent the uncontrolled exit of plant material.

5. Measures to restore the situation prior to the installation of the culture

In case of abandonment of the crop, the individuals of the species must be removed using the measures indicated in number 3.

The necessary measures must be taken to prevent the re-emergence of individuals of the species. For this purpose, the area where the species was cultivated must be subject to regular control visits (1 visit every 3 months), during a period of three years after the implementation of one of the measures indicated above. Whenever seedlings or plants of the species are detected, they must be removed and destroyed following the procedure in number 4.

6. Execution and monitoring of the control plan

It is the responsibility of management, managers, and supervisors of Nopal's cactus farm operations to adapt this Control Plan in the respective area, as well as in the surrounding additional buffer strip of 100 meters.

Field workers and supervisors in the field must notify management of situations in which plants of the species are observed beyond the security zone, if it is evident that their presence derives from dispersal from their production sites.

7. Plan Review

Management is to review this action plan, at least, every five years, according to the results obtained in the monitoring carried out, or with a shorter frequency if necessary.

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Annexure D

List of Interested and Affected Parties Consulted

Name & Surname	Organisation	Position	Tel.	E-mail	Means
Hon. Rev. S. M. April Mr. Herculus Jantze (Personal Assistant) & Mrs Rebekka Jossop (Private Secretary)	Office of the Governor Hardap Regional Council Private Bag 2017 Mariental	Governor	063-240944	herculus@gmail.com imeldajossob@gmail.com	Called 08/02/2024; letter sent via e-mail on 27/02/2024
Mr. Julian W. Engelbrecht Ms. PM Eiseb (Senior Private Secretary		Acting Chief Regional Officer	063-245830	eiseb.pauline@gmail.com peiseb@hardaprc.gov.na	Letter sent via e-mail on 27/02/2024
Hon. Nicodemus Jesaja Motinga	Daweb Constituency P.O. Box 25 Maltahöhe	Constituency Councillor	063-293311	njmotinga@gmail.com	Called 08/02/2024 and 09/02/2024; letter sent via e-mail on 27/02/2024
Mr Gerson Tjitaura	Maltahöhe Townlands Maltahöhe Village Council P.O. Box 98 Maltahöhe	Acting CEO	063-293048 081-2307525	gmmbatjandangi@gmail.com	
Hon. Rev. N. J. Simon		Councillor	081-2849231		Called 08/02/2024 and sent sms; letter sent via e-mail on 27/02/2024
Ms Ndiyakupi Nghituwamata	Ministry of Agriculture, Water and Land Reform (MAWLR) Private Bag 13184 Windhoek	Executive Director	061-2087649 (Secretary) 061-2087651 (PA)	ED@mawlr.gov.na PA.ED@mawlr.gov.na Ndiakupi.Nghituwamata@mawlr.gov.na	Letter sent via e-mail on 27/02/2024

Name & Surname	Organisation	Position	Tel.	E-mail	Means
Mr Penda Ithindi (Secretary)	Ministry of Mines and Energy Private Bag 13297 Windhoek	Executive Director	061-2848234 061-2848312	Johanna.Ambata@mme.gov.na	Called 08/02/2024; letter sent via e-mail on 27/02/2024
Mr John Titus		Director Energy	061-2848305	John.Titus@mme.gov.na	Letter sent via e-mail on 27/02/2024
Mr Willem Ockhuizen	Farm Gluckauf 34 P.O. Box 10482 Khomasdal	Farm Owner	081-4399581	ockhuizenwillem0@gmail.com	Letter sent via e-mail on 27/02/2024
Mrs Marlene Johr	Farm Marion Reitz 25	Farm Owner	081-3515167	marlenewjohr@gmail.com	Letter sent via e-mail on 27/02/2024
Mr Brian Feris	Farm Karab 23 P.O. Box 20638 Windhoek	Farm Owner	081-1241312	precastworld@gmail.com	Called 08/02/2024; letter sent via e-mail on 27/02/2024
Mrs Franziska Keresztesi	Farm Nutupsdrift 112	Farm Owner	081-2059333	franziska.aandster@gmail.com	Letter sent via e-mail on 27/02/2024
Mr. Alfred Sikopo	Ministry of Agriculture, Water and Land Reform (MAWLR) Private Bag 13184 Windhoek	Acting Deputy Executive Director Department of Land Reform, Resettlement and Regional Program	061-2965143	Alfred.Sikopo@mlr.gov.na	Letter sent via e-mail on 27/02/2024

Name & Surname	Organisation	Position	Tel.	E-mail	Means
Mr. Petrus Nangolo	Resettlement Farms: Farm Halifax 113 Farm Grootplaas 95 Farm Christiania No. 44 Farm Daweb 43 Farm Namseb Portion A	Director: Land Reform Directorate Land Reform	061-2965102	Petrus.Nangolo@mlr.gov.na	Letter sent via e-mail on 27/02/2024

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27 February 2024

To: Potential Interested and/or Affected Parties

Notice of an Environmental Assessment Process

Dear Sir/Madam,

Notice is hereby given to all potentially Interested and/or Affected Parties (I&APs) that an application for an Environmental Clearance Certificate has been submitted to the Executive Director, Ministry of Agriculture, Water and Land Reform, and the Environmental Commissioner, Ministry of Environment, Forestry and Tourism in terms of the Environmental Management Act 7 of 2007 and the Environmental Impact Assessment Regulations (06 February 2012) for the following:

Proponent: Gusinde Von Wietersheim Successors Trust

Project Name, Location and Description: Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia.

Environmental Assessment Practitioner: Dr Lima Maartens

In order to comment, raise concerns, and to receive further information relating to the Project, I&APs must please register; registration (name, contact details, and interest in the Project) and any comments and/or concerns must be submitted in writing to **LM Environmental Consulting** by no later than 20 March 2024.

P.O. Box 1284
Windhoek
Tel: +264 61 255750
Fax2Email: 088 61 9004
E-mail: lmecppp@gmail.com

Please feel free to distribute this Notice to anyone you feel may be Interested and/or Affected.

Yours sincerely,

Dr. L. Maartens

Background Information Document (BID)

Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

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Purpose of the BID

LM Environmental Consulting is appointed by Gusinde Von Wietersheim Successors Trust to undertake an Environmental Assessment (*Scoping, Impact Assessment and Environmental Management Plan*) for the proposed Project.

The **Scoping** Process determines the extent of and approach to the detailed assessment; Scoping Report is defined as "*a document prepared by the proponent to present the case for the assessment of an activity as part of the initial assessment process*" (Government of the Republic of Namibia (GRN), 2012).

Environmental Assessment is the "*process of identifying, predicting and evaluating the effects of proposed activities on the environment. It should include information about the risks and consequences of activities, possible alternatives, and steps which can be taken to mitigate (minimize or off-set) any negative impacts. It should also discuss steps to increase positive impacts and to promote compliance with the principles of environmental management"* (Ministry of Environment and Tourism (MET), 2008).

An **Environmental Management Plan** is a "*key document that should consist of the set of measures to be taken during implementation and operation to eliminate, offset, or reduce adverse environmental impacts to acceptable levels. Also included in the plan are the actions needed to implement them*" (Directorate of Environmental Affairs (DEA) (now Environmental Affairs and Forestry (DEAF)), 2008).

Environment is defined as the "*surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation*" (International Organization for Standardization (ISO), 2004).

As part of the Environmental Assessment Process, a **Public Consultation Process** is being carried out. The purpose of Public Participation or Consultation is to provide stakeholders, including the public, an opportunity to participate in the Environmental Assessment Process, in order to ensure that the intended development initiatives consider broad-based concerns. It further improves governance in that the intended development must consider a wide range of issues, e.g. the need to conserve the natural environment and the need to maintain a functioning ecology.

The purpose of the BID is thus to: i) provide stakeholders, including the public, with more information regarding the Project; and ii) give stakeholders, including the public, an opportunity to register as Interested and/or Affected Parties (I&APs) and comment on, or raise any issues and/or concerns related to the Project.

Background

The Gusinde Von Wietersheim Successors Trust, in association with Nopal Corp. in Portugal, is proposing to plant 500 hectares (ha) of *Opuntia ficus-indica*.

According to Government Notice (GN) No. 29 (Government Gazette of the Republic of Namibia, No. 4878, 06 February 2012) the following activities may not be undertaken without an Environmental Clearance Certificate (ECC):

ENERGY GENERATION, TRANSMISSION AND STORAGE ACTIVITIES The construction of facilities for - (a) the generation of electricity; (b) the transmission and supply of electricity
WASTE MANAGEMENT, TREAMENT, HANDLING AND DISPOSAL ACTIVITIES 2.3 The ~~import, processing, use and recycling~~, temporary storage, ~~transit or export~~ of waste.

AGRICULTURE AND AQUACULTURE ACTIVITIES 7.5 Pest control. 7.8 The introduction of alien species into local ecosystems.
WATER RESOURCE DEVELOPMENTS 8.1 The abstraction of ground or surface water for ~~industrial or~~ commercial purposes. 8.7 Irrigation schemes for agriculture excluding domestic irrigation.
HAZARDOUS SUBSTANCE TREATMENT, HANDLING AND STORAGE 9.1 The ~~manufacturing~~, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974.

In line with the Commencement of the Environmental Management Act (EMA), 2007 (Act No. 7 of 2007) (06 February 2012; GN No. 28), the Listed Activities that may not be undertaken without an ECC (GN No. 29), and the Environmental Impact Assessment (EIA) Regulations (GN No. 30) (GRN, 2012), an application for an ECC was thus submitted to the Executive Director, **Ministry of Agriculture, Water and Land Reform** (MAWLR; Competent Authority), and the Environmental Commissioner, **Ministry of Environment, Forestry and Tourism** (MEFT).

Project Location

The proposed irrigation Project will be located on Farm Namseb No. 24, around 17 km north-west of Maltahöhe.

Project Description

An electrical fence will be constructed around the entire Project area (630 ha).

It is proposed to plant 500 ha of *Opuntia ficus-indica*; 10,000 plants will be planted per ha: 40 rows per ha with 250 plants per row.

Opuntia ficus-indica cladodes will be obtained from the existing Nopal Corp. farm in Portugal, shipped in containers to Walvis Bay, and then transported via truck to the site.

Each plant requires at least 48 litres of water per annum and it is proposed to make use of drip irrigation. The water will be obtained from six solar-powered boreholes (depth of less than 100 metres (m)). The daily water requirement is estimated at 660 cubic metres per day (m^3/day) or 110 m^3/day from each of the six boreholes. The annual water requirement (for 500 ha) is estimated at 240,000 m^3.

It is proposed to use organic fertilizer (e.g. dung from local sheep and goats), as well as bio-stimulants (e.g. kelp extract and wood vinegar). NPK+MgO fertilizer in liquid form may be applied through the dripper system, as or when required.

Pest management (pesticides, and including herbicides (weed management) and insecticides (for e.g. Cochineal *Dactylopius* spp. and Cactus moth *Cactoblastis cactorum*)) may be needed. It is proposed to use organic spot treatment with e.g. neem oil, or wood vinegar (vs pesticides); the following insecticides may be used: carbaryl, deltamethrin and methidathion, as well as tralomethrin (pesticide).

The fruit will be harvested for (local) consumption. The cladodes will be used as animal feed (sold wet to local farmers especially during times of drought / dried whole or chopped and sold to animal feed companies / processed on site and made into pellets and fodder blocks which can be sold directly to farmers or to agricultural wholesalers). Both the fruit and cladodes will be harvested using manual labour.

It is foreseen that the following infrastructure will needed: i) office; ii) processing warehouse (possibly two) (and including cold storage facilities); iii) solar system; iv) workshop; v) fuel storage; vi) paved turnaround and loading; vii) weighbridge; viii) guardhouse; ix) manager and guest houses; and x) two accommodation units.

Best practices for the management of *Opuntia ficus-indica* in order to minimise spread (or other potential negative impacts on the environment), will be implemented. A hydrogeological specialist study will also be carried out as part of the Environmental Assessment.

Employment

It is anticipated that around 20 persons will be employed during the initial set-up phase of the proposed Project. During maintenance, approximately 20 persons will be employed, and another 50 persons during periods of harvesting.

Future Involvement

If you would like to remain involved in this process, please register as an I&AP and submit any comments and/or concerns in writing by **20 March 2024**.

Note that the *Draft* Environmental Assessment Report will be made available to registered I&APs for review around **April/May 2023**. Comments received will be incorporated and a Final Environmental Assessment Report will then be submitted to the Executive Director, Ministry of Agriculture, Water and Land Reform (MAWLR), and the Office of the Environmental Commissioner, Ministry of Environment, Forestry and Tourism (MEFT) for review and decision-making.

Contact Details

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References

Directorate of Environmental Affairs (DEA). 2008. *Draft Procedures and Guidelines for Environmental Impact Assessment (EIA) and Environmental Management Plans (EMP)*. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek.

Government of the Republic of Namibia (GRN). 2012. Ministry of Environment and Tourism. Government Notice No. 28. *Commencement of the Environmental Management Act, 2007*. Government Notice No. 29. *List of activities that may not be undertaken without Environmental Clearance Certificate: Environmental Management Act, 2007*. Government Notice No. 30. *Environmental Impact Assessment Regulations: Environmental Management Act, 2007*. Government Gazette of the Republic of Namibia. No. 4878. 6 February 2012.

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Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

Registration as an Interested and Affected Party (I&AP)

Date:	
Title, Name & Surname:	
Organization & Designation:	
Postal Address:	
Telephone:	
Cell:	
E-mail / Fax:	

Declaration of Interest:

Issues / Concerns / Comments:

Please E-mail or Fax to:

E-mail: lmecppp@gmail.com

Fax2Mail: 088 61 9004

environmental consulting

Notices Displayed re the Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

Daweb Constituency Office:

Maltahöhe Village Council:

Agra Maltahöhe:

by franchisee John A Baladakis as "vague", "frivolous" and "superficial".
Baladakis told News24 previously he did not think the debt was lawful, so he decided to challenge it, but Pick n Pay argued it had been left with little option.
The matter centred on the implementation of a bulk discounting model

AECI FLAGS EARNING DROP
Chemicals group AECI has flagged a between 7% and 16% fall in headline

and R12.8 billion respectively.
A tough outlook for commodity prices, as well as Eskom tariffs, also helped prompt impairments, notably R3.9 billion for its Secunda liquid fuels

Please forward your CV before
07 March 2024 to **oosie.ecv@gmail.com**

Only shortlisted candidates will be contacted for an interview.

Woensdag 28 Februarie 2024

Republikein

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Jou land. Jou mense. Jou nuus.

nopal

NOTICE OF AN ENVIRONMENTAL ASSESSMENT PROCESS

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Environmental Assessment Practitioner: Dr Lima Maartens

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LM Environmental Consulting
P.O. Box 1284, Windhoek
Tel: +264 61 255750, Fax2Email: 088 61 9004
E-mail: lmecppp@gmail.com

Duties:

- Detailed knowledge of Full Aniline Finishing of Upholstery Leather.
- Detailed technical knowledge of Corrected Grain Finishing of Upholstery Leather.
- Detailed knowledge of production and finishing of Automotive Leather.
- Detailed technical knowledge of Leather Finishing Machinery & Equipment.
- Producing finished sheep Nappa and Suede for garments, shoes and handbags from sheep pickles.
- Managing Import orders of chemicals and maintaining adequate chemical stock. Levels.
- Preparing of finishing recipes together with accurate costing per process step.
- The applicant must have experience in the training of tannery workers.
- The applicant must be a team player and fluent in English.

Applications must be e-mailed to: jaco@nakara.na

Only e-mailed CV'S will be considered.

Closing date: 22 March 2024

Only shortlisted candidates will be contacted

by franchisee John A Baladakis as "vague", "frivolous" and "superficial".

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A tough outlook for commodity prices, as well as Eskom tariffs, also helped prompt impairments, notably

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TODAY | DAUSAB DRAWS 'PAINFUL' GENOCIDE PARALLELS - **PAGE 5**

Namibian Sun
Tells it all

NEWS
'Social babies' abandoned at state hospital 3

NEWS
Police respond to Amushelelo's claims 5

Grade 2 book available in today's paper.

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MITTWOCH, 28. FEBRUAR 2024

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AZ Allgemeine Zeitung

SEIT 1916 | 108. JAHRGANG, NUMMER 42 | ISSN 1560-9421

AKTUELL MITTENDRIN FÜR DICH

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Polizei rät

Der Öffentlichkeit rät die Polizei davon ab, irreführende Informationen in den sozialen Medien zu verbreiten. Seite 3

Budget 2024/25

Analysten erwarten für den Haushalt 2024/25 Steuererleichterungen und höhere Ausgaben, die durch die bevorstehenden Wahlen bedingt sind. Lesen Sie die vollständige Geschichte in Market Watch.

NT LIVE STREAMING
On Market Watch FACEBOOK Page
@14:00

Morgen können Sie die Live-Übertragung der Budget-Verlesung mitverfolgen - auch auf unserer Internetseite.

Erhalten Sie neuste Nachrichten unter diesem Link: http://info.my.na/

Das Wetter

Windhoek .....18°|32°
Walvis Bay.....15°|24°

Weitere Werte und Vorhersage Seite 2

lm

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035 Regskennisgewings Legal Notices

IN THE HIGH COURT OFNAMIBIA (Main Division – Windhoek)
CASE NO: HC-MD-CIV-ACT-CON-2021/04231
In the matter between: BUSINESS PARTNERS INTERNATIONAL SMALL AND
MEDIUM ENTERPRISES FUND NAMIBIA (PTY) LTD EXECUTION CREDITOR and
KAPOLO PROPERTIES (PTY) LTD FIRST EXECUTION DEBTOR
GIDEON KAPOLO SECOND EXECUTION DEBTOR
SUSAMA NDATAAMBA KAPOLO THIRD EXECUTION DEBTOR
ETEMO TRADING ENTERPRISES FOURTH EXECUTION DEBTOR
NOTICE OF SALE IN EXECUTION – IMMOVABLE PROPERTY IN EXECUTION OF COURT ORDER of THE HIGHCOURT OF NAMIBIA, given on the 18th of MARCH 2022, in the above mentioned case, a judicial sale by publicauction will be held on TUESDAY, the 12th day of MARCH 2024

035 Regskennisgewings Legal Notices

NOTICE OF MOTION PART 1 IN THE HIGH COURT OF NAMIBIA (Main Division)
CASE NO: HC-MD-CIV-ACT-CON-2023/00223
In the matter between:
BANK WINDHOEK LIMITED, Applicant / Plaintiff and
PATRICK SEPLANI, Respondent / Defendant
BE PLEASED TO TAKE NOTICE THAT the above-named Applicant/Plaintiff intends to make application to the above Honourable Court on 20 March 2024 at 10h00 or as soon thereafter as Counsel for the Applicant may be heard for an order in the following terms:
1. An order declaring the following immovable property specially executable:
CERTAIN: ERF NO. 168 BENGUELA
SITUATE: IN THE TOWN OF LUDERITZ, REGISTRATION DIVISION "N", KARAS REGION
MEASURING: 264 (TWO HUNDRED AND SIXTY-FOUR) SQUARE METRES
HELD BY: DEED OF TRANSFER NO. T4575/2019
SUBJECT: TO ALL THE CONDITI-

035 Regskennisgewings Legal Notices

NOTICE OF MOTION PART 2
TAKE NOTICE FURTHER THAT if you intend to oppose this application you are required to:
1. Within 10 days from the date of service of this application on you, deliver your notice(s) of intention to oppose the application and to place relevant facts and/or circumstances before this Honourable Court under oath showing why the immovable property(ies) should not be declared executable. Failure to do so may result in the immovable property(ies) being declared specifically executable.
2. Further that you are required to appoint in such notification an address within a flexible radius from the court, referred to in rule 65(5) at which you will accept notice and service of all documents in these proceedings.
If no notice of intention to oppose is given, the application will be moved on the 20th day of March 2024.
KINDLY SET THE MATTER DOWN ACCORDINGLY.
DATED AT WINDHOEK THIS

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E-mail: lmecppp@gmail.com

Woensdag 6 Maart 2024
Republikein
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Jou land. Jou mense. Jou nuus.

ties. GBA m²
Unit 1 Ground Floor 157.6m², First Floor 59.8 m² Total 217.4m²,
Unit 2 Ground Floor 156.7m², First Floor 59.8m², Total 216.5m²
Unit 3 Ground Floor 156.7m², First Floor, 59.8m², Total 217.4m²
Unit 4 Ground Floor 156.7m², First Floor 59.8m², Total 217.4m²
Unit 5 Ground Floor 162.8m², First Floor 59.8m², Total 222.6m²
Unit 6 Ground Floor 62.9m²

TAKE NOTICE FURTHER THAT the Applicant/Plaintiff will seek an order declaring the mortgaged property(ies) to be executable. The Respondent(s)/Defendant(s)are herewith advised of the Plaintiff's intention to seek an order declaring the immovable property(ies) executable as provided for by Rule 108(2).
DM0202400414557

IN THE Magistrate's Court
For the District Of Windhoek
Held At Windhoek
Case No: 3837/2021

AND
ERF 1182, BENGUELA LUDERITZ
AND TO: ALL LESSEES
ERF NO.: 168, BENGUELA LUDERITZ
NAMIBIA
DM0202400414556

GENERAL NOTICE LAYOUT APPROVAL AND TOWNSHIP ESTABLISHMENT OF HAMAKARI EXTENSION 2 AND 3 ONPORTION 19 AND 20 OF THE REMAINDER FARM OKAKARA-

Mr. Erick Fundula Nenghwanya as its Chief Executive Officer, with effect from 1 April 2024 for a period of five years.

Mr. Nenghwanya holds a Master's degree in Educational Policy and Leadership from East China Normal University; an International Diploma in Educational Planning and Administration from the National University of Educational Planning and Administration of

O&L BRA

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HELD BY: DEED OF TRANSFER NO. T4575/2019
SUBJECT: TO ALL THE CONDITIONS CONTAINED THEREIN

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2. Further that you are required to appoint in such notification an address within a flexible radius from the court, referred to in rule 65(5) at which you will accept notice and service of all documents in these proceedings.
If no notice of intention to oppose is given, the application will be moved on the 20th day of March 2024.
KINDLY SET THE MATTER DOWN ACCORDINGLY.
DATED AT WINDHOEK THIS 12th DAY OF FEBRUARY 2024

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TODAY | UNESCO, HELAO NAFIDI PARTNER FOR EDUCATION - **PAGE 5**

Namibian Sun Tells it all

Grade 1 book available in today's paper.

First Floor, 59.8m², Total 217.4m²
Unit 4 Ground Floor 156.7m², First Floor 59.8m², Total 217.4m²
Unit 5 Ground Floor 162.8m², First Floor 59.8m², Total 222.6m²
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Held At Windhoek
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MITTWOCH, 6. MÄRZ 2024 9 N$

AZ Allgemeine Zeitung

SEIT 1916 108. JAHRGANG, NUMMER 47 ISSN 1560-9421

AKTUELL MITTENDRIN FÜR DICH

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Neues Material

Der „African Child Development Trust" wird in den nächsten Tagen wieder Bildungsmaterial zur Verfügung stellen. Seite 2

Schule vor Aus

Wie soll es mit der Ndama East Primary School in Rundu weitergehen? Die Regierung will die Schule schließen. Seite 3

28 Seiten Inhalt

EM steht bevor

Die Fußball-Europameisterschaft in Deutschland steht im Sommer an. Wissenswertes zu dem Wettbewerb lesen Sie auf der Seite 5.

Erhalten Sie neuste Nachrichten unter diesem Link: http://info.my.na/

Das Wetter

Windhoek .....12°|32°
Walvis Bay..... 14°|26°
Weitere Werte und Vorhersage Seite 2

Unit 5 Ground Floor 162.8m², First Floor 59.8m², Total 222.6m²
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Administration from the National University of Educational Planning and Administration of

List of Registered Interested and Affected Parties

Name & Surname	Organisation	Position	Tel.	E-mail
Authorities				
Hon. Rev. S. M. April Mr. Herculus Jantze (Personal Assistant) & Mrs Rebekka Jossop (Private Secretary)	Office of the Governor Hardap Regional Council Private Bag 2017 Mariental	Governor	063-240944	herculus@gmail.com imeldajossob@gmail.com
Hon. Nicodemus Jesaja Motinga	Daweb Constituency P.O. Box 25 Maltahöhe	Regional Councillor / MP	063-293311 081-2787878	njmotinga@gmail.com
Mr Gerson Tjitaura	Maltahöhe Townlands Maltahöhe Village Council P.O. Box 98 Maltahöhe	Acting CEO	081-2307525	gmmbatjandangi@gmail.com
Me Hanna E Swartbooi		Chairlady	081-6812045	gmmbatjandangi@gmail.com
Me Elphina M Skrywer		Vice Chairlady	081-4100025	gmmbatjandangi@gmail.com
Mr Böck		Councillor	081-2362857	bocklennos@gmail.com
Mr N.J. Simon		Councillor	081-2849231	gmmbatjandangi@gmail.com
Me Juliane Ndeunyema		Councillor	081-2119470	gmmbatjandangi@gmail.com
Ms Ndiyakupi Nghituwamata	Ministry of Agriculture, Water and Land Reform (MAWLR) Private Bag 13184 Windhoek	Executive Director	061-2087649 (Secretary) 061-2087651 (PA)	ED@mawlr.gov.na PA.ED@mawlr.gov.na Ndiakupi.Nghituwamata@mawlr.gov.na
Mr Penda Ithindi (Secretary)	Ministry of Mines and Energy Private Bag 13297 Windhoek	Executive Director	061-2848234 061-2848312	Johanna.Ambata@mme.gov.na

Name & Surname	Organisation	Position	Tel.	E-mail
Registered I&APs				
Ndelimona Iipinge	Namibian Environment and Wildlife Society	EIA Tracking and Monitoring in Namibia (EIA Tracker)	081-4138822	info@eia-tracker.org.na
Dr Detlof von Oertzen	VO Consulting P.O. Box: 8168 Swakopmund Namibia	Director	081-314 9664	Detlof@voconsulting.net
Mrs Gunhild Voigts	P.O. Box 9034 Eros Widnhoek	CactusClean-Up Namibia (https://www.cactusclean-up.com/)	081-2085757	gunhild.voigts@gmail.com

Correspondence with I&APs re the Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

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From: lmecppp@gmail.com lmecppp@gmail.com
Sent: Monday, July 8, 2024 7:29 PM
To: lmecppp@gmail.com
Bcc: bocklennos@gmail.com; boscia.nam@gmail.com; Detlof@voconsulting.net; diganta@namibhydro.com; ED@mawlr.gov.na; gmmbatjandangi@gmail.com; guido.vonwietersheim@commonwaters.de; gunhild.voigts@gmail.com; herculus@gmail.com; imeldajossob@gmail.com; info@eia-tracker.org.na; Johanna.Ambata@mme.gov.na; Ndiakupi.Nghituwamata@mawlr.gov.na; nicole@manta-ventures.com; njmotinga@gmail.com; PA.ED@mawlr.gov.na
Subject: Draft Environmental Assessment Report for Review

Dear Interested and/or Affected Party,

Attached please find the *Draft ENVIRONMENTAL ASSESSMENT FOR THE OPUNTIA FICUS-INDICA IRRIGATION PROJECT, FARM NAMSEB NO. 24, HARDAP REGION, NAMIBIA* for your information and attention.

I apologise for the poor quality, but had to compress the files in order to be able to send it via e-mail.

Please send any comments/queries that you may have to me via e-mail. The review period ends at 17h00 on Friday, 26 July 2024.

I would appreciate it if you could please confirm receipt of this e-mail.

Best regards
Lima

Dr. Lima Maartens

environmental consulting

Telephone: +264 61 255750
Mobile: +264 81 2458790
e-mail: lima@iway.na
PO Box 1284,
Windhoek, Namibia

From: Gerson Matjiua Tjitaura gmmbatjandangi@gmail.com
Sent: Monday, July 8, 2024 11:14 PM
To: lmecppp@gmail.com
Subject: Re: Draft Environmental Assessment Report for Review

Good evening,your email is well received.
Best regards
Gerson Tjitaura

From: Johanna Ambata Johanna.Ambata@mme.gov.na
Sent: Tuesday, July 9, 2024 8:52 AM
To: lmecppp@gmail.com
Subject: Read: Draft Environmental Assessment Report for Review

Your message
To: Johanna Ambata
Subject: Draft Environmental Assessment Report for Review
Sent: Monday, July 8, 2024 7:29:03 PM (UTC+02:00) Windhoek
was read on Tuesday, July 9, 2024 8:50:49 AM (UTC+02:00) Windhoek.

From: Detlof von Oertzen | VO Consulting detlof@voconsulting.net
Sent: Tuesday, July 9, 2024 6:04 PM
To: lmecppp@gmail.com
Subject: RE: Draft Environmental Assessment Report for Review

Dear Lima

Many thanks for sharing the Draft EIA, which arrived safe and sound on my side.

Hope all is well with you?

Best wishes, groete

Detlof

_____
Dr Detlof von Oertzen
VO Consulting
P.O. Box: 8168
Swakopmund, Namibia

Tel: +264 81 314 9664
Mail: Detlof@voconsulting.net
Web: https://voconsulting.net

From: PA to Executive Director PA.ED@mawlr.gov.na
Sent: Friday, July 12, 2024 7:50 PM
To: lmecppp@gmail.com
Subject: Read: Draft Environmental Assessment Report for Review

Your message
To: PA to Executive Director
Subject: Draft Environmental Assessment Report for Review
Sent: 08 July 2024 19:29:03 (UTC+02:00) Windhoek
was read on 12 July 2024 19:49:47 (UTC+02:00) Windhoek.

Environmental Assessment for the proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia

Registration as an Interested and Affected Party (I&AP)

Date: 15-3-2024	
Title, Name & Surname:	Mrs Gunhild Voigts
Organization & Designation:	www.cactusclean-up.com
Postal Address:	PO Box 9034 Eros Windhoek
Telephone:	
Cell:	081 2085747
E-mail / Fax:	gunhild.voigts@gmail.com

Declaration of Interest: preventing damaging invasiveness

Issues / Concerns / Comments:

1. Fruit and seeds of ficus indica are eaten and spread by birds and can not be stopped by electric fences
2. Glochids are not harmless and need a lot of equipment for eyes and skin. They prevent useful fodder production.
3. Cochineal insects and Cactoblastis cactorum are present in Namibia to prevent invasiveness
4. According to law of heritage a share of descendants produces spines again and being invasive result in tremendous cost for others to be cleared
5. Namibia must be very careful not to loose our "grass fed meat" status for export.
6. Shallow root systems of Cacti prevent rainwater from reaching the roots of Namibian vegetation

Please E-mail or Fax to:
E-mail: lmecppp@gmail.com
Fax2Mail: 088 61 9004

environmental consulting

From: lmecppp@gmail.com lmecppp@gmail.com
Sent: Monday, March 18, 2024 3:02 PM
To: 'Gunhild Voigts' gunhild.voigts@gmail.com
Subject: RE: Environmental Assessment Opuntia ficus indica Irrigation Project

Dear Mrs Voigts

Apologies for the delayed response.

I have registered you as an I&AP, and thank you for your comments.

Regards
Lima

From: Marlene Johr marlenewjohr@gmail.com
Sent: Friday, March 15, 2024 9:02 AM
To: lmecppp@gmail.com
Subject: Re: Notice of an Environmental Assessment Process

Mail received thank you

From: Detlof von Oertzen | VO Consulting detlof@voconsulting.net
Sent: Wednesday, February 28, 2024 2:47 PM
To: Dr Lima Maartens <lima@iway.na>; lmecppp@gmail.com
Subject: Register as I&A Party: project at Farm Namseb

Dear Lima,

Hope all is well on your side?

Herewith, I'd kindly request to be registered as an interested and affected party for the proposed project at Farm Namseb, as per the ad in today's Namibian newspaper.

If you've prepared a BID, could this be shared with me please?

Best wishes from Swakopmund, groete

Detlof

_____

Dr Detlof von Oertzen
Director, VO Consulting
P.O. Box: 8168
Swakopmund, Namibia

Tel: +264 81 314 9664
Email: Detlof@voconsulting.net
Web: https://voconsulting.net

From: Lima Maartens lima@iway.na
Sent: Wednesday, February 28, 2024 5:12 PM
To: 'Detlof von Oertzen | VO Consulting' detlof@voconsulting.net
Cc: lmecppp@gmail.com
Subject: RE: Register as I&A Party: project at Farm Namseb

Dear Detlof

All well, and I hope with you as well? I just got back from Maltahöhe.

Thank you, I have registered you as an I&AP; attached please find the BID.

I gave your cell number to Guido Von Wietersheim, and he may contact you re (other) solar and wind projects.

Have a good evening.

Regards
Lima

Dr. Lima Maartens

environmental consulting

Telephone: +264 61 255750
Mobile: +264 81 2458790
e-mail: lima@iway.na
PO Box 1284,
Windhoek, Namibia

From: info@eia-tracker.org.na info@eia-tracker.org.na
Sent: Wednesday, February 28, 2024 7:39 AM
To: lmecppp@gmail.com
Subject: Environmental Assessment Process for the proposed Opuntia ficus-indica Irrigation Project, Farm Namaseb No.24, Hardap Region Namibia

Dear Dr Marteens

I am hereby requesting to be registered as an I&AP for the EIA:
-Environmental Assessment Process for the proposed Opuntia ficus-indica Irrigation Project, Farm Namaseb No.24, Hardap Region Namibia, as issued in your public notice in The Namibian Sun (Market Watch) newspaper on the 28th of February 2024

Kindly forward me the Background Information Document (BID)

Regards
Ndelimona Iipinge
EIA Tracking and Monitoring in Namibia (EIA Tracker)
Namibian Environment and Wildlife Society
Cell:+264814138822
https://eia-tracker.org.na
Like us on Facebook

The EIA Tracker Project keeps track and maps all EIAs countrywide to enhance public access to EIA information and promote transparency within the EIA sector. The information collected is only used for the public to access and the EIA Tracker has no intention and will not use these for financial or any other benefits.

From: lmecppp@gmail.com lmecppp@gmail.com
Sent: Monday, March 4, 2024 7:09 PM
To: info@eia-tracker.org.na

Subject: RE: Environmental Assessment Process for the proposed Opuntia ficus-indica Irrigation Project, Farm Namaseb No.24, Hardap Region Namibia

Dear Ndelimona Iipinge

Apologies for the delayed response.

Thank you, I have registered you as an I&AP; attached please find the BID.

Regards
Lima

From: info@eia-tracker.org.na info@eia-tracker.org.na
Sent: Monday, March 4, 2024 8:56 PM
To: lmecppp@gmail.com
Subject: Re: Environmental Assessment Process for the proposed Opuntia ficus-indica Irrigation Project, Farm Namaseb No.24, Hardap Region Namibia

Thank you Dr Maartens

Ndelimona Iipinge
EIA Tracking and Monitoring in Namibia (EIA Tracker)
Namibian Environment and Wildlife Society
Cell:+264814138822
https://eia-tracker.org.na
Like us on Facebook

The EIA Tracker Project keeps track and maps all EIAs countrywide to enhance public access to EIA information and promote transparency within the EIA sector. The information collected is only used for the public to access and the EIA Tracker has no intention and will not use these for financial or any other benefits.

From: lmecppp@gmail.com lmecppp@gmail.com
Sent: Tuesday, February 27, 2024 6:04 PM
To: lmecppp@gmail.com
Bcc: ED@mawlr.gov.na; eiseb.pauline@gmail.com; franziska.aandster@gmail.com; gmmbatjandangi@gmail.com; guido.vonwietersheim@commonwaters.de; herculus@gmail.com; imeldajossob@gmail.com; info@maltahoehe-hotel.com; Johanna.Ambata@mme.gov.na; John.Titus@mme.gov.na; marlenewjohr@gmail.com; Ndiakupi.Nghituwamata@mawlr.gov.na; nicole@manta-ventures.com; njmotinga@gmail.com; ockhuizenwillem0@gmail.com; PA.ED@mawlr.gov.na; peiseb@hardaprc.gov.na; Petrus.Nangolo@mlr.gov.na; precastworld@gmail.com
Subject: RE: Notice of an Environmental Assessment Process

Dear Sir/Madam,

Attached please find the notice re the Environmental Assessment Process for the Proposed *Opuntia ficus-indica* Irrigation Project, Farm Namseb No. 24, Hardap Region, Namibia.

In order to comment, raise concerns, and to receive further information relating to the Project, Interested and/or Affected Parties (I&APs) must please register; any comments and/or concerns must please be submitted in writing to LM Environmental Consulting by 20 March 2024.

I would appreciate it if you can please confirm receipt of this mail.

Best regards
Lima

Dr. Lima Maartens

environmental consulting

Telephone: +264 61 255750
Mobile: +264 81 2458790
e-mail: lima@iway.na
PO Box 1284,
Windhoek, Namibia

From: Johanna Ambata Johanna.Ambata@mme.gov.na
Sent: Tuesday, February 27, 2024 6:15 PM
To: lmecppp@gmail.com
Subject: Read: Notice of an Environmental Assessment Process
Your message
To: Johanna Ambata
Subject: RE: Notice of an Environmental Assessment Process
Sent: Tuesday, February 27, 2024 6:03:38 PM (UTC+02:00) Windhoek
was read on Tuesday, February 27, 2024 6:15:00 PM (UTC+02:00) Windhoek.

From: Nicole Maske nicole@manta-ventures.com
Sent: Tuesday, February 27, 2024 7:34 PM
To: lmecppp@gmail.com
Subject: Read: Notice of an Environmental Assessment Process
Your message
To: Nicole Maske
Subject: RE: Notice of an Environmental Assessment Process
Sent: Tuesday, February 27, 2024 6:03:38 PM (UTC+02:00) Windhoek
was read on Tuesday, February 27, 2024 7:33:27 PM (UTC+02:00) Windhoek.

From: Maltahohe Hotel info@maltahoehe-hotel.com
Sent: Tuesday, February 27, 2024 7:44 PM
To: lmecppp@gmail.com
Subject: Read: Notice of an Environmental Assessment Process
Your message
To: lmecppp@gmail.com
Subject: RE: Notice of an Environmental Assessment Process
Sent: 27-Feb-24 6:03 PM
was read on 27-Feb-24 7:43 PM.

From: John Titus John.Titus@mme.gov.na
Sent: Wednesday, February 28, 2024 9:05 AM
To: lmecppp@gmail.com

Subject: Read: RE: Notice of an Environmental Assessment Process

Your message
To: John Titus
Subject: RE: Notice of an Environmental Assessment Process
Sent: 27 February 2024 18:03:38 (UTC+02:00) Windhoek
was read on 28 February 2024 09:05:00 (UTC+02:00) Windhoek.